SECTION 03 6021

GROUTING – HIGH CONFIDENCE

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LANL MASTER SPECIFICATION

Document online at <http://engstandards.lanl.gov>

This section includes general, product and execution requirements for high-confidence/safety-related**\*** concrete repair material, epoxy grout, and non-shrink cementitious grout, all of which are typically specified in a manner that results in little-to-no volume change/shrinkage. Not included is grout for prestressed or precast concrete, or for reinforced masonry.

* Concrete repair material is dimensionally stable (i.e., “shrinkage-compensated”). Although generally termed “material” (versus grout) herein, its procurement and use is similar enough to warrant inclusion in this Section.
* Rapid-curing epoxy grout is typically used for grouting base plates, machinery, equipment, etc.; and when dynamic/impact loading, vibration, or chemical attack is/are applicable. It’s ideal for applications where precise change in elevation during curing is required. Additionally, epoxy grout can be tailored to provide improved properties related to high early strength; and high chemical, acid, and fatigue resistance.
* Non-shrink cementitious grout is typically used for grouting base plates, machinery, equipment, etc. While non-shrink cementitious grout is typically less resistant to chemical attack and fatigue than epoxy grout, it is more resistant to heat and tends to be less expensive. It is also more “precise” than a Portland cement grout, especially one that requires measurement of dry constituents (and which is not included in this Section).

**\*** Nuclear applications, ML-1/ML-2 (and ML-3 potentially), and NPH Design Category (NDC)-3.

If the application is ML-3 or ML-4, Section 03 6000 should be used since it is simpler and will be less costly; however, this section may be used for ML-3 with modifications when higher confidence is desired.

The section was prepared by an organization operating under a quality assurance program that meets the requirements of DOE Order 414.1 and 10 CFR 830 (suitable for ML-1 through ML-4 projects). When this section is used with nuclear facilities subject to 10 CFR 830, modification of it must be performed by an individual or organization operating under a quality assurance program that meets the requirements of that CFR and the modified section must undergo independent technical and QA reviews.

Use of this section requires modification of it to meet project-specific requirements. Responsibility for modification of the section to meet project-specific requirements lies with the organization responsible for preparing the project specification. Brackets are used herein to indicate user choices or locations where text must be supplied by the user. Delete requirements herein that aren’t applicable to the project to include author/user notes such as these.

To seek a variance from requirements in this section that are applicable to the project, contact the Engineering Standards Manual (ESM) Structural Specs [POC](http://engstandards.lanl.gov/POCs.shtml).

When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General Requirements.

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PART 1 GENERAL

* 1. SUMMARY
     1. Section includes requirements for furnishing, delivering, and installing pre-mixed, pre-packaged material compliant with ASME NQA-1 Quality Programs including:

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If project includes the use of only one of the following three types of material, then edit these subparagraphs accordingly, as well as the remainder of the section.

If more than one material type is being specified by this Section (thus more than one paragraph below retained, and the location(s) in which each material type is to be used isn’t indicated elsewhere (e.g., other spec sections, drawings, etc.), then this Section must be edited (i.e., at least PART 3) to indicate the location(s).

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* + - 1. Concrete repair material
      2. Rapid-curing epoxy grout
      3. Non-shrink cementitious grout
    1. Section shall not be used for cosmetic repairs (e.g., filling form-tie holes, etc.).

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Edit the following Paragraph to include the project-specific need for high-confidence (H-C) material. The options provided are some of the more typical LANL applications that require H-C material.

If concrete restoration/repair is applicable, and the project includes more than one (1) slab and/or wall then the following paragraph shall be edited to be more specific (e.g., 2nd floor, room xyz, corridor wall; north-facing exterior wall; etc.).

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* + 1. The nuclear-safety element[s] in this project that require[s] high-confidence material [is] are [a] battery rack[s][,] [uninterruptable power supply (UPS)][,] [and] [a] [ concrete [slab][,] [wall] requiring restoration/repair] [\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_].

