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*Note: The paragraphs below are meant to be incorporated into Parts 1, 2 and 3 of a standard CSI 3 Part Format specification, the General Structural Notes, or directly onto the plans. They must be carefully reviewed by a qualified design professional and edited to meet the requirements of the project and governing building codes. Coordinate with other specification sections and drawings. In no case shall these Guide Specifications be considered to be Contract Documents or serve as installation instructions for the product being discussed. In any case of discrepancy the manufacturer's most recently published data sheet shall take precedence.*

*Consult Euclid Chemical for assistance in editing this Section for the specific project.*

*This document contains hidden text. View with hidden text shown.*

**SECTION 03 47 00 SITE CAST TILT-UP CONCRETE**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

 A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Site cast tilt-up concrete panels.
2. Site cast tilt-up insulated sandwich concrete panels.
3. Site cast tilt-up curing compounds, bond breakers, bearing shims, lifting inserts, bracing inserts, coloring agent, grout and sandwich panel insulation systems.

*Specifier Notes: Edit the following list of related sections as required. Limit the list to sections with specific information that the reader might expect to find in this section but is specified elsewhere. Consult with Euclid Chemical for recommendations regarding high build acrylic coatings for tilt-up concrete panels.*

**1.2 RELATED REQUIREMENTS**

 A. Section 03 11 00 Concrete Forming : Requirements for form work used in tilt-up construction.

 B. Section 03 20 00 Concrete Reinforcing: Requirements for reinforcing steel used in concrete tilt-up panel construction.

 C. Section 03 30 00 Cast In Place Concrete: Requirements for slab on grade design and construction and general requirements for concrete used in tilt-up panels,

 D. Section 05 50 00 Metals: Requirements for metal components used in tilt-up panel construction.

 E. Section 07 20 00 Insulation: Requirements for insulation used in tilt-up panel construction.

 F. Section 07 62 00 Sheet Metal Flashing and Trim: Requirements for flashing to adjacent materials.

 G. Section 07 92 00 Joint Sealants: Requirements for joint sealants used in tilt-up panel construction.

 H. Section 09 90 00 Painting and Coating: Requirements for painting and coating of tilt-up panels where applicable.

**1.3 SUBMITTALS**

 A. Comply with Section 01 30 00.

 B. Product Data: Submit manufacturer’s product data, including surface preparation and application instructions for the following:

1. Bearing shims.
2. Bond breakers.
3. Bracing inserts.
4. Coloring agents.
5. Connection devices.
6. Curing products.
7. Grout.
8. Lifting inserts.
9. Sandwich panel insulation including details of wythe connections, thickness and type of insulation to be used.

 C. Shop Drawings: Provide shop drawings in accordance with requirements of ACI 301 Section 12 that have been reviewed by Licensed Design Professional. Detail fabrication and installation of tilt-up concrete units including temporary bracing. Indicate panel locations, plans, elevations, dimensions, shapes, cross sections, and details of steel embedments. Match panel identification designations on Shop Drawings with those on Drawings.

1. Reinforcing bars shown on drawings are not checked for lifting and erection stresses.
2. Include steel reinforcement, detailing fabrication, bending, and placing. Include material, grade, bar schedules, stirrup spacing, bent-bar diagrams, arrangement, and supports of concrete reinforcement.
3. Include additional steel reinforcement to resist hoisting and erection stresses.
4. Include locations and details of hoisting points and lifting devices for handling and erection.
5. Include engineering analysis data of additional steel reinforcement and hoisting and erection details, signed and sealed by the qualified professional engineer responsible for their preparation.
6. Indicate welded connections by AWS standard symbols. Detail cast-in inserts, connections, and joints, including accessories.

 D. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

1. Concrete mix designs for each mix specified.

 E. Material Test Reports and Certificates: Submit certified laboratory test reports confirming physical characteristics of materials used in performance of Work of this Section.

 F. Temporary Bracing Plan

1. Prior to commencing work, panel erection subcontractor involved in temporary bracing must provide an engineered bracing plan signed and stamped by a Licensed Design Professional.
2. Wind loads: comply with ASCE-7.
3. Bracing plan must be distributed to panel erection crew to follow and copy is to remain on-site for reference during duration of temporary controls.
4. Plan must specify items such as bracing size, spacing, angle anchorage points, panel attachment information and when it is safe to remove temporary bracing.
5. Requirements specified in temporary bracing plan are sole responsibility of erection subcontractor's engineer.

 G. Methods and materials for repair of defects.

 H. Proof of tilt-up concrete contractor qualifications as specified herein.

**1.5 QUALITY ASSURANCE**

 A. Perform work of this section in accordance with ACI 301 Specifications for Concrete Construction Sections 1 through 5 and Section 12 except where noted herein.

 B. Regulatory Requirements: Comply with applicable codes and regulations of governmental agencies having jurisdiction. Where those requirements conflict with this Specification, comply with the more stringent provisions.

 C. Ready Mix Concrete Manufacturer: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94 requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

 D. Source Limitations: Obtain all liquid curing compounds, tilt-up bond breakers, penetrating liquid densifiers, and penetrating sealers from a single manufacturer that has ISO 9001 Quality Certification.

 E. Tilt-Up Contractor Qualifications:

1. Workers proficient in concrete tilt-up production and erection operations under direct supervision of ACI/TCA certified Tilt-Up Supervisor.
2. Minimum 2 years experience in tilt-up product erection including projects similar in size and scope.
3. Employ persons trained for application of tilt-up concrete cure and bond breakers and approved by manufacturer.

