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THE CITY OF
COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF
PUBLIC SERVICE

DESIGN MEMO 4.13

To: Designers, Contractors, and City Departments

Date: January 1, 2025

Subject: Roadway Cross Slope

Category: Horizontal and Vertical Design

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1 Purpose

The purpose of this design memo is to establish guidelines for roadway cross slopes and allowable deviations. The roadways discussed in this memo include both curbed and un-curbed roadways. This memo will provide guidance for roadways of various design speeds and traffic flows.

2 Applicability

Until further notice, this direction will be used for scoping, design and review within the City of Columbus jurisdiction. The guidance provided in this memo is applicable to all projects including both capital improvement projects and private development projects.

3 Definitions

Definitions of key terms in this memo are provided in City of Columbus Design Memo 1.00: Introduction and as outlined below:

Crown: A crown point is the point of the roadway cross section where the road reaches a vertical high point. Crowned pavement features a high point in the road with two sides sloping away from the crown point. A City of Columbus “normal crown” is a roadway that contains a crown point at the centerline of the roadway then sloping away from the crown at a 1.6% slope towards the pavement edge.

**Roadways proposed to have a brick paver surface treatment shall utilize a “rounding” at the crown of the road to minimize exposed brick edges. The rounding length shall be consistent and between 5 feet and 10 feet wide centered on the crown of the road.

Intersection: As defined by AASHTO, “An intersection is defined as the general area where two or more highways join or cross, including the roadway and roadside facilities for traffic movements within the area.”

Cross Slope: Pursuant to the Ohio Department of Transportation (ODOT) Location and Design Manual, Volume 1, Cross Slope is defined as, “the rate of change of elevation along a straight line from one point in cross section to another”

4 Considerations

4.1 ODOT Location and Design Manual

Pursuant to the ODOT Location and Design Manual, Volume 1: “Normal crowned pavements in Ohio are sloped at the rate of 1.6%. There are occasions when, because of drainage, pavement type, higher potential for subgrade settlement, this rate may be increased to 2.0%. An increase in the 1.6% slope rate normally takes place on facilities maintained by local governmental agencies and usually at design speeds less than 50 mph.”

“Cross slope arrangements for normal crowned sections vary based on features such as the number of lanes, whether or not the highway is divided or undivided, the type and width of the median, and

drainage. Figure 301-6 [within the ODOT Location and Design Manual, Volume 1] shows examples normally used in Ohio. Generally, the following are applicable on normal crowned pavements:

1. Crowns are to be located between lanes.
2. For three or four lane roadways, no more than two lanes should slope in the same direction.
3. When 3 or more lanes are sloped in the same direction on a high-speed roadway (50 mph or greater), the first two lanes from the crown point should have the normal cross slope of 1.6% and any adjacent outside lanes may have an increased maximum cross slope of 2.0%.
4. On new roadway designs or major pavement rehabilitation projects when 3 or more lanes are sloped in the same direction on a high-speed roadway (50 mph or greater) and the profile grade is 3.0% or steeper, the first two lanes from the crown point should have the normal cross slope of 1.6% and any adjacent outside lanes should have an increased maximum cross slope of 2.5% when feasible [however, anything in excess of a 2.0% cross-slope under this application within the City of Columbus and under Columbus' sole jurisdiction, would require City of Columbus variance approval].
5. Narrow raised median sections are crowned such that the majority of the pavement will drain toward the outside.
6. Pavement sections on either side of wide, depressed medians are to be treated similarly to undivided pavement sections (See Item 3 above), with the majority of the pavement sloped to the outside."

4.2 AASHTO

Pursuant to AASHTO A Policy on Geometric Design of Highways and Streets: "The rate of cross-slope is an important element in cross-section design. …cross slope or crown on tangents or on long-radius curves are complicated by two contradictory controls. On one hand, a reasonably steep lateral slope is desirable to minimize ponding of water on pavement with flat profile grades as a result of pavement imperfections or unequal settlement. A steep cross slope is also desirable on curbed pavements to confine water flow to a narrow width of pavement adjacent to the curb. On the other hand, steep cross slopes are undesirable on tangents because of the tendency of vehicles to drift toward the low edge of the traveled way. This drifting becomes a major concern in areas where snow and ice are common. Cross slopes up to and including 2.0% are barely perceptible in terms of vehicle steering. Furthermore, steep cross slopes increase the susceptibility to lateral skidding when vehicles brake on icy or wet pavements or when stops are made on dry pavements under emergency conditions."

4.3 Driver Perception

Pursuant to AASHTO A Policy on Geometric Design of Highways and Streets: "Cross slopes up to and including 2.0% are barely perceptible in terms of vehicle steering. However, cross slopes steeper than 2% are noticeable and require a conscious effort in steering."

