

## SECTION 02300

### PERFORMANCE DESIGN, DESIGN-BUILD PILE FOUNDATIONS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division I Specification sections apply to work of this section.
- B. The drawings and general conditions of the contract including General and Supplementary Conditions and other Division 1 Specification sections apply to work of this section.
- C. Examine all other sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- D. Coordinate work with that of all trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

##### 1.02 DESCRIPTION OF WORK

- A. **PERFORMANCE DESIGN:** The complete pile design shall be the responsibility of the Design-Build Pile Subcontractor. The Design-Build Pile Subcontractor's Engineer shall be the Engineer of Record for the pile foundations. Submittals prepared by the Design-Build Pile Subcontractor's Engineer shall be signed and sealed. The Design-Build Pile Subcontractor's Engineer shall be licensed in the State of Maine at the time of project bidding and for the duration of the project.
- B. The work covered by this Section, without limiting the generality thereof, consists of labor, equipment, and material and performing all operations in connection with the furnishing and installing 70 ton (140 kips) minimum net allowable axial capacity piles at the locations and to the lines and grades shown on the drawings. Additional requirements are indicated within this specification.
- C. If a pile spacing greater than indicated on the Drawings is required for the Design Build Pile design and/or installation purposes, notify the Design-Build Contractor at time of bidding.
- D. Suitable pile types are indicated here within.

##### 1.03 RELATED WORK:

- 1. Cast-in-Place Concrete: Section 03300
- 2. Structural Steel: Section 05120

##### 1.04 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of the latest edition of the following except where more stringent requirements are shown or specified:
  - 1. IBC: "International Building Code, 2003 edition", as published by the International Code Council
  - 2. ASTM: Specifications of the American Society for Testing and Materials.

3. AWS: Standard Code for Welding in Building Construction, of the American Welding Society,
  4. AISC: Specification of the American Institute of Steel Construction.
  5. ACI: Specification of the American Concrete Institute
  6. PCI: Precast, Prestressed Concrete Institute
  7. "Code of Federal Regulations, Part 1926" per the Occupational Safety and Health Administration (OSHA), Department of Labor (Latest Revision).
- B. Comply with all rules, regulations, laws and ordinances of the City of Portland, and of all other authorities having jurisdiction, including State and Federal laws including OSHA. All labor, materials, equipment and services necessary to make work comply with such requirements shall be provided without additional cost to Design-Build Contractor.
- C. All welding shall be performed by operators who have been previously qualified by tests as prescribed in the AWS D1.1 "Standard Code for Welding in Building Construction". Evidence that welders meet qualification requirements shall be submitted to the Design-Build Contractor's Representative (Testing & Inspection Agency) before welding has begun. The Design-Build Contractor's Representative (Testing & Inspection Agency) may require a weld test for each operator.
- D. Field Monitoring and Testing
1. Full-time monitoring of pile driving operations shall be provided by the Design-Build Contractor's Representative (Geotechnical Consultant and Testing & Inspection Agency). No piles shall be driven except in the presence of the Design-Build Contractor's Representative (Geotechnical Consultant and Testing & Inspection Agency).
  2. Monitoring of welding and weld testing (if applicable) will be performed by the Design-Build Contractor's Representative (Testing & Inspection Agency). The Design-Build Pile Installation Subcontractor and Design-Build Contractor shall fully cooperate with the agency to facilitate inspection, notifying it in advance when welding operations are to be performed. Welds which do not conform to applicable specifications shall be repaired as directed by the Design-Build Contractor's Representative (Geotechnical Consultant and Testing & Inspection Agency).
    - a. Visual Inspection: All pile splice welds shall be visually inspected.
    - b. Ultrasonic Testing: Ultrasonic testing of welded pile splices shall be performed on the first 5 pile splices, and on 15 percent of the pile splices throughout the project.
  3. Certification of quality of pile materials to be used in the work shall be furnished, in a form acceptable to the Design-Build Contractor's Representative (Testing & Inspection Agency), at the time of delivery of materials to the site. Pile materials shall also be subject to on-site observation for conformance with specifications.
  4. Approvals given by the Design-Build Contractor's Representative (Geotechnical Consultant and Testing & Inspection Agency) shall not relieve the Design-Build Pile Subcontractor and Design-Build Contractor of their responsibility for performing the work in accordance with the Contract Documents.
  5. Instrumentation for Pile Installation

- a. Diesel Hammers: Open-type diesel hammers shall be equipped with a gauge for measuring ram height at the top of the stroke. Closed-type diesel hammers shall be equipped with an output energy gauge, calibrated for measurement of the total hammer energy. One spare output gauge shall be maintained at the site.
6. The Design-Build Contractor's Representative (Geotechnical Consultant and Testing & Inspection Agency) shall submit an installation summary. An installation summary given by the Design-Build Contractor's Representative (Geotechnical Consultant and Testing & Inspection Agency) shall not relieve the Design Build Pile Subcontractor and Design-Build Contractor of their responsibility for performing the work in accordance with the Contract Documents. Installation summary shall include the following:
- A. Project name and number.
  - B. Name of Contractor.
  - C. Pile location in pile group and designation of pile group.
  - D. Sequence of driving in pile group.
  - E. Pile dimensions, plumbness and offset.
  - F. Ground elevation.
  - G. Elevation of tips after driving.
  - H. Final tip and cutoff elevations of piles after driving pile group.
  - I. Records of re-driving.
  - J. Elevation of splices.
  - K. Type, make, model, and rated energy of hammer.
  - L. Weight and stroke of hammer.
  - M. Type of pile-driving cap used.
  - N. Cushion material and thickness.
  - O. Actual stroke and blow rate of hammer.
  - P. Pile-driving start and finish times, and total driving time.
  - Q. Time, pile-tip elevation, and reason for interruptions.
  - R. Number of blows for each 12 inches of penetration, and number of blows per for set criteria.
  - S. Pile deviations from location and plumb.
  - T. Weld testing and inspection results.
  - U. Unusual occurrences during pile driving.

#### 1.05 SUBMITTALS

- A. Unless otherwise specified, submittals required in this section shall be submitted to the Design-Build Contractor for review. The Design Build Contractor will forward the submittals to the Design-Build Contractor's Representative (Geotechnical Consultant). Submittals shall be prepared and submitted in accordance with this section and Division 1.
- B. Design-Build Contractor shall submit a Submittal Schedule to the engineer within 30 days after they have received the Notice to Proceed.
- C. All submittals shall be reviewed by the Design-Build Contractor's Representative (Geotechnical Consultant) and returned to the Design-Build Contractor within 10 working days following receipt by the Design-Build Contractor's Representative (Geotechnical Consultant).
- D. **INCOMPLETE SUBMITTALS WILL NOT BE REVIEWED. SUBMITTALS NOT BEARING AN ENGINEERING SEAL AND SIGNATURE WHEN REQUIRED WILL BE REJECTED AND RETURNED WITHOUT REVIEW.**

