New Jersey Turnpike Authority

P.O. Box 5042, Woodbridge, NJ 07095

November 3, 2023

Document Change Announcement

2007 Design Manual

Structural and Geotechnical Miscellaneous Updates

DCA2023DM-02

Subject: Revisions to

Section 3 Structures Design
Section 6 Geotechnical Engineering

Description of Change:

This DCA updates cross-references within the Design Manual and references to other publications, including the AASHTO LRFD Bridge Design Specifications, 9th Edition (2020), the NJDOT Design Manual for Bridges and Structures, 6th Edition (2016).

Notice to New Jersey Turnpike Authority Staff and Design Consultants

Effective immediately, all contracts currently in the design phase shall incorporate the revisions herein. For advertised contracts awaiting the opening of bids, this revision shall be incorporated by addendum. Contact your New Jersey Turnpike Authority Project Manager for instruction.

The revisions may be accessed on the Authority's webpage: https://www.njta.com/doing-business/professional-services

Recommended By:

Lamis T. Malak, P.E.
Deputy Chief Engineer - Design

Daniel Hesslein, P.E.
Deputy Chief Engineer - Construction

Approved By:

Michael Garofalo, P.E.
Chief Engineer

Distribution: Senior Staff Engineering, Law, Maintenance & Operations Depts., All Prequalified Consultant Firms, File

NOTE: All text herein are REVISIONS, as indicated by the tracked changes, to the latest version of the 2007 Design Manual.

3.2.2. Modifications to Current Codes

The following modifications to the current AASHTO LRFD Bridge Design Specifications shall apply:

…

5.9.2.3.2b~~5.9.4.2.2~~ ~~Tension~~ Tensile Stresses (AASHTO)
Article 5.9.2.3.2b~~5.9.4.2.2~~ shall be replaced by the following:

For service load combinations that involve traffic loading, tension stresses in members with bonded or unbonded pre-stressing tendons should be investigated using Load Combination Service III and the tension in the pre-compressed tensile zone shall be zero. Stress Limit limitations stated in AASHTO LRFD Specification Table ~~5.9.4.2.2-1~~5.9.2.3.2b-1 shall be accounted for in the NJDOT permit vehicle check, where applicable.

~~5.12.3~~5.10.1 Concrete Cover (AASHTO)
Article ~~5.12.3~~5.10.1 shall be replaced by the following:

The minimum clear cover for all reinforcement shall be two inches except as given below:

1. Concrete permanently in contact with earth: 3 inches

2. Concrete exposed to salt or brackish water:
   Piers and abutments: 4 inches
   Walls and culverts: 3 inches

3. Concrete in piers and abutments exposed to flowing water other than the above: 3 inches

…

3.2.4.2. Deck Slabs

…

3. Concrete Haunches

Haunches shall be provided for all cast in place concrete decks. The haunch shall be made deep enough to ensure that the concrete slab can be constructed to the nominal depth shown on the plans and with its top surface at the required profile, without any decrease in slab depth over the Stringer due to construction tolerances, variation in Stringer depth, variation in camber, deflection of the Stringer or other causes. The dimension from the top surface of the slab to the top of the Stringer shall not be less than the nominal slab plus 1" (minimum 1" haunch). The top of the Stringer shall normally be set so as to provide the minimum haunch depth over the thickest flange plate and at the most restrictive side of the Stringer when a cross slope is present. Where field splices in the Stringers are shown on the plans, or permitted by the Specifications, the haunch shall be a minimum depth of 1" over the splice plate. Bolt heads may project into the haunch, but 1" minimum of clear cover shall be maintained between the main steel reinforcement and the bolts.

Haunches that are over 4" high shall be reinforced~~ per details shown on Standard Drawing RP-5~~. Shear studs in reinforced haunches shall penetrate at least 2" above the top of the haunch reinforcement stirrup. Haunch reinforcement shall be designed as shear reinforcement and shall, in combination with the shear capacity of the unreinforced concrete, meet or exceed the fatigue resistance of the shear connectors as defined in Section 6.10.10.2 of the AASHTO LRFD BDS.

…

3.2.5.2. Abutments

…

4. Inte~~r~~gral ~~-~~and Semi-Integral Abutments

Integral abutment design shall conform to the ~~most current~~ provisions of the ~~4th~~ 6th Edition of the NJDOT Bridges and Structures Design Manual, Section 15, and the associated NJDOT Standard Drawing Plates ~~2.9-1~~2.5-1 through ~~2.9-5~~2.5-6, except as supplemented/modified by the following:

…

3.2.5.3. Scour Design

1. Bridge substructures and foundations shall be evaluated for scour conditions in accordance with the AASHTO LRFD BDS. Hydraulic and scour analysis shall be performed in accordance with Section ~~4~~ 5 of this Manual.

