

SECTION 03 62 13

NON-METALLIC GROUTING

PART 1 – GENERAL

1.01 REQUIREMENTS

- A. This Contractor shall provide grout in accordance with the Contract Documents.
- B. The following types of grout shall be covered in this section.
 - 1. Non-Shrink Grout: This type of grout is to be used whenever grout is shown in the Contract Documents unless another type is specifically referenced. For the purpose of these Specifications, “non-shrink grout” shall be defined as a high strength mortar or grout that does not shrink in the plastic state, is dimensionally stable in the hardened state and bonds permanently to a clean metal base plate and concrete substrate.
 - 2. Cement Grout.
 - 3. Epoxy Grout.
 - 4. Pump and Motor Grout.
 - 5. Topping Grout and Concrete Fill.

Note: Masonry grout is specified in Division Four.

1.02 REFERENCES, SPECIFICATIONS, CODES AND STANDARDS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
 - 1. ACI INTERNATIONAL (ACI)
 - ACI 308 Standard Practice for Curing Concrete
 - 2. CRD
 - CRD C621 Corps of Engineers Specification for Non-Shrink Grout
 - 3. ASTM INTERNATIONAL (ASTM)
 - ASTM C 78 Test Method for Flexural Strength of Concrete (Using Simple Beam with Third Point Loading)
 - ASTM C 109 Test Method for Compressive Strength of Hydraulic Cement Mortars (Using two inch Cube Specimens)
 - ASTM C 348 Test Method for Flexural Strength of Hydraulic Cement Mortars
 - ASTM C 469 Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
 - ASTM C 531 Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts and Monolithic Surfacing

ASTM C 827	Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixture
ASTM C 579	Test Methods for Compressive Strength of Chemical Resistant Mortars, Grouts and Monolithic Surfacing
ASTM C 615	Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixture
ASTM C 882	Standard Test for Bond Strength of Epoxy Resins Systems Used with Concrete
ASTM C 884	Standard Test Method for Thermal Compatibility Between Concrete and an Epoxy Resin Overlay
ASTM C 939	Test Method for Flow of Grout for Preplaced Aggregate Concrete (Flow Cone Method)
ASTM C 1090	Test Method for Measuring Change in Height of Cylindered Specimens for Hydraulic Cement Grout
ASTM C 1107	Specification Packaged Dry, Hydraulic Cement Grout (Non-Shrink)
ASTM C 1181	Test Method for Compressive Creep of Chemical Resistant Polymer Machinery Grouts
ASTM C 1339	Test Method for Flowability and Bearing Area of Chemical Resistant Polymer Machinery Grouts
ASTM C 1042	Test Method for Bond Strength of Latex Systems used with Concrete by Slant Shear
ASTM C 1202	Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM D 638	Standard Test Methods for Tensile Properties of Plastics
ASTM D 696	Test Method for Coefficient of Linear Thermal Expansion of Plastics
ASTM D 2471	Standard Test Methods for Gel Time and Peak Exothermic Temperature of Reacting Thermosetting Resins.

1.03 CONTRACTOR SUBMITTALS

- A. Submit in accordance with Section 01 33 00, Submittal and Substitutions.
- B. Submit certified test results verifying the compressive strength, shrinkage and expansion requirements indicated herein and manufacturer's literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of non-shrink and epoxy grout used in the work.
- C. Provide Manufacturer's independent certification of ASTM C 1107, "Standard Specification Packaged Dry, Hydraulic Cement Grout (Non-Shrink)" compliance without modification of the standard methods certifying that the Class B or C grouts post hardening non-shrink properties are not based on gas expansion, grouts have strengths of 3,500 psi at one day, 6,500 psi at three days and 7,500 psi at 28 days when cured at 72 degrees F as well as meeting the 3-, 7-,and

28-day strengths when tested and cured at the 45 degree and 95 degree limits and all other requirements of ASTM C 1107.

- D. The Contractor shall hire an independent testing laboratory to run a 24-hour grout evaluation in accordance with ASTM C 1107 of each grout submitted for approval showing compliance to all aspects of the evaluation submitting results to the Construction Manager for review.