- E. Submittals not reviewed by the Design-Build Contractor prior to submission to the Design-Build Contractor's Representative (Geotechnical Consultant) will not be reviewed. Include on the submittal statement or stamp of approval by Design-Build Contractor, representing that the Design-Build Contractor has seen and examined the submittal and that all requirements listed in Division 1 have been complied with.
- F. The Design-Build Contractor's Representative (Geotechnical Consultant) will review submittals a maximum of two review cycles as part of their normal services. If submittals are incomplete or otherwise unacceptable and re-submitted, Design-Build Contractor shall compensate Design-Build Contractor's Representative (Geotechnical Consultant) for additional review cycles.
- G. PERFORMANCE DESIGN: Performance design shall be prepared by an Engineer registered in the State of Maine, retained by the Design-Build Pile Subcontractor. The Performance Design submittal shall bear the Engineer's seal and signature. The Design-Build Pile Subcontractor's Engineer shall be the Engineer of Record for the pile foundations. The Performance Design is subject to the review of the Design-Build Contractor's Representative (Geotechnical Consultant) prior to equipment mobilization.
  - 1. All project piles shall be of uniform section and material
  - 2. Acceptable Pile Materials and Sections:
    - a. Steel HP Piles, HP12 or HP14 nominal section, ASTM A992 or A572, Grade 50 Material.
    - b. Square, Solid Core, Precast, Prestressed Concrete Piles, 12 or 14 inches square, minimum 5,000 psi 28-day Concrete Compressive Strength and minimum 700 psi effective prestressing.
    - c. ICP High Performance, Pretensioned Spun Concrete Piles, 9.8 or 11.8 inch diameter (proprietary design).
    - d. Concrete filled Steel Pipe Piles: Minimum 10" nominal diameter, steel ASTM A252 or ASTM A283, minimum yield stress 36 ksi and concrete minimum 3,000 psi.
    - e. Alternate Pile Sections: Pile Sections not indicated are subject to the approval of the Design-Build Contractor's Representative (Geotechnical Consultant).
  - 3. Design Requirements: Unless noted otherwise the piles shall meet the following design requirements:
    - a. Minimum net allowable axial pile load: 70 tons (140 kips). Net capacity shall be determined after including the effects of downward frictional forces imposed on pile from subsiding soil strata(s) (down drag).
    - b. Minimum factor of safety for ultimate capacity: 2.0 after all reductions including soil down drag, corrosion reduction and as indicated in the IBC Code.
    - c. Building Code Requirements: The pile design shall meet the requirements of Chapter 18 of the International Building Code, 2003 Edition, except where more stringent requirements are noted here within and/or on the Documents.

- d. Material Stresses: Material Stresses indicated in the Code shall not be increased without the approval of the Design Build Contractor's Representative (Geotechnical Consultant).
- e. Splices: Splices shall develop the full engineering and material properties of the spliced sections. Submit evidence of compliance to this requirement.
- f. Cut offs and connection to pile cap: The Design-Build Pile Contractor is responsible for cutting off and disposing of pile waste, and providing sufficient tie-in to pile caps. Connection to pile cap will be determined by the Structural Engineer once a pile design is submitted. Reinforcement from pile may be required to be embedded within the pile cap.
- g. Pile Interaction: Pile spacing shall be as shown on Drawings. Pile design shall account for pile-to-pile interaction. Design shall be such that interaction effects shall not reduce the net capacity of the piles. If a pile spacing greater than indicated on the Drawings is required for the Design Build Pile design and/or installation purposes, notify the Design-Build Contractor at time of bidding.

4. Corrosion Allowance:

- a. Steel Sections: 1/8 inch Corrosion Allowance
- b. Alternate to Corrosion Allowance for Steel Piles: Coating may be permitted as an alternate to a corrosion allowance. When acceptable, coating is required at the fill levels anticipated at the upper strata of the soils. Coating system is subject to the review of the Design-Build Contractor's Representative (Geotechnical Consultant).
- c. Concrete Pile Corrosion Protection: Reinforcement for prestressing steel and pile reinforcement shall have a cover of not less than 1 1/2".
- d. Splices: Splice made within the upper fill soil strata shall have adequate corrosion protection. Submit proposed corrosion protection for review by the Design-Build Contractor's Representative (Geotechnical Consultant).

5. Determination of Allowable Geotechnical Capacity/Driving Criteria

- a. Submit information on proposed pile driving system and procedures for review by the Design-Build Contractor's Representative (Geotechnical Consultant) prior to equipment mobilization. The system should be capable of installing the piles to the specified minimum ultimate geotechnical capacity without exceeding the allowable driving stresses.
- b. Proposed 'set' or stop driving criteria determined the Design-Build Pile Subcontractor using information obtain from the pile load testing..
- c. Submit a Wave Equation Analysis which indicates the selected pile hammer can drive the piles to the required minimum ultimate capacity without overstressing or damaging piles. Minimum ultimate pile factor of safety shall be 2.0.

- d. Soil Down Drag: Determine soil down drag anticipated from site soil subsidence. Include soil down drag in design when determining net pile capacity. The determination of down drag is the responsibility of the Design Build Pile Subcontractor's Engineer. Calculations of down drag shall be included in the signed and sealed submittal.
  - e. Submit driving tip product information for driving tip to be utilized for pile installation, if applicable.
6. Load Tests: Per the requirements of Chapter 18 of the IBC Code, pile load test(s) shall be a requirement of this work. The proposed load testing procedures shall be included in the pile design submission.
- a. Load Testing shall be the responsibility of the Design-Build Pile Subcontractor.
  - b. The Design-Build Contractor shall engage a qualified firm with a minimum of 5 years experience in such testing to perform dynamic load testing if utilized.
  - c. Static Load Tests: Per ASTM D1143; If static load testing methods are employed, at least one pile shall be load tested in each area of uniform soil conditions.
  - d. Dynamic Load Tests: Per ASTM D4945; If dynamic load testing methods are employed, at a minimum a total of 10 piles shall be tested. A minimum of 5, single piles shall be tested in unique pile groups of 3 or more. All test piles shall be re-struck and tested after 24 hours to verify the effects of soil relaxation.
  - e. Additional tests and testing requirements may be required by the Building Code Official. The Design-Build Contractor shall with the Design-Build Pile Subcontractor and the Build Code Official to coordinate load testing.
  - f. Load Tests shall be continuously documented by the Design-Build Contractor's Representative (Geotechnical Consultant).

#### H. Shop Drawings

- 1. Pile location plan: A plan, prepared by the Design-Build Pile Installation Subcontractor, showing the location and designation of piles by an identification system shall be submitted prior installation. Detailed records for piles shall bear an identification corresponding to that shown on the plan. The pile location plan should indicate which piles are to be designated as test piles.
- 2. Shop Drawings showing sizes, tip details, and details for splice and shear connections, and other items pertinent to pile design.
- 3. Information on proposed pile driving system for review by the Design-Build Contractor's Representative (Geotechnical Consultant) prior to equipment mobilization. The system should be capable of installing the piles to the specified minimum ultimate geotechnical capacity without exceeding the allowable driving stresses. Review by the Design-Build Contractor's Representative (Geotechnical Consultant) shall not relieve the Design-Build Pile Installation Subcontractor and Design-Build Contractor of their responsibility for performing the work in accordance with the Contract Documents.
- 4. Details of equipment and procedures.

