NORTHWESTERN UNIVERSITY

DESIGN GUIDELINES
AND
TECHNICAL STANDARDS

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DIVISION 3 – CONCRETE

SECTION 03 3000 – CAST-IN-PLACE CONCRETE

1. General: This section outlines requirements for cast-in-place concrete construction.

2. Concrete Design Criteria:

    a. Except for lean concrete, which is typically used for backfill, minimum 28-day concrete strength shall be 3,000 psi, for below grade construction, and 3,500 psi for slabs-on-grade and above-grade construction.

    b. Concrete exposed to freeze / thaw shall have a minimum air content of 4.5%.

3. Design Considerations:

    a. No conduit shall be placed in concrete slabs without approval by the University.

    b. Consideration must be given to the precast connection to the superstructure, prior to commencement of construction.

    c. Precast camber – minimum thickness of topping shall be measured at the high point of camber.

    d. Do not use gypsum-based products for anchorage into exterior exposed concrete.

    e. Epoxy coat all reinforcing in exterior permanently-exposed face of concrete.

    f. Coordinate brick ledges and exterior grades so that soils are not placed against exterior façade materials (e.g. stone, precast concrete, or masonry).

    g. Form tie depressions shall be patched on all vertically formed concrete surfaces that are either exposed to view or are to receive damp-proofing or waterproofing.

    h. Perimeter foundation walls shall receive, at minimum, fluid-applied damp-proofing. Foundation walls that form the perimeter of a basement or crawl space, and elevator pit walls, shall be waterproofed. Provide a footing / wall water stop at waterproofed locations.

    i. Pipe, conduit, and other penetrations through perimeter basement walls shall be provided with an appropriate seal as manufactured by Link-Seal or approved equal.

    j. The minimum reinforcing for slab-on-grade and slab-on-deck concrete shall be WWF 6x6 – W1.4 x W1.4, with the WWF supplied in sheets, not rolls.

    k. The minimum allowable vapor barrier under interior slabs-on-grade shall be a 12 mil reinforced polyethylene product (“Moistop” or approved equal.) The joints in the vapor barrier shall be sealed with the manufacturer’s recommended tape.

l. Concrete placement during cold weather conditions shall be performed in strict accordance with the ACI Standard Specification for Cold Weather Concreting.

m. Concrete slabs (exclusive of mud slabs) shall receive a minimum of a float finish; if indicated to be broomed, the slab shall be floated and then broomed.

n. Apply an acrylic curing compound similar to Sonneborn “Kure-N-Seal” to cast-in-place slab concrete. If there is a specified surface finish product or adhesive that is not compatible with the curing compound, it shall be the finish installer’s responsibility to remove the compound (sand, etch, bead blast, etc. as needed) prior to their installation.

4. Tolerances: The University requires proper forming, placement and finishing to meet the following:

   a. Sizes of sleeves, floor openings, and wall openings: Center line of sleeves, floor and wall openings, +/-1/2”.

   b. The following are recommended tolerances for finished slab surfaces:

      i. Scratch Finish: For surfaces to receive concrete floor topping or mortar setting beds for tile and other bonded applied cementitious finish flooring material: Depressions between high spots shall not exceed 1/4” under a 10-foot straightedge.

      ii. Float Finish: For surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing: Depressions between high spots shall not exceed 5/16” under a 10-foot straightedge.

      iii. Trowel Finish: For surfaces to be exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system: Achieve level surface plane so that depressions between high spots do not exceed 1/8” under a 10-foot straightedge.

   c. Floor Leveling: Contractor, at his own expense, shall provide floor leveling, to the satisfaction of the University, in areas where the above tolerances are not achieved.

5. Quality Assurance:

   a. Installer Qualifications: An experienced installer who has completed Concrete Work similar in material, design, and extent to that indicated for the intended Project and whose work has resulted in construction with a record of successful in-service performance.

   b. Professional Engineer Qualifications: An Illinois licensed structural engineer who is experienced in providing engineering services of the kind indicated. Delete this requirement if Contractor is not required to engage the services of a professional engineer.

c. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

    i. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.

d. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

e. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

6. Pre-Installation Conference: Architect/Engineer shall review requirements for pre-installation conference with NU Project Manager.

7. Mockups: Architect/Engineer shall review requirements for mock-ups with NU Project Manager.

    a. Cast concrete slabs-on-grade mockup to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.

    b. Obtain Architect/Engineer's approval of mockups before starting construction.

    c. If Architect/Engineer determines that mockups do not meet requirements, demolish and remove them from the site and cast another until the mockup is approved.

    d. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

    e. Demolish and remove mockups when directed.

    f. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

8. Delivery, Storage, and Handling:

    a. Deliver, store, and handle steel reinforcement to prevent bending and damage.

    b. Avoid damaging coatings on steel reinforcement. Repair damaged epoxy coatings on steel reinforcement.

9. Accessories:

    a. Vapor Retarder: not less than 15 mils thick.

    b. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand.

c. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel.

10. Concrete Mixes:

    a. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases.

    b. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.

11. Concrete Mixing:

    a. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.