2. In accordance with the AASHTO LRFD BDS, new and replacement bridges shall be designed for the scour condition for a recurrence interval that is expected to produce the most severe adverse condition, up to 100 years maximum. Other existing bridges scheduled to be significantly rehabilitated or widened will be identified by the Authority on a Project by Project basis. Scour evaluations of existing bridges shall also take into account past history of floods in the Project area. The use of flood criteria greater than 100 years may be necessary and shall be evaluated on an individual bridge basis.
3. In accordance with the AASHTO LRFD BDS, new, replacement and widened bridges shall be checked for the scour condition for a 500-year flood.
4. In accordance with Section ~~4~~ 5 of this Manual, a Scour Report shall be submitted which shall include scour countermeasure and resistance recommendations.
5. Scour considerations and / or countermeasures shall be selected and designed as directed in Section 5 of this Manual.

…

3.2.6.8. Vulnerability Assessment and Retrofit Design

…

For existing bridge seismic retrofit evaluation, Method C: Component Capacity/Demand Method, as described in Subsection ~~6.4~~5.4 for Seismic Retrofit Category C and D, and Appendix D of the Retrofitting Manual shall be used, at a minimum.

Nonlinear static and / or dynamic analyses are recommended, but not required, where bridges with ductile details are to be evaluated, or where member strengthening and/or ductility enhancement are considered as part of the retrofitting concept.

Seismic retrofitting of existing bridges constitutes a substantial structural alteration. The Design Engineer shall perform a complete LRFR load rating analysis of the as-retrofitted bridge in accordance with the NJTA Load Rating Manual unless directed otherwise by the Engineer.

Isolation strategies, if employed, shall be designed in accordance with the AASHTO GSSID. This document is explicitly intended to function in concert with the AASHTO LRFD BDS and the AASHTO LRFD SBD. The use of Load Factor Design or Allowable Stress Design methodologies in concert with these Specifications is not permitted.

3.2.7. **Computer Software**

(For Design Purposes Only – See Section ~~2.4~~2.3 of the NJTA Load Rating Manual for Load Rating Computer Software Requirements)

…

3.4. CULVERTS

~~Culverts~~ The design of cast-in-place concrete Culverts, precast concrete box Culverts, precast concrete arch structures and precast concrete three-sided rigid frame structures shall conform to Subsection ~~6.14.5~~5.12 of this Manual and Section 12 of the AASHTO LRFD BDS.

…

3.5.1. General Design Criteria

…

Parkway - Multi-Timber Post / Pole

See Standard Drawings SL-1 to SL-7 and SI-43 to SI-47.

Timber double post sign structures included in Standard Drawing SI-44 are breakaway designs and are required when sign structures are to be placed within the roadway clear zone and lack roadside protection measures.

Timber double and triple post sign structures included in Standard Drawing SI-45 are non-breakaway designs and shall be provided with roadside protection measures or shall be located outside of the clear zone.

It is not necessary to perform design computations for sign panel and post configurations shown on the Standard Drawings. Where custom designs are required for configurations not shown on the Standard Drawings, the following wind loading criteria shall be followed when computing loads per AASHTO LTS Section 3:

- Wind Speed of 110 mph
- Kz = 0.87
- 10 year anticipated design life
- Note 'a' below Table ~~3-2~~3.8.3-1 is waived

…

3.5.2. Sign Structure Design

In the event that the standard sign structure configurations do not meet the specific needs of the Project, a custom design will be required. The Design Engineer will follow the provisions of the AASHTO LTS with the following provisions:

Wind Load

Basic Wind Speed as defined in Section 3.8.2 of the AASHTO LTS shall be defined as a minimum of 100 mph for all Turnpike and Parkway sign structures.

Wind Drag Coefficients, Cd, shall be determined in accordance with Table ~~3-6~~3.8.6-1 of the AASHTO LTS. Where the exact dimensions of a sign panel or sign structure element cannot be determined, the Design Engineer shall select the most conservative Drag Coefficient available for the most appropriate element type denoted in Table ~~3-6~~3.8.6-1 of the AASHTO LTS. When determining the Wind Drag Coefficient for square shaped tubular truss members, the radius (r) denoted in Table ~~3-6~~3.8.6-1 of the AASHTO LTS may be assumed as twice the thickness of the square shaped tubular member. VMS/CMS panels may use a drag coefficient of 1.2 for design.

The Height and Exposure Factor, KZ, shall be no less than 0.94 for all parts of the sign structure under normal exposure. Higher values of KZ shall be considered, in accordance with Table ~~3-5~~3.8.4-1 of the AASHTO LTS, when structures are situated in abnormally exposed conditions on high embankments or on bridge piers or superstructures. The standard designs have been prepared using a value of KZ of 1.0. The Design Engineer shall check the design of the standard sign structures for the particular use intended wherever it is determined that a higher value of the KZ is appropriate.