1.04 QUALITY ASSURANCE

A. Field Tests

1. Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the Construction Manager to insure continued compliance with these Specifications. The specimens will be made by the Construction Manager or its representative.
2. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the Construction Manager. A set of three specimens will be made for testing at seven days, 28 days, and each additional time period as appropriate.
3. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579 at intervals during construction as selected by the Construction Manager. A set of three specimens will be made for testing at seven days and each earlier time period as appropriate.
4. All grout, already placed, that fails to meet the requirements of these Specifications is subject to removal and replacement at no additional cost to the Owner.
5. The cost of all laboratory tests on grout will be borne by the Owner, but the Contractor shall assist the Construction Manager in obtaining specimens for testing. However, the Contractor shall be responsible, without additional cost to the Owner, for the cost of any additional tests and investigation on work performed that does not comply with the Specifications. The Contractor shall supply all materials necessary for fabricating the test specimens.

- B. Construction Tolerances: Construction tolerances shall be as specified in the Section 03 30 00, Cast-in-Place Concrete, except as modified herein and elsewhere in the Contract Documents.

PART 2 – PRODUCTS

2.01 CEMENT GROUT

- A. Cement Grout: Cement Grout shall be composed of one part cement, three parts sand and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white Portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 days shall be 4,000 psi.
- B. Cement grout materials shall be as specified in Section 03 30 00, Cast-in-Place Concrete.

2.02 PREPACKAGED GROUTS

- A. Non-shrink Grout
 - 1. Non-shrink grout shall be a prepackaged, inorganic, non-gas liberating, non-metallic, cement based grout requiring only the addition of water. Cement from kilns burning metal rich hazardous waste fuel shall not be used. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout herein shall be that recommended by the manufacturer for the particular application. All grouts (Grade A, B, and C) shall be tested for height change of the hardened grout at 1, 3, 14, and 28 days in accordance with ASTM C1090, "Test Method for Measuring Change in Height of Cylindered Specimens for Hydraulic Cement Grout" and shall be tested for compression at 1, 3, 7, and 28 days in accordance with the modified ASTM C109 testing procedure.
 - 2. Class A non-shrink grouts shall have a minimum 28-day compressive strength of 5,000 psi and shall meet the requirements of ASTM C 1107 when mixed to a flowable, plastic or stiff consistency. When tested in accordance with ASTM C 1090, grout shall have a maximum of 4% expansion in the pre-hardened state. Use NS Grout by Euclid Chemical or equal.
 - 3. Class B or C high precision, fluid, extended working time, non-shrink grouts shall have a minimum 28-day compressive strength of 7,500 psi, shall have no shrinkage (0.0 percent) and a maximum 4.0 percent expansion in the plastic state when tested in accordance with ASTM C 827 – Test Method for Early Volume Change of Cementitious Mixtures; and shall have no shrinkage (0.0 percent) and a maximum of 0.2 percent expansion in the hardened state; and when mixed to a fluid consistency of 20 to 30 seconds per ASTM C 939 – Test Method for Flow Grout for Preplaced Aggregate Concrete (Flow Cone Method) at temperature extremes of 45 to 90 degrees F shall have an extended working time of 30 minutes when tested in accordance with ASTM C 1107. Class B or C non-shrink grout shall be Masterflow 928 by ChemRex MBT, Sika Grout 212 by Sika Corporation, Hi Flow Grout by Euclid Chemical, or equal.
 - 4. Application:
 - a. Class A non-shrink grout shall be used for grouting railing posts in place. Class A non-shrink grout shall not be used for dry packing applications or repair of concrete.

- b. Class B or C non-shrink grout shall be used for grouting under all base plates for structural steel members, grouting under all equipment base plates and at all locations where grout is required by the Contract Documents except where epoxy grout is specifically required. Class B or C non-shrink grout may be used in place of Class A non-shrink grout for all applications. Class B or C non-shrink grout shall not be used for dry packing applications or repair of concrete.

