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## Section 210 Street Design

A. Pavement materials and construction work must comply with the current Oregon Standard Specifications for Construction. Abbreviations and terms used within this section are as defined or used in the ODOT/APWA standard specifications unless otherwise defined.

B. Pavement materials for each new roadway classification shall be as shown in Table 210.1.

**Table 210.1 – Pavement Materials**

| Functional Classification | Subcategory | Pavement Material |
|---|---|---|
| Arterial | - | Asphalt or Concrete |
| Collector | Commercial & Industrial | Asphalt or Concrete |
| | Residential | Asphalt |
| Neighborhood Route | Commercial & Industrial | Asphalt or Concrete |
| | Residential | Asphalt |
| Local Road | Commercial & Industrial | Asphalt |
| | Residential | Asphalt |
| Alley | - | Asphalt |

### 210.1 Designed Pavement Sections

A. Pavement design period

1. **New pavement**: 40 years.
2. **Rehabilitation**: 20 years.
3. **Widening**: 20 years, plus 20-year rehabilitation of existing pavement.
4. **Reconstruction**: 40 years.
5. Design period may be conditioned in the land use decision. If unsure, contact the city engineer.

B. Pavement designs shall be developed using the following:

1. **Asphalt concrete**: AASHTO *Guide for Design of Pavement Structures* (AASHTO Guide) and the design guidelines of the latest ODOT/APWA *Pavement Design Guide* (ODOT/APWA Guide).
2. **Portland cement concrete**: 1998 *Supplement for Rigid Pavement Design* (AASHTO Supplement) or the StreetPave™ design software by the American Concrete Pavement Association (ACPA).

C. Pavement designs shall be developed and documented by an engineering report prepared and stamped by an Oregon registered Professional Engineer experienced in pavement design. The report must include specific pavement design recommendations for materials and construction. Additionally, the report must include sufficient design documentation regarding site conditions, design assumptions and design parameters to allow for independent peer review of the design recommendations. The engineering report shall address considerations for year-round construction. Recommendations for both wet and dry weather construction shall be included.

D. Field testing of pavement construction work shall follow the procedures and testing schedule listed in the latest edition of the *ODOT/APWA Manual of Field Test Procedures* (MFTP) for the applicable type of work.

## 210.2 Subgrade Evaluation

A. Conduct sufficient soil explorations (at least one per 500-feet of roadway and at least two total) to visually classify the soils within three feet below the planned subgrade surface. Conduct laboratory testing on samples of the subgrade soils including determination of moisture content, Atterberg Limits as necessary for soil classification, moisture-density relationship by standard Proctor compaction and subgrade support values for the in-situ subgrade and compacted subgrade.

B. Subgrade support values for design of flexible pavement (resilient modulus) and rigid pavement (modulus of subgrade reaction or k-value) shall be estimated by one or more of the following methods:

1. Estimate in situ subgrade support values by back calculation of Falling Weight Deflectometer (FWD) deflections measured on paved or aggregate surfaced areas within the project limits. FWD testing shall be conducted in accordance with ASTM D 4694 and D 4695. The FWD must have been reference calibrated at a FHWA/SHRP Regional Calibration Center within twelve (12) months preceding the testing. Back calculate the elastic modulus of the subgrade soil for flexible pavement design in accordance with the back-calculation procedures described in the AASHTO Guide or other procedures meeting the guidelines of ASTM D 5858. Use the modulus correction factors given in the ODOT/APWA Guide to convert back calculated elastic moduli into equivalent saturated laboratory resilient moduli. Back calculate the dynamic k-value of the subgrade for rigid pavement design in accordance with the back-calculation procedures described in the AASHTO Supplement and correct the dynamic k-value to static k-value using a factor of 0.5.

2. Estimate in situ subgrade support values by measuring subgrade soil penetration resistance using the dynamic cone penetrometer (DCP) in accordance with ASTM D 6951. Estimate the subgrade resilient modulus for flexible pavement design from DCP Index (mm/blow) using the correlation given in the ODOT/APWA Guide. Use the modulus correction factors given in the ODOT/APWA Guide to convert DCP determined resilient moduli into equivalent saturated laboratory resilient moduli. Estimate subgrade static k-value for rigid pavement design from DCP Penetration Rate (inches/blow) using the correlation given in the AASHTO Supplement.

3. Determine in situ resilient modulus by laboratory testing of push tube samples of subgrade soil. Conduct the resilient modulus testing using the ODOT/APWA testing protocol. Evaluate resilient modulus at a deviator stress of 6 psi without confining pressure.

4. Determine the resilient modulus of compacted subgrade by testing laboratory compacted subgrade soil. Compact the subgrade sample to 95% of standard Proctor maximum dry density at moisture content of 1 to 2 percentage points above standard Proctor optimum moisture content. Conduct the resilient modulus testing using the ODOT/APWA testing protocol. Evaluate resilient modulus at a deviator stress of 6 psi without confining pressure.

5. Estimate the k-value of compacted subgrade by CBR testing of a laboratory compacted subgrade soil. Compact the subgrade sample to 95% of standard Proctor maximum dry density at moisture content of 1 to 2 percentage points above standard Proctor optimum moisture content. Conduct the CBR testing in accordance with ASTM D 1883 using surcharge weight equivalent to the proposed pavement section. Estimate the static k-value from the CBR value using the correlation given in the AASHTO Supplement.

   In lieu of testing to establish subgrade support values, presumptive design values of 3,000 psi for resilient modulus and 50 pci for k-value may be used.

## 210.3 Traffic Loading Analysis

A. The pavement design traffic loading is the total number of Equivalent 18-kip Single Axle Load (ESAL) repetitions that the pavement is expected to experience during the design period. Traffic engineering analysis shall be conducted to estimate existing and/or projected average daily traffic volumes, percentage of heavy vehicles, distribution of heavy vehicle volumes according to the Federal Highway Administration (FHWA) axle classifications and projected growth rate in heavy vehicle volumes during the design period.

B. Daily heavy vehicle volumes shall be multiplied by the conversion factors shown below in Table 210.2 to calculate annual ESAL repetitions for each heavy vehicle. The cumulative ESAL repetitions from all heavy vehicles during the design period shall be calculated taking into account the expected annual growth in heavy vehicle volumes. The minimum traffic loading for pavement design shall be 50,000 ESAL repetitions.

**Table 210.2 – Annual ESAL Conversion Factors**

| FHWA Classification | Daily Vehicle Volume to Annual ESAL Repetitions Conversion Factors | |
|---|---|---|
| | Flexible Pavement | Rigid Pavement |
| Weight restricted buses, school buses | 246 | 269 |
| 2-axle Transit Buses | 780 | 1170 |
| Articulated Transit Buses | 1550 | 2320 |
| 5 | 104 | 99 |
| 6 | 284 | 417 |
| 7 | 757 | 1199 |
| 8 | 253 | 277 |
| 9 | 466 | 715 |
| 10 | 561 | 912 |
| 11 | 603 | 606 |
| 12 | 546 | 663 |
| 13 | 1037 | 1660 |

C. The presumptive traffic loadings shown below in Table 210.3 may be used as design values in lieu of a detailed traffic analysis.

**Table 210.3 – Presumptive Traffic Loadings**

| Functional Classification | Flexible Pavement 40-yr ESAL Repetitions | Rigid Pavement 40-yr ESAL Repetitions |
|---|---|---|
| Alley, Local Residential, and Neighborhood Route (note 1) | 50,000 | 70,000 |
| Commercial/Industrial | 1,000,000 | 1,600,000 |
| Collector | 4,000,000 | 6,000,000 |
| Arterial | 8,000,000 | 13,000,000 |

Note: Use Commercial/Industrial Functional Classification traffic loadings if street will be used by a Tri-Met bus line or similar shuttle buses.

D. The traffic loading for circulatory lanes within roundabouts should be 1.5 to 2 times the highest traffic loading on the approach lanes to account for the combined loading from the approaches.

E. If using StreetPave™ load spectrum traffic analysis is required. Use site specific total truck traffic with the default typical traffic category corresponding to the road type. For transit bus routes, default to major arterial traffic category.

## 210.4 Flexible Pavement Thickness Design Criteria

A. Use the design parameter values shown below in Table 210.4 for flexible pavement design.

**Table 210.4 – Flexible Pavement Design Parameter Values**

| Parameter | Design Value |
|---|---|
| Design Reliability Level: | 90% arterial, collector, commercial, and bus routes<br>80% Local residential and neighborhood routes |
| Initial Serviceability, Po: | 4.2 |
| Terminal Serviceability, Pt: | 2.5 |
| Standard Deviation: | 0.50 |
| New Asphalt Concrete Layer Coefficient: | 0.42 |
| New Aggregate Base Layer Coefficient: | 0.10 |
| New Aggregate Base Resilient Modulus, psi: | 20,000 |
| New Aggregate Base Drainage Coefficient: | 1.0 |
| New Aggregate Subbase Layer Coefficient: | 0.08 |
| New Aggregate Subbase Resilient Modulus, psi: | 11,200 |
| New Aggregate Subbase Drainage Coefficient: | 1.0 |

B. The pavement section shall be designed using the Layered Design Analysis method described in Section 3.1.5 of Part II of the 1993 AASHTO Guide. The calculated pavement thickness should be rounded to the nearest 0.5-inch.