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Edit the following paragraph as required such that only those project spec sections that require/might require the use of the material in this section (i.e., 03 6021) are listed. And, for each section retained/listed, indicate the affected portion(s) of the section.

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* + 1. Related Sections:
       1. Section 01 4000 *Quality Requirements – Nuclear*: General and Execution requirements.
       2. Section 01 6000 *Product Requirements*: Requirements for transporting, handling, storing, and protecting products; and for environmental conditions affecting products on site.
       3. Section 03 3021 *Reinforced Concrete – High Confidence*: [Form Materials and Accessories] [, and] [Accessories] [, and] [\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_].
       4. Section 05 0521 *Post-Installed Concrete Anchors – High Confidence*: repair of [exploratory, abandoned and/or unused anchor holes][, and] [damaged surfaces].

[5. Section \_\_ \_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_– High Confidence: \_\_\_\_\_\_\_\_\_\_\_\_.]

* 1. ACRONYMS, DEFINITIONS, AND SYMBOLS
     1. Cementitious materials: Materials as specified in ACI 349 Chapter 3, which have cementing value when used in concrete either by themselves, such as Portland cement, blended hydraulic cements, and expansive cement, or such materials in combination with fly ash, other raw or calcined natural pozzolans, silica fume, and/or ground-granulated blast-furnace slag.
     2. Certificate of Conformance (COC).
     3. Certified Material Test Report (CMTR).
     4. Commercial Grade Dedication (CGD).
     5. Creep: Time-dependent deformation due to sustained load.

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In the last sentence of the following paragraph, delete the brackets if Project’s usage of this section will be performed by LANL (i.e., “self-performed work”).

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* + 1. Engineer/Engineer of Record (EOR): The licensed professional engineer, employed by the owner-contracted design authority or other agency, responsible for the overall design of the facility or Project (e.g., issues Construction Drawings, Specifications, or other documents, etc.). EOR and Architect/Engineer are synonymous. [For this Project the EOR and LANL are the same entity.]
    2. Los Alamos National Laboratory (LANL): The managing contractor of LANL is a corporation (e.g., TRIAD National Security, LLC); however, “LANL” is used herein, which acts as Owner. LANL also means Subcontract Administrator, the individual authorized to act on the behalf of LANL
    3. LANL Building Official (LBO).
    4. Material: Unless stated otherwise, any/all of concrete repair material, rapid-curing epoxy grout, and non-shrink cementitious grout.
    5. Restore: Repair a structural item (e.g., beam, column, foundation, etc.) to its near-original state.
    6. Shrinkage: Time-temperature-humidity-dependent volume reduction of concrete as a result of hydration, moisture migration, and drying process.
    7. Specified compressive strength of material (f’c), psi.
    8. Verification of Inspection and Test (VIT).

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Edit the following paragraph to include the project-specific safety function that the high-confidence (H-C) material must perform. The options provided are some of the more typical LANL applications that require H-C material.

If concrete restoration is applicable, and the project includes more than one (1) slab and/or wall then the following paragraph shall be edited to be more specific (e.g., 2nd floor, room xyz, corridor wall; north-facing exterior wall; etc.).

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* 1. SAFETY FUNCTION PERFORMANCE REQUIREMENTS

[A. Provide uniform support for [fixture[s]] [floor] [base] plate[s]] that support[s] [a] [battery rack[s]][,] [UPS][,] [and] [\_\_\_\_\_\_\_].

[B. Restore (by repair) exploratory, abandoned and/or unused anchor holes in [slab][,] [and] [wall]].

[C. Restore (by repair) damaged surface[s] of [slab][,] [and] [wall]].

[D. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.]

