Section 305, Foundation Design

Section 307, Retaining Walls

Sections 600 and 700: Foundation and Wall Plan Notes

Associated Special Provisions
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○ 307 Retaining Walls
  ○ 307.9 Soil Nail Walls
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In the following, red text describes specific changes in content:

305.1 General Discussion

- 305.1.1 Overall Stability
- 305.1.2 Lateral Loading on Deep Foundations
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- 305.1.3 Vertical and Horizontal Movements
  - Builds on existing guidance in LRFD 10.5.2.2, and definitive limits to bridge substructure differential settlement, based on superstructure type. Provides guidance for remediation to limit structural deformations due to settlement.

- 305.1.4 Ground Improvements
SPECIFIC CONTENTS AND REVISIONS

- **305.1.5 Seismic Design**
  - Sets Site Class D as the limit for Ohio, and sets valid ranges for seismic coefficients within the state of Ohio. Also states, “The site-specific procedure, per LRFD 3.10.2.2 is not required for Ohio.”

- **305.1.6 Scour**
  - All foundation requirements shall be satisfied for the changes in conditions resulting from the design flood at the strength and service limit states and the check flood at the extreme event limit.
states. The changes in foundation conditions resulting from scour do not apply to the overall (global) stability. Determine the design flood frequency and the check flood frequency for scour, in accordance with L&D, Vol. 2, Section 1008.10.1. Ignore Rock Channel Protection in the prediction of scour depths.
SPECIFIC CONTENTS AND REVISIONS

- 305.2 Spread Footings
  - 305.2.1 General Discussion
    - 305.2.1.1 Settlement
  - 305.2.1.2 Minimum Depth and Scour Considerations
    - In addition to guidance stated above in the presentation, within the 500-yr flood plain, perform an Extreme Event II Limit State check with all resistance factors = 1.00. At the 100-yr flood scour condition, evaluate the foundations at the Strength I
SPECIFIC CONTENTS AND REVISIONS

- 305.2 Spread Footings
  
  Limit State. Sets 4 feet as the minimum embedment for footings in soil, and 5 feet as the minimum embedment for footings on embankment fill.

- 305.2.1.3 Resistance to Horizontal Forces
- 305.2.1.4 Reinforcing Steel
- 305.2.1.5 Design Considerations
SPECIFIC CONTENTS AND REVISIONS

- 305.2 Spread Footings
  - 305.2.2 Spread Footings on Cohesionless Soils
    - Directs consideration of settlement due to incremental loading during the construction sequence.
  - 305.2.3 Spread Footings on Cohesive Soils
    - Sets a minimum $S_u = 2$ ksf for bridge spread footing foundations.
305.2.4 Spread Footings on Bedrock

- The sliding resistance factor shall be taken as $\varphi = 0.9$ for pier footings founded on weak or very weak bedrock ($Q_u < 1500$ psi).

305.3 Driven Piles

- 305.3.1 General Discussion
  - 305.3.1.1 Pile Types
  - 305.3.1.2 Pile Driving Hammers
- 305.3.2 Load Effects
SPECIFIC CONTENTS AND REVISIONS

- 305.3 Driven Piles
  - 305.3.2.1 Scour
  - 305.3.2.2 Downdrag and Drag Load
    - Directs location of the neutral plane per the Goudreault and Fellenius (1994) method and analysis of downdrag and drag load per the Siegel et al. (2013) method, both as described in FHWA-NHI-16-009/010, Geotechnical Engineering Circular 12 (GEC 12) “Design and Construction of Driven Pile Foundations.”
SPECIFIC CONTENTS AND REVISIONS

- 305.3 Driven Piles
  - 305.3.2.3 Uplift
  - 305.3.2.4 Setup
    - Gives guidance on how to estimate pile setup for consideration in design, including recommended setup factors. Piles incorporating setup in design are driven to a specified EOID resistance and then restruck to verify UBV. The recommendations of this section may be changed based on the outcome of the following ongoing research project:
SPECIFIC CONTENTS AND REVISIONS

- Research Project:
  - Pile Driving Setup for Ohio Soils

  - This is a study to quantify and predict pile setup for soils based on soil type and/or region within Ohio.
305.3 Driven Piles

305.3.3 Point Bearing Piles on Bedrock

The table specifying the factored structural resistance \( Pr \) for common H-pile sizes has been moved to the commentary, in recognition of different pile sizes and strengths being utilized in design, particularly in DB projects.
SPECIFIC CONTENTS AND REVISIONS

- 305.3 Driven Piles
  - 305.3.4 Friction Piles
    - The tables specifying the maximum UBV for common pile sizes have been moved to the commentary, in recognition of different pile sizes and strengths being utilized in design, particularly in DB projects.
  - 305.3.5 Design Considerations
    - 305.3.5.1 Minimum Pile Spacing, Clearance, and Embedment into Cap
SPECIFIC CONTENTS AND REVISIONS