 F. Qualifications for Welding: Qualify welding processes and welding operators in accordance with ANSI/AWS D1.4. Provide certification that welders to be employed in Work have satisfactorily passed AWS qualification tests within previous 12 months.

 G. Mockups: Utilizing same materials, methods, equipment and personnel as will be used for final work, cast and erect tilt-up concrete panel mockups to demonstrate typical reveals, surface finishes, texture, color, and standard of workmanship.

*Specifier Notes: Insert mockup sizes below.*

1. Build two **<<INSERT SIZES>>** mockup panels in location and of size indicated on drawings. Incorporate edge and reveal conditions as detailed on project drawings.
2. Leave mockup in place, protected and undisturbed throughout Work as established acceptance criteria.
3. Cast mock-up over slab joint or column joint if actual panels will be affected by these conditions.
4. For painted concrete finishes, utilize full range of color as specified. Utilize reveal characterization as specified.
5. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
6. Acceptance of mockup does not imply acceptance of materials and workmanship that may be in non-compliance with Contract Documents.

*Specifier Notes: Edit preinstallation conference language below as required for project.*

 H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section **<<INSERT SECTION>>.**

1. Convene preinstallation meeting two weeks before start of concrete slabs on grade and casting beds.
2. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with tilt-up concrete to attend, including the following:
	1. Independent testing agency responsible for concrete design mixtures.
	2. Ready-mix concrete manufacturer.
	3. Tilt-up concrete subcontractor.
	4. Concrete curing compound and bond breaker manufacturer’s representative.
	5. **[Liquid densifier manufacturer’s representative.]**
	6. Owner’s testing and inspection agency.
3. Review procedures; testing and inspecting agency procedures for field quality control; tilt-up concrete finishes and finishing; cold and hot weather concreting procedures; curing procedures; casting-slab construction, flatness and levelness, finish, and joint requirements; steel reinforcement installation; hoisting and erection plans; measurement of fabrication and erection tolerances; tilt-up concrete repair procedures; and tilt-up concrete protection.
4. Record and type minutes of meeting and distribute to all attendees and concerned parties within 5 days of meeting.

**1.6 PROJECT CONDITIONS**

 A. Perform cold weather concreting work in accordance with ACI 306.1 Specifications for Cold Weather Concreting except where noted herein.

 B. If enclosed shelters are used, direct fired heat is prohibited. General Contractor is responsible for monitoring interior concrete floor exposure to excessive exhaust gases containing carbon dioxide (CO2) or carbon monoxide (CO) during delivery, placement and finishing of concrete and until concrete floor is protected by specified curing method.

1. CO2 levels shall not exceed 4,500 parts per million. CO levels shall not exceed 15 parts per million at concrete surface within 5 feet of any source of exhaust gases.
	1. Levels shall be monitored utilizing appropriate meter from company similar to CEA Instruments, Inc., 16 Chestnut Street, Emerson, NJ 07630; Phone (201-967-5660).
2. Unvented combustion heaters are PROHIBITED to be in operation during concrete placement.
3. Limit combustion engine equipment inside building during concrete to only that equipment necessary to place and finish concrete.
4. Only two concrete trucks are permitted in sheltered area at any given time and under no circumstance shall there be any earth moving equipment, dump trucks, grading equipment, or any other motorized equipment in operation until after the interior concrete floor is placed and protected by specified curing method. www.ceainstr.com.

 C. Perform hot weather concreting work in accordance with ACI 305.1 Specifications for Hot Weather Concreting except where noted herein.

 D. Substrate and Ambient Temperatures: Apply tilt-up concrete cure and bond breakers at substrate and ambient temperatures between 50 and 100 degrees F (10 and 38 degrees C).

 E. Do not apply tilt-up concrete cure and bond breakers in wet conditions or when wet conditions are anticipated within 12 hours of application. Product must be allowed to fully dry after application to achieve proper bond breaking performance.

**PART 2 PRODUCT**

**2.01 FORMS**

A. Provide forms in accordance with Section 03 11 00 Concrete Forming except where noted herein.

 B. Attach forms to slab using non-intrusive glues and/or adhesives wherever possible in lieu of nails and bolts.

 C. Provide forms that contain block-outs as required to provide openings detailed on Drawings. Coordinate all openings with other trades.

 D. Provide panel boundary forms rigidly constructed of well braced steel or wood, straight and with precise corners. Design forms to withstand stresses resulting from the casting process. Consideration should be given to exposed formed surfaces. All forming surfaces must be smooth and clean prior to pouring of concrete.

 E. Panels may be stacked for ease of casting, in forms as specified above.

 F. When panels are stack cast, maintain a continuous sound and smooth surface with forming and plaster at all openings.

 G. Reveal Materials: Materials used for creating reveals or relief in exterior face of panel must be of adequate strength to withstand construction traffic/loads without damage.

**2.02 STEEL REINFORCING**

A. Steel reinforcing for slabs on grade, tilt-up casting beds and panels is to be in accordance with Section 03 20 00 Concrete Reinforcing and CRSI's "Manual of Standard Practice" except where noted herein.

 B. Supports for Steel Reinforcement: Supports may consist of metal, all-plastic and concrete materials.

1. Design steel supports for reinforcement to prevent spalling of concrete surfaces or streaking of panel face from corrosion.
2. Metal supports are to be either galvanized after fabrication or with tips protected with plastic. No galvanized or plastic tip metal supports are to be used on panels to receive exposed or sandblasted finish.
3. All-plastic supports are to be of such design as to adequately support reinforcement, provide minimal surface contact and be of such coloring as to not be distinguishable on any surfaces. Minimal surface contact is defined as having a total contact surface area not to exceed 0.10 square inches (64.5 mm²) per contact point. Refer to CRSI Manual of Standard Practice.
4. Concrete supports may only be used in situations where surface contact is not visible.