The Wind Importance Factor and Velocity Conversion Factors defined in Tables ~~3-2~~3.8.3-1 and ~~3-4~~3.8.3-3 of the AASHTO LTS shall consider a 50 year design life, unless otherwise directed by the Authority.

…

1. Loadings for Design

   The foundations of span-type sign structures shall be designed for a band of signs having a length extending over the entire width of the roadway plus shoulders and having a height equal to the maximum height of sign that can be accommodated by the end frame of the sign structure. The maximum area of sign that need be used for design of structures shall be as specified on the Standard Drawings. Where the actual sign panel(s) width x length is unknown, the most conservative Wind Drag Coefficient (Cd) for sign panels shall be selected from Table ~~3-6~~3.8.6-1 of the AASHTO LTS.

…

3.9.4.13. ~~Welding~~ Welded Joints Design and Detailing

Welded joint design and detailing shall comply with the latest edition of the AASHTO/AWS D1.5 Bridge Welding Code. Information provided on Contract Plans shall conform to ~~Subsection~~ Clause ~~2.14~~4.1 of the same text. Weld call-outs and symbols shall conform to AWS A2.4. Finish grinding, where required, shall be shown on the welding symbol in the Contract Plans. Contract Plans shall show PJP or CJP requirements for all groove welds. It is not necessary for the Contract Plans to detail the specific joint designation for the welding procedure, however, the specific joint designation proposed by the Contractor is required for all welding symbols placed on working or shop drawings.

Specific reference is made within this section to the definition of Fracture Critical Members and guidelines related to member identification. A note shall be added to the structural steel plans that Fracture Critical Members and/or member components shall be subject to the provisions of the current Edition of the AASHTO/AWS D1.5 Bridge Welding Code, ~~Section~~ Clause 12.

…

6.2. Purpose & Content

Section 6 of the Authority's Design Manual provides guidance, policies, and standard practice for the Geotechnical Exploration Plan (GEP), geotechnical analysis and design, and construction monitoring. The instructions found within Section 6 constitute the minimum required level of effort on the part of the EOR. The EOR is encouraged to exceed the minimum required level of effort when best practices dictate. The Authority desires the "best value" geotechnical solution, not the "lowest cost" geotechnical solution in cases when these two conditions are not the same.

Section 6 of the manual is intended to work in tandem with the Authority's Procedures Manual. As stated in the Procedures Manual, the Geotechnical Engineering effort will be conducted in Preliminary and Final Design Phases A through D:

- Preliminary Design - Perform Desk Study.
- Phase A - Geotechnical Engineering: Prepare and submit Phase A Geotechnical Engineering Report, Desk Study, and GEP.

…

6.4.2.4. **Geophysical Testing**

Geophysical Testing offers nondestructive and/or non-invasive methods that can be used for stratigraphic profiling and delineation of subsurface geometries. Certain geophysical tests shall either be required or recommended for different situations. A comprehensive reference on this subject is provided in the AASHTO "Manual on Subsurface Investigations" and Federal Highway Administration publication FHWA-IF-04-021 entitled "Application of Geophysical Methods to Highway Related Problems". A list of common methods is described below:

A. Crosshole Seismic Testing (CST): Where requested by the GE through the EOR and approved by the Authority, CST shall be performed in accordance with ASTM D4428. Crosshole Seismic Testing shall be performed to obtain soil shear wave velocities and is the preferred method for determination of this parameter. CST may be performed for site specific seismic design or liquefaction evaluation.

B. Downhole Seismic Testing (DST): Where requested by the GE through the EOR and approved by the Authority, DST shall be performed in accordance with ASTM D7400 as a substitute to the CST. Similar to the CST, it provides soil shear wave velocities, however only one cased borehole is required to perform the test. The DST may be replaced by suspension PS logging system.

~~B.~~C. Parallel Seismic Testing (PST): Where requested by the GE through the EOR and approved by the Authority, PST shall be performed in accordance with ASTM D8381. PST shall be performed to measure the depth of deep foundation elements for foundations are in consideration for reuse. PST should be considered for existing deep foundation elements where the as built information is not available.

~~C.~~D. Multichannel Analysis of Surface Waves (MASW): Where requested by the GE through the EOR and approved by the Authority, MASW may be performed to delineate construction debris within fills to assess the potential for obstructions, estimate removal volumes and costs or to identify shallow bedrock surfaces to estimate volumes and costs of rock excavation.