C. The minimum roadway AC section thickness shall be 5 inches consisting of a 3-inch thick base lift and 2-inch thick wearing course. Multi-use pathways shall have a minimum AC section thickness of 3-inches placed in a single lift.

D. The minimum thickness of aggregate base shall be 8-inches. Geotechnical Engineer to provide analysis of rock section's suitability to support construction traffic. Analysis should include construction time of year. Plant mixing is required for all aggregate.

E. The asphalt concrete should be ½- or ¾- inch dense ACP according to ODOT/APWA 00744. A request can be made for low nominal maximum aggregate size for thin lift paving.

F. Minimum and maximum lift thicknesses are 2.0 and 3.0 inches for dense ACP.

G. Compact asphalt concrete to a minimum of 91% of MAMD for the base lift and 92% of MAMD for all subsequent lifts.

H. Binder should be PG 64-22 for local, commercial, and collectors and PG 70-22 for arterials. However, the binder grade should be adjusted depending on aggregate gradation, traffic levels, and the amount of recycled asphalt material. Binder grade discussion and reasoning must be submitted in the engineering report.

I. Use ¾"-0 or 1½"-0 dense graded aggregate meeting the requirements of ODOT/APWA 00331.

J. Full depth reclamation with cement can be included and used as a base material alternative provided laboratory testing and design is provided in the engineering report. Layer coefficient shall be 0.16 where at least 50 percent, by weight, of existing material to be treated is granular, otherwise layer coefficient shall be considered equal to aggregate subbase (0.08). Project specification must be developed for full depth reclamation construction, practices, materials, and equipment.

## 210.5 Rigid Pavement Thickness Design Criteria

A. Design Requirements and Inputs

1. Use the design parameter values shown below in Table 210.5 for rigid pavement design by the AASHTO Supplement procedures and Table 210.6 for rigid pavement design with the StreetPave™ system.

2. The minimum PCC slab thickness shall be six (6) inches. Streets with transit or shuttle bus traffic shall have minimum PCC slab thickness of eight (8) inches.

3. The minimum thickness of aggregate base shall be four (4) inches. Geotechnical Engineer to provide analysis of rock section's suitability to support construction traffic. Analysis should include construction time of year. Plant mixing is required for all aggregate.

4. The slab thickness design shall take into account the slab edge support condition as defined within the AASHTO Supplement and/or StreetPave™.

5. For AASHTO Supplement design, if the transverse joints are un-dowelled, the tensile stress at the top of the slab needs to be checked for axle loading near the transverse joint (joint loading). Dowels are required if the tensile stress for joint loading exceeds the tensile stress calculated at the bottom of the slab for the mid-slab loading case (as used for the slab thickness design).

6. For AASHTO supplement design, estimate the magnitude of joint faulting at the end of the design period for dowelled or un-dowelled joints using the predicative models. Adjustment to the design is required if the predicted faulting magnitude exceeds the critical values given in Table 28 of the 1998 Supplement. Potential adjustments include use of dowels or increase in dowel diameter, use of treated base material and use of subsurface drains to improve drainage conditions.

7. For StreetPave™ design, default setting should be "No" under macro fibers. If macro fibers are proposed, project specific test results must be provided using the ASTM C1609 test method with an analysis showing a maximum residual strength of 15 percent.

8. Requirements under ODOT/APWA 00756.60 must be met prior to opening to traffic.

B. Materials

1. Use ¾"-0 or 1½"-0 dense graded aggregate meeting the requirements of ODOT/APWA 00331.

2. Use Class 4000 or Class 5,000, 1½" paving concrete according to ODOT/APWA 02001. Concrete must meet a minimum compressive strength of 3,000 psi prior to opening. Concrete options with higher strength and high early strength can be considered if approved by City Engineer.

3. Use epoxy coated, 1.25-inch diameter by 18-inch long smooth circular steel dowel bars at 12-inch spacing along all transverse joints. Bars should be coated with a bond breaker to be approved by the Engineer.

## Table 210.5 – Rigid Pavement Design Parameter Values (AASHTO supplement)

| Parameter | Design Value |
|---|---|
| Design Reliability Level: | 90% arterial, collector, commercial, and bus routes<br>80% Local residential and neighborhood routes |
| Initial Serviceability, Po: | 4.5 |
| Terminal Serviceability, Pt: | 2.5 |
| Standard Deviation: | 0.40 |
| 28-day Flexural Strength, psi: | 600[1] |
| Modulus of Elasticity of Concrete, psi: | 3,600,000 |
| Modulus of Elasticity of Base Material, psi | Median value from Table 14 of AASHTO Supplement for the base type |
| Drainage coefficient for faulting analysis: | 0.80 |
| Poisson's Ratio of PCC: | 0.15 |
| Edge Support Adjustment Factor: | As recommended in AASHTO Supplement for type of edge support |
| Friction Coefficient between Slab and Base | Median value from Table 14 of AASHTO Supplement for the base type |
| Mean Annual Wind Speed, mph: | 7.9 |
| Mean Annual Temperature °F: | 53.6 |
| Mean Annual Precipitation, inches: | 36.3 |
| Moisture Gradient & Construction Temperature Differential in Slab: | 1 °F per inch of slab thickness |
| Mean Annual Freezing Index: | 33 degree (F) days |
| Annual Temperature Range °F: | 46.6 |
| Number of Days with Maximum Temperature above 90 °F: | 10.8 |

1. If Class 5000 paving concrete use 650.

## Table 210.6 – Rigid Pavement Design Parameter Values (StreetPave™)

| Parameter | Design Value |
|---|---|
| Design Reliability Level | 90% arterial, collector, commercial, and bus routes<br>80% Local residential and neighborhood routes |
| Terminal Serviceability | 2.5 |
| 28-day Flexural Strength, psi | 600[1] |
| Modulus of Elasticity of Concrete, psi | 3,600,000 |
| Slabs Cracked | 10% |
| Drainage coefficient for faulting analysis | 0.80 |
| Poisson's Ratio of PCC | 0.15 |
| Edge Support | Design dependent. Exception required for untied support |
| Macro fibers in concrete | Default to No. Maximum of 15% residual if approved by City |

1. If Class 5000 paving concrete use 650.

## 210.6 Rigid Pavement Jointing Design Criteria

A. The Design Engineer shall provide a jointing plan in the project plans showing the construction joints and transverse and longitudinal joints in the concrete pavement to control cracking. The jointing plan shall show to scale at a minimum: manholes, valve boxes, inlets, joint layouts, dowels, tie bars and other required reinforcement and joint details including sawing depths.

B. Joint layout shall be designed in accordance with American Concrete Pavement Association (ACPA) recommendations and the criteria described herein. The Design Engineer shall avoid or minimize: joints that intersect another joint or the pavement edge at an angle of less than 60-degrees, interior corners (L-shaped slabs), slabs less than 1-foot wide, odd shapes (keep slabs rectangular, trapezoidal or triangular). Utility fixtures shall be isolated from the slab by box-outs with isolation joints in accordance with Std. Drg. No. 220-2. Coordinate the joint layout with fixture locations so that the joints are centered on the box-outs or coincide with the isolation joints around the box-outs.

C. Gutter joints shall be aligned with the transverse joints on the adjoining slab unless an isolation joint is placed between the gutter and the slab. Note that if the gutter is isolated from the slab by a butt type joint, then an edge support factor of 1.0 shall be used in the slab thickness design.

D. Longitudinal joints shall coincide with lane lanes. Note that on streets with an odd number of lanes this will require an offset crown. Spacing between longitudinal joints shall not exceed 15 feet or 24x slab thickness on unbound base or 21x slab thickness on stabilized base

E. Transverse contraction joints shall be spaced at relatively equal intervals and shall be close to the same spacing as the longitudinal joints so that the panels are relatively square. The ratio of the maximum to minimum slab dimensions (aspect ratio) formed by joints shall not exceed 1.25. Spacing between transverse joints shall not exceed 15-feet or 24x slab thickness on unbound base or 21x slab thickness on stabilized base. If the aspect ratio cannot be met, a reinforcement grid shall be installed as shown on Std. Drg. Nos. 220-1 and 250-3.

E. Joint construction, dowel bar installation and tie bar installation shall conform to the details shown on Std. Drg. Nos. 220-1 and 250-3.