**2.03 FIBER REINFORCING**

 A. Synthetic Macrofiber: Polypropylene/polyethylene synthetic macrofiber complying with ASTM C 1116 Type 3, minimum 2 inch length, aspect ratio 50 to 90.

 1. Basis of Design:

 a) Euclid Chemical Company (The); [TUF-STRAND SF](https://www.euclidchemical.com/products/concrete-fibers/synthetic-macrofibers/tuf-strand-sf/); [www.euclidchemical.com](https://tremcoinc-my.sharepoint.com/personal/mhansen_euclidchemical_com/Documents/Documents/Euclid%20Chemical/NBDG/Specifications/Guide%20Specs/Euclid%20Web%20Site%20Specs/Eucotilt%20Guide%20Specs/www.euclidchemical.com)

 2. Fiber manufacturer shall have ISO 9001 certification.

 3. Synthetic macrofiber shall be tested in concrete to meet the requirements of ICC-C383

4. Fiber must provide minimum plastic shrinkage crack reduction of 86 percent when tested in accordance with ASTM C1579.

 5. Fiber reinforcement is PROHIBITED for use as flexural reinforcement in tilt-up panels.

**2.04 CAST-IN ANCHORS AND CONNECTIONS**

 A. Provide lifting hardware, inserts, braces, and related embedded and attached items manufactured specifically for site cast, tilt-up concrete construction.

 B. Lifting Inserts: From a single source manufacturer, provide structural inserts and components manufactured specifically for site cast tilt-up concrete construction, to engage lifting inserts for lifting tilt-up panels.

 C. Bracing Inserts: Provide structural inserts from a single source manufacturer for temporary bracing of tilt-up concrete panels.

 D. Embedded Metal Items and Loose Hardware: Conform to requirements of Section 05 50 00 – Metal Fabrications and the recommendations of subcontractor's embedded metal supplier.

 E. Steel that will be exposed to the exterior or damp environments in finished panels must be plastic-tipped, hot-dipped galvanized in accordance with ASTM A123 or protected by other means to prevent corrosion or oxidation of metal after fabrication.

1. Selection of plastic-tipped treatments: Ensure that plastic will not create stress concentrations within thin sections of concrete when located near a surface from differential thermal expansion and contraction ultimately resulting in local shear failure of concrete surface producing surface blemishes.

*Specifier Notes: Retain Article 2.04 below if tilt-up will consist of insulated sandwich panels. Insert required R value.*

**2.05 SANDWICH INSULATION SYSTEMS**

 A. Construct insulated concrete sandwich panels to provide a continuous layer of insulation throughout entire panel surface. No cross section of panel is to contain less than the specified minimum R-value below unless compliance is proven through performance-based analysis and reviewed by Architect.

 B. Insulated Concrete Sandwich Panels: Engineered and constructed to maintain effective acceptable material R- **<<INSERT VALUE>>** of panels with less than one (1) percent reduction due to penetrations and connection detailing. Reduction in thermal performance must be calculated using Isothermal planes method of R-value calculation as provided by ASRHAE 90.1.

*Specifier Notes: Delete paragraph below if integral vapor barrier is not required.*

 C. Install continuous vapor retarding membrane with a minimum thickness of **<<INSERT VALUE>>** mils between the outer wythe of concrete and insulation system prior to the placement of insulation system. Tape all joints in vapor retarding membrane with minimum 2-inch wide adhesive tape product.

**2.06 CONCRETE MATERIALS**

 A. Concrete materials are to be in accordance with Section 03 30 00 Cast in Place Concrete except where noted herein.

**2.07 CURING COMPOUNDS AND BOND BREAKERS**

*Specifier Notes: Choose one or both of the following curing compound/bond breakers and retain description. These products are to be used to cure casting slab surfaces.*

*EUCOTILT WB is a water based, chemically reactive, membrane forming cure and bond breaker engineered specifically for tilt-up construction. Containing no wax or hydrocarbon resins, EUCOTILT WB is formulated using organic compounds that react with the free lime in the concrete casting surface to form amorphous gels / metallic soaps that, when properly applied, provide for clean release of cast panels. The unique blend allows for quick drying, even in cool, damp conditions.*

 A. Water Based Reactive Curing Compound and Bond Breaker for Casting Slab Surfaces: Provide water based, chemically reactive, membrane forming cure and bond breaker formulated specifically for tilt-up concrete construction.

1. Product must meet moisture retention requirements of ASTM C309 when applied to hard troweled surfaces prepared in accordance with CEN/TS 14754.
2. Products containing wax or hydrocarbon resins are PROHIBITED.
3. VOC 50 g/L.
4. Basis of Design Product:
	1. Euclid Chemical Co. (The): [EUCOTILT WB](https://www.euclidchemical.com/products/construction-products/bond-breakers/eucotilt-wb/); [www.euclidchemical.com](http://www.euclidchemical.com)

*EUCOTILT SB is a solvent based, chemically reactive, and membrane forming cure and bond breaker engineered specifically for tilt-up construction. Containing no wax or hydrocarbon resins, EUCOTILT SB is formulated using organic compounds that react with the free lime in the concrete casting surface to form amorphous gels / metallic soaps that, when properly applied, provide for clean release of cast panels. The unique solvent blend allows for quick drying, even in cool, damp conditions.*

 B. Solvent-Based Reactive Curing Compound and Bond Breaker for Casting Slab Surfaces: Provide solvent based, chemically reactive, membrane forming cure and bond breaker formulated specifically for tilt-up concrete construction.