~~D.~~E. Acoustic Televiewer (ATV) and Optical Televiewer (OTV): Where requested by the GE through the EOR and approved by the Authority, ATV or OTV logging shall be performed in accordance with ASTM D5753. ATV and OTV logging may be performed within boreholes to log bedrock conditions including fracture location, orientation, size, strike, dip, and infill material. ATV and OTV logging may also be used to investigate the soil/rock interface, particularly if soil boring or rock coring may not provide adequate definition of conditions. ATV and OTV should be considered where rock socketed foundations are anticipated.

~~E.~~F. Ground Penetrating Radar (GPR): Where requested by the GE through the EOR and approved by the Authority, shall be performed in accordance with ASTM D6432. GPR is performed from the ground surface and is often limited in its depth of survey depending on subsurface conditions. It is often used to detect near surface utilities or obstructions.

…

6.4.7. As-Drilled Boring Location Plans

…

E. In situ Test Designation:

- ATV – Acoustic Televiewer
- CST – Crosshole Seismic Test
- DMT – Flat Plate Dilatometer Test
- DST – Downhole Seismic Test
- OTV – Optical Televiewer
- PMT – Pressuremeter Test
- PSL – PS Logging
- PST – Parallel Seismic Test
- PT – Permeability Test
- VST – Vane Shear

…

6.6.1. Structural Foundations

6.6.1.1. Soil and Rock Properties

Soil and rock properties shall be obtained from the in-situ tests, laboratory tests, and published correlations developed for similar type of materials. Use of published correlations should be used with caution. Consideration to the source documents, basis of studies and sample population and study setting employed to establish such correlations needs to be carefully considered. Judgment shall be applied based on the relative importance and reliability of the methods. Published AASHTO-LRFD-BDS Subsection 10.4, FHWA Geotechnical Engineering Circular (GEC) No. 5, FHWA Soils and Foundation Reference Manual, FAVFAC Design Manuals 7.01 & 7.02, Unified Facilities Criteria (UFC) DM 7.1, and EPRI Manual on Estimating Soil Properties for Foundation Design shall be utilized. Parameters provided in technical manuals of computer programs may be used.

…

6.6.1.5. **Driven Piles**

A. In addition to the methods and recommendations outlined in the AASHTO-LRFD-BDS, the procedures in the ~~Federal Highway~~ FHWA GEC No. 12, Design and Construction of Driven Pile Foundations Reference Manual Volumes I & II (~~,~~ FHWA-NHI-~~05~~16-~~042~~ 009 & FHWA-NHI-~~05~~16-~~043~~ 010) shall be followed. Driven piles utilized for the support of fenders shall be designed with the requirements specified in this Subsection and Subsection 6.7.8.

…

G. Steel pile sections shall be reduced for corrosion as specified in FHWA-~~NHI-05-042~~GEC No. 12. Additional section loss shall be considered where aggressive conditions exist. Refer to AASHTO and the FHWA driven pile reference for guidance on deterioration mechanisms and mitigation measures for piles. If the soils are of an aggressive nature, a site specific corrosion assessment shall be considered and if deemed necessary shall be performed by an underground Corrosion Specialist. Specific corrosion rates and protection methods shall be included in the Phase B Geotechnical Engineering Report submittal.

…

6.6.1.6. **Drilled Shafts**

A. In addition to the methods outlined in the AASHTO-LRFD-BDS Specifications, the procedures in the ~~Federal Highway~~ FHWA GEC No. 10, Drilled Shafts: Construction Procedures and Design Methods (FHWA-NHI-~~10~~18-024~~16~~) shall be followed. Drilled shafts utilized for the support of fenders shall be designed with the requirements specified in this Subsection and Subsection 6.7.8.

B. The minimum diameter of a drilled shaft shall be 30 inches. The minimum center to center spacing of any two drilled shafts shall be 3.0 diameters. However, if the center to center spacing is less than 4.0 diameters, the group reduction factors presented in Table 10.8.3.6.3-1 (Group Reduction Factors for Bearing Resistance of Shafts in Sand) of AASHTO-LRFD-BDS shall be applied, and the sequence of construction should be specified in the contract document.

C. Foundation redundancy shall be defined as when a single foundation unit contains 3 or more drilled shafts. Where a single foundation contains less than 3 drilled shafts, a 20 percent reduction shall be applied to the resistance factors presented in Table 10.5.5.2.4-1 ~~"~~“Resistance Factors for Geotechnical Resistance of Drilled Shafts~~"~~” of AASHTO-LRFD-BDS.

…

H. Permanent Steel Casing sections shall be reduced for corrosion as specified in FHWA GEC No. 10 ~~NHI-05-042~~. Additional section loss shall be considered where aggressive conditions exist. Refer to AASHTO and the FHWA driven pile reference for guidance on deterioration mechanisms and mitigation measures for piles If the soils are of an aggressive nature, a site specific corrosion assessment shall be considered and if deemed necessary shall be performed by an underground Corrosion Specialist. Specific corrosion rates and protection methods shall be included in the Phase B Geotechnical Engineering Report submittal.

…

Q. The decision to require load testing and/or demonstration shafts shall be based upon the recommendation of the GE at the approval of the Authority. The GE should consider issues such as redundancy, shaft diameter, load demand, and site constraints in making this recommendation. At a minimum, load tests shall be performed on demonstration or production shafts (as recommended) to verify the geotechnical resistance or establish the final shaft tip elevation during construction for bridge substructures. Bidirectional –Load Cells, ASTM D8169 or AASHTO TP 100 "Standard Method of Test for Deep Foundation Elements under Bidirectional Static Axial Compressive Load", and or ASTM D1143, "Standard Test Methods for Deep Foundations Under Static Axial Compressive Load" are acceptable test methods. Other methods such as Statnamic load tests or the "Standard Test Methods for Axial Compressive Force Pulse (rapid) Testing" (ASTM D7383) shall be specified and used only with approval by the Authority. When performing such tests on production shafts, care shall be taken not to fail the shafts and specific project guidance should be included in the Contract Documents.

…

6.6.1.7. Micropiles

In addition to the methods outlined in the AASHTO-LRFD-BDS, the procedures in the Federal Highway Micropile Design and Construction Reference Manual (FHWA-NHI-05-039) shall be followed.

…

6.6.2.7. Non-Gravity Cantilevered Walls

…

B. Soldier Pile and Lagging Walls

…

6.6.2.8. **Anchored Walls**

Anchor walls (also referred to as tieback walls), whose elements may be proprietary, employ grouted anchor elements, vertical elements and facing. Any of the above Non-Gravity Cantilever Walls could be augmented with ground anchors to increase stability or decrease ground movements. The feasibility of using an anchored wall at a particular location should be based on the suitability of subsurface soil and rock conditions within the bonded anchored stressing zone. The availability of permanent ROW for the ground anchors must also be considered.

AASHTO-LRFD-BDS Subsection 11.9 and FHWA GEC No. 4 ~~-~~"Ground Anchors and Anchor Systems" (FHWA-IF-03-017) shall be followed. Corrosion protection for anchored wall systems shall be in accordance with AASHTO-LRFD-BDS Subsection 11.9.7 and GEC No. 4, Chapter 7 Corrosion Consideration in Design" Class I or Class II corrosion protection is required for permanent applications. Anchored Wall drainage systems shall be in accordance with Subsection 6.6.2.3.

…

6.6.2.9. **Mechanically Stabilized Earth Walls (MSE)**

…

AASHTO-LRFD-BDS and FHWA GEC No. 11 Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes, Volumes I and II (-FHWA-NHI-10-024 and 025) shall be supplemented with the following:

A. Wall systems specified in NJTA Specifications shall be used. Other type of MSE wall types shall be pre-approved by the Authority.

B. NJTA Standard and Supplementary Specifications.

C. The GE is responsible for the external stability of MSE walls including bearing resistance, eccentricity, sliding and global stability. Slope stability analysis shall be performed to investigate global stability and compound stability.

- Global stability analysis shall be conducted such that the failure surfaces are forced outside of the reinforced zone by modeling the reinforced portion of the wall as a rigid body.

- Compound stability analyses shall be performed for MSE walls to investigate potential compound failure surfaces by allowing failure planes to pass behind or under and through a portion of the reinforced soil zone. When compound stability becomes as a concern, the GE shall provide minimum reinforcement requirements in the Contract Plans (Ex: minimum 3 layers of reinforcement in bottom 5 feet). See Subsection 11.10.4.3 of AASHTO-LRFD-BDS and Subsection 4.4.10 of FHWA ~~Federal Highway~~ GEC No. 11~~, FHWA-NHI-10-024~~ for more details.

D. Design guidelines for geometrically complex MSE wall systems such as tiered walls, ~~back to back~~back-to-back walls, or walls which have trapezoidal sections shall be in accordance with the procedures in ~~the~~FHWA ~~Federal Highway~~ GEC No. 11~~, FHWA-NHI-10-024~~.

…

H. Guidelines for corrosion/degradation of steel or geosynthetic reinforcements shall be in accordance with ~~FHWA NHI 10 024 and 025~~FHWA GEC No. 11 and shall be supplemented with NJTA Standard and Supplementary Specifications.

…

6.7.5. Ground Improvement Methods

Significant sections of the existing Authority roadways are underlain by soft, weak, compressible soils which include peats, organic silty clays and varved clays. These areas have required special foundation treatment to maintain a stable embankment and minimize roadway settlements. In some areas the Authority's roadways are in cuts that extend into clayey soils which have required underdrains and/or undercutting to maintain stability and a smooth pavement surface. These potential problems should be investigated and evaluated as part of the preliminary exploration of embankment foundation and cut areas.