* 1. REFERENCES
     1. The publications listed in this Article form a part of this section to the extent referenced, and they are referred to subsequently by basic designation only.
     2. Unless otherwise indicated herein, work, products, and materials shall conform to ACI 301, ACI 349, and the standards referenced therein.
     3. Standards: The following lists indicate the standards are referenced herein. The applicable edition/version of a given standard shall be either the latest one or the one referenced by the versions of ACI 301 and 349 that apply to the Project. Standards referenced within listed standards shall be considered to be applicable to the project.
        1. American Concrete Institute (ACI)
           1. ACI 301 – *Specifications for Structural Concrete*
           2. ACI 349 – *Code Requirements for Nuclear Safety-Related Concrete Structures*
        2. American Society of Mechanical Engineers (ASME)
           1. ASME NQA-1 – *Quality Assurance Requirements for Nuclear Facility Applications*, 2008 with 2009 addenda.
        3. ASTM International
           1. ASTM C 109 – *Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)*
           2. ASTM C 157 – *Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete*
           3. ASTM C 307 – *Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings*
           4. ASTM C 531 – *Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes*
           5. ASTM C 579 – *Standard Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes*
           6. ASTM C 666 – *Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing*
           7. ASTM C 827 – *Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures*
           8. ASTM C 882 – *Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear*
           9. ASTM C 942 - *Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory*
           10. ASTM C 1077 – *Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation*
           11. ASTM C 1090 – *Standard Test Method for Measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout*
           12. ASTM C 1107 – *Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)*
           13. ASTM C 1202 – *Standard Test Method for Electrical Indication of Concrete’s Ability to Resist Chloride Ion Penetration*
  2. ACTION SUBMITTALS AND RECORDS MANAGEMENT
     1. Submit the following, each of which requires LANL approval, in accordance with Project submittal procedures for specified items:
        1. General Requirements:

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If work is “self-performed,” include Section [01 1117](https://engstandards.lanl.gov/specs.shtml#01) Work by Owner–Self Perform in Spec. This eliminates the need to replace numerous uses of “Subcontractor” with “LANL.”

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* + - * 1. Subcontractor Quality Assurance (QA) Plan (QAP) including all subtier Subcontractors.
        2. For material not obtained from an approved ASME NQA-1 supplier provide the following:

CGD Plans for review and approval by LANL prior to procurement including technical evaluations, identification of critical characteristics and acceptance criteria, and acceptance methods.

CGD report or package containing sufficient data to validate acceptance of the item in accordance with the approved CGD Plan. Documentation shall include but not be limited to procurement documentation and results of the dedication including COC indicating compliance with approved CGD Plan, CMTRs (when available)/MTRs, test reports or results, inspection reports, analysis, commercial grade survey reports (if a commercial grade survey is conducted) and source verification reports (if source verification is performed).

* + - * 1. Subcontractor shall prepare a VIT Plan in accordance with Section 01 4000 *Quality Requirements – Nuclear* that includes all inspections and tests required by this section, as well as standards and CGD Plans applicable to the work[[1]](#footnote-1).
        2. Documentation required by VIT Plan such as logs and results of tests and inspections performed.

Required tests are those associated with witness and hold points listed in following Article “Quality Assurance” and those stipulated in PART 3 Article “Field Quality Control.”

Required inspections are those associated with witness and hold points listed in “Quality Assurance.”

* + - * 1. Documentation that testing agencies have been approved by the LBO and EOR before performing any testing.\*
        2. Documentation that testing agencies have an ASME-NQA-1-compliant quality program prior to performing any work.**\***

**\*** The LBO-approval and ASME-NQA-1-compliance requirements flow down to any subtier testing agencies and/or locations. This places a premium on planning to ensure the testing agencies and their respective locations are properly approved before all of the required grout constituent/material testing to support any alternate grout products/mix(es) that have to be submitted for approval to LANL begins.

* + - * 1. Submit the QAP/Quality Control Program and applicable Implementing Procedures of the grout supplier(s) to be implemented during material receiving, storage, and handling; grout production; and delivery.
        2. Qualification records for inspection and test personnel per Section 01 4000 *Quality Assurance – Nuclear*.
        3. The Subcontractor's testing agency shall submit test and inspection results that pertain to the work to LANL and grout supplier(s) within seven (7) calendar days of performing such inspections and tests. Any deficiencies discovered shall be reported to LANL in writing during the shift of discovery and managed in accordance with Subcontractor QAP and Subcontract requirements.
    1. Manufacturer’s Information:
       1. Product Data: Submit product data on material included in this section.
       2. Manufacturer’s Installation Instructions: Submit manufacturer's instructions for mixing, handling, surface preparation and placing the material included in this section.
       3. Manufacturer's COC: Certify material meets or exceeds the properties of the material indicated in PART 2 of this section.
       4. Manufacturer’s CMTRs as indicated in PART 2 of this section.
    2. Records: Unless otherwise specified (elsewhere the project specification), within 30 working days after completion of the work, or as requested by LANL for any portion or portions of the work, all quality-related records generated throughout the order-completion process shall be submitted to LANL for inclusion into the permanent project record. Copies of the records shall be maintained by the Subcontractor in accordance with subcontract requirements:
  1. QUALITY ASSURANCE
     1. Refer to Section 01 4000 for quality requirements.
     2. All safety-related material shall be procured as “High Confidence” from a LANL-qualified (IESL) supplier (meeting ASME NQA-1) or procured as Commercial Grade Items (CGI) in accordance with ASME NQA-1 Part II Subpart 2.14 and Subcontractor’s LANL-approved QAP with a nuclear-safety designation.
     3. The placement of all material shall be compliant with ASME NQA-1 and Subcontractor’s LANL-approved QA Program.

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Edit the following paragraph to indicate the required concrete critical characteristics (CCs) based on the material’s credited safety function.

While the two (2) CCs listed below will apply to/for most projects, the EOR is responsible for ensuring the CCs are what is necessary and sufficient for his/her project.

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* + 1. Critical characteristics required for the material to perform its credited safety function are:
       1. f’c: Lack of achieving f’c could lead to inadequate load transfer.
       2. Volume Change: Shrinkage could result in [non-uniform bearing pressures] [and] [inadequate load transfer].
    2. Witness or hold points for the work shall be as follows:
       1. Hold and witness points per the LANL-approved CGD Plan.
       2. Witness point to verify correct material prior to placement.
       3. Hold point to verify area(s)/surface(s) to receive material have been prepared in accordance with this section.
       4. Hold point to verify that material is placed in accordance with this section, and/or, as applicable, other high-confidence specification sections that are related to this one.
       5. Hold point for LANL to perform inspections, tests, and observations per Project Statement of Special Inspections[[2]](#footnote-2).
       6. Witness points and hold points as required/applicable by other high-confidence specification sections that are related to this one.
  1. DELIVERY, STORAGE, AND HANDLING
     1. Material is classified as Level C and shall be controlled in accordance with manufacturer's instructions and ASME NQA-1, Part II, Subpart 2.2, *Quality Assurance Requirements for Packaging, Shipping, Receiving, Storage, and Handling of Items for Nuclear Facilities*.
     2. Deliver material in manufacturer's unopened packaging/containers with intact and undamaged labels that clearly identify, as a minimum, the manufacturer, product name, lot/batch number, and the expiration date.
     3. Store material in a clean, dry shelter, protected from moisture; and maintained at a temperature and humidity as required by manufacturer(s).
     4. Identification shall be maintained on material(s) up to the point of use. Inspection and test records shall provide traceability between the lot/batch number of material and the point of use.
     5. Do not use material stored beyond the shelf life recommended by the manufacturer(s).
  2. ENVIRONMENTAL REQUIREMENTS
     1. Do not perform installation if ambient temperature exceeds that which is specified by the manufacturer(s).
     2. Maintain minimum temperature specified by manufacturer(s) before, during, and after installation, until material has set.