- 305.3 Driven Piles
  - 305.3.5.2 Estimated Pile Length
  - 305.3.5.3 Corrosion and Protection
    - Directs reference to Eurocode 3, Part 5, Section 4.4 for the environmental conditions at the site to determine the appropriate corrosion loss rate for carbon steel. For zinc coatings, the minimum coating thickness is 4 mils, and the corrosion loss rate is considered as ½ the respective loss rate for carbon steel.
SPECIFIC CONTENTS AND REVISIONS

- 305.3 Driven Piles
  - 305.3.5.4 Vertical and Horizontal Movements
  - 305.3.5.5 Buckling and Lateral Stability
  - 305.3.5.6 Steel Pile Points or Shoes
    - Gives conditions for specifying steel points or shoes for H-piles, CIP reinforced concrete pipe piles, or steel open-ended pipe piles, along with corresponding plan notes in 606.3.
SPECIFIC CONTENTS AND REVISIONS

- 305.3 Driven Piles
  - 305.3.5.7 Minimum Pile Penetration Requirements
  - 305.3.5.8 Battered Piles
  - 305.3.5.9 Pile Setup and Relaxation
    - Gives direction on when to consider setup in the design, and three methods for incorporation of setup through plan notes. Potential relaxation is ignored in design.
305.3 Driven Piles

305.3.6 Vibration Monitoring


305.3.7 Embankment Construction Constraints
SPECIFIC CONTENTS AND REVISIONS

• 305.4 Drilled Shafts
  • 305.4.1 General Discussion
  • 305.4.2 Load Effects
    • 305.4.2.1 Scour
    • 305.4.2.2 Downdrag and Drag Load
      • Recommends location of the neutral plane and analysis of downdrag and drag load per FHWA GEC 10 Section 13.6.
    • 305.4.2.3 Uplift
  • 305.4.3 Rock-Socketed Drilled Shafts
SPECIFIC CONTENTS AND REVISIONS

- 305.4 Drilled Shafts
  - 305.4.4 Friction Drilled Shafts
  - 305.4.5 Design Considerations
    - 305.4.5.1 Drilled Shaft Spacing, Clearance, and Embedment into Cap
    - 305.4.5.2 Drilled Shaft Size
      - Sets new limits on cover over longitudinal reinforcement as follows:
        - 3.0 inches for shafts ≤ 3'-0" diameter
        - 4.0 inches for > 3'-0" but < 5'-0" diameter
        - 6.0 inches for shafts ≥ 5'-0" diameter
SPECIFIC CONTENTS AND REVISIONS

- 305.4 Drilled Shafts
  - 305.4.5 Design Considerations
    - 305.4.5.3 Reinforcing Steel
    - 305.4.5.4 Drilled Shaft Design Depth
    - 305.4.5.5 Vertical and Horizontal Movements
  - 305.4.5.6 Demonstration Drilled Shafts
    - Gives conditions for specifying a demonstration drilled shaft. A plan note is provided.
o 305.4 Drilled Shafts
  o 305.4.6 Integrity Testing of Drilled Shafts
    o Gives conditions for specifying drilled shaft integrity testing. Thermal Integrity Profiling (TIP), is the preferred method. Plan notes are provided for TIP and CSL.
  o 305.4.7 Embankment Construction Constraints
SPECIFIC CONTENTS AND REVISIONS

○ 305.5 Micropiles

○ 305.6 Continuous Flight Auger (CFA) Piles
  ○ CFA piles (auger-cast piles) are allowed for many applications, except deep foundation elements supporting bridge substructures. Design is referred to FHWA GEC 8. A new AASHTO LRFD Section is under consideration, and may result in changes to this BDM Section.
305.7 Field Verification of Nominal Resistance

- 305.7.1 Dynamic Testing
- 305.7.2 Static Load Test
  - Provides direction for specification of static load tests for all deep foundation types. Allows for alternate high strain dynamic testing of drilled shafts.
SPECIFIC CONTENTS AND REVISIONS

- 305.7 Field Verification of Nominal Resistance
  - 305.7.3 Special Load Tests
    - Allows specification of a drop weight test, Osterberg load cell test, lateral load test, or Statnamic test with consultation of the Office of Geotechnical Engineering.
307.1 General Discussion

- Abutments are retaining walls! So is any structure with greater than 2 feet of differential height of soil from one side to the other.

