

SECTION 01 82 13 – FOUNDATIONS

1.01 SUMMARY:

- A. ^{A17}The Contractor shall provide ^{A17} foundations as required to support the proposed buildings and other structures, except lock structures defined in Section 01 81 16 (*Lock Structures*) ^{A13} and dam foundations defined in Section 35 73 00 (*Borinquen Dams 2E, 1W and 2W and Dry Excavation North of the Pacific Locks*) ^{A13}, safely and without settlement or movement that would adversely affect their serviceability.
- B. Foundations comprise the following elements:
1. **Standard Foundations:** Includes spread footings below columns, linear spread footings below load bearing walls, and foundation walls.
 2. **Other Foundations:** All types of special foundation systems, including but not limited to permanent shoring and underpinning, raft foundations, sheet piles, piles, and pile/piers.
 3. **Floors on Grade:** All elements necessary for slab (mat) foundations, including trenches, beams, pits, sumps, equipment bases, vapor barriers, slab moisture protection, and sub-drainage system.
 4. **Other Foundation Elements:** Includes high mast foundations, pole foundations, communications tower foundations, storage tank foundations, and retaining walls.
- C. Where foundations are integral with elements defined within another element group, meet requirements of both element groups.
- D. In addition to the requirements of this ^{A5}Section^{A5}, comply with all applicable requirements of Sections 01 81 36 (*O^{A5} & ^{A5}M Buildings and Facilities Program*) and 01 81 36.13 (*O^{A5} & ^{A5}M Buildings and Facilities - Space Programming*).

1.02 ^{A16}REFERENCES:^{A16}

- A. **International Code Council (ICC) Code Publications:**
International Building Code, 2006
- B. **Junta Tecnica de Ingenieria y Arquitectura (JTIA) Resolution (Panama):**
Reglamento para el Diseño Estructural en la República de Panama (REP 2004)
- C. **Eurocodes Expert, an Institution of Civil Engineers (ICE) and Institution of Structural Engineers Publications:**
BS EN 97-1 Eurocode 7: Geotechnical Design
BS EN 98 Eurocode 8: Design of Structures for Earthquake Resistance

D. American Association of State Highway and Transportation Officials (AASHTO) Standards:

LRFD Bridge Design Specifications, 4th Edition.

Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals, 4th Edition.

E. American Society for Testing and Materials (ASTM) International Standards:

D 2487-00 Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D 2488-06 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

1.03 REQUIREMENTS ^{A5, A5}

A. Waterproofing ^{A5, A5}

1. ^{A17}The Contractor shall provide ^{A17} permanent waterproofing at portions of foundation that extend below water table and enclosed habitable space (shaft elevators, tunnels, Crossunders, pits, cable trenches, cable galleries). ^{A16}See Volume VI, Part 7 (*Hydro-meteorological Report*) for information on water levels which the Employer has provided as reference only. ^{A16}

B. Drainage:

1. Refer to Section 01 86 36 (*Drainage Systems*).

C. Geotechnical ^{A5, A5}

1. The Contractor shall:

- a. Conduct geotechnical analyses, design and construction in accordance with all applicable criteria and standards cited herein and in accordance with these specifications.
- b. ^{A16}Review the available information, data, drawings, and geotechnical and geological reports and maps for the Site.
- c. Conduct additional investigations to supplement the currently available information and to properly characterize the subsurface conditions at the Site for the design and construction of the ^{A17}Works. ^{A17}
- d. Provide geotechnical data, interpretation, and design reports that include, at the minimum, the following:
 - 1) A description of the geology, groundwater, and various soil types that were encountered at the locations of structures. The relevant boring logs shall be included.

- 2) A description of the geotechnical information that was collected and analyzed in developing the interpretations used to develop the proposed foundations.
- 3) An assessment of the engineering properties of all soil types, including the expected average and range of soil strengths and deformation properties.
- 4) The recommended design parameters for all soil types.
- 5) A description of the anticipated behavior during construction and after the completion of the various structures and foundations.
- 6) ^{A16}A description of how the interpretation was derived from the geotechnical data made available by the Employer and/or obtained by the Contractor. ^{A16}