- I. Manufacturer's literature, including technical and performance literature for pile driving hammer, cushions, driving tips and other equipment for piles.
- J. Mill certificates stating the chemical composition, yield point and ultimate strength of the steel and/or concrete strength data.
- K. Qualifications for Welding Work: Qualify welding processes and welding operators in accordance with AWS D1.1 "Standard Qualification Procedure."
  - 1. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests.
  - 2. If re-certification of welders is required, retesting will be the Contractor's responsibility.
- L. As-Driven Pile Location Data:
  - 1. Submit pile location two days after individual pile or pile cluster is completed.
  - 2. All survey information to locate pile locations, elevations and offsets shall be supplied by the Design-Build Contractor.
  - 3. At the completion of pile driving, submit final as-driven pile location plan with tabulated lengths, certified by a Registered Land Surveyor or Registered Professional Engineer.
- M. Pile Installation Summary

#### 1.06 JOB CONDITIONS

##### A. Site and Subsurface Conditions

- 1. Subsurface investigation data are available from the Design-Build Contractor in the report "Geotechnical Engineering Services, Proposed Housing, 84Marginal Way, Portland Maine" dated September 7, 2006 prepared by SW Cole Engineering. Prior to submitting a bid, the Design-Build Pile Installation Subcontractor shall review and understand the information contained in the report. The geotechnical investigation report is made available to the Design-Build Pile Installation Subcontractor for information on factual data only and shall not be interpreted as a warranty for subsurface conditions whether interpreted from written text, boring logs, or other data.

##### B. Adjacent properties

- 1. Pre-driving survey: The Design-Build Pile Subcontractor shall perform a pre-driving survey on structures adjacent to the project. The pre-driving survey shall include photographs and the installation of crack monitors as appropriate to establish a base line prior to the start of pile driving activities.
- 2. The Design-Build Pile Subcontractor shall protect adjacent property, public utilities and structures, and completed work, from damage associated with the pile driving operation. All damage due to any pile driving operations shall be repaired by the Design-Build Pile Subcontractor at the Design-Build Pile Subcontractor's own expense.

#### 1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. The Contractor shall deliver piles at times and in sequence to assure continuity of pile driving.

- B. Piles shall be handled, transported, stacked and protected to prevent damage to piles.

#### 1.08 LINES AND GRADES

- A. The Design-Build Pile Subcontractor shall stake the pile locations and establish all elevations required. A baseline and benchmark located on or close to the site will be provided by the Design-Build Contractor. The Design Build Pile Subcontractor shall be responsible for the maintenance and protection of the baseline and benchmark, and all pile location stakes.
- B. The Design-Build Contractor shall employ a licensed Registered Land Surveyor familiar with pile installation, who shall verify driven pile. Locations of the centers of as-driven piles shall be shown on a drawing in relation to the design location and submitted to the Design-Build Contractor within two days after the individual pile or pile group is completed. Drawings shall include the following:
  - 1. Base line and north arrow.
  - 2. Each pile identified by a separate number.
  - 3. Elevation of each top of pile prior to cutting, to nearest 0.1 foot.
  - 4. Deviation in inches, to the nearest one-fourth inch, from plan location at cutoff elevation.
- C. Within one week after the completion of all pile driving, the Surveyor shall provide to the Design-Build Contractor a plan, certified by said Surveyor or Engineer, showing the as-driven location of all piles. Plan shall be immediately distributed to Structural Engineer.

### PART 2 EXECUTION

#### 2.01 SEQUENCE OF OPERATIONS AND EQUIPMENT REQUIREMENTS

- A. The Design-Build Pile Subcontractor shall provide equipment to maintain the schedule as developed by the Design-Build Contractor, and shall mobilize additional equipment, if necessary, to complete the work on schedule.
- B. Pile Load Test: As indicated in this specification.
- C. When piles are located in an area where excavation is to be made, the piles shall not be driven until the excavation has been completed.
- D. The Design-Build Contractor shall coordinate his pile driving operations with other work on the project.

#### 2.02 EQUIPMENT

- A. Piles shall be installed with modern equipment as approved by the Design-Build Contractor's Representative (Geotechnical Consultant), per the Performance Design. Approval shall be obtained from the Design-Build Contractor's Representative (Geotechnical Consultant) a minimum of one week prior to commencement of pile driving.
- B. The leads of the pile driving rig shall be fixed at two points; the points shall be at least half the length of the leads apart in order to maintain the pile and hammer in axial alignment at the correct plan location during the entire driving operation. The leads shall extend down to the lowest point at which the hammer must operate.



- C. Piles may be driven with a single acting, double acting, or differential acting hammer.
- D. In the case of diesel hammers, the Design-Build Pile Installation Subcontractor will be required to provide an apparatus, approved by the Design-Build Contractor's Representative (Geotechnical Consultant), to measure gas pressures inside the hammer for closed hammers or ram bounce height in the case of open hammers.
- E. An aluminum micarta cushion block, or other cushion material approved by the Design-Build Contractor's Representative (Geotechnical Consultant), shall be used in the hammer for driving piles. The cushion shall be replaced when, burned or otherwise worn. The introduction of fresh hammer cushion or pile cushion material just prior to final penetration
- F. The use of followers will not be permitted unless authorized in writing by the Design-Build Contractor's Representative (Geotechnical Consultant).

### 2.03 OBSTRUCTIONS AND OUT-OF-TOLERANCE PILES

- A. The Design-Build Pile Installation Subcontractor shall make reference to the test boring and test pit logs and available plans showing the site conditions.
- B. Piles abandoned because of obstructions encountered or out of tolerance shall be cut off or pulled out at the discretion of the Design-Build Contractor's Representative (Geotechnical Consultant) and the hole filled with sand.
- C. Removal of obstructions by spudding, augering, drilling, etc. is not recommended, however, may be allowed in certain conditions with the approval of the Design-Build Contractor's Representative (Geotechnical Consultant).

### 2.04 INSTALLATION

- A. Driving
  - 1. As part of the preparation for driving, each pile shall be marked at one-foot intervals. In addition, the footage shall be marked and designated at five-foot intervals, starting from the tip of the pile.
  - 2. All Piles shall be driven at the locations and orientations shown on the drawings. Pile location shall be checked during driving and appropriate measures taken, as necessary, to maintain the correct pile position.
  - 3. Each pile shall be driven to the Design-Build Pile Subcontractor's set criteria to achieve the required capacity of the Performance Design. Pile driving shall be continuous and without interruption for the final 20 feet of penetration. The set criteria shall be as determined in the approved Pile Performance Design. An abrupt increase in driving resistance shall be evaluated by the Design-Build Pile Subcontractor. All production piles shall be restruck as determined by the dynamic load test report.
  - 4. Immediately after a pile in a pile group is driven, the Contractor shall establish a reference point and its elevation on the pile for the purpose of checking uplift of the pile tip.
  - 5. After all piles within the radius of uplift have been driven, the Design-Build Pile Subcontractor shall determine the elevation of the reference points on each of the piles in the group. If uplift determined to be unacceptable by the Design-Build Performance Design has occurred, the pile shall be re-driven to its original elevation, and deeper if necessary to the specified final driving resistance. After re-driving each pile, the Design-Build Pile

Subcontractor shall re-establish the elevation of the reference point. Re-driving shall be repeated as often as necessary until the measured uplift on any pile is within the acceptable limit of the design.