PART 2 PRODUCTS

* 1. GENERAL
     1. The work and all materials used in it (i.e., not just concrete repair material and/or grout) shall conform to applicable provisions of the standards listed in PART 1 herein except as otherwise indicated in what follows.
     2. LANL has the right to order testing of any/all material used in the work to determine if it is of the quality specified herein.
     3. A complete record of tests performed shall be available for inspection by LANL.

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The reason for the prohibition in the following paragraph is that low- and non-shrink grouts are intended for placement into confined conditions, primarily because they exhibit expansive characteristics. Placing them in unconfined conditions (as can be the case in some concrete repairs) can lead to cracking, issues with thermal expansion (since these grouts expand differently than concrete), and other issues.

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* + 1. Neither rapid-curing epoxy grout nor non-shrink cementitious grout shall be used for concrete repair.
  1. CONCRETE REPAIR MATERIAL

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The products listed in paragraph below comply with ASME NQA-1 and meet the descriptive specifications and Performance Criteria in the two subsequent Paras; however, the manufacturer isn’t currently listed on the LANL IESL. If/when the manufacturer is listed, use of the products will likely be preferable to “CGD route (i.e., descriptive specifications and Performance Criteria).” If CGD route is taken, POC has a previously used package (TEA).

Either retain the “Manufacturer” para. or the descriptive specifications and Performance Criteria Paras, and delete the “OR note” in-between these options.

If retaining the Manufacturer Para., retain the 1st product option if the concrete requiring repair isn’t vertical or overhead (V/O), and retain the 2nd option if it is. If retaining both options then edit the paragraph to indicate that the 1st option shall not be used for vertical or overhead repairs.

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* + 1. Manufacturer:
       1. [Five Star Products](https://www.fivestarproducts.com/), Inc.: [Structural Concrete] [and] [Structural Concrete V/O]
       2. Substitutions: Not Permitted – No Substitutions.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + 1. Concrete Repair Material: Blended, packaged cement-based mortar requiring only the addition of potable water. The material shall not contain any chlorides or lime other than amounts contained within the hydraulic cement composition, and it shall be dimensionally stable (i.e., “shrinkage-compensated”).
    2. Performance Criteria: Certified to meet the following minimum properties when tested in accordance with the respective indicated ASTM standard:

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Edit the options in the following table in accordance with project requirements.

Regarding the tabulated default values, the 1st option pertains to material not used for overhead or vertical repairs, and the 2nd option pertains to material that is used for overhead and/or vertical repairs. If both of the aforementioned repair types are applicable, then edit Result column of table accordingly. For example, in the “f’c row,” the Result would include both of the following statements:

6,000 psi min. at 7 days for horizontal repairs

4,000 psi min. at 7 days for overhead/vertical repairs

The reason for the range (of coulombs) in the option for chloride permeability is because ASTM C 1202 results are expressed this way (ref. Table X1.1 therein). Per Table X1.1, a result of 100—1,000 coulombs is, qualitatively, “Very Low.”

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|  |  |  |
| --- | --- | --- |
| Property | Test or CMTR | Result |
| f’c | ASTM C 109  (Field-QC test)\* | [6,000] [4,000] psi minimum at 7 days**\*** |
| Bond Strength | ASTM C 882  (CMTR only) | [2,150] [2,200] psi minimum at 7 days |
| Length Change/Drying Shrinkage | ASTM C 157  (CMTR only) | [-0.09] [-0.13] % maximum at 28 days |
| Freeze/Thaw Resistance | ASTM C 666 Procedure A  (CMTR only) | [95] [95]% minimum at 300 cycles |
| Chloride Permeability | ASTM C 1202  (CMTR only) | [100–1,000] coulombs maximum at 28 days |
| **\***Compliance shall be proven via the field-quality-control testing indicated in PART 3 herein. | | |

* 1. RAPID-CURING EPOXY GROUT

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Epoxy grout is typically used for grouting base plates, machinery, equipment, etc.; and when dynamic/impact loading, vibration, or chemical attack is/are applicable. It’s ideal for applications where precise change in elevation during curing is required. Additionally, epoxy grout can be tailored to provide improved properties related to high early strength; and high chemical, acid, and fatigue resistance.