1.04 DESIGN CRITERIA/SYSTEM DESCRIPTION ^{A5}; ^{A5}

- A. **Performance:** The foundation of any structure shall satisfy the following design criteria.
1. The foundations shall be designed for an acceptable allowable bearing capacity that includes a minimum factor of safety of 2.5 against bearing failure on the foundation soils.
 2. Settlements during the life of the structure shall not be of a magnitude that will cause structural damage, or impair the operational efficiency of the facilities.
 3. ^{A5}The Contractor shall prepare the design criteria for limiting total settlement of structures and differential settlement of the various parts of the structures to prevent cracking or tilting that adversely affects serviceability, and/or causes damage that affects structural integrity or stability of the structure. ^{A5} [The design criteria shall meet the requirements of “Reglamento para el Diseño Estructural en la República de Panama \(REP 2004\).”](#)
 4. ^{A5}Settlement calculations shall be based on the results of consolidation tests performed on unaltered samples. ^{A5}
 5. ^{A16}Trenches and galleries for utilities shall be designed to maintain the environment and conditions required by the specific parts on these structures. ^{A16}
 6. The assessment and calculations of the above bearing capacities and settlements shall be based on the best-estimate soil parameters and groundwater conditions, taking into considerations the range and variability of those parameters.
 7. The effects of geo-hazards (if any), such as expansive soil and liquefaction, shall be considered in the design.
 8. The performance criteria specified herein shall apply to both the gravity and seismic loading conditions.
- B. **Capacity:** Provide load bearing foundation members as required to carry the loads and provide support for the structures identified in Sections 01 81 36 (*O* ^{A5} & ^{A5} *M Buildings*)

and Facilities Program), Section 01 83 00 (*Facility Shell Performance Requirements*), Section 26 05 43 (*Underground Ducts and Raceways for Electrical Systems*), 01 86 13 (*Plant – Mechanical System and Equipment*) and other electrical and communication systems in other ^{A5}Sections ^{A5} of these specifications.

1. **Minimum Wall Thickness:** Not less than the thickness of superstructure walls supported by foundation walls, but in no case shall the minimum foundation wall thickness be less than 200 mm.
2. **Footings:** Minimum concrete compressive strength of 21 MPa and minimum effective depth of 200 mm. Concrete and reinforcing shall comply with the requirements of Section 03 30 00 (*Concrete*).
3. **Pile Caps:** Minimum concrete compressive strength of 21 MPa and minimum effective depth of 300 mm. Concrete and reinforcing shall comply with the requirements of Section 03 30 00 (*Concrete*).
4. **Uplift Pile Capacity:** It shall be determined by the contact area and shear strength of penetration section. The point (tip) bearing shall be ignored.
5. Soil classification system shall be the Unified Soil Classification System (USCS) in accordance with ASTM D 2487 and ASTM ^{A5}D 2488. ^{A5}
6. All foundations shall be specified by referencing a current standard design with clear notation on the plans of specific wall heights, dimensions, reinforcement options, exceptions, and modifications. All exceptions and modifications must be justified by the Contractor to the satisfaction of the Employer's Representative.
7. Analysis of design capacity shall be based on SPT or cone penetrometer results, laboratory and in-situ strength tests, consolidation tests, and the results of instrumentation programs, if available.
8. All retaining walls, including gravity walls, cantilever walls, crib walls, mechanically stabilized earth (MSE) walls, and soil nail walls, must be designed in accordance with the current design specifications with adequate soil resistance against the overall stability (bearing, sliding, and overturning) as well as internal stability.
9. Scour shall be addressed for all foundations located within a stream or flood plain of the stream. ^{A16}The Contractor shall perform hydraulic modeling and analyses and scour analyses to determine the design scour depths. ^{A16}
10. Foundation capacities for the gravity and seismic loadings shall be evaluated.

C. **Products:**

1. Do not use any of the following:
 - a. Wood foundation systems.
 - b. Masonry footings.

- c. Foam plastic insulation below grade.

D. Methods of Construction:

- 1. ^{A16}Existing foundation elements found in the way of new work must be removed to perform new construction. ^{A16} Such foundations shall only be removed using methods that will maintain the stability and operational functions of the affected facilities.
- 2. Do not use any of the following methods and techniques:
 - a. Nuclear related methods.
 - b. Unproven technology (or methods or techniques not successfully used in the last five years, counted from date of ^{A17}the Tender). ^{A17}

- E. ^{A17}**Design Development:** Volume VI, Part 2 (*Geotechnical Data Report*) contains the geotechnical information for the Site. The Contractor shall supplement it with any additional site investigation that he deems necessary to determine the design requirements. The Contractor is referred to Clause 5.1 of the Conditions of Contract concerning documents in Volume VI. ^{A17}

- F. **Construction Documents:** Product data on specific water protection materials and systems; details of construction to achieve permanent water protection.