1. Product must meet moisture retention requirements of ASTM C309 when applied to hard troweled surfaces prepared in accordance with CEN/TS 14754.
2. Products containing wax or hydrocarbon resins are PROHIBITED.
3. VOC 800 g/L.
4. Basis of Design Product:
	1. Euclid Chemical Co. (The): [EUCOTILT SB](https://www.euclidchemical.com/products/construction-products/bond-breakers/eucotilt-sb/); [www.euclidchemical.com](http://www.euclidchemical.com)

*Specifier Notes: The dissipating resin curing compounds listed below are intended to be used to cure the face up surfaces of panels. They leave a residue that is more easily removed from the surface prior to application of subsequent treatments, paints and coatings. If the intent is to coat the face up (interior) side of the panels, the curing compound will need to be removed prior to application. In such cases wet cover cure methods may be more appropriate.*

*Choose appropriate product below. KUREZ DR VOX has VOC of 301 g/L. KUREZ DR 100 has VOC of <98 g/L.*

 C. Dissipating Resin Concrete Curing Compound for Face Up Panel Surfaces: Provide a ready-to-use, dissipating compound for use on new, interior and exterior, horizontal and vertical concrete surfaces. Product must conform to ASTM C 309, Types 1 and 1D, Class A & B and AASHTO M 148, Types 1 and 1D, Class A & B

1. Basis of Design Product:
	1. Euclid Chemical Co. (The); [KUREZ DR VOX](https://www.euclidchemical.com/products/construction-products/curing-compounds/kurez-dr-vox/) or [KUREZ DR 100](https://www.euclidchemical.com/products/construction-products/curing-compounds/kurez-dr-100/); [www.euclidchemical.com](http://www.euclidchemical.com)
2. Not for use on surfaces to receive liquid Bond Breaker.

 D. Moisture-Retaining Cover for Face Up Panel Surfaces:

1. Plastic Film: ASTM C 171, 10 mil minimum thickness polyethylene film.
2. White burlap-polyethylene sheet meeting ASTM C 171.
3. Reinforced Curing Paper: Complying with ASTM C 171.
4. Moisture Retaining Fabric: Conforming to ASTM C171: Naturally colored, non-woven polypropylene fabric with a 4 mil non perforated reflective (white) polyethylene coating containing stabilizers to resist degradation from ultraviolet light. Fabric to exhibit low permeability and high moisture retention.

**2.08 ACCESSORIES**

 A. Bearing Shims: Plastic bearing shims with adequate capacity to support applied loads before grouting panels. AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet; Type A Shore durometer hardness of 50 to 70, ASTM D2240; and minimum tensile strength 2250 psi, ASTM D412.

*Specifier Notes: Non-shrink grout can also be produced by ready mix concrete producers through the use of Euclid Chemical CONEX shrinkage compensating admixture. Go to* [*https://www.euclidchemical.com/products/admixtures/specialty-admixtures/shrinkage-control/conex/*](https://www.euclidchemical.com/products/admixtures/specialty-admixtures/shrinkage-control/conex/) *for more information and contact your local Euclid Representative for assistance.*

 B. Non-Shrink Grout: Provide non-shrink, non-metallic grout meeting ASTM C1107 and of consistency suitable for application.

1. Basis of Design Product:
	1. Euclid Chemical Co. (The): NS GROUT; [www.euclidchemical.com](http://www.euclidchemical.com)

 C. Surface Repair Mortar for Tilt-Up Panels: Provide single component, polymer modified, cement based mortar designed specifically for smoothing, re-profiling or rubbing tilt-up concrete surfaces.

1. Basis of Design Product:
	1. Euclid Chemical Co. (The): [EUCOREPAIR SMOOTH](https://www.euclidchemical.com/products/construction-products/repair/repair-vertical-overhead/cementitious/eucorepair-smooth/) or [TAMMS CEMENT WASH](https://www.euclidchemical.com/products/construction-products/repair/repair-vertical-overhead/cementitious/tamms-cement-wash/); [www.euclidchemical.com](http://www.euclidchemical.com)

 D. Trowelable Vertical and Overhead Repair Mortar for Tilt-Up Panels: Cement-based, one component, low shrinkage, polymer modified, fiber reinforced repair mortar, suitable for interior or exterior use, and containing corrosion inhibiting admixture. Material shall have the following properties neat:

1. Compressive Strength minimum 2,000 psi (13.8 MPa) at 3 hours, minimum 3,000 psi (20.7 MPa) at 1 day and minimum 4,500 psi (31.0 MPa) at 7 days and minimum 6,000 psi (41.4 MPa) at 28 days per ASTM C 109, 2” (50 mm) cubes.
2. Flexural Strength minimum 600 psi (4.1 MPa) at 28 days per ASTM C 348.
3. Length Change maximum -0.02% at 28 days per ASTM C157.
4. Basis of Design Product:
	1. Euclid Chemical Co. (The); [EUCOREPAIR V100](https://www.euclidchemical.com/products/construction-products/repair/repair-vertical-overhead/cementitious/eucorepair-v100/); [www.euclidchemical.com](http://www.euclidchemical.com)

 E. Rapid-Setting Urethane Repair for Slabs on Grade: Two-component, clear, ultra-low viscosity hybrid urethane repair liquid intended to mend cracks in concrete, repair spalled joints and repair damaged or uneven concrete surfaces. Capable of being opened to heavy traffic in less than one hour. Capable of being mixed with aggregate to make a tough mortar for quickly repairing pop-outs and spalls.