1. Transverse joints (sawed or construction) in plain concrete pavement slabs 7 inch thick or greater shall be dowelled. All joints within intersections shall be dowelled when dowels are needed on the transverse joints in one of the approach lanes. Plate dowels will not be allowed. Dowel installation shall be per ODOT/APWA 00756.43(a).

2. All joints shall be sealed with joint sealant listed on the ODOT/APWA QPL placed in a joint reservoir sized in accordance with the recommendations of the joint sealant manufacturer (typically the reservoir width should be twice the sealant depth for silicone sealant). The sealant shall be supported by a backer rod of the size and material recommended by the joint sealant manufacturer. The top of the sealant shall be recessed below the slab surface by 1/8 to 3/8-inch.

## 210.7 Structural Rehabilitation Design

A. Pavement coring shall be performed at representative locations to determine the thickness and composition of the pavement materials and evaluate cracking depth, investigate cracking mode (top-down or bottom-up) and investigate for moisture induced damage (asphalt stripping damage). Investigation shall also include a visual survey of pavement distress.

B. Field investigation shall include falling weight deflectometer (FWD) testing of existing pavement to determine structural condition and remaining structural life for Commercial/Industrial, Collector, and Arterial street sections.

1. FWD testing conducted in accordance with ASTM D 4694 and D 4695. The FWD must have been calibrated within twelve (12) months preceding the testing. Investigation shall also include a visual survey of pavement distress.

2. The FWD test data shall be analyzed to delineate analysis units representing segments having distinctly different structural characteristics.

3. The in situ resilient modulus of the subgrade and the effective structural number of the existing pavement structure shall be estimated from back-calculation analysis of the FWD test data using the back-calculation analysis procedure described in the AASHTO Guide or other procedures meeting the guidelines of ASTM D 5858.

C. Resilient modulus analysis for residential street sections should be one of the options listed under 210.2B. Additionally, residential effective structural analysis should be layered based on the suggested coefficients listed in Table 5.2 of the AASHTO guide.

D. Design for structural rehabilitation of existing pavement shall be accomplished using the procedures described in Part III of the AASHTO Guide and the rehabilitation design guidelines in the ODOT/APWA Guide. The rehabilitation recommendations shall include consideration to measures for mitigation of reflective cracking.

## 210.8 Widening Design

A. Widening connections/joints must not be located within the wheel paths. Joints should be on lane lines or in the middle of the lane. See Chapter 3 for joints in bike lanes.

B. Design report must include consideration for lateral drainage for differing pavement widths (existing as compared to widening). Widening base and/or subbase material thickness should be equal to or greater than the adjacent existing base/subbase material. If existing base/subbase depth cannot be adequately determined, widening base/subbase material thickness must be at least 18 inches. Exceptions to be approved by the City Engineer.

## 210.9 Subgrade Evaluation

A. The Design Engineer shall evaluate the laboratory soils test data to determine if subgrade compaction is feasible including consideration of moisture conditions during construction and whether the compacted subgrade will support construction activities and traffic.

B. If subgrade compaction is deemed feasible, the pavement section shall be designed based on the subgrade support values determined from the laboratory tests of compacted subgrade. Compaction of the subgrade shall be accomplished in accordance with the procedures and compaction criteria given in ODOT/APWA 00330.43 including deflection testing according to ODOT/APWA TM 158. Subgrade separation geotextile shall be placed over the compacted subgrade prior to placing aggregate base.

C. If subgrade compaction is not deemed feasible, the subgrade shall be stabilized by one of the following methods:

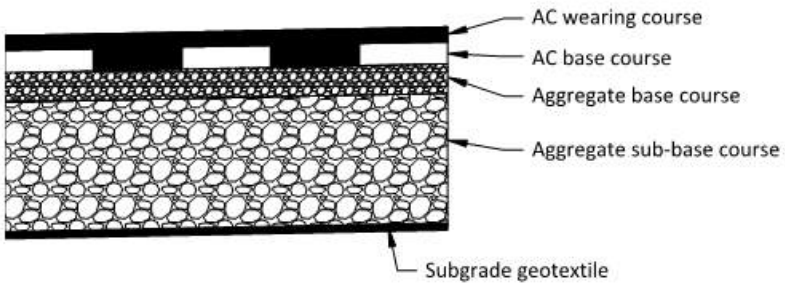
1. Conduct subgrade stabilization in accordance with ODOT/APWA 00331. Use aggregate bases conforming to section 2630. Use of geosynthetic reinforced aggregate backfill is allowed. Include subgrade separation geotextile placed directly over the subgrade to prevent infiltration of subgrade fines into the aggregate backfill.

2. Treat the subgrade with portland cement in accordance with ODOT/APWA 00344 including the compaction criteria given in ODOT/APWA 00344.45. Determine the cement treatment rate to achieve a seven (7) day compressive strength of at least 100 psi as determined by ASTM D 1633 Method A on specimens compacted to 95% of maximum dry density at optimum water content as determined by ASTM D 558. Portland cement content greater than 8 percent requires City approval.

## 210.10 Standard Pavement Sections

A. The pavement designs shown in Figures 210.1 and 210.2 may be used as alternatives to prepare a project-specific design.

**Figure 210.1 - Standard Asphalt Concrete (AC) Pavement Section**

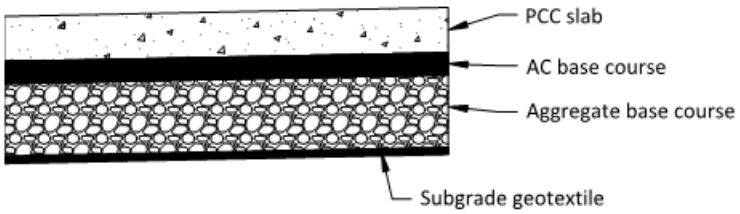


## Table 210.7 – Standard Asphalt Concrete (AC) Pavement Section

| Functional Classification | Subcategory | Thickness (inches) | | | | AC Mix Design Level |
|---|---|---|---|---|---|---|
| | | AC Wearing Course (Note 3) | AC Base Course (Note 3) | Aggregate Base Course (Note 4) | Aggregate Sub Base Course (Note 5) | |
| Arterial | - | 2.0 | 9.0 | 5.0 | 18.0 | 3 |
| Collector | Residential | 2.0 | 8.0 | 5.0 | 16.0 | 3 |
| Neighborhood Route | Residential | 2.0 | 3.0 | 4.0 | 12.0 | 2 |
| Local Road | Commercial & Industrial | 2.0 | 6.0 | 6.0 | 12.0 | 2 |
| | Residential | 2.0 | 3.0 | 4.0 | 12.0 | 2 |
| Alley | - | 2.0 | 2.0 | 4.0 | 10.0 | 2 |
| Multi-Use Path[1] | - | 3.0 | -- | 10.0 | - | 2 |

1. Use by maintenance vehicles require design for the appropriate design vehicle.

## Figure 210.2 – Standard Portland Cement Concrete (PCC) Pavement Section




## Table 210.8 – Standard Portland Cement Concrete (PCC) Pavement Section

| Functional Classification | Subcategory | Thickness (inches) | | |
|---|---|---|---|---|
| | | PCC Slab (Note 6, 7) | AC Base Course (Note 3) | Aggregate Base Course (Note 4) |
| Arterial | - | 10.0 | 4.0 | 10.0 |
| Collector | Commercial & Industrial | 9.0 | 4.0 | 10.0 |
| Neighborhood Route | Commercial & Industrial | 9.0 | 4.0 | 10.0 |

NOTES TO FIGURES 210.1 AND 210.2:

1. These standard pavement sections are based on conservative design criteria including anticipated traffic and construction vehicle loading under poor soil conditions. These assumptions may not be representative of typical conditions for many locations.

2. For Local Roads, use the Commercial & Industrial pavement section if a transit bus line or similar shuttle buses will use the street.

3. Use Level 2, ½ inch dense ACP PG 64-22. Place in 2-inch to 3-inch lifts.

4. These standard pavement sections are based on conservative design criteria including anticipated traffic and construction vehicle loading under poor soil conditions. These assumptions may not be representative of typical conditions for many locations.

5. For Local Roads, use the Commercial & Industrial pavement section if a transit bus line or similar shuttle buses will use the street.

6. Use Level 2, ½ inch dense ACP PG 64-22. Place in 2-inch to 3-inch lifts.

7. Use ¾"-0 or 1"-0 dense graded base aggregate meeting the requirements of 00641. Thickness may need to be increased to 12 inches or more for constructability in areas of soft or wet subgrade.

8. Use 1½"-0 dense graded aggregate meeting the requirements of 00331.

9. Use Class 4000, 1½" paving concrete.

10. Use epoxy coated, 1.25-inch diameter by 18-inch long smooth circular steel dowel bars at 12-inch spacing along all transverse joints. Bars should be coated with a bond breaker to be approved by the Engineer.

## 210.11 Functional Classification

The functional classification of existing and proposed roads is established by the City of Beaverton Comprehensive Plan. Streets shall be designed to the minimum standards of this manual. The design of regionally significant streets designated in Metro's Regional Transportation Plan shall consider the function of the street and character of surrounding land uses. Metro's publications Creating Livable Streets: Street Design for 2040 and Green Streets: Innovative Solutions for Stormwater and Street Crossings are resources.

## 210.12 Access

Access to public streets shall conform to the requirements of the *Comprehensive Plan* and the *Development Code.* The City Engineer shall have the authority to limit access and designate access locations on public streets under the jurisdiction of the City. Access to streets and highways under Washington County or State of Oregon jurisdiction must be formally approved by those entities at the applicant's initiative and expense.

## 210.13 Design Speed

Design speeds shall be as follows:

**Table 210.9 – Design Speeds by Street Classification**

| Street Classification | Design Speed (mph) |
|---|---|
| Arterials | 45 |
| Collectors | 35 |
| Neighborhood Routes | 25 |
| Locals | 25 |

Design speed is the maximum safe speed that can be maintained over a specified section of roadway when traffic, weather, and other conditions are so favorable that the design features of the roadway govern. The City Engineer may approve a lower alternative design speed where it can be shown that the 85th percentile speed of traffic will be lower than the design speed standard during all hours. The design speed is the minimum speed that shall be used in design

of safe road geometry. The design speed shall not prohibit the use of traffic calming features or signing, where appropriate, to encourage lower traffic speeds.

## 210.14 Horizontal Alignment

Alignments shall meet the following requirements:

A. Center line alignment of improvements should be parallel to the center line of the right-of-way.

B. Center line of a proposed street extension shall be aligned with the existing street center line.

C. Horizontal curves in alignments shall meet the minimum radius requirements as shown in Table 210.9.

Reversing horizontal curves shall be separated by no less than 50 feet of tangent. On arterials, the separation shall be no less than 100 feet.

**Table 210.10 – Design Speed / Center Line Radius – Minimums**

| Design Speed (MPH) | Friction Factor (F) | Minimum Curve Radius (ft.) for Various Cross Slopes | | | | |
|---|---|---|---|---|---|---|
| | | (e) 2.5% | (e) 0% | (e) 2.5% | (e) 4% | (e) 6% |
| 15 | 0.330 | 50 | 45 | 45 | 40 | 40 |
| 20 | 0.300 | 100 | 90 | 85 | 80 | 75 |
| 25 | 0.252 | 185 | 165 | 150 | 145 | 135 |
| 30 | 0.221 | 305 | 275 | 245 | 230 | 215 |
| 35 | 0.197 | 475 | 415 | 370 | 345 | 320 |
| 40 | 0.178 | 700 | 600 | 525 | 490 | 450 |
| 45 | 0.163 | 980 | 830 | 720 | 665 | 605 |

**Notes:** For Table 210.9 - off right-of-way runoff shall be controlled to prevent concentrated cross flow in superelevated sections. The above tables are to be used unless otherwise directed by the City Traffic Engineer.

Superelevations will be required as directed by the City Traffic Engineer. Where superelevation is used, street curves should be designed for a maximum superelevation rate of 4 percent. If terrain dictates sharp curvature, a maximum superelevation of 6 percent is justified if the curve is long enough to provide an adequate super elevation transition.

On local streets, requests for design speeds less than 25 miles per hour shall be based on topography, right-of-way, or geographic conditions, which impose an economic hardship on the applicant. Requests must show that a reduction in centerline radius will not compromise safety. There will be posting requirements associated with designs below 25 miles per hour.

Source: American Association of State Highway and Transportation Officials, *A Policy on Geometric Design of Highways and Streets 2001*, Fourth Edition. (Standards for Low-Speed Urban Streets).

## 210.15 Vertical Alignment

Alignments shall meet the following requirements:

A. Minimum tangent street gradients shall be one-half (0.5) percent along the crown and curb.

B. Maximum street gradients shall be fifteen (15) percent for local streets and neighborhood routes, and ten (10) percent for all other streets. Grades greater than fifteen (15) percent must be approved by the City Traffic Engineer on an individual basis.

C. Local streets intersecting with a neighborhood route or greater functional classification street, or streets intended to be posted with a stop sign, shall provide a landing averaging five (5) percent or less. Landings are that portion of the street within twenty (20) feet of the projected curb line of the intersecting street at full improvement.

D. Grade changes of more than one (1) percent shall be accomplished with vertical curves.

E. At street intersections, the crown of the major (higher classification) street shall continue through the intersection. The roadway section of the minor street will flatten to match the longitudinal grade of the major street at the projected curb line.

F. Street grades, intersections, and super elevation transitions shall be designed to not allow concentrations of storm water to flow across the travel lanes.

G. Off-set crowns and shed sections may be allowed only with the specific prior approval of the City Traffic Engineer. Off-set crown sections must conform to the standard drawing. Shed street sections are generally allowed.

H. Slope easements and shed sections may be dedicated or obtained for the purposes of grading outside of the right-of-way.

I. Streets intersected by streets not constructed to full urban standards shall be designed to match both present and future (as far as practicable) vertical alignments of the intersecting street. The requirements of this manual shall be met for both present and future conditions.

When new streets are built adjacent to or crossing drainage ways, the following standards shall govern the vertical alignment:

| **Functional Classification** | **Vertical Standard** |
|---|---|
| Freeways and Arterials | Travel lanes shall be at or above the 100 year flood elevation. |
| Collectors | Travel lanes shall be at or above the 50 year flood elevation but not lower than 6 inches below the 100 year flood elevation. |
| Neighborhood Routes and Local streets (residential) | Travel lanes shall be at or above the 25 year flood elevation but not lower than 6 inches below the 100 year flood elevation. |
| Local streets (non-residential) | Travel lanes shall be at or above the 25 year flood elevation but not lower than 6 inches below the 50 year flood elevation. |

If alternate access is available for properties served by a particular local street, a design could be considered for approval by the City Engineer that would set the travel lanes at or above the 10 year flood elevation but not lower than 6 inches below the 25 year flood event.

Vertical curves shall conform to the values found in Table 210.10.

## Table 210.11 – Design Controls for Crest and Sag Vertical Curves

| Design Speed (mph) | Minimum Rate of Vertical Curvature, K | |
|---|---|---|
| | Crest | Sag |
| 15 | 3 | 5 |
| 20 | 7 | 9 |
| 25 | 12 | 13 |
| 30 | 19 | 19 |
| 35 | 29 | 26 |
| 40 | 44 | 34 |
| 45 | 61 | 44 |

Source: American Association of State Highway and Transportation Officials, *A Policy of Geometric Design of Highways and Streets 2001*, Fourth Edition.

Table 210.10 assumes that street lighting exists. The City Traffic Engineer may require a higher K value for sag vertical curves if the roadway will not be lighted.

## 210.16 Width

The street standard drawings provide the minimum road width standards by functional classification of the road. While the street standard drawings provide standard road and lane widths, it is possible that alternate widths may be acceptable based on the context and use of the street. Designers are encouraged to use a context sensitive design approach that considers alternative design options that reflect the intent of context sensitive design and are safe for all users of the facility. Modifications to minimum street design standards require approved design exceptions documenting the decision to use an alternate width and how the design provides for the safety of those using the facility.

It should be noted that public utility easements beyond the right-of-way are typically required.

In locations where traffic signals exist or are anticipated for installation within five years, provide additional right-of-way to accommodate signal poles and cabinets clear of the sidewalk.

When the standard drawings show on-street parking, parking may be restricted as necessary for purposes of safety and/or functionality. In determining the locations of on-street parking, consideration should be given to sight distance, truck access, and emergency access as appropriate for existing and proposed development along the street.

When the standard drawings show no on-street parking, parking may be allowed if the street section is widened to add a parking lane. On local streets, the minimum width of a parking lane is seven (7) feet. On collector streets and arterial streets, the minimum width of a parking lane is eight (8) feet.

Where on-street parking is allowed on local streets and along Major Pedestrian Routes, curb tight sidewalks may be allowed, but only with the City Engineer's express approval, through the Sidewalk Design Exception application process. See Section 40.58 of the Development Code. When curbtight sidewalks adjacent to on-street parking, the minimum width shall be at least two (2) feet wider than the standard sidewalk required for the functional classification of the street. Transitions in sidewalk widths shall be accomplished by a tapering section of sidewalk that is at least twenty (20) feet long. Where Design Review Standards require a wider sidewalk, the wider width requirements shall govern.

Deviations from the City's sidewalk design standard require a Sidewalk Design Exception per the *Development Code*.

Street right of way shall extend a minimum of 0.5 feet beyond the outside edge of the sidewalk.

The standard street width may be developed in stages when development is occurring on only one side of the proposed street and where staging is essential to the reasonable development of properties. Staging may be allowed if necessary to maintain minimum depth and setbacks on adjoining lots or to match the existing alignments of abutting streets.

Staging shall only be approved where future development can reasonably be expected to complete the standard width. Staging shall only be approved where sufficient right-of-way for completion to standard width already exists or will be provided by future development.

If staging is approved, the initial stage shall provide improvements to the standards of this manual on the side of the street adjacent to the proposed first stage of development. These improvements shall include a minimum 20-foot pavement width for vehicular travel and any additional right-of-way, shoulder improvements, and drainage improvements as required for the half street to be fully functional.

## 210.17 Number of Lanes

The *Comprehensive Plan* identifies the number of lanes for each class of street. Additional lanes may be required at intersections in excess of the minimum street standards shown in the standard drawings. Right-of-way may also be needed in addition to that shown in the minimum street Standard Drawings to accommodate the increased number of lanes at intersections.

## 210.18 Intersection Sight Distance Policy

It is the policy of the City of Beaverton to have the applicant's Project Engineer evaluate safe intersection sight distance using the principles and methods recommended by AASHTO. This policy shall apply to the design of new streets and driveways, and to the placement of any object in the public right-of-way, including landscaping features. The following minimum standards shall apply:

**Intersection (and Driveway) Sight Distance**: The following table is for intersection and driveway sight distances:

**Table 210.12 - Intersection Sight Distance**

| Design Speed (mph) | Minimum Intersection Sight Distance (Feet) |
|---|---|
| 15 | 145 |
| 20 | 195 |
| 25 | 240 |
| 30 | 290 |
| 35 | 335 |
| 40 | 385 |
| 45 | 430 |

Source: American Association of State Highway and Transportation Officials, *A Policy of Geometric Design of Highways and Streets 2001*, Fourth Edition, (based on AASHTO Case B2 and B3).

Sight distance shall be determined for each street approach to an intersection. A driver on the approach street should be able to see each vehicle on the intersecting street from the time that the vehicle is the sight distance from the intersection until the time that the vehicle reaches the intersection. Poles, trees, and similar obstructions will be allowed within the sight distance area only if it can be shown that such obstructions do not prevent the continuous view of the vehicle approaching on the intersecting street.

For purposes of this calculation, the driver's eye is assumed to be 15 feet from the near edge of the nearest lane of the intersecting street, and at a height range of 3.5 feet to 7.6 feet above the approach street pavement. The sight distance criteria should be met throughout the range of driver's eye heights. The top of the vehicle on the intersecting street is assumed to be 3.5 feet above the cross-street pavement.

The traffic speed used in the calculation shall be the highest of the following: (1) the design speed of the intersecting street; (2) the posted speed of the intersecting street; or (3) the measured 85$^{th}$ percentile speed of the intersecting street. Where the intersecting street is controlled by a stop sign or yield sign, a design speed of zero may be assumed. Where traffic signal control exists at an intersection or where a traffic signal is likely to be installed in the future, adequate sight distance shall be provided for potential right turns on red.

In some locations, maintenance of the required sight distance may require restrictions to potential development outside the public right-of-way. If so, the Project Engineer shall demonstrate that adequate restrictions are in place (and enforceable by the City) to assure that the required sight distance can be maintained in the future.

No modifications or exceptions to these standards shall be allowed unless approved by the City Traffic Engineer.

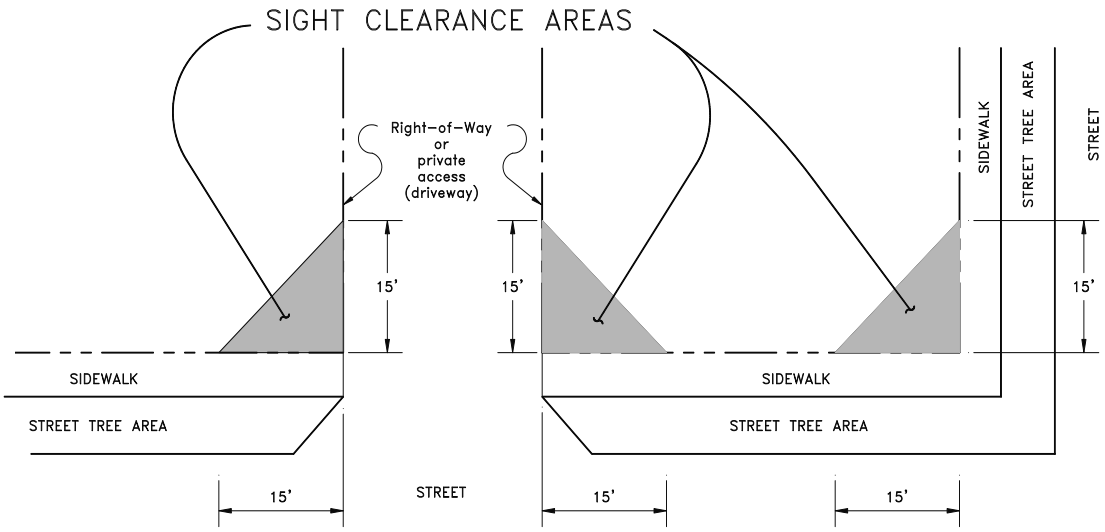
### 210.18.1 Visibility at Intersections

All work within the public right-of-way and adjacent to public streets and accessways shall comply with the standards of this section.

1. Except as otherwise provided in this section, no fence, berm, wall, commercial sign, vehicle, hedge, off-street parking space, or other planting or structure shall be erected, planted, placed, or maintained within a sight clearance area. If the relation of the surface of the lot to the streets is such that visibility is already obscured, nothing shall be done to reduce visibility within the sight clearance area.

    a. The horizontal limits of the sight clearance area shall be a triangular area measuring 15 feet along the right-of-way or private access, as shown in the following diagram. The edge of the hard surface area of the private access, be it roadway, curb, or sidewalk, shall be treated as the right-of-way line in determining the site clearance areas.

**Figure 210.3 – Sight Clearance**




b. The vertical limits of the sight clearance area shall be two planes. The lower plane shall intersect the right-of-way line at points three (3) feet above the elevation of the centerline of the adjoining street. The upper plane shall intersect the right-of-way line at points ten (10) feet above the elevation of the centerline of the adjoining street.

c. Poles, tree trunks, and similar objects less than 12 inches in width may be allowed in the sight clearance area if such objects meet the intersection sight distance requirements.

d. No modifications or exceptions to these standards shall be allowed unless approved by the City Traffic Engineer.

## 210.19 Intersections

A. The interior angle at intersecting streets shall be kept as near to 90 degrees as possible and in no case, shall it be less than 75 degrees. A straight horizontal alignment (no curves, no angle points) shall be used through the intersection and for a minimum of 25 feet each side of intersecting right-of-way lines.

B. Curb radii at intersections shall be as shown in Table 210.12 for the various functional classifications. The right-of-way radii at intersections shall be sufficient to maintain at least the same right-of-way to curb spacing as the lower classified street.

## Table 210.12 - Minimum Curb Radii at Intersections (in feet)

| Street Classification | Arterial | Collector | Neighborhood Route | Local |
|---|---|---|---|---|
| **Arterial** | See Note 3 | See Note 3 | See Note 2 | See Note 2 |
| **Collector** | See Note 3 | See Note 3 | See Note 2 | See Note 2 |
| **Neighborhood Route** | See Note 2 | See Note 2 | See Note 1 | See Note 1 |
| **Local** | See Note 2 | See Note 2 | See Note 1 | See Note 1 |

**Note 1:** Except in areas zoned for industrial uses, the intersections of local streets and neighborhood routes shall have a minimum curb radius of 15 feet. In areas zoned for industrial uses, the minimum curb radius shall be 30 feet.

**Note 2:** The intersection of a neighborhood route or local street with an arterial or collector street shall have a minimum curb radius of 25 feet. In areas zoned for industrial uses, the intersection of a neighborhood route or a local street with an arterial or collector street shall be designed to accommodate a WB-50 Semitrailer Design Vehicle and the curb alignment shall be designed so that the vehicle can complete a right turn using only the vehicle lanes nearest to the curbs of the two streets. See Note 4.

**Note 3:** At an intersection where each street is an arterial or a collector, the intersection shall be designed to accommodate a WB-50 Semitrailer Design Vehicle If either street is designated as a Truck Route in the *Comprehensive Plan Transportation Element*, the intersection shall be designed to accommodate a WB-65 Interstate Semitrailer Design Vehicle The curb alignment shall be designed so that the vehicle can complete a right turn using the vehicle lane nearest to the curb on the approach street and using all available lanes in the direction of travel on the departure street. See Note 4.

**Note 4:** Curbs should be designed to minimize the length of pedestrian crossings. Designers are encouraged to consider curb alignments with compound curves and other methods to minimize the intersection width needed to satisfy Notes 2 and 3. Parking lanes and bicycle lanes may be included in considering the effective width available to accommodate the turning design vehicle.