G. Acoustical Performance:

- 1. **Vibration Control:** Use foundation elements that are designed to avoid sympathetic vibration at frequencies within the audible range of 500-4000 Hz.
 - a. **Mass:** Not less than 1200 kg/cu m.
 - b. **Air Space:** Not less than 40 mm wide void within overall foundation element.

1.05 SUBMITTALS: All drawings and other submittals shall be submitted in accordance with the requirements of Section 01 33 00 (*Submittal Procedures*) and the requirements of this Section for the following phases:

- A. ^{A16}**Intermediate Design:** After the design has advanced sufficiently to permit the Employer to review the design submitted the Contractor shall submit the information indicated below. ^{A16}

1. **Drawings showing:**

- a. Layout plans, showing the types and locations of the foundations
- b. Foundation details with sections, dimensions, and elevations and details of water protection system.

2. **Documentation:**

- a. Concrete and reinforcing steel requirements, based on the design and Section 03 30 00 (*Concrete*).

- b. Proposed methods for sub-grade preparation and stabilization, if required.
 - c. Proposed material specifications, including those for sheet piles, piles or caissons.
 - ^{A5}d. Design assumptions and calculations (such as, selected soil parameters and loadings) for all foundations covered under this Section.^{A5}
- B. ^{A16}**Final Design:** After the design is complete, the Contractor shall submit the information indicated below for review no later than 42 days before construction is to begin:^{A16}
 - 1. **Drawings showing:**
 - a. Layout plans, showing the types and locations of the foundations.
 - c. Foundation details for all foundations, showing the sections, dimensions, and elevations and details of water protection system.
 - 2. **Documentation:**
 - a. Concrete and reinforcing steel requirements, based on the design and Section 03 30 00 (*Concrete*).
 - b. Methods for sub-grade preparation and stabilization, if required.
 - c. Design assumptions and calculations (such as, selected soil parameters and loadings) for all foundations covered under this ^{A5}Section. A report detailing the design criteria for settlement to meet the requirements of Subparagraph 1.04 A.3. The report shall include, but is not limited to:
 - 1) Geotechnical analysis of foundation materials.
 - 2) Proposed methods and sequence of construction to be used.
 - 3) Assumptions and calculations.
 - 4) Predicted long-term ground movements.
 - 5) Allowable movements of structures.
 - 6) Other issues which in the Contractor's opinion will affect the structures.
 - d. Design criteria, assumptions and calculations for sheet piles, piles or caissons, if required.^{A5}
 - e. Material specifications, including those for sheet piles, piles or caissons.
- C. ^{A17}**Before Construction:** 28 days ^{A17} ^{A16} before construction begins the Contractor shall submit the information indicated below for review.^{A16}

1. **Drawings showing:**

- a. Construction and assembly details.

2. **Documentation:**

- a. Construction procedures, sequence, and methods.
- b. Welding procedures (WPS and PQR).
- c. Driving procedures and termination criteria, if sheet piles, piles or caissons are used.
- d. Sub-grade preparation and compaction requirements.
- e. Control of water, including dewatering requirements, ^{A5}where ^{A5} high groundwater is anticipated.
- f. Material certifications for materials that are not covered in other ^{A5}Sections^{A5} of the specifications.

D. **After Construction:**

1. **Drawings:**

- a. ^{A16}As built drawings for all items covered under this ^{A5}Section ^{A5} shall be submitted for approval. ^{A16}

2. **Documentation:**

- a. ^{A16}Design calculations including additional calculations required due to changes in the field shall be submitted for approval. ^{A16}
- b. ^{A16}Pile driving records shall be submitted for review. ^{A16}
- c. ^{A16}Results of concrete and soil compaction tests shall be submitted for review. ^{A16}

1.06 QUALITY ASSURANCE:

- A. Verify conformance with the requirements of this ^{A5}Section ^{A5}. All requirements in Section 01 40 00 (*Quality Requirements*) shall apply to this ^{A5}Section ^{A5}.
- B. ^{A16}General Testing and Procedures for approval: ^{A16}
1. Submit a list and technical data of instruments and equipment for inspection and testing.
2. Submit designations (standards) on how quality control tests will be conducted.
3. Submit ^{A5}technical procedures and methods of performing quality control inspections ^{A5} for all features of the work.

END OF SECTION

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