6. The radius of uplift is defined as the maximum distance between piles such that pile driving causes uplift of an amount greater than that indicated in the Design-Build Performance Design, in the affected pile. Survey instruments used to establish the reference elevations shall be carefully checked and adjusted as necessary to insure accurate readings. Uplift measurements shall be submitted to the Design-Build Contractor Representative (Geotechnical Consultant).

#### B. Splicing

1. A maximum of 2 pile splices shall be allowed for any pile type
2. No splices will be permitted in the upper 10 feet of the embedded portion of the pile.
3. The strength of all splices, in compression, tension, and bending, shall be equal to or greater than the ultimate capacities of the pile section.
4. Piles may be spliced in the leads. The sections of piles to be spliced shall be secured in alignment such that there is no eccentricity between the axes of the two spliced lengths, or angle between them, after the splice has been completed.
5. Welded steel sections shall be spliced by continuous, butt-joint, 45 degree bevel; or vee, complete penetration, arc welding around the entire circumference, to produce joints developing 100 percent of the pile section strength.
  - a. Electrodes conforming to ASTM A233, E-70 series, compatible with the pile steel, shall be used.
  - b. Welds which do not conform to specifications shall be gouged and repaired as directed by the inspector.
6. Mechanical drive-fit splices shall not be used.

#### C. Cutting off Piles

1. Pile tops shall be cut off square within one inch of the elevations shown on the drawings. The pile cut-offs shall become the property of the Design-Build Pile Installation Subcontractor and shall be removed from the site. Strands or reinforcement may be required to be exposed to allow embedment into the pile cap.
2. When piles are driven below the design cut-off grade, due to unexpected penetration, a limited number of build-ups will be permitted in accordance with designs provided by the Design-Build Pile Installation Subcontractor and reviewed by the Design-Build Contractor's Representative (Geotechnical Consultant). Build up costs shall be the responsibility of the Design-Build Pile Installation Subcontractor.

### 2.05 TOLERANCES AND CRITERIA FOR ACCEPTANCE

- A. Piles shall be driven as close as practicable to the plan location. Allowable maximum deviations shall be as follows:

1. Lateral deviation from column centerline and centroid of pile or pile group for single piles and groups of two piles: 1 inches.
  2. Lateral deviations from column centerline and centroid of pile group for groups of three or more piles: 3 inches.
  3. Design cut off elevations: 1 inch.
  4. Plumbness of a driven pile measured on the projection above ground: 3 inches in 10 feet.
- B. Structural Engineer shall be immediately informed of out-of-tolerance piles. The Structural Engineer will evaluate out-of-tolerance piles and recommend remedial action if required.
- C. Pile damage: The Design-Build Contractor's Representative (Geotechnical Consultant) will note if a pile is likely to have been unacceptably damaged based on his knowledge of the subsurface conditions and comparison of the subject piles driving performance with that of other driven piles. In the case of a questionable pile, the pile shall be considered rejected unless the pile can be proven intact by methods approved by the Design-Build Contractor's Representative (Geotechnical Consultant).
- D. Piles indicating sudden or peculiar decrease in penetration resistance during driving will be assumed to be broken and will be rejected unless Design-Build Contractor's Representative (Geotechnical Consultant) review of available data indicates that sudden decrease in driving resistance is due to natural, subsurface conditions and continued acceptable driving behavior is observed. In the case of a questionable pile, the pile shall be considered rejected unless the pile can be proven intact by methods approved by the Design-Build Contractor's Representative (Geotechnical Consultant).
- E. Except in the case of obstructions, piles that are rejected because of damage, mis-location or misalignment, or failure to meet the driving criteria, shall be cut off below the limits of the structure and abandoned, and additional piles shall be driven as directed by the Design-Build Contractor's Representative or the Structural Engineer. New piles required due to piles driven out-of-tolerance shall be provided at the Design-Build Pile Installation Subcontractor's expense.
- F. When otherwise acceptable, the Design-Build Contractor shall provide an accurate survey to the Structural Engineer of installed piles exceeding the specified tolerances as specified. The maximum compressive load on any pile due to mis-location shall not exceed 110 percent of the minimum net allowable axial capacity. If the load on any pile exceeds 110 percent of the minimum net allowable axial capacity, corrections shall be made in accordance with a design provided by the Structural Engineer.
- G. The installation of replacement piles and other corrective measures shall in all cases be in accordance with designs provided by the Structural Engineer.

### PART 3 MEASUREMENT AND PAYMENT

#### 3.01 MEASUREMENT

- A. Piles will be measured for payment on the basis of length along the axis of the pile in place below the design cutoff elevation.

#### 3.02 BASIS OF PAYMENT

- A. Work included under this contract shall include installation of the piles. The amount of such work shall include, but not by way of limitation, location of, design, furnishing and driving the piles, load testing, splicing, pile tips, and all work incidental thereto, and mobilization and demobilization which

shall include job set-up, moving, equipment including pile driving rigs on and off the project, establishing and dismantling the Design-Build Pile Installation Subcontractor's field administration forces and equipment, and all other work incidental thereto.

- B. The footage of foundation piles for payment shall be the sum of the lengths of the piles below design cutoff grade actually driven and accepted.
- C. Piles rejected in accordance with the provisions of these Specifications and which result in the judgment of the Design-Build Contractor's Representative (Geotechnical Consultant and Testing & Inspection Agency) or Structural Engineer, from the Design-Build Pile Installation Subcontractor's violation of the Specifications or his other error, will not be paid for. If one or more replacement piles are required by the Design-Build Contractor's Representative (Geotechnical Consultant and Testing Agency) or Structural Engineer to compensate for a rejected pile, the Design-Build Pile Installation Subcontractor will be paid at the Contract unit price per foot for only the longer of the replacement piles and not for the rejected pile. Additional piles required to compensate for production piles or replacement piles driven out of design location or tolerance due to Design-Build Pile Installation Subcontractor error will be installed at no additional cost to the Design-Build Contractor.
- D. Piles rejected, in the judgment of the Design-Build Contractor's Representative (Geotechnical Consultant) due to causes other than the Design-Build Pile Installation Subcontractor's violation of the Specifications or his other error, will be measured and included in the aggregate footage of piles for payment.
- E. Whenever, in the judgment of the Design-Build Contractor's Representative (Geotechnical Consultant) and/or Structural Engineer, misalignment or rejection of a pile or piles caused by the Design-Build Pile Installation Subcontractor's violation of the specifications or his other error necessitates structural redesign of the pile cap, and the redesigned pile cap requires greater quantities of concrete and reinforcing steel, the quantities required shall be compared with quantities required for the pile cap for the design pile group configuration, and the additional cost for pile cap concrete, reinforcing steel and form work shall be deducted from the contract price, in addition to redesign cost. Whenever, in the judgment of the Design Build Contractor's Representative (Geotechnical Consultant) and/or Structural Engineer, misalignment or rejection of a pile or piles caused by the Design-Build Pile Installation Subcontractor's violation of the specifications or his other error necessitates structural redesign, the cost of such redesign shall be deducted from sums otherwise due to the Design-Build Pile Installation Subcontractor under the contract.
- F. No payment will be made for pile cut-offs, splices and pile buildups.