- 307.1.1 Loading
- 307.1.2 Overall Stability
- 307.1.3 Resistance to Horizontal Forces
- 307.1.4 Limiting Eccentricity and Overturning Resistance
SPECIFIC CONTENTS AND REVISIONS

- **307.1 General Discussion**
  - 307.1.5 Bearing Resistance
  - 307.1.6 Vertical and Horizontal Movements
    - Gives limits on differential settlement for various types of retaining walls.
  - 307.1.7 Seismic Design
SPECIFIC CONTENTS AND REVISIONS

- 307.2 Rigid Gravity and Semigravity Walls
  - Traffic barrier shapes supporting >2 feet differential height of earth on either side are considered rigid gravity walls.
    - 307.2.1 Rigid Gravity Walls
    - 307.2.2 Cantilever Walls
    - 307.2.3 Counterfort Walls
SPECIFIC CONTENTS AND REVISIONS

- 307.2 Rigid Gravity and Semigravity Walls
  - 307.2.4 Precast Gravity and Semigravity Walls
    - Allows use of precast footings with a leveling pad or sub-footing.
SPECIFIC CONTENTS AND REVISIONS

- 307.3 Prefabricated Modular Walls
  - 307.3.1 Modular Block Walls
  - 307.3.2 Bin Walls
  - 307.3.3 Crib Walls
  - 307.3.4 Gabion Walls

- See Supplemental Specification 870
SPECIFIC CONTENTS AND REVISIONS

- 307.4 MSE Walls
  - In a permanent condition, do not use corners with interior angles of less than 90 degrees (acute corners). Do not use corners with interior angles of less than 45 degrees for temporary MSE walls utilized for maintenance of traffic. Lesser angles require a different kind of wall.
SPECIFIC CONTENTS AND REVISIONS

○ 307.4 MSE Walls
  ○ 307.4.1 Two-Stage MSE Walls
    ○ Allows use of a two-stage MSE wall, with permanent precast panels attached to a wire-faced MSE wall. References SS867 for design of the wire-faced MSE wall.
  ○ 307.4.2 GRS-IBS Abutments
    ○ GRS-IBS shall not be used to support bridges on Interstate, U.S. Federal Route, or State Route highways. GRS-IBS shall not be constructed with dry-cast block wall facing elements.
SPECIFIC CONTENTS AND REVISIONS

- **307.5 Reinforced Soil Slopes**
  - Per FHWA GEC 11

- **307.6 Drilled Shaft Walls**
  - **307.6.1 Tangent Drilled Shaft Walls**
  - **307.6.2 Secant Drilled Shaft Walls**
  - **307.6.3 Soldier Pile Walls**
    - Provides requirements for reinforcement and concrete cover of concrete lagging panels and permanent cast-in-place face.
SPECIFIC CONTENTS AND REVISIONS

- 307.6.4 Landslide Drilled Shafts
  - Per ODOT GB-7

- 307.7 Steel Sheet Pile Walls
  - 307.7.1 Cantilever Sheet Pile Walls
  - 307.7.2 Cellular Sheet Pile Walls
    - Gravity bin-wall composed of PS-Sections. Allows use of deeper elements for increased sliding resistance. Provides resistance factors for Connection Interlock Tension: $\varphi_{\text{interlock}} = 0.75$ and Horizontal Pullout Resistance: $\varphi_{\text{pullout}} = 1.00$. 

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SPECIFIC CONTENTS AND REVISIONS

- **307.8 Anchored Walls**
  - Per LRFD 11.9, SS866, and FHWA GEC 4

- **307.9 Soil Nail Walls**
  - Per FHWA GEC 7

- **307.10 Temporary Walls**
  - **307.10.1 Wire Faced MSE Walls**
    - Per SS867
  - **307.10.2 Fabric Wrapped Walls**
    - Per FHWA GEC 11
SPECIFIC CONTENTS AND REVISIONS

- **New Plan Notes:**
  - 605.1 and 605.2 Pile Driving Constraints and Footing Construction Constraints:
    added optional waiting period to all notes
  - 605.6 Shaft Drilling Constraints
  - 605.5-2 Foundation Bearing Resistance (MSE Walls)
  - 606.3 Steel Pile Points or Shoes: for H-piles, CIP reinforced concrete pipe piles, or steel open-ended pipe piles
SPECIFIC CONTENTS AND REVISIONS

- **New Plan Notes:**
  - 606.6 Foundation Reference Monuments for Retaining Wall Footings
  - 606.7 New Section: Pile Driving
    - 606.7-1 Pile Driving Hammer Minimum Rated Energy
    - 606.7-2 Vibration Monitoring
    - 606.7-3 Preconstruction Condition Survey
    - 606.7-4, 606.7-5, and 606.7-6 Pile Setup Notes
New Plan Notes:

- 606.8 Drilled Shafts:
  - 606.8-2 Friction Drilled Shafts
  - 606.8-3 Laterally Loaded Drilled Shafts
  - 606.8-4 Drilled Shafts Installed to Tip Elevation for Uplift
  - 606.8-5 Demonstration Drilled Shaft
SPECIFIC CONTENTS AND REVISIONS

- New Plan Notes:
  - 606.8 Drilled Shafts:
    - 606.8-6 Thermal Integrity Profiler (T.I.P.) Wire Cable Testing of Drilled Shafts
    - 606.8-7 CSL Testing of Drilled Shafts
    - 606.8-8 High-Strain Dynamic Testing of Drilled Shafts
SPECIFIC CONTENTS AND REVISIONS

- **New Plan Notes:**
  - 606.8 Drilled Shafts:
    - 606.8-6, 606.8-7, and 606.8-8 reference Special Provisions, now available on OGE Website: