GROUTING

US SPEC
Non-Shrink Cementitious Grouts

INTRODUCTION

There are many types of grouts designed for various applications. Non-shrink grout is formulated using hydraulic cement, sand, and proprietary admixtures. Proprietary admixtures are utilized to compensate for the traditional volume changes/shrinkage properties normally encountered with the use of hydraulic cement-based products.

Although non-shrink grout is acceptable for use in a multitude of applications, its intended design is to fill contained areas for critical load bearing and load transferring applications. For non-shrink grouts the vertical dimension is the most important design characteristic and is controlled throughout the plastic and hardened states. Controlled expansion rates and proper placement should facilitate an effective load-bearing area.

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PROPERTIES

Most non-shrink cementitious grouts have properties in both plastic and hardened states which make them acceptable for most applications. True non-shrink grouts will not shrink in the plastic or hardened states and should be versatile enough to be poured, pumped, dry-packed or plunged. They are suitable for transfer of large static compressive loads and for transfer of many dynamic and impact loads.

US SPEC Grouts can be used for a variety of applications including but not limited to:

Precision Grouting: Machinery bases, Compressors, Punch-Presses, Generators
Structural Grouting: Steel columns, Pre-cast columns, Crane rails, Beams
Anchoring: Guard rails, Sign posts, Dowels, Rods, Bolts

TRADITIONAL GROUT CLASSIFICATIONS

With the release of the 2005 edition of ASTM Standards for Concrete and Aggregates, a revision was made to ASTM C-1107 the Standard Specification for packaged dry, hydraulic-cement non-shrink grout. Up until 2005 ASTM specified three grade classifications for non-shrink grout:

Grade A Pre-Hardening Volume-Adjusting
Grade B Post-Hardening Volume-Adjusting
Grade C Combination Volume- Adjusting

Originally, Grade A grout was only tested for pre-hardening volume changes and Grade B grout was only tested for post-hardening volume changes. In 2005 the grading classifications were removed from ASTM C-1107. The result is a streamlined specification requiring the pre and post hardening volume changes be determined for all grouts seeking compliance with C-1107.

The revision of C-1107 does not restrict the use of traditionally graded non-shrink grouts. It only clarifies that all non-shrink grouts (A, B, C) must undergo the same testing and comply with the same requirements.

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APPLICATION

Surface Preparation

All surfaces that come into contact with grout should be clean and free of dirt, oil, grease, laitance (a weak layer of cement and fines on the concrete surface) and other contaminants that may act as bondbreakers. All unsound concrete, previous coatings and sealers should be removed to provide a clean substrate that will allow the formation of a good bond.

Smooth, dense surfaces may need to be mechanically abraded to provide necessary bonding requirements. If available, refer to the project specifications to determine the correct surface preparation abrasion profile. The International Concrete Repair Institute is a good reference for proper surface preparation techniques (www.icri.org).

Acid-etching is sometimes recommended but typically as a last resort. For any surfaces that are to receive a subsequent coating acid-etching is not recommended. When in doubt contact the grout manufacturer for further instructions.

ACI recommends saturating the surface to be grouted for 24 hours before grout placement and concluded immediately prior to grouting. After the 24 hour time frame has elapsed remove all free standing water from the surface & from any bolt or anchor holes that grout is to be place over. The condition of the substrate following this method of saturation is referred to as saturate, surface dry (SSD) condition. The saturation of the surface is to prevent water from being rapidly absorbed from the grout. Rapid water loss will result in shrinkage.

Maintain contact areas between 45^{o} F - 90^{o} F prior to grouting and during initial curing period.

Forming

Method of forming must provide for rapid, continuous grout placement. For pourable grout, construct forms to retain grout without leakage. Forms should be coated with a form release for easy removal.

Mixing

For best results, use a mechanical mixer with rotating blades. Pre-wet mixer and empty excess water. Place cool, clean, potable water in mixer, then add dry material. Mix on low RPM for a total of 3 to 5 minutes to achieve desired consistency. US SPEC mix ratios provide a guildeline only of the amount of water needed to achieve a stiff, plastic, flowable, or fluid consistency. The actual water demand will depend on the type of grout, mixer used, water temperature and ambient temperature. Adjust the water to achieve the desired flow for workability. Recommended flow is 25 to 35 seconds using the ASTM C-939 Flow Cone Method.

For placements greater than 3" depth, grout can be extended by up to 30% by weight, with clean, washed and dried 3/8" (1 cm) pea gravel. Do not blend excess water as this will cause bleeding and segregation. Do not use any other admixtures or additives.