The product listed in paragraph below complies with ASME NQA-1 and meets the descriptive specifications and Performance Criteria in the two subsequent Paras; however, the manufacturer isn’t currently listed on the LANL IESL. If/when the manufacturer is listed, use of the product will likely be preferable to “CGD route (i.e., descriptive specifications and Performance Criteria).” If CGD route is taken, POC has a previously used TEA package.

Either retain the “Manufacturer” paragraph or the descriptive specifications and Performance Criteria Paras, and delete the “OR note” in-between these options.

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* + 1. Manufacturer:
       1. Five Star Products, Inc.: Five Star HP Epoxy Grout (Standard and High Flow).
       2. Substitutions: Not Permitted – No Substitutions.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + 1. Rapid-Curing Epoxy Grout: Precision, high strength, minimal shrinkage, 100% solids, three-component epoxy grout. Rapid-curing, low creep, high effective bearing area, high-vibration and chemical resistance.
    2. Performance Criteria: Certified to meet the following minimum properties when tested in accordance with the respective indicated ASTM standard:

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Edit the options in the following table in accordance with project requirements. Ensure the “C 579” Procedure used here is mirrored in the Epoxy-Grout paragraph in PART 3 Article FIELD QUALITY CONTROL.

Regarding the default value of f’c, it is the lowest strength that all of the manufacturers considered report. The reason being, f’c can be reported for multiple consistencies (i.e., flowable/standard and fluid/high flow), and the number and /or names of the consistencies can vary from manufacturer to manufacturer.

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|  |  |  |
| --- | --- | --- |
| Property | Test or CMTR | Result |
| f’c | ASTM C 579  [Procedure B]  (Field-QC test)\* | [12,000] psi minimum at 7 days**\*** |
| Tensile Strength | ASTM C 307  (CMTR only) | [2,000] psi minimum |
| Coefficient of Expansion | ASTM C 531  (CMTR only) | [30x10-6 ] maximum per degree F |
| Shrinkage | ASTM C 827  (CMTR only) | Very Low - None |
| **\***Compliance shall be proven via the field-quality-control testing indicated in PART 3 herein. | | |

* 1. NON-SHRINK CEMENTITIOUS GROUT

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Non-shrink cementitious grout is typically used for grouting base plates, machinery, equipment, etc. While non-shrink cementitious grout is typically less resistant to chemical attack and fatigue than epoxy grout, it tends to be more resistant to heat and less expensive. It is also more “precise” than a Portland cement grout, especially one that requires measurement of dry constituents (and which is not included in this Section).

The product listed in paragraph below complies with ASME NQA-1 and meets the descriptive specifications and Performance Criteria in the two subsequent Paras; however, the manufacturer isn’t currently listed on the LANL IESL. If/when the manufacturer is listed, use of the product will likely be preferable to “CGD route (i.e., descriptive specifications and Performance Criteria).” If CGD route is taken, POC has a previously used package.

Either retain the “Manufacturer” paragraph or the descriptive specifications and Performance Criteria paragraphs, and delete the “OR note” in-between these options.

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* + 1. Manufacturer:
       1. Five Star Products, Inc.: Five Star Grout
       2. Substitutions: Not Permitted – No Substitutions

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + 1. Non-shrink Cementitious Grout: Pre-mixed, ready-for-use formulation requiring only addition of water; non-shrink, non-corrosive, non-metallic, non-gas forming, no chlorides.
    2. Performance Criteria: Certified to maintain initial placement volume or expand after set, and to meet the following minimum properties when tested in accordance with the respective indicated ASTM standard:

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Edit the options in the following table in accordance with project requirements.

Regarding the tabulated default values of f’c, they are the lowest strengths that all the manufacturers considered report (i.e., for grout that is fluid/contains max. amount of water). The reason being, f’c is typically reported for multiple consistencies (i.e., plastic, flowable and fluid), and the number and /or names of the consistencies can vary from manufacturer to manufacturer.