END OF SECTION

## SECTION 03300 – CAST -IN-PLACE CONCRETE

### PART 1 GENERAL

#### 1.01 RELATED DOCUMENTS

- A. The drawings and general conditions of the contract including General and Supplementary Conditions and other Division 1 Specification sections apply to work of this section.
- B. Examine all other sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- C. Coordinate work with that of all trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

#### 1.02 DESCRIPTION OF WORK:

- A. Work included: Provide labor, materials, and equipment necessary to complete the work of this Section and, without limiting the generality thereof, furnish and include the following:
  - 1. The extent of cast-in-place concrete work is shown on drawings and includes (but not by way of limitation) formwork, reinforcing, cast-in-place concrete, accessories, finishing, and casting in of items specified under other Sections of the Specifications or furnished by Design-Build Contractor that are required to be built-in with the concrete.
  - 2. Equipment support pads indicated on mechanical drawings to be installed.
  - 3. Cast-in-place retaining walls, exterior slabs on grade and other concrete shown on site drawings, unless specifically noted otherwise.

#### 1.03 RELATED WORK:

- A. Metal Fabrications: Section 05500
  - 1. Expansion Anchors - Section 05120
  - 2. Embedded Items - Section 05500
- B. Anchor Bolts: Section 05120
- C. Joint Sealants: Section 07900
- D. Underslab Vapor Retarders/Wall Waterproofing: Division 7

#### 1.04 QUALITY ASSURANCE:

- A. Codes and Standards: Comply with provisions of the latest edition of the following except where more stringent requirements are shown or specified:
  - 1. ACI “Manual of Concrete Practice”.
  - 2. ACI 117 “Standard Specifications for Tolerances for Concrete Construction and Materials”.

3. ACI 211.1 "Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete."
  4. ACI 212.3R "Chemical Admixtures for Concrete."
  5. ACI 301 "Specifications for Structural Concrete for Buildings."
  6. ACI 302.1R "Guide for Concrete Floor and Slab Construction."
  7. ACI 304R "Guide for Measuring, Mixing, Transporting and Placing Concrete."
  8. ACI 304.2R "Placing Concrete by Pumping Methods."
  9. ACI 306 R "Cold Weather Concreting."
  10. ACI 308 "Standard Practice for Curing Concrete."
  11. ACI 309R "Guide for Consolidation of Concrete."
  12. ACI 315 "ACI Detailing Manual."
  13. ACI 318 "Building Code Requirements for Reinforced Concrete."
  14. ACI 347R "Guide to Formwork for Concrete."
  15. Concrete Reinforcing Steel Institute, "Placing Reinforcing Bars."
  16. AISC "Code of Standard Practice for Steel Buildings and Bridges."
  17. "Code of Federal Regulations, Part 1926" per the Occupational Safety and Health Administration (OSHA), Department of Labor (Latest Revision).
- B. Materials and installed work may require testing and retesting, as directed by the Engineer, at any time during progress of work. Allow free access to material stockpiles and facilities.

1.05 SUBMITTALS:

- A. Unless otherwise specified, submittals required in this section shall be submitted for review. Submittals shall be prepared and submitted in accordance with Division 1.
- B. Design-Build Contractor shall submit a Submittal Schedule to the engineer within 30 days of project mobilization.
- C. All submittals shall be reviewed and returned to the Design Build Contractor within 10 working days.
- D. Incomplete submittals will not be reviewed.
- E. Submittals not reviewed by the Design-Build Contractor prior to submission to the Engineer will not be reviewed. Include on the submittal statement or stamp of approval by Design-Build Contractor, representing that the Design-Build Contractor has seen and examined the submittal and that all requirements listed in this Section and Division 1 have been complied with.

- F. Engineer will review submittals a maximum of two review cycles as part of their normal services. If submittals are incomplete or otherwise unacceptable and re-submitted, Design-Build Contractor shall compensate Engineer for additional review cycles.
- G. Product Data: Submit producer's or manufacturer's specifications and installation instructions for the following products. Include laboratory test reports and other data to show compliance with specifications (including specified standards).
1. Reinforcement certified mill reports covering chemical and physical properties and yield strength.
  2. Patching products.
  3. Non-shrink grout.
  4. Curing compounds, where applicable.
  5. Admixtures.
  6. Expansion/Adhesive Anchors.
- H. Shop Drawings:
1. Shop Drawing Preparation: Electronic files of structural drawings will not be provided to the contractor for preparation of shop drawings. Reproduction of any portion of the Construction Documents for use as Shop drawings is prohibited. Shop drawings created from reproduced Construction Documents will be returned without review. Submit shop drawings for fabrication, bending and placement of concrete reinforcement. Comply with ACI 315, showing bar schedules, stirrup and tie spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required at openings through concrete elements. Include supplemental reinforcing and bar supports necessary to support reinforcing steel at proper location within forms or slabs.
    - a. Review of the shop drawings will be made for the size and arrangement of reinforcement. Conformance of the Shop Drawings to the Contract Drawings remains the responsibility of the Design-Build Contractor. Engineer's review in no way relieves the Design-Build Contractor of this responsibility. Submit three prints. Prints will be reviewed by the Engineer, and then the Architect. One marked print will be returned to Design-Build Contractor for printing and distribution. Multiple copies will not be marked by the Engineer.
    - b. Shop drawings will not be reviewed as partial submittals. A complete submittal shall be provided all items listed prior. Incomplete submittals will not be reviewed.
  - I. Mix designs: Submit all laboratory test reports and materials for each mix design listed within. Prepare mixes by the field experience method and/or trial mixtures per the requirements of chapter 5 of ACI 318. Include the calculation of average strength and standard deviation. Proportioning by water cement ratio method will not be permitted.
  - J. Samples: Submit samples of materials as specified and as otherwise requested by Engineer or Architect, including names, sources and descriptions.

- K. Curing Methods: Submit documentation of curing methods to be used for review. Account for anticipated project temperature ranges and conditions in curing methods.
- L. Contraction/Construction Joints: Submit plan indicating proposed location of contraction and construction joints in walls and slabs.
- M. Test Reports: Test reports shall be submitted to the Design-Build Contractor and Engineer within 48 hour after completion of each test.

## PART 2 PRODUCTS

### 2.01 FORM MATERIALS:

- A. Forms for Exposed Finish Concrete: Unless otherwise indicated, construct formwork for exposed concrete surfaces with plywood, metal, metal-framed plywood faced or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient thickness to withstand pressure of newly-placed concrete without bow or deflection.
  - 1. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class I, Exterior Grade or better, mill-oiled and edge-sealed, with piece bearing legible inspection trademark.
- B. Forms for Unexposed Finish Concrete: Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.
- C. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

### 2.02 REINFORCING MATERIALS:

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Welded Wire Fabric: ASTM A 185, welded steel wire fabric. Provide welded wire fabric in flat sheets.
- C. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use plastic, wire bar type supports or concrete block supports complying with CRSI recommendations, unless otherwise specified. Wood, clay brick and other unspecified devices are not acceptable.
  - 1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
  - 2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class I) or stainless steel protected (CRSI, Class 2).