Placement

Pouring: When grout is to be placed from the perimeter of a machine base, the formwork must be constructed so a pressure head can be developed in a headbox on one side of the plate. All pouring placement should begin at one end of the plate and continue at that point until the grout rises above the bottom of the plate on the opposite side of the plate. The portable head box can be moved along the side of the plate from one end to the other. Continuous movement of a single face of grout prevents air entrapment.

To facilitate grout compaction and flow, rodding, tamping or flexible strapping in short strokes while maintaining an adequate head of grout is recommended.

For thick placements, control the heat generation and shrinkage is critical. US SPEC's recommendations for thick placement must be followed for the particular grout.

Pumping: When grout is to be placed through holes in the machine base, formwork should be constructed as already discussed. Pumping should begin at the grout inlet nearest one end of the plate. Grout should be pumped into that inlet until it flows up into an adjacent inlet and flows from the entire plate perimeter adjacent to the inlet. The pumpline should be moved to successive inlets until grouting is complete. Grout should not be pumped into more than one inlet simultaneously because air will be trapped.

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Dry Pack: Dry pack is the placement of damp, but very stiff, non-plastic grout into places by a heavy ramming force from a hard wooden ram struck with a mallet or hammer. Excellent high-early strengths and reduced shrinkage can be obtained through the use of less water than required for flowable grouts. There is minimum formwork and minimum equipment required. Dry pack is economical for small scale work.

Disadvantages to Dry Pack:

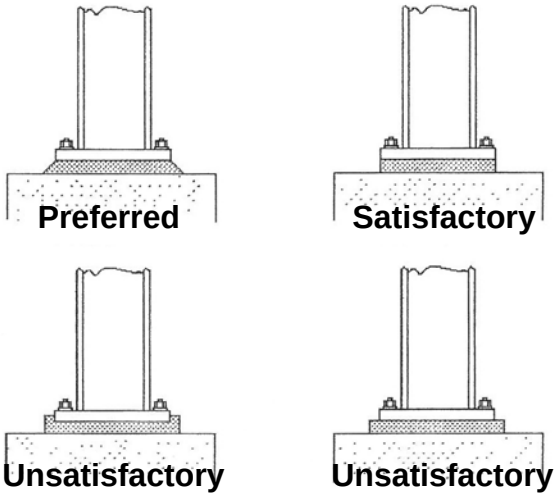
- No assurance that a uniform density grout is obtained or that minimum support under base plate is obtained without lifting and inspecting each plate.
- Very slow placement of grout
- Very skilled craftsmen needed
- No accurate test for mixing adequacy and proper consistency
- Test specimens difficult to prepare
- Heavy ramming required for proper compaction may knock plate out of alignment
- Can only be used under small flat plate with a minimum number of anchor bolts and shims

When a hose is used to pump grout under a plate, the hose should be inserted under the plate to the point farthest from the point of insertion. The hose should be withdrawn as grout is pumped under the plate.

Finishing Shoulders

When the grout has stiffened to the point that it will hold its shape when scored with the point of a trowel, remove the forms and cut the shoulders back at a 45 degree angle from the bottom edge of the baseplate to the foundation. Finish the grout shoulder with a trowel, float, or brush finish, as desired. Do not allow grout to remain above the bottom edge of the baseplate or in an unchamfered shoulder. In those locations, grout is prone to cracking because of differential expansion when the temperature changes. Sometimes, when anchor bolts are close to the edge of the baseplate, a vertical crack may occur in the grout sounder. Shoulder cracks rarely propagate under the baseplate and do not affect the vertical load-carrying capacity of the grout. For a cosmetic repair, coat the crack with a paste made from the grout and a little water.

GROUT SHOULDER CONFIGURATIONS



Curing

Continuous wet curing after placement results in higher compressive strength of the grout and better durability. Follow standard ACI curing practices. Do not disturb formwork or grout for 24 hours. Use wet rags or burlap to cure for 6 hours after placement. After 6 hours, remove rags from exposed surfaces and cure with a membrane forming curing compound such as US SPEC Maxcure Resin Clear, US SPEC Hydrasheen 15% or US SPEC CS-25-1315. For best results, exposed grout should extend downward at a 45º angle from edge of the base.