Ground improvement techniques shall be considered to strengthen loose granular soils or compressible organic and inorganic silts and clays, to provide adequate foundation or embankment support or to reduce deformations and accelerate the time rate of consolidation. Guidance for analysis and design of ground improvement techniques shall be found in ~~Federal Highway~~FHWA GEC No. 13-Ground Modification Methods Reference Manual, Volumes I and II (FHWA-NHI-1~~0~~6-027~~19~~ and 028~~0~~), ~~"Ground Improvement Methods Reference Manual",~~ ASCE Geotechnical Special Publications No. 104, 112, 119, 120, 124, 136, 168, 172, 187, 188, 207, 228, 238, and SHARP 2 Geotech Tools Website, however many ground improvement methods are performance based and/or proprietary and may require design input by others. Following methods shall be considered:

…

6.7.7. Reuse of Foundations

Important technical issues must be addressed to ensure that foundation reuse is undertaken appropriately. Foundation reuse is not explicitly addressed in current foundation design standards and may not comply with current standards, particularly for materials and construction quality control. The amount of investigation of a reused foundation system may need to be balanced against perceived risks as well as the amount and veracity of information. Guidance on the type of investigations shall be found in AASHTO Manual on Subsurface Investigations. The design of foundations that are reused or incorporate reused elements may require explicit assessment to address the uncertainty inherent in current understanding of foundation behavior.

…

D. Foundation design shall be performed to confirm load bearing and deformation criteria are met. Service life of the foundations and retaining walls shall be estimated from AASHTO Guide Specifications for Service Life Design of Highway Bridges.

1. Structural foundations shall follow Subsection 6.6.1.
2. Walls and Abutments shall follow Subsection 6.6.2.
3. Buried Structures shall follow Subsection 6.6.3.
4. Sound Barriers shall follow Subsection 6.6.4.

…

6.8.2.1. Seismic Site Class

A site shall be classified, based on the stiffness of the subsurface material, as A though F in accordance with the Site Class definitions in Table 3.10.3.1-1 of AASHTO-LRFD-BDS and AASHTO Guide Specification for LRFD Seismic Bridge Design. Site classification shall be determined using shear wave velocity, SPT blow counts, and/or undrained shear strength for the surficial 100 feet of subsurface. The methods specified based on SPT blow count or based on correlated shear strength values may not be representative for sites with zero or very low SPT blow counts especially in very soft clayey/organic soils and very loose sands. A Project site may be subdivided into different site classes depending on site variation.

Site class for building structures shall be performed in accordance with IBC NJ Edition.

6.8.2.2. Acceleration Coefficients

Peak Ground Acceleration coefficient on rock (PGA), horizontal response spectral acceleration coefficient at 0.2-sec period on rock (S_S), and horizontal response spectral acceleration coefficient at 1.0 sec period on rock (S_1) are provided in Subsection 3.10 of AASHTO-LRFD-BDS for 1,000 Year return period event (7% probability in 75 years). The acceleration coefficients for 2,500 Year return period events can be obtained from USGS website: http://earthquake.usgs.gov/hazards/. The acceleration coefficients for buildings shall be obtained from IBC NJ Edition.

…

6.8.3.2. Site Specific Response Spectrum

…

- Soil and rock material properties such as initial shear modulus, unit weight, gradation, plasticity index, and relative density are important parameters in obtaining an accurate and appropriate site-specific response spectrum. Selection of these material properties can be in accordance with FHWA GEC No. 3-LRFD Seismic Analysis and Design of Transportation Geotechnical Features and Structural Foundations Reference Manual (FHWA-NHI-11-032). In order to accommodate the variation in material properties, sensitivity studies should be conducted. A range of material parameters an appropriate range based upon the standard deviation above and below the average value should be assessed.

…

6.8.6. Seismic Hazards

- The site-adjusted peak ground acceleration, As (Fpga × PGA, as specified in AASHTO-LRFD-BDS Article 3.10.3.2), shall be used for evaluating seismic hazards.
- Earthquake Magnitude of 6.0 shall be used unless directed by the Authority.
- Liquefaction potential shall be evaluated using FHWA GEC No. 3 or EERI Monograph 12-Soil Liquefaction During Earthquakes.

…

6.12. References

1. American Association of State Highway and Transportation Officials (AASHTO), "AASHTO Guide Specifications and Commentary for Vessel Collision Design of Highway Bridges," 2nd Edition, 2009 with 2010 Interim Revisions.

2. American Association of State Highway and Transportation Officials (AASHTO), "AASHTO Guide Specifications for LRFD Seismic Bridge Design," 2nd Edition, 2011 with 2012, 2014, 2015, 2022 Interim Revisions.

3. American Association of State Highway and Transportation Officials (AASHTO), "Guide Specification for Service Life Design of Highway Bridges," 1st Edition, 2020.