### 2.03 CONCRETE MATERIALS:



- A. Portland Cement: ASTM C 150, Type I or Type II, unless otherwise approved Use one brand of cement throughout project, unless otherwise acceptable to Engineer.
- B. Normal Weight Aggregates: ASTM C 33. Provide from a single source for exposed concrete. Do not use aggregates containing soluble salts or other substances such as iron sulfides, pyrite, marcasite, or ochre which can cause stains on exposed concrete surfaces.
- C. Light Weight Aggregates: ASTM C 330.
- D. Water: Potable.
- E. Air-Entraining Admixture: ASTM C 260.
- F. High-Range Water-Reducing Admixture (Super Plasticizer): ASTM C 494, Type F or Type G containing not more than 1% chloride ions.
- G. Fiber reinforcement shall be Type III Synthetic Virgin Homopolymer Polypropylene Fibers conforming to ASTM C1116. Fiber reinforcing shall be added and distributed prior to incorporation of Super Plasticizer.
- H. Normal range water reducing admixture: ASTM C 494 Type A containing no calcium chloride.
- I. Accelerating Admixture: ASTM C 494, Type C or E.
- J. Blast Furnace Slag: ASTM C989
- K. Fly Ash: ASTM C618, Class C or F
- L. Calcium Chloride is not permitted.

2.04 RELATED MATERIALS:

- A. Underslab Vapor Retarder: Provide vapor retarder over prepared sub base for interior slabs. Refer to Architectural drawings, geotechnical report and/or division 7 specifications for additional requirements and vapor retarder location.
- B. Non-Shrink Cement-based Grout: Provide grout consisting of pre-measured, prepackaged materials supplied by the manufacturer requiring only the addition of water. Manufacturer's instructions must be printed on the outside of each bag.
  - 1. Non-shrink: No shrinkage (0.0%) and a maximum 4.0% expansion when tested in accordance with ASTM C-827. No shrinkage (0.0%) and a maximum of 0.2% expansion in the hardened state when tested in accordance with CRD-C-621.
  - 2. Compressive strength: A minimum 28 day compressive strength of 5000 psi when tested in accordance with ASTM C-109.
  - 3. Setting time: A minimum initial set time of 60 minutes when tested in accordance with ASTM C-191.
  - 4. Composition: Shall not contain metallic particles or expansive cement.

- C. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M182, Class 2.
- D. Moisture-Retaining Cover: One of the following, complying with ANSI/ASTM C 171.
  - 1. Waterproof paper.
  - 2. Polyethylene film.
  - 3. Polyethylene-coated burlap.
- E. Liquid Membrane-Forming Curing Compound: Liquid type membrane forming curing compound complying with ASTM C 309, Type I, Class A unless other type acceptable to Engineer. Curing compound shall not impair bonding of any material, including floor finishes, to be applied directly to the concrete. Demonstrate the non-impairment prior to use.
- F. Preformed Expansion Joint Formers:
  - 1. Bituminous Fiber Type, ASTM D 1751.
  - 2. Felt Void, Poly-Styrene Cap with removable top as manufactured by SUPERIOR.
- G. Slab Joint Filler: Multi-component polyurethane sealant (self-leveling type).
- H. Waterstops shall be Bentonite/Butyl Rubberbased product. Use in conjunction with manufacturer's approved mastic. Acceptable products include:
  - 1. "Waterstop Rx," by American Colloid Co.
  - 2. "Adeka Ultra Seal MC-2010," by Asahi Denka Koeoyo, Kik MN.

2.05 PROPORTIONING AND DESIGN OF MIXES:

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 318. Use material, including all admixtures, proposed for use on the project. If trial batch method used, use an independent testing facility acceptable to Engineer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing unless otherwise acceptable to Engineer.
- B. Submit written reports to Engineer of each proposed mix for each class of concrete. Do not begin concrete production until mixes have been reviewed by Engineer.
- C. Proportion design mixes to provide concrete with the following properties:
  - 1. Footings, foundation walls, pile caps and grade beams.
    - a. Strength: 3000 psi at 28 days.
    - b. Aggregate: 3/4"
    - c. W/C Ratio: 0.54 maximum

- d. Entrained Air: 6% +/- 1.5%
  - e. Slump: 4" maximum
2. Interior Slabs on grade and elevated slabs (including plank topping):
- a. Strength: 3000 psi at 28 days, Fiber Reinforced
  - b. Aggregate: 3/4" minimum, 1 1/2" maximum, 3/8" aggregate for plank topping 2 inches and less thickness..
  - c. W/C Ratio: 0.54 maximum
  - d. Entrapped Air only (no entrainment), 2% maximum
  - e. Slump: 4" maximum
3. Exterior Slabs and all other exposed Site Concrete not specified elsewhere:
- a. Strength: 5000 psi at 28 days, Fiber Reinforced
  - b. Aggregate: 3/4"
  - c. W/C Ratio: 0.40 maximum
  - d. Entrained Air: 6% +/- 1.5%
  - e. Slump: 4" maximum
4. Add air entraining admixture at manufacturers prescribed rate to result in concrete at point of placement having the above noted air contents.
5. Additional slump may be achieved by the addition of a mid-range or high-range water reducing admixture. Maximum slump after the addition of admixture shall be 6 or 8 inches for mid-range or high range water reducing admixtures, respectively.
- D. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor, when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, at no additional cost to Design-Build Contractor and as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Structural Engineer before using in work.
- 1. Water may be added at the project only if the maximum specified slump and design mix maximum water/cement ratio is not exceeded.
  - 2. Additional dosages of superplasticizer should be used when delays occur and required slump has not been maintained. A maximum of two additional dosages will be permitted per ACI 212.3R recommendations.

## 2.06 CONCRETE MIXING:

- A. Job-Site Mixing will not be permitted.

- B. Ready-Mix Concrete: Must comply with the requirements of ASTM C 94, and as herein specified. Provide batch ticket for each batch discharged and used in work, indicating project name, mix type, mix time and quantity.
  - 1. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C94 may be required by Structural Engineer.
  - 2. When the air temperature is between 85 degrees F. and 90 degrees F., reduce the mixing and delivery time from 1 1/2 hours to 75 minutes, and when the air temperature is above 90 degrees F., reduce the mixing and delivery time to 60 minutes.

### PART 3 EXECUTION

#### 3.01 FORMS:

- A. Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation and position.
- B. Design, construct, erect, maintain, and remove forms for cast-in-place concrete work in compliance with ACI 347.
- C. Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.
- D. Construct forms to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.
- E. Vertical dovetail slots may be required for masonry tie installation. Coordinate dovetail slot spacing and location with division 4 specifications and Architectural drawings.
- F. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, dovetail slots, reglets, recesses, and the like to prevent swelling and for easy removal.
- G. Provide temporary openings where interior area of formwork is inaccessible for clean out, for inspection before concrete placement and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.
- H. Chamfer exposed corners and edges as indicated, using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- I. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.