C. The radii standards in subsection B of this section may also be applied by the City Traffic Engineer to driveways.

D. ADA ramps shall be provided at all corners of all intersections, regardless of curb type.

E. Intersection Spacing Along Streets. The minimum and maximum distance between streets shall be as follows:

| Street Functional Classification*: | Distance between intersections along the street shall be at least: | Distance between intersections along the street shall not exceed: |
|---|---|---|
| **Arterial** | 600 feet | 1000 feet |
| **Collector** | 200 feet | 530 feet |
| **Neighborhood Route** | 100 feet | 530 feet |
| **Local** | 100 feet | 530 feet |

* Street Functional Classifications are identified in the *Comprehensive Plan Transportation Element* Figure 6.4.

1. Distance between streets is measured from the near side right-of-way line of the subject street to the near side right-of-way line of the adjacent street.

2. Local street connections at intervals of no more than 330 feet should apply in areas planned for the highest density mixed-use development.

## 210.20 Cul-de-sacs, Eyebrows, Turnarounds

The following specifies the minimum requirements for cul-de-sacs, eyebrows, and turnaround areas. Other turnaround geometrics may be used when conditions warrant and City Engineer approves the design and application of its use.

A. Cul-de-sacs, eyebrows, and turnaround areas shall be allowed only on local streets and commercial/industrial streets.

B. Cul-de-sacs shall not be more than 200 feet in length. The length of a cul-de-sac shall be measured along the center line of the cul-de-sac from the near side right-of-way of the nearest through traffic intersecting street to the farthest point of the cul-de-sac right-of-way. See the standard drawings for cul-de-sac right-of-way and pavement requirements.

C. The minimum curb radius for transitions into cul-de-sac bulbs shall be 25 feet, and the right-of-way radius shall be sufficient to maintain the same right-of-way to curb spacing as in the adjacent portion of the road.

D. In a cul-de-sac serving only residential uses and having no more than five (5) abutting residential units, the dimensions of the cul-de-sac bulb may be reduced as shown in the standard drawing "minimum cul-de-sac standards."

E. An eyebrow corner may be used on a local street where expected ADT will not exceed 500 vehicles per day or as otherwise approved by the City Traffic Engineer. Minimum curb radius on the outside of an eyebrow corner is 36 feet; minimum right-of-way radius is 45 feet. Eyebrow geometry shall be evaluated based on turning requirements for Fire Department vehicles. The minimum curb radius is the straight-line distance measured from the point of intersection of the tangents (of the projected centerline) to the face of the curb (36 feet required), or to the edge of right-of-way (45 feet required).

## 210.21 Driveways

A. Design standards. Driveways shall be designed and constructed to City standards per this manual and the appropriate Standard Drawings.

B. Elevations of Driveways. Driveways and private property access providing primary emergency vehicle access to habitable structures shall be designed with travel lanes at or above the 25-year flood elevation but not lower than six (6) inches below the 100-year flood elevation.

C. Corner Clearance for Driveways. Corner clearance shall be based on an intersection analysis and shall conform to the following minimum distances:

| FOR LOTS FRONTING ON: | DESIGN SPEED (MILES PER HOUR) | MINIMUM DISTANCE BETWEEN FACE OF CURB OF INTERSECTING STREET AND NEARSIDE EDGE OF DRIVEWAY (FEET) |
|---|---|---|
| **Arterials and Collectors** | 25 | 150 |
| | 30 | 180 |
| | 35 | 180 |
| | 40 | 200 |
| | 45 | 230 |
| | 50 | 350 |
| **Neighborhood Routes** | | 50 |
| **Local Streets** | | 25 |

Note: Street Functional Classifications are identified in the *Comprehensive Plan Transportation Element* Figure 6.4.

D. If the minimum standards in this subsection would prohibit access to the site, a driveway with restricted turn movements acceptable to the City Traffic Engineer may be approved.

E. Minimum driveway spacing between driveways on arterials and collectors shall also conform to the corner clearance standards of this section.

F. Driveway Approaches

The City Traffic Engineer has the authority to limit access and access locations. Access to streets and highways under Washington County or State of Oregon jurisdiction must be formally approved by those entities at the applicant's initiative and expense. The following specifies the minimum requirements for driveways:

1. Driveways shall be constructed to City standards per this manual and the appropriate standard drawing.

2. Driveways shall not be permitted in conflict with existing or proposed non-access reserve strips.

3. Concentrated surface runoff shall not be allowed to flow over commercial driveways or sidewalks into the street.

4. Driveway approaches shall meet the minimum intersection sight distance requirements for street intersections.

G. Driveway Grades.

1. The minimum and maximum longitudinal grades for driveways shall be as shown on the Standard Drawings for driveways.

2. The maximum longitudinal grades shown on the Standard Drawings do not apply to driveways less than 20 feet in length and driveways behind curbtight sidewalks. Such driveways, including their aprons, shall be designed individually by qualified designers to ensure that the slope of each driveway is not so steep as to prohibit adequate undercarriage clearance for any conventional unmodified passenger vehicle using the driveway.

3. On common residential driveways (i.e., driveways serving two or more single family residential tax lots or condominium units), the maximum longitudinal slope of the shared driveway within its intersections with each individual driveway shall be no steeper than 5 percent.

4. The finished grade elevations of common driveways in residential areas shall be designed at or above the 25-year flood elevation but not lower than 6 inches below the 100-year flood elevation.

H. Driveway Width.

1. Residential Driveway Width.

a. For a residential driveway serving 1 to 3 single family residential units, the required hard surface shall meet the unobstructed width as shown in the Standard Drawings. It shall be the applicant's responsibility to determine the correct width of the driveway consistent with these minimum and maximum widths and with the dimensions of the parking area or garage served by the driveway.

b. For a residential driveway serving four or more single-family residential units, the required hard surface, not including the width of the driveway apron in the right-of-way, shall meet the unobstructed width as shown in the Standard Drawings.

2. Commercial Driveway Width.

a. For a commercial driveway, the required hard surface shall have a minimum and maximum unobstructed width as shown in the Standard Drawings. See standard drawing 210 for reference.

b. If the driveway will serve more than one tax lot, an easement or similar written agreement shall assure the following: (1) that safe access and egress is provided for each tax lot; (2) that maintenance of the driveway pavement to ensure safe access and egress is provided; and, (3) that control of storm drainage from the driveway and surrounding area is provided to protect property that is contiguous to the driveway.

The easement or agreement shall be submitted to the City Engineer for approval. Once approved, the maintenance easement or agreement shall be recorded with Washington County and a copy of the recorded agreement or easement shall be provided to the City Engineer.

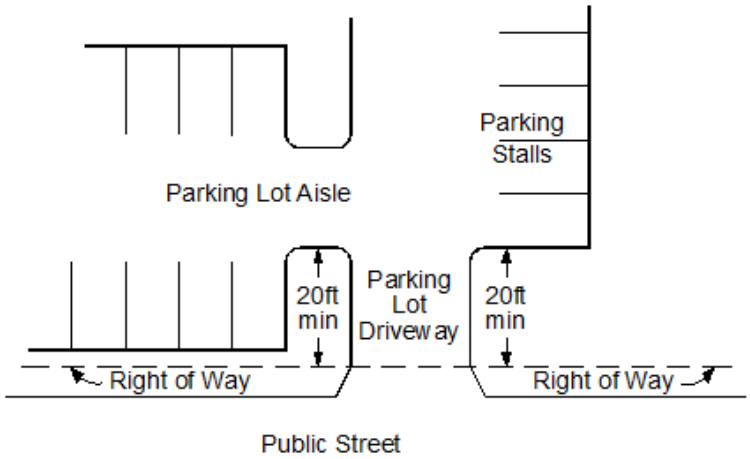
I. Parking Lot Driveways and Parking Stalls.

1. Parking Lot Driveway Width. For a parking lot driveway, the required hard surface shall have a minimum and maximum unobstructed width as shown in the Standard Drawings.

2. Driveway Location. Parking lot driveways shall be located not closer than ten (10) feet to a side lot line, except that driveways serving two adjacent properties may be provided at the common lot line.

3. Parking Stall Location. On parking lot driveways that connect to a public or private street, there shall be no parking stalls within 20 feet of the street right-of-way or within 20 feet of the back of sidewalk on a private street.

**Figure 210.4 – Parking Stall Location**



J. Joint-use Agreement for Common Driveways.

The applicant seeking a permit for a common driveway shall provide documents defining ownership, use rights, and allocation of space ("lanes") for vehicles and pedestrians using the driveway.

1. The documents shall provide perpetual joint-use rights for each of the tax lots served by the driveway in a joint-use agreement or similar document and shall include a drawing of the driveway, lot lines, and adjacent buildings drawn to scale.