1. Viscosity of 60cp.
2. VOC of 19 g/l.
3. ASTM D2240 Shore D Hardness of 70.
4. ASTM D638 Tensile Strength 3,400 psi at 7 days.
5. ASTM D638 Tensile Elongation of 16.3 percent.
6. ASTM D695 Compressive Strength of 5,000 psi at 24 hours.
7. ASTM C882 Bond Strength of 1,800 psi.
8. Basis of Design Product:
	1. Euclid Chemical Co. (The): [EUCO QWIKSTITCH](https://www.euclidchemical.com/products/construction-products/repair/repair-horizontal/urethane/euco-qwikstitch/); [www.euclidchemical.com](http://www.euclidchemical.com)

*Specifier Notes: For more information on Euclid Chemical high quality, elastomeric, urethane joint sealants EUCOLASTIC 1 NS and EUCOLASTIC 1SL and Joint Sealant Guide Specifications go to* [*https://www.euclidchemical.com/products/construction-products/joint-sealants/polyurethane/*](https://www.euclidchemical.com/products/construction-products/joint-sealants/polyurethane/) *or contact your local Euclid Representative.*

 C. Joint Sealants: See Section **[07 92 00]<<INSERT SECTION>>** Joint Sealants.

*Specifier Notes: For more information on Euclid Chemical high build, high performance acrylic coatings and High Performance Coatings Guide Specifications designed specifically for application to concrete tilt-up panels go to* [*https://www.euclidchemical.com/products/construction-products/coatings/coatings-architectural-wall/acrylic/*](https://www.euclidchemical.com/products/construction-products/coatings/coatings-architectural-wall/acrylic/) *or contact your local Euclid Representative.*

 D. Tilt-Up Panel Coatings: See Section **[09 90 00]<<INSERT SECTION>>** Painting and Coating

**2.09 CONCRETE MIXTURES**

*Specifier Notes: Insert required concrete properties below.*

 A. Prepare designed mixes in accordance with Section **[03 30 00]<<INSERT SECTION>>** Cast In Place Concrete to provide following properties:

1. Compressive Strength (28 Days): **<<INSERT COMPRESSIVE STRENGTH>>.**
2. w/cm = **<<INSERT WATER/CEMENTITIOUS MATERIALS RATIO>>**
3. Air Content: **<<INSERT AIR CONTENT>>.**
4. Contact Bond Breaker manufacturer for recommendations when concrete mixtures will contain supplementary cementitious materials such as flyash and slag.

 B. Fiber reinforcement is PROHIBITED for use as flexural reinforcement in tilt-up panels.

 C. Synthetic macrofibers may be used to replace WWF or steel bars in slabs on grade and topping slabs. Dosage for synthetic macrofibers fibers must be determined based on the required residual strength (fe3) in accordance with ASTM C1609 and the general recommendations of ACI 544.4r-18. Contractor to submit fiber manufacturers recommended dosage rate and testing indicating that specified (fe3) value is satisfied. Under no circumstances shall minimum dosage rate be less than 3 lbs per cubic yard of concrete for synthetic macrofibers. These minimum dosage rates apply to any required (fe3) values of 100 psi or less. The following table may be used for estimating the required residual strength (fe3). Contact fiber manufacturer for recommended dosage to meet required (fe3).

**FIBER REPLACEMENT OF STEEL - REQUIRED RESIDUAL STRENGTH (fe3) TABLE** 

**PART 3 EXECUTION**

**3.01 CASTING SLAB**

 A. Place and finish concrete slab on grade casting slabs in accordance with Section 03 30 00 Cast In Place Concrete.

 B. Waste slabs if used are to be minimum 2 inches thick if cast on compacted base and 3 inches thick if compacted base is not used. Minimum compressive strength for waste slab concrete is 2,500 psi.

 C. Contractor is responsible for compatibility of curing agents, sealants, and bond breaker agents utilized in Work. If panels are to be stacked, troweled surface shall be considered the casting bed and treated as same.

 D. Immediately following final finish of casting slab, uniformly apply cure coat of Curing Compound Bond Breaker in accordance with manufacturer’s written instructions and as indicated on drawings.

1. If saw cutting of joints is performed prior to application of cure coat, saw cut residue must be removed prior to application.

 E. Temporarily fill saw cuts, cracks, joints or defects in the casting bed so as to minimize transfer of joint line to panel face.

 F. Adhere reveals to prevent floating and movement during concrete panel placement operations. Locate reveals as indicated on drawings and within ACI 117 tolerances for cast in place concrete.

 G. Locate and install inserts and anchorages required for panels prior to casting of any concrete. When approved by engineer of record, embedded items such as dowels, inserts or anchorages, that either protrude from concrete or remain exposed for inspection, may be installed while concrete is in a plastic state. This is provided item(s) is not required to be hooked or tied to reinforcement within concrete and are maintained in correct position until concrete hardens. Such items must be properly anchored to ensure full development of design load. Concrete surface adjacent to embedded item must be properly finished for correct interfacing.

**3.02 FORMING OF PANELS**

A. Forming for concrete panels is to be in accordance with Section 03 11 00 Concrete Forming.

 B. Layout panels for casting in a manner that minimizes locations of floor joints, column isolation joints and other construction joints in panel faces. Prevent layout of panels over temporarily poured casting surfaces such as pre-formed columns and pits unless deemed absolutely necessary.

 C. Design and place forms to maintain perimeter of panel as shown on the Drawings within 1/4-inch maximum deflection during pouring.

 D. Design and place formed block outs for openings in panels so as to limit deflection during pouring to a maximum of 1/8 inch.