~~3.~~4. American Association of State Highway and Transportation Officials (AASHTO), "LRFD Bridge Design Specifications," 9th Edition, 2020.

~~4.~~5. American Association of State Highway and Transportation Officials (AASHTO), "LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals," 1st Edition, 2015.

6. American Association of State Highway and Transportation Officials (AASHTO), "Manual on Subsurface Investigations," 2nd Edition, 2022.

~~5.~~7. American Association of State Highway and Transportation Officials (AASHTO), "Standard Specifications for Highway Bridges," 17th Edition, 2002.

~~6.~~8. American Association of State Highway and Transportation Officials (AASHTO), "Standard Specifications for Transportation Materials and Methods of Sampling and Testing".

~~7.~~9. American Railway Engineering and Maintenance-of-Way Association, "Manual for Railway Engineering," Volumes 1-4, ~~2014~~2022.

~~8.~~10. American Society of Civil Engineers (ASCE), Geotechnical Special Publications.

~~9.~~11. Arneson, L.A., Zevenbergen, L.W., Lagasse, P.F., and Clopper, P.E., "Hydraulic Engineering Circular (HEC) 18 – Evaluating Scour at Bridges," Federal Highway Administration Publication No. FHWA-HIF-12-003, Fifth Edition, April 2012.

~~10.~~12. ASTM International, "Annual Book of ASTM Standards".

~~11.~~13. Berg, R.R., Christopher, B.R., Samtini, N.C., "Geotechnical Engineering Circular (GEC) No. 11 – Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Volumes I & II," Federal Highway Administration Publication Nos. FHWA NHI-10-024 & FHWA NHI-10-025, November 2009.

~~12.~~14. Brown, D.A., Dapp, S.D., Thompson III, WR., Lazarte, C.A., "Geotechnical Engineering Circular (GEC) No. 8 – Design and Construction of Continuous Flight Auger (CFA) Piles," Federal Highway Administration Publication No. FHWA-HIF-07-039, April 2007.

~~13.~~15. Brown, D.A., Turner, J.P., Castelli, R.J., Loehr, E.J., "Geotechnical Engineering Circular (GEC) No. 10 - Drilled Shafts: Construction Procedures and ~~LRFD~~ Design Methods," Federal highway Administration Publication No. FHWA-NHI-18~~0-~~024~~16~~, September~~May~~ 2018~~0~~.

~~14.~~16. Buckle, I.G., Friedland, I., Mander, J., Martin, G., Nutt, R., Power, M., "Seismic Retrofitting Manual for Highway Structures: Part 1 – Bridges," Multidisciplinary Center for Earthquake Engineering Research Publication No. MCEER-06-SP10, December 2006.

~~15.~~17. Burmister, D.M., "Principals and Techniques of Soil Identification," Proceedings of the Highway Research Board, December, 1949.

~~16.~~18. Carlos A. Lazarte, Ph.D., P.E., Victor Elias, P.E., R. David Espinoza, Ph.D., P.E., Paul J. Sabatini, Ph.D., P.E., "Geotechnical Engineering Circular (GEC) No. 7 – Soil Nail Walls," Federal Highway Administration Publication No. -. FHWA-NHI-14-007.

~~17.~~19. Collin, J.G. (2004). "Column Supported Embankments - Technical Summary #7. Ground Improvement Methods", FHWA NHI-04-001, October, Federal Highway Administration, Washington, D.C.

~~18.~~20. Collin, J. G., Hung, J. C., Lee, W. S., Munfakh, G., "Soil Slope and Embankment Design Reference Manual," Federal Highway Administration Publication No. FHWA-NHI-01-026, March 2001.

~~19. Commonwealth of Kentucky Transportation Cabinet (KTC), "Geotechnical Guidance Manual," June 2005.~~

~~20.~~21. Dalton, R., Monteverde, D., Sugarman, P., and Volkert, R., "Bedrock Geologic Map of New Jersey," New Jersey Department of Environmental Protection, 2014.

~~21. Elias, V., Welsh, J., Warren, J., Lukas, R., Collin, G., and Berg, R.R., "Ground Improvement Methods Reference Manual – Volumes I & II," Federal Highway Administration Publication No. FHWA-NHI-06-019 & FHWA-NHI-06-020, August 2006.~~

22. Golder Associates, "Rock Slopes: Design, Excavation, Stabilization," Federal Highway Administration Publication No. FHWA-TS-89-045, September 1989.