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| Property | Test or CMTR | Time | Result |
| --- | --- | --- | --- |
| Early Height Change | ASTMC 827  (CMTR only) |  | [+4.0%] maximum |
| Hardened Height Change | ASTM C 1090  (CMTR only) |  | [0%] minimum  [+0.3%] maximum |
| f’c | ASTM C 109 (as modified by ASTM C 1107, or as indicated in ASTM C 942)  (Field-QC test)\* | 1 day | [2,000] psi minimum |
| 7 days | [5,000] psi minimum |
| 28 days | [6,500] psi minimum**\*** |
| **\***Compliance shall be proven via the field-quality-control testing indicated in PART 3 herein. | | | |

* 1. FORMWORK
     1. Follow all recommendations pertaining to formwork material and accessories made by the manufacturer(s) of the concrete-repair and/or grout material(s) to be used.
     2. Where there is no conflict with the preceding formwork provision, formwork shall be as specified in the Article, Form Materials and Accessories in in PART 2 of Section 03 3021, *Reinforced Concrete – High Confidence*.

PART 3 EXECUTION

* 1. EXAMINATION
     1. Verify areas to receive material.
  2. PREPARATION
     1. If concrete repair is included in the work, obtain and comply with LBO-approved repair scheme/plan.
     2. Follow all recommendations pertaining to preparation made by the manufacturer(s) of the material to be used.
     3. Remove foreign materials from metal surfaces in contact with material.
     4. Align, level, and maintain final positioning of components to be repaired/grouted.
     5. If it is necessary to use a bonding agent, then it shall be installed in accordance with the manufacturer’s installation instructions.
  3. INSTALLATION
     1. Formwork:
        1. Follow all recommendations pertaining to formwork installation made by the manufacturer(s) of the concrete-repair and/or grout material(s) to be used.
        2. Where there is no conflict with the preceding formwork provision, formwork shall be as follows:
           1. Constructed to be leak-proof, and anchored and shored to withstand material pressures.
           2. Installed with clearances to permit proper placement of material.
           3. Coated with approved form release agents.
           4. As specified in the Article, General in PART 3 of Section 03 3021 *Reinforced Concrete – High Confidence*.
     2. Mixing
        1. Follow all recommendations pertaining to mixing made by the manufacturer(s) of the material to be used.

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Some manufacturers of pre-mixed, pre-packaged cementitious repair materials and grouts recommend “extending” the product using coarse aggregate (CA) in certain circumstances (e.g., large volume placements that are several inches deep, etc.), See Five Star Products’ *A Professional’s Handbook on Grouting and Concrete Repair* for more detail.

Extending isn’t permitted w/o prior approval from LANL for the following reasons: Large volume, deep pours aren’t common; the addition of CA has the potential to result in the occurrence of alkali-silica reaction (ASR), and/or in interfering with Field QC (i.e., the 2” test cubes in ASTM C 109 don’t include aggregate).

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* + - 1. Assuming the work necessitates extending the material with aggregate, and such is allowed by the manufacturer, written approval from LANL is required prior to doing so. In addition, a version of the VIT Plan edited to include the use of aggregate shall be submitted to LANL for review and approval prior to “extending.”
      2. Mix material in proximity to work area and transport mixture quickly and in manner not permitting segregation of materials.
    1. Placing
       1. Develop a grouting plan that includes application and finishing of the material. The plan shall, at a minimum, include all related recommendations made by the manufacturer(s) of the material to be used.
       2. Where there is no conflict with the preceding placing provision, the grouting plan shall also include the following:
          1. Elimination of the possibility of entrapping air.

NOTE: This is typically achieved for grouted base plates by providing an additional hole(s) in the plate that allows for an air path for the air to escape during grouting operations.

* + - * 1. Placement of material quickly and continuously.
        2. Where leveling shims are to be removed after grouting they shall be coated/wrapped with a bond breaker (e.g., paste wax, polyethylene film, etc.), and removal shall occur no sooner than 48 hours after grout has been placed.