1. Unless otherwise indicated, provide ties for concrete surfaces to be exposed to view in the final condition so portion remaining within concrete after removal is 1" (minimum) inside concrete.
  2. Form ties shall not leave holes larger than 1" diameter in concrete surface. Repair holes left by form ties after removal of formwork.
- J. Provision for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- K. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Retighten forms and bracing after concrete placement as required to eliminate mortar leaks and maintain proper alignment.

### 3.02 PLACING REINFORCEMENT:

- A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.
1. Subgrade tolerance shall conform to a tolerance of  $+0/-1 \frac{1}{2}$ ". Base tolerance (fine grading) for slabs shall conform to a tolerance of  $+0"/-3/4$ " in. Confirm compliance of above tolerances with surveyed measurements taken at 20 ft. intervals in each direction.
  2. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.
  3. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required.
  4. Place reinforcement to obtain specified coverage for concrete protection within tolerances of ACI-318. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
  5. Install welded wire fabric in flat sheets in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

### 3.03 JOINTS:

- A. Construction Joints: Locate and install construction joints, which are not shown on drawings, so as not to impair strength and appearance of the structure, as acceptable to Engineer. Submit plan indicating proposed location of construction joints for review prior to beginning work.
1. Provide keyways at least 1-1/2" deep in construction joints in walls, and slabs; bulkheads reviewed by the Engineer, designed for this purpose may be used for slabs.

2. Roughened surfaces shall be used between walls and footings unless shown otherwise on the drawings. The footing surface shall be roughened to at least an amplitude of 1/4" for the width of the wall before placing the wall concrete.
3. Place construction joints perpendicular to the main reinforcement. Continue reinforcement across construction joints.
4. Joints in slabs on grade shall be located and detailed as indicated on the drawings. If saw-cut joints are required, the early-entry dry-cut process shall be used. Refer to ACI 302, section 8.3.12.

#### 3.04 INSTALLATION OF EMBEDDED ITEMS:

- A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached thereto. Notify other trades to permit installation of their work. Templates to be utilized for setting of anchorage devices shall be constructed in a manner to allow mechanical consolidation of concrete. “Wet Setting” of embedded items into plastic concrete will not be permitted without special permission from the Engineer.
- B. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface.
- C. Provide PVC sleeves where pipes and/or conduit pass through exterior concrete or slabs. Sleeves or penetrations shall not be placed through footings, piers, pedestals, drop caps, columns or pilasters unless specifically noted.
- D. Tolerances: Tolerances for Anchor Bolts/Rods, bearing surfaces and other embedded items shall meet the requirement set forth in the latest edition of the American Institute of Steel Construction “Code of Standard Practice for Steel Buildings and Bridges,” and ACI 117. The more stringent criteria from these documents shall apply.

#### 3.05 INSTALLATION OF GROUT

- A. Place grout for base plates in accordance with manufacturer's recommendations.
- B. Grout below setting plates as soon as practicable to facilitate erection of steel and prior to removal of temporary bracing and guys. If leveling bolts or shims are used for erection grout shall be installed prior to addition of any column load.
- C. Pack grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials and allow to cure. For proprietary grout materials, comply with manufacturer's instructions.

#### 3.06 PREPARATION OF FORM SURFACES:

- A. Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.
- B. Thin form-coating compounds only with thinning agent of type, and in amount, and under conditions of form-coating material manufacturer's directions. Do not allow excess form coating to accumulate in forms or to come into contact with concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

3.07 CONCRETE PLACEMENT:

- A. Preplacement Review: Footing bottoms are subject to review by the Geotechnical Engineer. Reinforcement and all concrete preparation work shall be subject to review by the Structural Engineer. Verify that reinforcing, ducts, anchors, seats, plates and other items cast into concrete are placed and securely held. Notify Engineer/Project Special Inspector 48 hours prior to scheduled placement and obtain approval or waiver of review prior to placement. Be sure that all debris and foreign matter is removed from forms.
- B. Concrete shall be placed in the presence of an approved testing agency.
- C. General: Comply with ACI 304, and as herein specified.
  - 1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation due to rehandling or flowing.
  - 2. Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods which will prevent segregation or loss of ingredients and in a manner which will assure that the required quality of the concrete is maintained.
  - 3. Conveying equipment shall be approved and shall be of a size and design such that detectable setting of concrete shall not occur before adjacent concrete is placed. Conveying equipment shall be cleaned at the end of each operation or work day. Conveying equipment and operations shall conform to the following additional requirements:
    - a. Belt conveyors shall be horizontal or at a slope which will not cause excessive segregation or loss of ingredients. Concrete shall be protected against undue drying or rise in temperature. An arrangement shall be used at the discharge end to prevent apparent segregation. Mortar shall not be allowed to adhere to the return length of the belt. Long runs shall be discharged into a hopper or through a baffle.
    - b. Chutes shall be metal or metal-lined and shall have a slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal. Chutes more than 20 feet long, and chutes not meeting the slope requirements may be used provided they discharge into a hopper before distribution.
    - c. Pumping or pneumatic conveying equipment shall be of suitable kind with adequate pumping capacity. Pneumatic placement shall be controlled so that segregation is not apparent in the discharged concrete.
    - d. Concrete shall not be conveyed through pipe made of aluminum alloy. Standby equipment shall be provided on the site.
    - e. Tined rakes are prohibited as a means of conveying fiber reinforced concrete.
  - 4. Do not use reinforcement as bases for runways for concrete conveying equipment or other construction loads.

- D. **Placing Concrete in Forms:** Deposit concrete in forms in horizontal layers not deeper than 18 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
1. Consolidate placed concrete by mechanical vibrating equipment. Hand-spading, rodding or tamping as the sole means for the consolidation of concrete will only be permitted with special permission from the Engineer. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practices.
  2. Use vibrators designed to operate with vibratory equipment submerged in concrete, maintaining a speed of not less than 8000 impulses per minute and of sufficient amplitude to consolidate the concrete effectively. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine, generally at points 18 inches maximum apart. Place vibrators to rapidly penetrate placed layer and at least 6 inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion maintain the duration of vibration for the time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix, generally from 5 to 15 seconds. A spare vibrator shall be kept on the job site during all concrete placing operation.
- E. **Placing Concrete Slabs:** Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
1. Consolidate concrete using internal vibrators during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  2. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations. Do not sprinkle water on plastic surface.
  3. Maintain reinforcing in proper position during concrete placement operations.
  4. Slab thicknesses indicated on the drawings are minimums. Provide sufficient concrete to account for structure deflection, subgrade fluctuations, and to obtain the specified slab elevation at the flatness and levelness indicated here within.
  5. Finish: See “Monolithic Slab Finishes” in this specification for slab finish requirements.
- F. **Cold Weather Placing:** Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified (whichever requirement is more stringent).
1. When air temperature has fallen to or is expected to fall below 40 degrees F (4 degrees C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F (10 degrees C), and not more than 80 degrees F (27degrees C) at point of placement.
  2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  3. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators.



4. All temporary heat, form insulation, insulated blankets, coverings, hay or other equipment and materials necessary to protect the concrete work from physical damage caused by frost, freezing action, or low temperature shall be provided prior to start of placing operations.
  5. When the air temperature has fallen to or is expected to fall below 40 degrees F, provide adequate means to maintain the temperature in the area where concrete is being placed between 50 and 70 degrees F.
- G. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified (whichever requirement is more stringent).
1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees F. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated to the total amount of mixing water.
  2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
  3. Wet forms thoroughly before placing concrete.
  4. Do not use retarding admixtures without the written acceptance by the Engineer.