23. Han, J. and Akins, K. (2002). "Case Studies of Geogrid-Reinforced and Pile-Supported Earth Structures on Weak Foundation Soils," Proceedings of the International Deep Foundation Congress, Geotechnical Special Publication No. 116 - Deep Foundations 2002, M. W. O'Neill and F. C. Townsend (Eds.), ASCE, Orlando, FL, pp. 668-67

24. Hannigan, P.J., Rausche, F., Likins, G.E., Robinson B.R., and Becker M.L., "Geotechnical Engineering Circular (GEC) No. 12 – Design and Construction of Driven Pile Foundations – Volumes I & II," Federal Highway Administration Publication Nos. FHWA-NHI-16-009 & FHWA-NHI-16-010, September 2016~~Hannigan, P.J., Goble, G.G., Likins, G.E., Rausche, F., "Design and Construction of Driven Pile Foundations – Volumes I & II," Federal Highway Administration Publication Nos. FHWA-NHI-05-042 & FHWA-NHI-05-043, April 2006~~.

…

28. International Code Council Inc., "International Building Code – New Jersey Edition," ~~2009~~2021.

…

~~50. Oregon Department of Transportation (ODOT), "Geotechnical Design Manual," April 2010.~~

~~51.~~50. Puckett, J.A., Garlich, M.G., Nowak, A., Barker, M., "Development and Calibration of AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals," Transportation Research Board (TRB) National Cooperative Highway Research Program (NCHRP) Report 796, 2014.

~~52.~~51. Rutgers University College of Engineering, "Engineering Soil Survey of New Jersey," Rutgers University College of Engineering Research Bulletins - Nos. 15 through 36.

~~53.~~52. Sabatini, P.J., Bachus, R.C., Mayne, P.W., Schneider, J.A., Zettler, T.E. "Geotechnical Engineering Circular (GEC) No. 5 – Evaluation of Soil and Rock Properties," Federal Highway Administration Publication No. FHWA-IF-02-034, April 2002.

~~54.~~53. Sabatini, P.J., Elias, V., Schmertmann, R. Bonaparte, "Geotechnical Engineering Circular (GEC) No. 2 – Earth Retaining Systems," Federal Highway Administration Publication No. FHWA-SA-96-038, February 1997.

~~55.~~54. Sabatini, P.J., Pass, D.G., Bachus, R.C., "Geotechnical Engineering Circular (GEC) No. 4 – Ground Anchors and Anchored Systems," Federal Highway Administration Publication No. FHWA-IF-99-015, June 1999.

~~56.~~55. Sabatini, P.J., Tanyu, B., Armour, T., Groneck, P., Keeley, J., "Microp~~-P~~ile Design and Construction Reference Manual," Federal Highway Administration Publication No. FHWA-NHI-05-039, December 2005.

56. Samtani, N.C., Nowatzki, E.A., "Soils and Foundations Reference Manual – Volumes I & II," Federal Highway Administration Publication No. FHWA-NHI-06-088 & FHWA-NHI-06-089, December 2006.

57. Schaefer, V.R., Berg, R.R., Collin, J.G., Christopher, B.R., DiMaggio, J.A., Filz, G.M., Bruce, D.A., and Ayala, D., "Geotechnical Engineering Circular (GEC) No. 13 – Ground Modification Methods - Reference Manual – Volumes I & II," Federal Highway Administration Publication No. FHWA-NHI-16-027 & FHWA-NHI-16-028, April 2017.

58. Shan, H., Shen, J., Kilgore, R., and Kerenyi, K., "Scour in Cohesive Soils," Federal Highway Administration Publication No. FHWA-HRT-15-033, May 2015.

59. Tanyu, B.F., Sabatini, P.J., and Berg, R.R., "Earth Retaining Structures," Federal Highway Administration Publication No. FHWA-NHI-07-071, June 2008.

60. Terzaghi, K. and Peck, R.B., "Soil Mechanics in Engineering Practice," 2nd Edition.

61. Turner, J. P. 2006. *NCHRP Synthesis 360: Rock-Socketed Shafts for Highway Structure Foundations*. Transportation Research Board, National Research Council, Washington, DC, 148 pp.

~~61.~~62. Unified Facilities Criteria (UFC), Soil Mechanics – DM 7.1, UFC-3-220-10, 2022.

~~62.~~63. United States Department of Agriculture (USDA), “Soil Maps”.

~~63.~~64. United States Steel (USS), “Steel Sheet Piling Design Manual,” Updated and Reprinted by United States Department of Transportation (USDOT)/FHWA with permission, July 1984.

~~64.~~65. U.S. Army Corps of Engineers, “Seepage Analysis and Control of Dams,” USACOE Publication No. EM1110-2-1901, April 1993 (change 1).

~~65. Washington State Department of Transportation (WSDOT), “Geotechnical Design Manual,” April 2012.~~

66. Wightman, W.E., Jalinoos, F., Sirles, P., and Hanna, K., “Application of Geophysical Methods to Highway Related Problems,” Federal Highway Administration Publication No. FHWA-IF-04-021, 2003.