2. If a driveway serving more than one tax lot is within a development for which a plat is not required, the driveway may be allowed only when provision of perpetual joint-use rights for each tax lot served by the driveway is demonstrated in writing by the applicant in a joint-use agreement or similar document with the accompanying drawing, and the documents shall be submitted to the City Engineer at the time of application for a Site Development Permit or Right-of-Way Permit. Once the agreement is approved, the applicant shall have the agreement recorded with Washington County and shall provide a copy of the recorded agreement to the City Engineer.

3. If the driveway is within a development requiring a plat, the documents shall include the information and accompanying drawing and shall be submitted with the plat for review.

K. Maintenance Agreement for Common Driveways

1. The applicant seeking a permit for a common driveway shall provide documents defining ownership, use rights, and rights and allocation of liability for maintenance and for damages arising out of neglect. The documents shall provide for perpetual maintenance of the driveway in a joint-use agreement or similar document and shall include a drawing of the driveway, lot lines, and adjacent buildings drawn to scale.

2. If a driveway serving more than one tax lot is within a development for which a plat is not required, the driveway may be allowed only if the provision of perpetual maintenance of the driveway is demonstrated in writing by the applicant in a joint-use agreement or similar document with the accompanying drawing. These documents shall be submitted to the City Engineer at the time of application for a Site Development Permit or Right-of-Way Permit. Once the agreement is approved, the applicant shall have the agreement recorded with Washington County and shall provide a copy of the recorded agreement to the City Engineer.

3. If the driveway is within a development requiring a plat, the documents shall include the information and accompanying drawing and shall be submitted with the plat for review.

4. If a driveway serving two or more multi-family residential tax lots, three or more commercial or industrial tax lots, or four or more single family residential tax lots or condominiums units is within a development for which a plat is not required, the driveway may be allowed only when the provision by the property owners for perpetual driveway maintenance, safe access and egress, and safe and controlled conveyance of storm drainage from the common driveways connected to individual driveways and adjacent areas is demonstrated in writing in a maintenance agreement or other approved document provided by the applicant. The document shall ensure perpetual maintenance of the entire driveway. The document shall define ownership of the driveway, use rights, and allocation of liability among the owners of the property for maintenance, and shall include a drawing of the driveway(s), lot lines and adjacent buildings drawn to scale. The agreement shall be submitted to the City Engineer at the time of application for a Site Development Permit or Right-of-Way Permit. Once the maintenance agreement is approved, the applicant shall have the maintenance agreement recorded with Washington County and shall provide a copy of the recorded agreement to the City Engineer prior to approval of the Site Development Permit.

5. If the driveway is within a development requiring a plat, the maintenance documents, including the information prescribed above, and the accompanying drawings(s) shall be submitted with the plat for review.

M. Documentation to be provided by the applicant.

As a minimum, the applicant shall submit the following documentation to the City Engineer for approval of common driveways prior to approval of the Site Development Permit for the proposed development:

1. A joint-use agreement or crossover easement as described above.

2. A maintenance agreement or similar dedication as described above.

3. A description of the applicant's physical provisions for driveway maintenance, safe access and egress, and conveyance of storm drainage from the common driveways in the design of the development, including but not limited to the following:

   a. The type(s) of maintenance to be performed on the common driveways to ensure the safe conveyance of storm drainage, prevention of the transport of soil and other erodible materials adjacent to and deposited on the driveways to the storm drainage system, unobstructed access and egress for private utility and other service vehicles and emergency vehicles, unobstructed sight clearance at intersections, and free drainage of the driveways in the proposed development in conformance with all other storm drainage requirements of this Manual.

   b. The proposed finished grades of the common driveways and adjacent areas.

   c. Typical driveway cross-sections for the common driveways.

   d. The method(s) to be used for ensuring proper drainage of the common driveways, connected individual driveways, and adjacent unpaved areas, including but not limited to site grading, the layout of the public and private storm water collection system serving the common driveways and parking lots, related easements, and point(s) of connection of the private system to the public storm drainage system.

   e. Applicants are hereby advised that the information required herein is not for Plumbing Code approval, but for review of the coordination of on-site grading and drainage.

   f. The name or names of the entity or entities responsible for driveway maintenance, safe access and egress, and controlled conveyance of storm drainage from the driveway and surrounding area.

N. Driveway and Parking Lot Pavement Design and Construction

1. Applicability. The requirements of this subsection apply to new driveways, new parking lots, and to reconstruction of existing driveways and parking lots in which the reconstruction involves installation of new curb.

2. Pavement Standards. Pavements for driveways, parking lots, and parking maneuvering areas shall be constructed to the following minimum standards:

   a. Pavement Strength. The pavement structural section submitted by the Engineer shall be designed to support an 80,000-pound truck in all local weather conditions and ground conditions.

b. Subgrade. The parking surface shall be placed on a stable well-compacted subgrade.

c. Pavement Thicknesses.

i. Residential Areas. On private property, in all residential areas, the minimum pavement section shall be 2-1/2 inches of asphalt over 4 inches of 1 ½ inch – 0 inch compacted crushed rock aggregate base course or shall be 4 inches of Portland cement concrete over 2 inches of 1 ½ inch – 0 inch crushed rock aggregate base course over subgrade compacted to 95 percent AASHTO T-99. 3/4 inch – 0 inch compacted crushed rock aggregate base course is an acceptable alternative if 1 ½ inch – 0 inch is not available.

ii. Commercial and Industrial Areas. On private property, in commercial and industrial areas, the minimum pavement section shall be 3 inches of asphalt over 2 inches of compacted ¾ inch – 0 inch compacted crushed rock aggregate leveling course over 8 inches of compacted 1 ½ inch – 0 inch crushed rock aggregate base course or shall be 5 inches of Portland cement concrete over 2 inches of compacted 1 ½ inch – 0 inch crushed rock aggregate base course over subgrade compacted to 95 percent AASHTO T-99. 3/4 inch – 0 inch compacted crushed rock aggregate base course is an acceptable alternative if 1 ½ inch – 0 inch is not available.

3. All required parking lot spaces shall be striped. Compact spaces shall be identified by pavement markings using the word "Compact." Letter size for pavement marking shall be minimum 12-inch high letters. A sign may be used to supplement the pavement marking.

4. Parking spaces in parking lots along the outer boundaries of a parking area, except where specifically prohibited, shall be designed to include a continuous curb a minimum of four (4) inches high located not less than six (6) feet from the property line. The purpose of the curb is to prevent a motor vehicle from extending over an adjacent property line or a street right-of-way. The curb shall be a barrier-type curb per the standard drawing for "Type A Replacement Curb," except that it may be four (4) to six (6) inches high rather than six (6) inches high as shown in that standard drawing.

## 210.22 Curbs, Shoulders, and Grading

The following specifies the requirements for curbs and cross-slope grading for streets:

A. All streets shall include curbs on both sides except in the situations of interim width improvements. Interim designs shall have shoulders and ditches.

B. Interim width streets shall have 6-foot wide shoulders adjacent to the street at a 2-1/2 percent cross-slope and roadside ditches each side of the shoulders with a maximum side-slope of 2 horizontal to 1 vertical. The 6-foot shoulder area may consist of a section of pavement and/or a section of crushed rock. The pavement section shall be a minimum of 2 feet wide and a maximum of 6 feet wide.

C. Cross-slope of the street section shall be no less than 2.5 percent and no greater than 5 percent. Whenever possible, the crown of the street shall be the same elevation as the top of the curbs.

D. Streets with vertical curves with slopes less than 1% shall adjust the cross slope 50 feet each side of low point to a maximum of 4%

Grading outside the improved areas shall be as follows:

A. Collectors or higher functional classifications shall have a maximum 2 percent upward grading to the right-of-way line, and no steeper than 1-1/2 to 1 up, or 2 to 1 down, outside the right-of-way.

B. Local Street and Commercial/Industrial functional classifications shall have a maximum 2 percent upward grading to the right-of-way line, a 5 to 1 upward or downward grading within the public utility easement, and no steeper than 1-1/2 to 1 up, or 2 to 1 down outside the public utility easement.

C. Retaining walls shall be used if slopes are greater than the 1-1/2 to 1 requirement in the subsections above or where slope stability is a problem. If slopes are to be maintained (mowed) by the City, a maximum of 3 to 1 slope will be required. Retaining walls shall be constructed to a height where the slope is no more than 1-1/2 to 1.

When new curbing is being placed, a stamp or tag shall be placed to mark where each water, sanitary sewer service, and storm drain service crosses the curb line. The method of marking the curb shall be approved by the City Engineer and noted on the approved construction plans. If an imprinting stamp is used, the impression left for a water service shall be the letter "W"; for a sanitary service, it shall be the letter "S," and for a storm drain service, the letters “SD.” These impressions shall be 2 inches high, placed on the top of the curb. Tags shall be rectangular, three (3) inches in width by two (2) inches in height, stainless steel “INFOTAG” low-temperature tags by InfoSight Corporation and shall be attached to a 36-inch-long #3 re-bar driven 30 inches into the ground over the service line. The tag shall be twist-tied to the re-bar with 10-gauge galvanized steel wire.