B. Epoxy Grout

1. Epoxy grout shall be a pourable, non-shrink 100 percent solids systems. The epoxy grout system shall have three components: resin, hardener and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any nonreactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged. Epoxy grout shall be Ceilcote 648 CP+ by ChemRex MBT, Sikadur 42, Grout-Pak by Sika Corporation, E3G Epoxy Grout by Euclid Chemical, MP Epoxy Grout by deGassa (BASF) or equal.
2. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application.
3. The mixed epoxy grout shall have a minimum working life of 45 minutes at 75 degrees F.
4. The epoxy grout shall develop a compressive strength of 5,000 psi in 24 hours and 10,000 psi in seven days when tested in accordance with ASTM C 579, Method B. There shall be no shrinkage (0.0 percent) and a maximum 4.0 percent expansion when tested in accordance with ASTM C 827.
5. The epoxy grout shall exhibit a minimum effective bearing area of 95 percent. This shall be determined by testing in accordance with ASTM C 1339, "Standard Test Method for Flowability and Bearing Area of Chemical Resistant Polymer Machinery Grouts" for bearing area and flow.
6. The peak exotherm of a 2-inch diameter by four-inch-high cylinder shall not exceed 95 degrees F when tested with 75 degree F material at laboratory temperature. The epoxy grout shall exhibit a maximum thermal coefficient of 30×10^{-6} inches / inch / degree F when tested according to ASTM C 531 or ASTM D 696.
7. Application: Epoxy grout shall be used to embed all anchor bolts and reinforcing steel required to be set in grout and for all other applications in the Contract Documents where grout type is not specifically indicated.

C. Grout for Pumps and Motors

1. Grout for pumps and motors shall be epoxy grouts meeting the following minimum requirements:

- a. Creep shall be less than 0.005 inch / inch when tested by ASTM C 1181 method. The test shall be at 70 degrees F and 140 degrees F with a load of 400 psi.
 - b. Linear shrinkage shall be less than 0.080 percent and thermal expansion less than 17×10^{-6} inch / inch / degree F when tested by ASTM C 531.
 - c. The compressive strength shall be a minimum of 12,000 psi in seven days when tested by ASTM C 579 Method 8, modified.
 - d. Bond strength of grout to Portland cement concrete shall be greater than 2,000 psi when using ASTM C 882 test method.
 - e. Grout shall pass the thermal compatibility test when overlaid on Portland cement concrete using test method ASTM C 884.
 - f. Tensile strength and modulus of elasticity shall be determined by ASTM D 638. The tensile strength shall not be less than 1,700 psi and the modulus of elasticity shall not be less than 1.8×10^6 psi.
 - g. Gel time and peak exothermic temperature shall be determined by ASTM D 2471. Peak exothermic temperature shall not exceed 110 degrees F when a specimen six inches in diameter by 12 inches high is used. Gel time shall be at least 150 minutes.
 - h. The grout shall be suitable for supporting precision machinery subject to high impact and shock loading in industrial environments while exposed to elevated temperatures as high as 150 degrees F with a load of 2,000 psi.
2. Primer, if required, shall conform to the written recommendations of the grout manufacturer.
 3. Surface preparations shall conform to the written recommendations of the grout manufacturer.
 4. Placement and Curing
 - a. Placement and curing procedures shall be in accordance with the written recommendations of the grout manufacturer.
 - b. Grouting performance demonstration/training session shall be conducted by the grout manufacturer's representative prior to foundation and base plate preparation and the first grouting on site. This training session shall demonstrate proper preparation and installation methods and that the grouting material meets the strength requirements.
 5. Grout shall be Escoweld, Chockfast Red Epoxy Grout as manufactured by Philadelphia Resin Corporation, Five Start DP Epoxy Grout as manufactured by Five Star Products, Inc. or approved equal.

D. Grout for Repair of Concrete

1. Grout for repair of concrete for vertical, overhead and shotcrete applications shall not produce a vapor barrier, shall be one component, reoplastic, cement based, fiber reinforced, shrinkage compensated, non-expansive, gray concrete product. The grout shall be sprayable, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of

water. The grout shall be free of chlorides and other chemicals causing corrosion with the following properties:

- a. Minimum Slant Shear Bond Strength: 3,000 psi in 28 days when tested in accordance with ASTM C 882, modified.
 - b. Minimum Compressive Strength: 11,000 psi in 28 days when tested in accordance with ASTM C 109.
 - c. Minimum Direct Shear Bond Strength: 650 psi in 28 days.
 - d. Minimum Tensile Bond Strength: 700 psi in 28 days when tested in accordance with Washington DOT.
 - e. Minimum Flexural Strength: 1,300 psi when tested in accordance with ASTM C 348.
 - f. Modules of Elasticity: 5×10^8 psi when tested in accordance with ASTM C 469.
 - g. Maximum Rapid Chloride Permeability: 772 coulombs when tested in accordance with ASTM C 1202.
 - h. Manufacturers shall be Master Builders Technologies Company, EMACO.
2. Grout for repair of concrete for horizontal and formed applications shall not produce a vapor barrier, shall be one component, reoplastic, cement based, fiber reinforced, shrinkage compensated, non-expansive, gray concrete product. The grout shall be flowable, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of water. The grout shall be free of chlorides and other chemicals causing corrosion with the following properties:
- a. Minimum Shear Bond Strength: 2,150 psi in seven days when tested in accordance with ASTM C 1042.
 - b. Minimum Compressive Strength: 6,000 psi in seven days when tested in accordance with ASTM C 109.
 - c. Minimum Flexural Strength: 770 psi when tested in accordance with ASTM C 78.
 - d. Maximum Chloride Permeability: 1,000 coulombs when tested in accordance with ASTM C 1202.
 - e. Minimum Modulus of Elasticity: 4.8×10^6 psi when tested in accordance with ASTM C 469.
 - f. Manufacturers shall be Master Builders Technologies Company, EMACO.

2.03 TOPPING GROUT AND CONCRETE FILL

- A. Grout for topping of slabs and concrete fill for built up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water and admixtures proportioned and mixed as specified herein. All materials and procedures specified for normal concrete in Section 03 30 00, Cast-in-Place Concrete, shall apply except as noted otherwise herein.

- B. Topping grout and concrete fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water cement ratio of 0.45. Where concrete is thicker than three inches, sitework concrete, as specified in Section 03 30 00, Cast-in-Place Concrete, may be used when accepted by the Construction Manager.
- C. Course aggregate shall be graded as follows:

<u>U.S. Standard Sieve Size</u>	<u>Percent by Weight Passing</u>
1/2"	100
3/8"	90 - 100
Number 4	20 - 55
Number 8	5 - 30
Number 16	0 - 10
Number 30	0

- D. Final mix design shall be as determined by trial mix design under supervision of the approved testing laboratory.
- E. Strength: Minimum compressive strength of topping grout and concrete fill at the end of 28 days shall be 3,000 psi.

2.04 CURING MATERIALS

- A. Curing materials shall be as specified in Section 03 30 00, Cast-in-Place Concrete for cement grout and as recommended by the manufacturer of prepackaged grouts.

2.05 CONSISTENCY

- A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency, the type of grout to be used shall be as indicated herein for that particular application.
- B. The slump for topping grout and concrete fill shall be adjusted to match placement and finishing conditions but shall not exceed four inches.

2.06 MEASUREMENT OF INGREDIENTS

- A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement shall not be allowed.

- B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

PART 3 – EXECUTION

3.01 GENERAL

- A. All surface preparation, curing and protection of cement grout shall be as indicated in Section 03 30 00, Cast-in-Place Concrete. The finish of the grout surface shall match that of the adjacent concrete.
- B. Base concrete or masonry must have attained its design strength before grout is placed unless authorized by the Construction Manager.
- C. The Contractor shall coordinate with the manufacturer all demonstrations, training sessions and all applicable site visits. The grout manufacturer shall conduct onsite, demonstration and training sessions for bleed tests, mixing, flow cone measurements, cube testing, application and curing for each category and type of grout. The manufacturer of non-shrink grout and epoxy grout shall provide onsite technical assistance upon request.
- D. Training by the manufacturer is required for all types of grout installations. The grout manufacturer's representative shall train the Contractor to perform the grout work including mixing of grouts to required consistency, testing, placing and curing on actual project base plates, tie holes, rock pockets and other applications.

3.02 SURFACE PREPARATION

- A. Concrete surfaces to receive grout shall be prepared by chipping, sandblasting, water blasting or other accepted methods to remove defective concrete, laitance, dirt, oil grease and other foreign matter to achieve sound, clean concrete surfaces. Lightly roughen concrete for bond, but not enough to interfere with proper placement of grout.
- B. Cover concrete areas with protective waterproof covering until ready to place grout.
- C. Remove foreign matter from steel surfaces to be in contact with grout. Clean contact steel surfaces as necessary by wire brushing and wiping dust clean.
- D. Align and level components to be grouted and maintain in final position until grout placement is complete and accepted.