12. Embedded Items: Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

13. Vapor Retarders:

    a. Vapor Retarder: Place, protect, and repair vapor-retarder sheets.

    b. Fine-Graded Granular Material: Cover vapor retarder with fine-graded granular material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch (0 mm) or minus 3/4 inch (19 mm).

    c. Granular Fill: Cover vapor retarder with granular fill, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch (0 mm) or minus 3/4 inch (19 mm).

14. Steel Reinforcement:

    a. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

        i. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

    b. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.

    c. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

    d. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

    e. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh

spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

f. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating.

15. Joints: Typically joints are to constructed true to line with faces perpendicular to surface plane of concrete. Special requirements shall be indicated on the drawings.

16. Concrete Placement: Before placing concrete, contractor shall be required to verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

17. Concrete Surface Repairs:

    a. Filling In: Contractor shall be required to fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place.

    b. Defective Concrete: Contractor shall be required to repair and patch defective areas when approved by Architect/Engineer. Remove and replace concrete that cannot be repaired and patched to Architect/Engineer's approval.

    c. Patching Mortar: It is recommended to mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.2-mm) sieve, using only enough water for handling and placing.

    d. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

        i. Immediately after form removal, Contractor shall be required to cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension in solid concrete but not less than 1 inch (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

        ii. Contractor shall be required to repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

iii. Contractor shall be required to repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect/Engineer.

e. Repairing Unformed Surfaces: Contractor shall be required to test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

i. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

ii. After concrete has cured at least 14 days, correct high areas by grinding.

iii. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

iv. Correct other low areas scheduled to receive floor coverings with a repair underlayment.

v. Correct other low areas scheduled to remain exposed with a repair topping.

vi. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete.

vii. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar.

18. Polished Concrete Floor Finishing:

a. The desired results of a ground, polished floor should be specified in three categories:

i. Flatness and levelness of the concrete: Manufacturers typically recommend F(f)40 and F(l)25.

ii. Aggregate Exposure: Please note that each finish below will have some percentage of all four finishes. The finish choices are described as:

1. Cream: No exposed aggregates.

2. Salt and Pepper: Exposed sand and small aggregate.

3. Medium: 1/8-inch to 1/4-inch exposed aggregate.

4. Heavy: 1/4-inch to 1/2-inch exposed aggregate.

iii. Sheen:

1. Level A: Hard-shell, satin finish (400 grit).

2. Level B: Hard-shell, medium sheen finish (800 grit).

3. Level C: Light reflective, mirror finish (1800 grit).

b. The depth of the grind to achieve the desired results is dependent on the techniques used for finishing, the concrete mix, and the amount of time between concrete pouring and grinding. To avoid disputes later, however, it is necessary to specify a minimum required depth of the grind of at least 1/4-inch. That gives the contractor a starting point to achieve the desired finish results.

c. Utilize a mock-up to determine the final technique.

d. Do not grind and polish lightweight concrete. Shale aggregates will be pulled from the surface resulting in pits.

19. Field Quality Control – Testing Agency: Typically, Northwestern will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Architect/Engineer shall review project specific requirements with the NU Project Manager during the Design Phase of the project.

a. Testing Agency Qualifications: Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

b. Testing Services: The following are recommended minimums for field quality control and testing. Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

i. Testing Frequency:

1. Obtain one composite sample for each day's pour of each concrete mix exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.

2. Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mix placed each day.

3. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mix, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

ii. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete

mix. Perform additional tests when concrete consistency appears to change.

iii. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

iv. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.

v. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

vi. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of four standard cylinder specimens for each composite sample.

1. Cast and field cure one set of four standard cylinder specimens for each composite sample.

vii. Compressive-Strength Tests: ASTM C 39; test two laboratory-cured specimens at 7 days and two at 28 days.

1. Test two field-cured specimens at 7 days and two at 28 days.

2. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.

3. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

4. Strength of each concrete mix will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

viii. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.

c. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect/Engineer but will not be used as sole basis for approval or rejection of concrete.

d. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect/Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect/Engineer.

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DIVISION 3 – CONCRETE

SECTION 03 400 – PRECAST CONCRETE

1. General: This section outlines the requirements for precast concrete. Specific requirements shall be reviewed with the NU Project Manager during the design phases of the project

2. Submittal Requirements:

    a. Submittal requirements shall include fully-engineered shop drawings and design calculations stamped by an engineer registered in the State of Illinois.

    b. Fully-dimensioned shop drawings shall be required that include “closing” dimensions to the Architect/Engineer’s dimensional reference (grid lines, face of foundation, etc.) and that dimension rough opening sizes for windows, etc. bounded by precast components.

    c. Shop drawings shall specifically identify the locations and magnitudes of loads that will be imposed on the structure by precast connections.

3. Quality Assurance:

    a. Precast pieces that are damaged during shipping, handling, etc. shall be reviewed by the Architect/Engineer and Owner prior to installation.

    b. The Architect/Engineer and Owner shall have the discretion to require that damaged pieces be repaired to their satisfaction prior to installation.

END OF SECTION

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