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BEST PRACTICES

Cold Weather

Grout can be safely placed through the winter months in cold climates if certain precautions are taken. Cold weather is defined by the American Concrete Institute as, "a period when for more than 3 successive days the mean daily temperature drops below 40°F." In order to apply the grout material in cold weather conditions, the following precautions must be followed:

- Normal cement storage and handling practices should be observed. Store material in a dry area at room temperature or between 60° F - 90° F. The preferred method is to use infrared or electric heaters and tenting if necessary. Some fuel burning heaters can cause carbonation on the surface of the concrete, which can change the pH of the concrete.
- Begin grouting earlier in the day to take advantage of rising temperatures.
- During pumping applications, keep the pumping lines warm, especially with long lines. This can be accomplished by insulating the lines with blankets. Also, prior to priming the pump with cement slurry, pumping warm water through the lines will warm up the lines.
- Mixing water shall be kept at a temperature of 60° F - 80° F.
- The grout shall be protected from freezing until it has reached a minimum compressive strength of 1,000 psi with methods of insulating such as curing blankets or other insulating covers. After this time, freezing conditions are not likely to structurally affect the grout. The compressive strength of the grout may be tested by leaving cube specimens, according to ASTM C-109, at the job site in the same ambient conditions as the structure and breaking the cubes periodically. Use a surface thermometer to monitor temperature conditions of the grout.

Hot Weather

Grout can be safely placed through the summer months in hot, dry climates if certain precautions are taken. Hot weather is defined by the American Concrete Institute as, "a period when for more than 3 successive days the mean daily temperature is above 90 ºF." In order to apply the grout material in hot weather conditions, the following precautions must be followed:

- Normal cement storage and handling practices should be observed. Store material indoors or in the shade with the plastic shrink-wrap removed. Use water cooled with ice, if needed. A fine screen can be used to filter out the ice when pouring the mix water.
- Prior to grouting, it is crucial to keep the grout base saturated with water (SSD) for 24 hours in advance. The metal base plate should be cooled, and this can be accomplished with wet burlap or towels. If possible, create shade for the area to be grouted.
- Begin grouting later in the day to take advantage of the cooler temperatures. This also allows the grout to properly cure during the cool evening hours.
- During pumping applications, keep the pumping lines cool, especially with long lines. This can be accomplished with wet towels or rags. Also, prior to priming the pump with cement slurry, pumping cold water through the lines will cool the lines down.
- Mixing water shall be kept at a temperature of 30 ºF - 50 ºF.
- Hot weather will reduce the working time with the grout and smaller batches may be required. The compressive strength of the grout may be tested by leaving cube specimens, according to ASTM C-109, at the job site as previously mentioned and breaking the cubes periodically. Use a surface thermometer to monitor temperature conditions of the grout.

The above procedures are to serve as a basic outline for hot and cold weather grouting procedures.

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PRECAUTIONS/LIMITATIONS

- Cracking – in some instances, regardless of the curing method there is a probability of some superficial, hairline cracks appearing in the exposed grout perpendicular to the plate or member grouted. Fine hairline cracks are of no structural significance and do not detract from the quality and satisfactory results of the non-shrink, load-bearing grout, if the saturation and curing procedures listed previously are fully carried out.
- Grouts should not be used as a patching or overlay mortar or in unconfined areas.
- Store materials in a dry place
- Do not add admixtures or fluidifiers
- Employ cold weather or hot weather practices as temperatures dictate
- Do not use as a topping
- Proper curing is required.
- Keep grout from freezing until it reaches a minimum strength of 4,000 psi

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TESTING/APPROVALS

US SPEC Non-shrink Grouts are formulated to meet the requirements of ASTM C-1107, CRD C-621 Corps of Engineers, and various DOT Specifications.

Standard Specified Test Methods for Non-Shrink Cementitious Grouts

Compressive Strength: Determine grout compressive strength in accordance with ASTM C 109, Test Method for Compressive Strength of Hydraulic Cement Mortars using 2" x 2" cube specimens.

Consistency: The consistency of the grout mixture can be determined by testing in accordance with ASTM C 827.

Yield: The yield of grout can be determined by using the test method described in ASTM C 185.

Early Age Height Change: Determine the early-age height change of grout in accordance with the applicable portions of ASTM C 827.
Height Change of Hardened Grout: Determine the height change of hardened grout at 1, 3, 14 and 28 days in accordance with ASTM C 1090.

City of LA Approval for Use

City of LA – Research Report: RR 25526 (CSI#03600)

US SPEC MP Grout is approved for setting Column bases, bearing plates and similar applications. The approval is subject to the following conditions:

1. The product shall be delivered to the job site in sealed containers identified by the manufacturer's name and the product designation.
2. Grouting procedures shall be in accordance with the manufacturer's instructions, and details and specifications as indicated on approved plans by the design engineer.
3. Design bearing stress of the grout shall not exceed allowable bearing stress of the concrete supporting the column base or bearing plate.
4. Continuous inspection by a Los Angeles City registered deputy building inspector shall be provided when the design compressive strength of the grout exceeds 2000 psi at 28 days.

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