 E. Sandwich Installation Systems: Install in accordance with manufacturer's written recommendations.

**3.03 BOND BREAKER APPLICATION**

 A. Bond Breaker must be applied prior to placement of tilt-up panel reinforcing steel.

 B. Prepare surface to receive Bond Breaker in accordance with manufacturer’s written recommendations.

 C. Apply minimum two coats of Bond Breaker in accordance with manufacturer’s recommendations and as indicated on drawings.

 D. Do not overapply or underapply Bond Breaker.

 E. Bond Breaker from damage during construction.

 F. If concrete panel placement is delayed more than two weeks beyond final Bond Breaker application verify bond breaker presence and reapply as required prior to panel placement.

**3.04 SITE CAST TILT UP PANEL REINFORCEMENT AND INSERTS**

 A. Comply with CRSI’s Manual of Standard Practice for fabricating and placing reinforcement.

 B. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover.

1. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

 C. Install welded wire reinforcement 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.

 D. Accurately place and securely support embedded items, anchorages, inserts, cramps, retainers, bar chords and sleeves, and other items to be built into panels. Coordinate with other trades for installing cast-in items.

 E. After placing steel reinforcement for panels, check casting slab surfaces for continuity of Bond Breaker. Touch-up or recoat worn, damaged and missing areas as required. Steel reinforcing must be removed entirely prior to re-application of Bond Breaker unless approved by Architect.

**3.05 PLACING TILT-UP PANEL CONCRETE**

 A. Place concrete in accordance with Section 03 30 00 Cast In Place Concrete.

 B. Thoroughly work concrete around reinforcement, embedded items and into corners of forms.

 C. Cold joints are PROHIBITED in individual tilt-up panels.

 D. Screed panel surfaces to correct level with a straightedge and strike off.

1. Begin initial floating before excess moisture or bleed water appears on surface. Use bull floats or darbies to form a uniform and open-textured surface plane free of humps or hollows. Do not disturb panel surfaces before beginning finishing operations.

 E. Form chamfers at top edges of panel perimeters, openings, and similar locations not formed by chamfer strips, unless otherwise indicated.

**3.06 CASTING TOLERANCES**

 A. Dimensions of finished panels, at time of erection in structure, must conform to casting tolerances stated below unless otherwise specified or approved by Architect.

 B. Deviation from Specified Height or Width of Structural Panel:

1. Up to 20 feet ±1/4 in.
2. 20 feet to 30 feet ±3/8 in.
3. Each additional 10-foot increment in excess of 30 feet ±1/8 in.
4. Maximum overall tolerance ±5/8 in.

 C. Deviation from Specified Panel Thickness: Note the tolerance listed is for average variation of panel thickness through any cross-section of the panel.

1. Top surface of panel from casting slab ±3/8 in.
2. Thickness of panel, any one individual measurement –1/2 in.
3. Thickness of panel, average of all measurements –3/8 in.
4. Minimum number of panel thickness measurements, when taken, to be four (4) for each 5,000 sq.ft. or part thereof, or a minimum of three (3) measurements in any one panel less than 5,000 sq.ft.

 D. Deviation in Length of Diagonals for a Rectangular Member or Opening, where Length of Diagonal is as follows. Note the tolerance listed is the measured difference in length of the two diagonals across any rectangle.

1. Less than or equal to 6 ft. ±1/8 in.
2. Over 6 ft. but less than or equal to 12 ft. ±1/4 in.
3. Over 12 ft. but less than or equal to 18 ft. ±3/8 in.
4. Over 18 ft. ±1/2 in.

 E. Deviations from Specified Size:

1. Rough opening ±1 in.
2. Finished opening ±1/2 in.
3. Rustication or architectural feature ±1/8 in.

 F. Deviation from Specified Location (any direction):

1. Blockout or opening ±1 in.
2. Bolts, pipes or sleeves ±1/2 in.
3. Lifting and bracing inserts per manufacturer’s specs, not to exceed ±1 in.
4. Embeds ±1 in.
5. Reglets for flashing or bricks ±1/4 in.
6. Rustication or architectural feature ±1/8 in.
7. Electrical box or accessory of another trade ±1 in.

 G. Deviation from Plane:

1. Embeds (Tipping & Flushness) ±1/4 in.
2. Surface of concrete between embeds ±1/4 in.
3. Depth of recess, from casting surface ±1/4 in.

 H. Deviation from Specified Position of Reinforcement:

1. Cover, in accordance with ACI 318 and in no case less than specified elsewhere ±1/4 in.
2. Centroid within section, at any point within span ±1/2 in.
3. Plan position of reinforcement ±1 in.

**3.07 FACE DOWN PANEL FINISH**

*Specifier Notes: Indicate specified panel finishes on drawings. This will typically be the front side of the panel seen from the exterior of the building.*

 A. Finish exposed surfaces of panels as indicated on Drawings including both front and back of panels as well as any exposed edges as defined below. Visible surfaces of panels, when in place to be free from surface defects as defined below.