4.4 Drainage

When longitudinal slopes are relatively flat (less than 1.0%), an increased slope away from the crown improves drainage away from the pavement area. In a curbed roadway, a higher cross-slope will provide better drainage toward the gutter line and away from the pavement crown and also minimizes its lateral impact on the thoroughfare. A roadway with curbs should have a cross slope of 1.6% to avoid ponding in the roadway during significant rainfall. A cross slope of 1.6% can be used in most pavement conditions and is the preferred design cross-slope within the City of Columbus; however, a maximum pavement

cross-slope of 2.0% can be used with justification to provide adequate roadway drainage when necessary and where approval is granted by the City DPM. See the City of Columbus Stormwater Drainage Manual, including Table 2-9, for additional drainage considerations as well as section 6.2 of this Design Memo. Table 2-9 should be followed with exceptions as defined herein.

5 Design Guidance

5.1 Jurisdictional Authority

Cross slope preferences and guidelines documented herein are for use in designing roadways within the municipal boundaries of the City of Columbus. Roadways located outside the City of Columbus sole jurisdiction may rely on other state, regional or national (such as the Federal Highway Administration) entities' guidelines for design. Please refer to the Authorities Having Jurisdiction for the proper guidance.

5.2 Summary Table

Table 1 – Preferred Roadway Cross Slope Range, summarizes the preferred and allowable cross slope deviations. Roads within the municipal boundaries of the City of Columbus (that are not otherwise obligated to adhere to criteria required by other Authorities Having Jurisdiction) must use a cross slope of 1.6% or project specific justification is required.

Table 1 – Preferred Roadway Cross Slope Range

	*Minimum	Preferred	*Maximum
#Roadway Cross Slope	1.0%	1.6%	2.0%

#Typical for roadway speeds less than 50mph. For all other roadways, default to ODOT Location and Design Manual, Volume 1.

*Exemptions may be granted for deviations as outlined in Section 6 below.

6 Exemptions and Alternatives

6.1 Exemptions

The City of Columbus requirement is to use a 1.6% cross slope for all projects. Deviations from this requirement have been classified into four categories as noted below. When roadways require superelevation incorporated into the design due to geometric and topographic conditions, design variances related to maximum cross-slope are not required within the superelevated section of the project. Additionally, cross slope designs shall adhere to ADA requirements for public access routes (PAR). In the event that PAR cannot be maintained, a design variance shall be submitted.

Deviation Category 1:

Cross slope not equal to 1.6% and ranging between 1.0% and 2.0%.

- Provide project specific justification in memo format with exhibits to indicate respective grades on pavement
- Provide exhibits identifying potential impacts to items within and outside of right-of-way
- Requires City DPM review and approval

Deviation Category 2:

Cross slope modified using an alternate design process listed in Section 6.2 below.

- Provide project specific justification in memo format with exhibit to indicate respective grades on pavement
- Provide exhibits identifying potential impacts to items within and outside of right-of-way if cross slope is beyond those outlined in Table 1 (example exhibits may include detailed cross-sections)
- Requires City DPM review and approval
- Design Variance not required
- A NOTE TO REVIEWER added to the Title Sheet with deviations approved by the DPM. The note is to be removed prior to final signature submittal. Project specific justification memo to be provided to the City DPM.

Deviation Category 3:

Pavements with inverted crown (Other than alleys following COC STD DWG: 2151) or parabolic cross slope (not superelevated).

- Provide project specific justification in memo format with exhibit to indicate respective grades on pavement
- Provide exhibits identifying potential impacts to items within and outside of right-of-way if cross slope is beyond those outlined in Table 1 (example exhibits may include detailed cross-sections)
- Requires City DPM review and approval
- Design Variance not required
- NOTE TO REVIEWER added to the Title Sheet with deviations approved by the DPM. Note to be removed prior to final signature submittal. Memo to be provided with final submittal.

Deviation Category 4:

Cross slope modified beyond the limits outlined in Category 1, 2 or 3.

- Requires advanced City of Columbus review and approval
- Design variance required. See Design Memo 1.01 – DPS Design Variance Process.