## 210.23 Sidewalks

### 210.23.1 Sidewalks and Sidewalk Ramps

1. Sidewalks

   a. Sidewalks shall be separated from the curb as indicated in the street typical sections, except where physical or topographic conditions make it impracticable to separate the sidewalk from the curb, the City may approve a Design Exception to allow the sidewalk to be adjacent to the curb, through the Sidewalk Design Exception application.

   b. Sidewalks shall be at least 5 feet wide and separated from the curb by a landscape strip.

   c. Where clustered mailboxes, transit shelters, benches, or any other objects are within a sidewalk, the walk shall be widened to provide clearance equal to ADA minimum requirements.

   d. Sidewalks should be kept free of utility structures and other encroachments by locating such structures behind the sidewalk, in the landscape strip, or in the PUE. If a utility structure must be located in the sidewalk, it shall be installed flush with the sidewalk and have a non-skid walking surface rated for pedestrian traffic.

   e. Maximum designed cross-slope shall be 1.5 percent.

   f. The connection of sidewalks of different widths shall be accomplished by a transition section of sidewalk. The transition section shall be at least twenty (20) feet long. Its deflection angles from the centerlines of the two connected sidewalks shall not exceed 45 degrees without the City Engineer’s written approval.

   g. In instances where it is required to install sidewalks and a permanent sidewalk cannot be constructed, a temporary sidewalk may be constructed. The temporary sidewalk may

consist of an asphaltic concrete or portland cement concrete to a width, location, and structure approved by the City Engineer.

2. Sidewalk Ramps

a. Sidewalk ramps shall be designed and constructed in accordance with Title III of the Americans with Disabilities Act of 1990 (ADA) and the *Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way* (PROWAG).

b. All existing sidewalk ramps abutting a street overlay or pavement reconstruction project shall be brought into compliance with ADA requirements for sidewalk ramps.

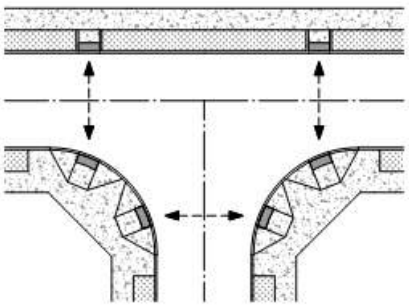
c. Marked crosswalks shall be provided at crossings that are protected by a traffic signal. Marked crosswalks may be provided at other locations only when approved by the City Traffic Engineer.

d. Ramps located within marked (striped) crossings shall be wholly within the crossing, excluding the flared wings.

e. Two directional ramps shall be provided at each street corner.

f. At Tee intersections, the "cross-bar" of the tee shall have two crossings equipped with ramps. All Tee intersections shall have at least six ramps, with two ramps on each corner of the intersection. See Figure 210.5.

**Figure 210.5 – Sidewalk Ramps at Tee Intersections**



g. See ODOT/APWA standard drawings RD754, RD155, RD756, RD757, RD758 and RD759 for ramp details. See ODOT/APWA standard detail DET1720 as a guide for the required level of design detail.

h. ADA ramps shall be 5 ft. wide and have 8.3% wings.

i. All truncated domes shall be federal yellow.

j. Maximum designed ramp slope shall be 7.5%. Maximum designed cross slope, flat landing or turning space shall be 1.5%.

## 210.24 Raised Medians

Where raised medians are allowed, the following criteria must be met:

A. The raised median shall be set back at least 2 feet from the median lane on both sides.

B. Street lighting shall be sufficient to provide illumination of the raised median.

C. Objects, such as trees, shrubs, signs, and light poles, shall not physically or visually interfere with vehicle or pedestrian traffic in the travel way.

D. The style and design of the raised median shall be site specific. The raised median shall be designed for the design speed and shall be subject to City approval.

## 210.25 Subsurface Drainage

Subsurface street drainage must be considered in the design of each street. Subsurface drains shall be designed and constructed per the recommendations of the soils report. If no subsurface drainage is required in the soils report, a transverse perforated drain pipe shall be installed below the subbase rock at the low point of each sag vertical curve. The subsurface drains are for collecting and conveying subsurface water only, not surface runoff. They are not to be considered part of the storm drainage system for storm drain pipe sizing purposes.

Subsurface drains shall connect and drain into the storm drainage system at catch basins, curb inlets, gutter inlets, manholes, or roadside ditches. Alternative subsurface drainage measures may be used if approved by the City Engineer.

## 210.26 Major Roadway Structures

A. Major roadway structures including but not limited to embankments, bridges, retaining walls, headwalls, crash rated traffic barriers, guardrails, handrails, and fencing on bridges and other major structures shall be designed and constructed in conformance with AASHTO and ODOT/APWA standards, except that all permanent crash rated roadside traffic barriers shall be designed to meet AASHTO's Test Level 4 (TL-4) criteria, regardless of the street's design speed.

B. Steeply sloped roadway embankments, steep slopes adjacent to driveways, and retaining walls at those locations shall be provided with crash rated traffic barriers where recommended by the aforementioned AASHTO and ODOT/APWA roadway design standards and shall be designed in accordance with subsection A.

## 210.27 Transitions

A. Street width transitions from a narrower width to a wider width shall be designed with a 3 to 1 taper. Delineators, as approved by the City, shall be installed to define the configuration.

B. For street width transitions from a wider width to a narrower width, the length of transition taper shall be determined as follows:

$L = S \times W$ (for S = 45 MPH or more)

$L = \frac{W \times (S)^2}{60}$ (for S = less than 45)

Where L = minimum length of taper (feet)
S = design speed (MPH)
W = EP to EP offset width

Delineators, as approved by the City Traffic Engineer, may be installed to define the configuration. Maximum spacing of delineators shall be the numerical value of the design speed, in feet (i.e., 35- foot spacing for 35 MPH).

In situations where a tapered transition cannot be provided, a barricade shall be installed at the end of the wider section of the street and a taper shall be appointed and delineated as approved by the City Traffic Engineer. The barricade shall conform to the Standard Drawing. If the wider section does not provide an additional travel lane, only a barricade is required without the transition.

## 210.28 Super Elevation Cross-Sections

A. Off-set crown cross-sections are not acceptable as super elevation sections.

B. Super elevation sections shall be designed using AASHTO guidelines.

C. Super elevation transitions shall be designed to not allow concentrations of storm water to flow over the travel lanes.

## 210.29 Stub Streets

Stub streets that are to allow for future extensions shall be barricaded and signed as per the Standard Drawings. A turnaround may be required depending on access and length of the street.

## 210.30 Private Streets

A. When allowed in development, private streets shall meet the requirements of the *Development Code* and the appropriate public street design standards.

B. Private streets shall also comply with Fire Code for load and fire apparatus access requirements. The Engineer shall provide a pavement section designed to support an 80,000-pound truck in all local weather conditions and ground conditions.

C. Modifications to minimum street design standards to allow deviations from the City's street width standard may be requested by the applicant per section 160 of this manual. Deviations from the City's sidewalk design standard require a Sidewalk Design Exception per the *Development Code*.

D. ADA Ramps in private streets shall be designed and inspected per public street standards. See Section 210.22.1 Sidewalks and Sidewalk Ramps.

E. Documents defining ownership, use rights, and allocation for liability for maintenance shall be submitted to the City prior to or in conjunction with final approval.

F. A sign per Standard Drawing 416 Private Street Sign shall be posted at each entrance to a private street from a public street.

G. This section only applies to the horizontal and vertical geometry of the street, including curb and gutter, sidewalk, and ADA accessible ramps and driveway connections. All stormwater piping is considered private and must conform to the Uniform Plumbing Code. All electrical lines and installations, such as street lighting, are considered private and must conform to the National Electrical Code. Obtain plumbing and electrical permits from the City of Beaverton Building Division. Exceptions are when the facilities are in public easement(s) and the public agencies are identified with the maintenance responsibilities.

H. A request for a private street to become a public street under City jurisdiction may be made to the City Engineer and shall include:

1. Documentation that the subject street meets all City standards or standards acceptable to the City Engineer, or written assurance that any repairs or improvements needed to meet the City's standards will be completed prior to acceptance of the street for maintenance by the City, and that any improvements required will meet all City permitting requirements.

2. Documentation that the street pavement has a Pavement Condition Index (PCI) of 70 or greater. The City's Operations Department shall be the only agency approved by the City to determine the PCI, and upon receiving a written request from the applicant, shall provide the PCI to the applicant in writing within a reasonable time after receiving said request.

3. Documentation demonstrating that right of way exists to City standard, or evidence that property owners are prepared to dedicate the right of way.