 B. Smooth panel finish (SPF) is to be a result of casting panel on hard-troweled finish.

1. SPF 1 - Utility: For remote areas with little or no public interaction and/or projects designed specifically for interior use with little or no emphasis towards the exterior design.
	1. Consult with the Architect and the Owner prior to initiating the project to determine the expectations for the project appearance.
	2. Panel surfaces showing voids, holes, pockets and other surface deformations are permissible provided they do not weaken the structural integrity of the panel or the finish of the panel/
	3. Cracked surfaces are permissible provided the cracks are not resulting from structural weakness or failure and provided they do not present the potential for failure of the finish over the life of the building.
	4. Non-casting surface faces are to receive a floated finish unless noted otherwise on the drawing elevations.
2. SPF 2 Standard: For the circulation of people within a distance greater than 25 feet while retaining an emphasis on quality finishes and aesthetic detail.
	1. Panel surfaces are to be free of all voids, holes, pockets and other surface deformations greater than 1/4 inch.
	2. Surfaces of panels may be repaired sufficiently to prevent excessive projection of blemishes through intended finish.
	3. Cracks are permissible as naturally resulting from drying. Cracks are not permissible as caused by erection forces.
	4. Surface repairs to improve appearance of panels within the descriptions above are acceptable provided they do not result in additional blemishes that are visible within distance set.
	5. Fill holes with specified repair materials to present a smooth surface ready for painting.
3. SPF 3 Architectural: For circulation of people within distance of 10 feet to 25 feet.
	1. Panel surfaces are to be free of voids, holes, pockets and other surface deformations greater than 1/8 inch.
	2. Reinforcing patterns, floor joints or other projections or voids from the casting surface are not acceptable.
	3. Cracks are not permissible in excess of 1/32 inch.
	4. Surface repairs are to be performed in such a way as to prevent projection of repair strokes through intended finish.
	5. Fill holes with patching material to present a smooth surface ready for painting.

 C. Prepare surfaces to be painted finish in accordance with Section 09 90 00 – Painting and Coating.

**3.08 FACE UP PANEL FINISH**

*Specifier Notes: Choose required finish below and indicate on drawings. This will typically be the back side of the panel seen from the inside of the building.*

 A. Float Finish: Consolidate surface of plastic concrete with power-driven floats or by hand floating. Restraighten and cut down high spots and fill low spots. Repeat float passes and restraighten until surface is left with uniform, smooth, granular texture.

 B. Trowel Finish: After applying float finish, apply first trowel finish and consolidate plastic concrete by hand trowel or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and is uniform in texture and appearance.

 C. Trowel and Fine-Broom Finish: After applying float finish, apply a partial trowel finish to plastic concrete, stopping after second troweling. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with fine broom. Final broom strokes are to all run in same direction.

**3.09 CURING AND PROTECTION**

 A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures and maintain without drying at a relatively constant temperature for period of time necessary for hydration of cement and proper hardening of concrete.

 B. Immediately upon completion of finishing operations, cure casting slabs utilizing Curing Compound and Bond Breaker in accordance with 3.01, D.

1. Underlying panels in a stack cast arrangement are to be cured in the same manner as casting beds.

 C. Immediately upon completion of finishing operations, cure face up panel surface in accordance with ACI 308.1 utilizing one of the following methods:

1. Perform uniform application of Dissipating Resin Curing Compound in accordance with manufacturer’s written instructions.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with Moisture-Retaining Cover placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive.
3. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
4. Cure for not less than 7 days.

**3.10 HANDLING AND ERECTION OF PANELS**

 A. Engineer panels for erection stresses and selection of lifting system and hardware.

1. Minimum strength of panels at time of erection is to be in accordance with lifting design.
2. It is recommended that Contractor take extra test specimens and field cure to verify concrete strength of panels or demonstrate acceptable strength through maturity prediction of calibrated mix designs.
3. Before starting erection operations, Contractor is to check relevant job site conditions insofar as they are ready for erection of panels. Each element must be properly marked to correspond with the designation indicated on the approved Shop Drawings.
4. Use erection equipment that will prevent damage to existing construction, permanent floor slabs and panels. Damage to Work is to be repaired or replaced at Contractor’s expense and in manner acceptable to the Architect prior to painting or coating.
5. Do not remove temporary panel bracing until roof diaphragm is completely welded and installed.

*Specifier Notes: Typically retain subparagraph 1 following. The project Structural Engineer should verify the footing design for point loading of panel supports during construction.*

 B. Set panels in the position assigned. Place panels evenly on prepared setting pads or proper-capacity shims. Grout space under panels for full bearing or provide additional support until grouting takes place.

1. Provide sufficient number of shims to adequately distribute load on footing or grout as soon as practical to prevent damage to footing.

 C. Panels not attached to building frame at time of erection are to be braced in position using bracing system designed to resist wind and other loads that may reasonably be determined until structural connections have been made. Minimum of two braces per panel. Engineering of bracing is responsibility of Contractor. Maintain panel bracing connection daily to assure tightness.

 D. Perform dry-pack grout installation and preparation for weld pockets and other panel block outs not cast in during pouring as follows:

1. Remove laitance down to sound concrete.
2. Surface to receive grout must be rough and reasonably level.
3. Surface shall have been properly wet cured.
4. Do not use curing compounds.
5. Clean surface of oil, grease, dirt and loose particles.
6. Remove free water from concrete and bolt holes immediately before grouting.

 E. After Panels are Erected:

1. Panels are to be braced into position until lateral load resisting system of structure is complete and final panel attachments are made. Check connecting bolts at floor and panels daily to ensure tightness.
	1. Perform welding in accordance with ANSI/AWS D1.4. Wait a minimum of 28 days from panel casting before making panel-to-panel welds.
2. Protect elements to prevent staining, warping or cracking. After panels are erected, dismantle panel erection devices.
3. Utilize Surface Repair Mortar for Tilt-Up Panels and/or Trowelable Vertical and Overhead Repair Mortar for Tilt-Up Panels to patch panels as required for uniform appearance matching mockup surfaces and as acceptable to Architect. Apply materials in accordance with manufacturer’s written instructions.
4. Utilize Rapid Setting Urethane Repair for Slabs on Grade to patch holes or other blemishes in casting slab in a manner acceptable to the Architect. Apply materials in accordance with manufacturer’s written instructions.
5. Remove and replace tilt-up panels that do not comply with requirements in this Section.
6. Demolish and remove temporary concrete casting slabs.