- E. Install forms for grout around the column base plates and other spaces to be grouted. The tops of such forms shall be one inch above the surfaces to be grouted.
- F. Remove protective waterproof covering and clean contaminated surfaces immediately before grouting.
- G. Provide air relief holes in large base plates and in base plates where underneath obstructions may cause air entrapment.
- H. Saturate concrete surfaces with clean water and remove excess water immediately before grouting.
- I. Where necessary or appropriate for better bond, epoxy adhesive may be applied to clean, dry substrate surfaces in accordance with applicable requirements of ACI 503.2.

3.03 GROUTING PROCEDURES

- A. Prepackage Grouts: All mixing, surface preparation, handling, placing, consolidation, curing and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.
- B. Base Plate Grouting
 - 1. For base plates, the original concrete shall be blocked out or finished off a sufficient distance below the plate to allow for a one inch thickness of grout or a thickness as indicated on the Drawings.
 - 2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink type grout. The mixture shall be of a trowelable consistency and tamped or rodded solidly into the space between the plate and the base concrete. A backing board or stop shall be provided at the back side of the space to be filled with grout. Where this method of placement is not practical or where required by the Construction Manager, alternate grouting methods shall be submitted for acceptance by the Construction Manager.
 - 3. Place grout in accordance with the respective manufacturer's installation instructions and recommendations. Pour grout from one side only until grout rises at least one inch above the plate on opposite side of said plate. Strapping and plunging or other recommended method may be used to force grout to flow under the entire area.
 - 4. Neatly trowel edges of grout base, tapered at an angle of 60 degrees when measured from the horizontal or as indicated. Provide dry pack cementitious grout where additional grout is required for shoulders.
 - 5. Do not remove leveling shims for at least 48 hours after grout has been placed.

- 6 After shims have been removed, if used, fill voids with grout, packing the material with a suitable tool.
7. Do not use grout that has begun to set or if more than one hour has elapsed after initial mixing.

C. Topping Grout

1. All mechanical, electrical and finish work shall be completed prior to placement of topping or concrete fill. The base slab shall be given a roughened textured surface by sandblasting or hydroblasting exposing the aggregates to ensure bonding to the base slab.
2. The minimum thickness of grout topping and concrete fill shall be one inch. Where the finished surface of concrete fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2 inches wide by 1-1/2 inches deep.
3. The base slab shall be thoroughly cleaned and wetted prior to placing the topping.
4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top for the full width of the placement.
5. The surface shall be tested with a straight edge to detect high and low spots that shall be immediately eliminated. When the topping and fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved typed of mechanical trowel may be used as an assist during this operation, but the last pass over the surface shall be by hand troweling. During finishing, no water, dry cement or mixture of dry cement and sand shall be applied to the surface.

D. Grout for Repair of Concrete

1. All repair shall be performed in accordance with the manufacturer's recommendations and with ICRI's Guideline Number 03730, "Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion" and ICRI's Guideline Number 03733, "Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces". These guidelines shall be followed for removal geometry, exposing and undercutting of reinforcing steel, cleaning and repair of reinforcing steel and edge and surface condition of concrete and shall be followed regardless of the amount of corrosion present or not present in the reinforcing steel.
2. Remove unsound deteriorated concrete from work by high pressure water blasting machines capable of scoring concrete surfaces to minimum amplitude roughness of 3/16 inch. Remove to provide for minimum thickness specified for mortar. If reinforcing is exposed in this process, then additional concrete shall be removed until the surface is a minimum of 1 inch or one bar diameter behind the exposed reinforcing.
3. Clean exposed reinforcing bars of rust and other deleterious material that may prevent bonding of the repair product.

4. Keep surface at saturated surface dry (SSD) condition for a minimum of 24 hours prior to placement of repair material.
5. Place material in accordance with manufacturer's written recommendations.
6. Cure material continuously for seven days with water fog nozzles or other applications that provide a continuous wet curing of the repaired area in accordance with ACI 308, "Standard Practice for Curing Concrete".

3.04 CURING

- A. Cementitious grout shall be cured the same as specified for concrete in Section 03 35 00, Concrete Finishing.
- B. Epoxy grout shall be cured as recommended by the grout manufacturer.

END OF SECTION