6.2 Alternative Design Processes

Existing constraints including but not limited to grade, slope, right-of-way, buildings, etc. limit the feasibility of providing a cross slope of 1.6%. The alternate design processes outline below are included to provide additional guidance for typical constrained conditions. This list does not attempt to cover all unique applications and the Designer shall coordinate with the City of Columbus, Department of Public Service (DPM) for conditions not covered herein:

- **Pervious Pavement:** Pervious pavement shall be a permitted exception to the cross-slope rules herein. The preference for pervious pavement within the City of Columbus limits is a 0% cross slope to more evenly distribute rainwater through the pavers. However, manufacturer's recommendations should be reviewed and discussed with the City DPM if the manufacturer's recommendations deviate from the 0% cross-slope preference. Under certain circumstances where a non-0% cross-slope is recommended by the manufacturer, pavement cross-slope design will require City of Columbus review and approval before proceeding.
- **Historical Brick Roadways:** Historical areas are exempt. In crosswalk areas, brick pavements (including materials) should meet ADA requirements. Modern and newly constructed brick roadways shall follow cross-slope requirements described herein. See Crown definition for further directions on brick roadways.
- **Roadway Widenings**: When widening a roadway, the following information should be considered in the order presented. Option 3 will only be considered if Option 1 and 2 are proven impractical.
    - **Extend Slope of Existing Pavement (Option 1 – Preferred)**:
        - Extend the existing cross slope of the roadway from the existing edge of pavement to the proposed edge of widening. This results in minimal pavement work and a uniform and continuous pavement transition from the existing edge of pavement to the proposed edge of widening.
    - **Remove and Rebuild Roadway to the Existing Crown (Option 2)**:
        - A secondary option is to full depth replace the roadway on the side of widening from the existing crown of pavement to the edge of widening. The roadway could be crowned at the same location, or a new crown could be established at the proposed centerline of the roadway however positive drainage must be maintained continuously towards the pavement edge. This results in a uniform and continuous pavement cross slope for the limits of the widening area. When practical, the roadway crown should not to be located in the vehicle wheel path. Pavement cross slope shall meet the guidelines within Table 1, from the crown of the pavement to the edge of the road widening.
    - **Cross Slope Break in Grade for Widening (Option 3 – Not Preferred):**
        - Where unique grading challenges may be present, the Designer may wish to break the roadway cross slope at the existing edge of pavement and use a 1.6% cross slope for the roadway widening. This may result in a horizontal grade break for roadway vehicles but may be necessary for drainage if the roadway is found to have a flat existing cross slope. For a project to consider this alternative, both previous conditions (Options 1 & 2) have to be proven impractical. This consideration is not preferred but if extensive circumstances are present, this option can be presented with justification to the City DPM for review and approval. A design variance is required for this option.

- **Utility Repairs:**
  - Where a project is installing, replacing, or modifying a subsurface utility, the project shall reinstate the roadway cross slope as existed previously and shall tie into the existing grades at the limits of pavement cutting. The Designer shall refer to City of Columbus Standard Drawing 1441 for additional design considerations.
- **Pavement Cross Slope Transitions**
  - When necessary to make cross slope deviations along a roadway corridor, the transition rate from one cross slope to the other shall occur smoothly and gradually over a defined rate and distance. The ODOT Location and Design Manual, Volume 1 outlines cross slope transition rates that should be used as the minimum governing guideline for establishing these transition rates and distances.
  - The Designer should consider intersecting existing and proposed grades to confirm positive drainage can be maintained throughout.
- **Maximum Existing Cross Slope to be Replaced**
  - In areas where full depth reconstruction is scoped/proposed and the existing roadway cross-slope is in excess of the maximum Table 1 cross-slope, and the length of the project is at least one (1) city block of length, the cross slope should be rectified to fall within the acceptable cross-slope limits defined herein. The replacement pavement should not be of less thickness than the existing pavement (unless a geotechnical or pavement report is prepared and supports otherwise) and curb reveals at the edge of pavement should be maintained or restored. ADA rules and regulations should be followed for any pedestrian access routes within the project limits. All transitions rates from one cross-slope to another shall comply with the ODOT Location and Design Manual, Volume 1 pavement transition rates.
- **Considerations for 3 Lane, 35mph or Less, Low Volume Roadways**
  - Roadways meeting these criteria historically generate stormwater design challenges as it relates to runoff spread on the pavement. Considering the Spread Calculation Requirements established within the City of Columbus Stormwater Drainage Manual (SWDM) Chapter 2, the Designer may present increasing the roadway cross slope up to 2.5% in areas of concern to reduce the frequency at which drainage infrastructure would be placed. The SWDM's threshold for considering alternative options is prompted when calculations result in spacing of stormwater drainage inlets to be less than 75 feet, as defined by the SWDM Table 2-9. An alternative may include, but is not limited to, increasing the gutter pan width to 2 feet. Increasing the gutter-pan to two feet, or adjusting the cross-slope in excess of 2.5% for stormwater spread considerations will require a Variance after concurrence from the City DPM that these non-standard designs should be pursued.
  - The Designer shall prepare a cost-benefit review to be reviewed with the City DPM for final consent of this alternative.
  - A NOTE TO REVIEWER Approval shall be obtained through variance process.