**3.11 ERECTION TOLERANCES**

 A. Erection Tolerances: Dimensions of finished panel in erected position in structure are to conform to ACI 117 and erection tolerances stated below unless otherwise specified or approved by the Architect.

 B. Deviation from Specified Dimension Between Controlling Surface or Line and Building Reference Line:

1. + 1/2 inch, - 1/4 inch Horizontal dimension to vertical surface.
2. + 1/4 inch, - 1/2 inch Vertical dimension to horizontal surface.
3. ±1/2 inch From top elevation.

 C. Deviation from Plumb of Controlling Surface or Line:

1. ± 1/4 inch Any 10 feet of member height.
2. ± 1/4 inch Each additional 10 feet of height.
3. ± 1 inch Not to exceed .

 D. Deviation from Specified Relationship of Adjacent Members:

1. ±1/2 inch Matching edges at horizontal and vertical joints.
2. ± 3/8 in Matching faces exposed to view.
3. ± 3/4 in Matching faces not exposed to view.
4. 1/2 in Bowing between adjacent members.
5. 1/8 inch Alignment of brick mortar joints across joints, jog in alignment.
6. ± 1/8 inch Alignment of brick mortar joints across joints, alignment with panel centerline.

 E. Deviation from Specified Joint Width:

1. ± 3/8 inch Vertical joint (governs over joint taper), total.
2. ± 3/8 inch Horizontal joint (governs over joint taper), total.
3. ± 1/2 inch Visually noncritical joint .
4. ± 3/8 inch Joint taper over any 10 ft. length measured between panels at exterior face of panels at joint. .
5. ± 1/2 in Joint taper over entire length measured between panels at exterior face of panels at joint.
6. ± 1/8 in Variation in width of exposed brick mortar joints measured difference in joint width indicating panel edges are not parallel

 F. Deviation of Architectural Features at Face of Panel:

1. - 1/4 inch Brick (individual) out of plane, any one (depth of form liner joint) .
2. - 1/4 inch Brick (individual) tipping, any one (depth of form liner joint).
3. ±1/16 inch Brick (individual) out of square, any one.
4. 2 percent Brick (field), max. per panel

**3.12 SEALING OF PANEL JOINTS**

 A. Clean panel joints of contaminants, including form release agents and concrete laitance. Remove dust and loose particles to provide proper bond.

 B. Install fire-resistive blanket where indicated.

 C. Install joint insulation where indicated to consist of limited expansion polyurethane insulation or an approved equal as provided in accordance with Section 07 20 00 – Insulation.

 D. Install back-up rod, primer, paint and sealant in accordance with Section 07 92 00 – Sealants and Caulking.

**3.13 FIELD QUALITY CONTROL TESTING**

*Specifiers Notes: Edit and insert language below as appropriate.*

 A. Testing and Inspecting: Owner will engage a **[special inspector] [and] [qualified testing and inspecting agency]** to perform tests and inspections and to submit reports.

 B. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Verification of use of required design mixture.
5. Concrete placement, including conveying and depositing.
6. Curing procedures and maintenance of curing temperature.
7. Verification of concrete strength before erection of tilt-up panels.

 C. Testing Services: Perform testing according to ACI 301.

 D. Field Testing:

1. Make and store a minimum of four 6x12 cylinders or five 4x8 cylinders and four 6x6x24 beams in accordance to ASTM C31. Make specimens for each class of concrete, for each 100 cu.yds. or fraction thereof, and for each day concrete is cast, or not less than once for each 5,000 sq.ft. of panel area.
2. Test cylinders in accordance with ASTM C39. Test minimum of 2 from each set at 7 days and the rest at 28 days.
3. Test beams in accordance with ASTM C78. Test at least two from each set prior to panel erection. Average of two beam results to be considered the tested flexural strength to determine if specified flexural strength has been met. Remaining specimens are to be kept in reserve in event that additional testing is needed.
4. Test specimens and test reports are to accurately indicate in which panel, by number and concrete delivery tag, the concrete represented by each test specimen was placed.
5. Copies of test reports are to be distributed to Owner, Architect, Building Official and Contractor. Reports are to indicate location of tests, dates, technician, and other pertinent information
6. Deficient Compressive Strength: In event that concrete tests indicate a 7-day or 28-day strength below that which was specified, Contractor with the agreement of Architect is to have the mix adjusted so that subsequent concrete will comply with minimum strength requirements.
7. Owner may require core specimens to be taken and tested, at Contractor’s expense. If core tests fall below minimum requirements, as determined by Architect, concrete in place will be deemed to be defective.
8. Defective concrete is to be removed and replaced or strengthened in a manner acceptable to the Owner and Architect, at Contractor’s expense.
9. Demolition or repair of other materials or systems as a result of repair or replacement of defective concrete are to be at the Contractor’s expense.

 E. Deficient Compressive Strength: In event that concrete tests indicate a 7-day or 28-day strength below that which was specified, Contractor with agreement of Architect is to have the mix adjusted so that subsequent concrete will comply with the minimum strength requirements.

1. Owner may require core specimens to be taken and tested, at Contractor’s expense. If core tests fall below minimum requirements, as determined by Architect, concrete in place will be deemed to be defective.
2. Defective concrete is to be removed and replaced or strengthened in a manner acceptable to Owner and Architect, at Contractor’s expense.
3. Demolition or repair of other materials or systems as a result of repair or replacement of defective concrete is to be at the Contractor’s expense.

**3.14 CLEANING AND PROTECTION**

 A. When Work of this Section has been completed, remove trash, debris, surplus materials, tools and equipment from site.

END OF SECTION