### 3.08 FINISH OF FORMED SURFACES:

- A. Rough Form Finish: For formed concrete surfaces not exposed-to-view in the finish work or by other construction, unless otherwise indicated. This concrete surface shall have texture imparted by form facing material, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4 in. in height rubbed down or chipped off.
- B. Smooth Form Finish: For formed concrete surfaces exposed-to-view, or that are to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, damp-proofing, painting or other similar system. This as-cast concrete surface shall be obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed.
- C. Grout Cleaned Finish: Provide grout cleaned finish to scheduled concrete surfaces which have received smooth form finish treatment. Combine one part Portland cement to 1-1/2 parts fine sand by volume and mix with water to consistency of thick paint. Proprietary additives may be used at Contractor's option. Blend standard Portland cement and white Portland cement, amounts determined by trial patches, so that final color of dry grout will closely match adjacent surfaces.
  1. Thoroughly wet concrete surfaces and apply grout to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

- D. Related Unformed Surfaces: At tops of walls and grade beams, horizontal offset surfaces occurring adjacent to formed surfaces, strike-off, smooth and finish with a texture matching adjacent unformed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

### 3.09 FLOOR FLATNESS AND LEVELNESS

- A. Floor flatness/levelness tolerances: Tolerances for various floor uses shall conform to the requirements set forth in ACI 117 and ACI 302 for “flat” floor profile.
  - 1. Minimum Test Area Flatness/Levelness:  $F_F30/F_L20$
  - 2. Minimum Local F Number:  $F_F15/F_L10$
- B. Levelness criteria shall be applied to slabs-on-grade only.
- C. Contractor shall measure floor finish within 72 hours after slab finishing and provide corrective measures for finishes not within tolerance. Corrective procedures shall be reviewed by the Engineer prior to implementation.

### 3.10 MONOLITHIC SLAB FINISHES:

- A. Scratch Finish: Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds, and as otherwise indicated.
  - 1. After placing slabs, plane surface to a tolerance not exceeding 1/2 in. in 10 ft. when tested with a 10-ft. straightedge. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms or rakes.
- B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, and as otherwise indicated.
- C. Trowel Finish: Apply trowel finish to monolithic slab surfaces indicated, including slab surfaces to be covered with carpet, resilient flooring, paint or other thin-film finish coating system.
- D. Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete platforms, steps and ramps (including garage ramp), and elsewhere as indicated.
- E. Slab finishes for floor coverings not indicated or exposed to view in the final condition shall be coordinated with the Engineer prior to slab placement.
- F. Slab Joints: Where indicated, sawn slab contraction joints shall be “soft cut”, immediately after concrete surface is firm enough not to be torn or damaged by the blade.

### 3.11 CONCRETE CURING AND PROTECTION:

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 308 as herein specified.

- B. Curing Methods: Perform curing of concrete by moist curing, by moisture-retaining cover curing, by curing compound, and by combinations thereof, as herein specified unless noted otherwise. Curing shall commence as soon as concrete surfaces are sufficiently hard as to withstand surface damage. Slabs-on-grade shall be cured by moist curing methods.
- C. Curing Formed Surfaces: Cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- D. Protection From Mechanical Injury: During the curing period and duration of construction, the concrete shall be protected from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration. All finished concrete surfaces shall be protected from damage by construction equipment, materials, or methods, by application of curing procedures, and by rain or running water. Self-supporting structures shall not be loaded in such a way as to overstress the concrete.

### 3.12 REMOVAL OF FORMS:

- A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 degrees F for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.
- B. Formwork supporting weight of concrete, such as joints, slabs and other structural elements, may not be removed in fewer than 14 days or until concrete has attained design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.
- C. Form facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and support.

### 3.13 REUSE OF FORMS:

- A. Clean and repair surfaces of forms to be reused in work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and latency, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to Engineer.

### 3.14 MISCELLANEOUS CONCRETE ITEMS:

- A. Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

### 3.15 CONCRETE SURFACE REPAIRS:

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to the Engineer.
  - 1. Cut out honeycomb, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts, down to solid concrete but in no case to a depth of less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush coat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.
  - 2. For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- B. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. Surface defects, as such, include color and texture irregularities, form tie holes, cracks, spalls, air bubbles, honeycomb, rock pockets, fins, and other projections on surface and stains and other discolorations that cannot be removed by cleaning.

### 3.16 QUALITY CONTROL TESTING DURING CONSTRUCTION:

- A. Testing Agency/Project Special Inspector shall verify reinforcement, including foundation reinforcement and slab reinforcement (WWF or reinforcing bar). Agent shall verify WWF or reinforcement has been chair/placed with proper clearances.
- B. The Design-Build Contractor shall employ a Testing Laboratory to inspect, sample and test the materials and the production of concrete and to submit test reports. Concrete testing shall be performed by technicians certified by the Maine Concrete Technician Certification Board and/or ACI Concrete Field Testing Technician Grade I.
- C. Concrete shall be sampled and tested for quality control during placement. Quality control testing shall include the following, unless otherwise directed by the Engineer.
- D. See Submittals section for report requirements.
- E. Sampling Fresh Concrete: ASTM C 172.
  - 1. Slump: ASTM C143; One test for each set of compressive strength test specimens. Sample shall be taken from middle third of the load per ASTM C172. A slump test must be run prior to the incorporation of the CFP fibers per recommendations of ACI 544. A slump test must be run prior to and following the addition of a water reducer (superplasticizer) per recommendations of ACI 301.
  - 2. Air Content: ASTM C231 "Pressure method for normal weight concrete." one test for each set of compressive strength specimens measured at point of discharge.
  - 3. Concrete Temperature: Per ASTM C-1064; one test each time a set of compression test specimens are made.
  - 4. Compression Test Specimen: ASTM C31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.

- a. An insulated Cure Box for specimen curing shall be supplied by Testing Agency for initial curing as defined in ACI C31.
  - b. Means of heating or cooling the Cure Box shall be provided by the Inspection Agency if required in order to maintain a temperature between 60 and 80 degrees F. Contractor shall provide an electrical source to the Testing Agency when required for temperature control.
  - c. A maximum-minimum thermometer shall be provided in the Cure Box by the Testing Agency to record the temperature range of the Cure Box during specimen curing. The Testing Agency shall record the maximum/minimum temperature of the Cure Box when transferring the specimens to the laboratory.
  - d. Test Specimens shall be moist cured.
  - e. Refer to ACI C31 for additional requirements for Test Specimens.
5. Compressive Strength Tests: ASTM C39; one set for each 50 cu. yds. or fraction thereof, of each concrete class placed in any one day or for each 4,000 sq. ft. of surface area placed; 1 specimen tested at 7 days, 2 specimens tested at 28 days, 1 specimen retained in reserve for later testing if required.
6. Pumped concrete shall be tested at point of discharge per ACI 301.
- F. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by the Engineer. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods, as directed. Cast-in-place Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.

**END OF SECTION**