NOTE: Leveling jack screws may be used in lieu leveling shims that are to be removed.

* + - 1. The grouting plan shall not include the following:
         1. Use of pneumatic-pressure or dry-packing methods.
         2. Vibration of placed material, or material placement when area is being vibrated by nearby equipment.
      2. Obtain LBO approval of grouting plan, and then place material in accordance with the plan.
    1. Curing
       1. Follow all recommendations pertaining to curing made by the manufacturer(s) of the material to be used.
       2. Where there is no conflict with the preceding curing provision, curing of cementitious materials shall include the following:
          1. Prevent rapid loss of water from material during first 48 hours by use of approved membrane curing compound or by using of wet burlap method.
          2. After material has attained its initial set, keep damp for minimum of three (3) days.
       3. Immediately after placement, protect material from premature drying, excessively hot or cold temperatures, and mechanical injury.
  1. FIELD QUALITY CONTROL
     1. Provide a certified testing agency to perform field testing in accordance with ACI 301 and ASME NQA-1. Testing laboratory certification may be obtained through AASHTO or another nationally-recognized accreditation service as allowed by ASTM C 1077. National accreditations must be associated with a specific facility and/or mobile unit. LBO, or designee, must approve the test agency prior to performance of any work.

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Five Star Products’ *A Professional’s Handbook on Grouting and Concrete Repair* points out that ASTM C 579 includes 3 different test-method procedures (i.e., A – C), and that the difference between the results from them can be as much as 2000 psi. Thus, the following epoxy-grout paragraph allows for flexibility in demonstrating that the f’c value indicated in PART 2 is met/exceeded. The default option is Procedure B since that’s what’s indicated in PART 2. If the user opts for a different Procedure, ensure the one indicated here is the same as that which is applicable to the 7-day f’c value indicated in PART 2.

Other than the aforementioned option, the verbiage of the next two Paras. was adapted from ACI 301-16 Section 13 para. 13.1.4.4(c).

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* + 1. Rapid-Curing Epoxy Grout: Determine f’c per ASTM C 579 [Procedure B]. The test result shall be considered satisfactory if the 7-day f’c value meets or exceeds that which is indicated herein.
    2. Concrete Repair Material and Non-Shrink Cementitious Grout: Determine f’c per ASTM C 109. The test result shall be considered satisfactory if the 28-day f’c value meets or exceeds that which is indicated herein.

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The verbiage in the next Para. was adapted from the Field-QC Article (i.e., 3.5) in the NNSA MOX Project Section 03601.

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* + 1. 2-inch cube samples shall be made and tested for each material each day it is used. The results of each test will be used to verify the applicable material strength indicated in PART 2 herein has been attained prior to final acceptance of the work. The number of cubes made and tested daily shall be as follows:
       1. Concrete Repair Material: Two (2) of the installed material.
       2. Rapid-Curing Epoxy Grout: Two (2) per batch consistency (i.e., fluid, flowable, or plastic) to be used in the installation.
       3. Non-Shrink Cementitious Grout: Two (2) per batch consistency (i.e., fluid or flowable) to be used in the installation.

END OF SECTION

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Do not delete the reference information below.

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THE FOLLOWING STATEMENT IS FOR LANL USE ONLY

This project specification section is based on LANL Master Specification Section 03 6021 Rev. 0, dated February 5, 2019.

1. This includes hold points associated with the inspections and tests required by IBC Ch. 17. Refer to the Project’s Statement of Special Inspections (SSI) for details. [↑](#footnote-ref-1)
2. As indicated the previous footnote (i.e., that associated with the “VIT-Plan subpara.” of the “General Requirements Para.” in the PART 1 Article, ACTION SUBMITTALS AND RECORD MANAGEMENT), “SSI-related hold points” must be included in Subcontractor’s VIT Plan. [↑](#footnote-ref-2)