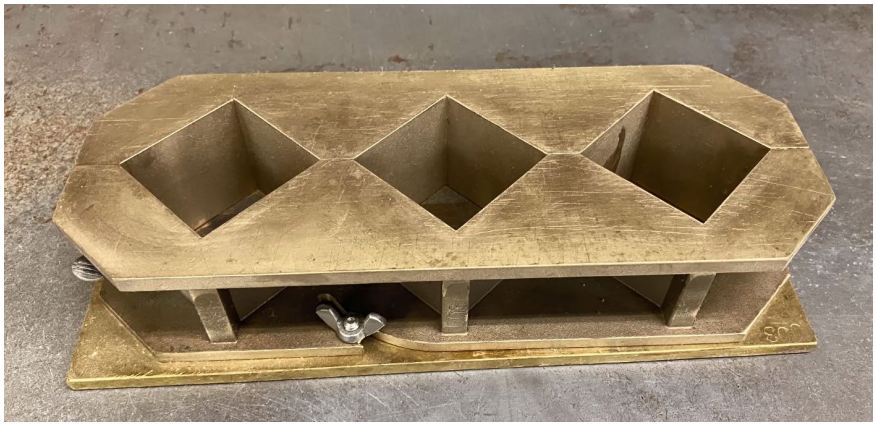
STRUCTURE BULLETIN

NCDOT Construction Unit

Website email



Current Issues: Grout Cubes

A new video is available on the NCDOT Communications YouTube channel under Construction Unit Training. This video shows the proper method for making grout cube samples. Grout is covered in Section 1003 of the Standard Specifications. Samples for Types 1-4 are to be grout cubes, while Type 5 may be cylinders. Structure applications normally call for a Type 3 grout. These applications would include grouting keyways in cored slabs or box beams, dowel holes, shear keys and grout pockets. Soil nails require a type 2 grout. The video shows proper methods for sampling both.

As with any material, the inspector should ensure that the Contractor follows the manufacturer's instructions for proper mixing of the grout being used on NCDOT projects. Proper measurement of the water is a critical factor in the performance of the grout. Proper sampling procedures should always be followed to ensure a representative sample of the grout is made and delivered to the lab.

Thanks to the folks at NCDOT M&T for helping us make this video.

1. Current Issues
2. New DTI Video
3. Grout Samples
4. Training

Skidmore-Wilhelm Setup:

In June of 2018 we added a video showing how to test Direct Tension Indicating washers (DTI's).

Another video has been added to show the correct way to set up the machine. The video shows two different types of machine and the proper hardware necessary to perform the test. Also shown is the new form for recording DTI test results. The form can be found at this link.

Specification Questions:

How many cubes samples do I need for Grout for Structures?

Different types of grout require different sample and different strengths at different times. Table 1003-2 in the Standard Specifications shows this. Normally the grout used for structure applications will be a Type 3 grout. The table shows both a 3- and 14-day compressive strength requirement of 5000 psi, and Section 1003-4 tells us the samples must be cubes. Note E tells us that "*Minimum compressive strength at 3 days is only required to approve Type 3 grout mix designs or evaluate Type 3 packaged grouts for the NCDOT APL.*" The three-day strength **is not** listed for acceptance. There should **always** be a set of cubes made for a 14-day acceptance break.

There has been some confusion when folks read the Grout for Structures Special provision. It states, "*Construction loading, and traffic loading shall not be allowed until the 3-day compressive strength is achieved.*" This means if the contractor wants to place a load on the bridge (equipment, paving, etc.) they must have the 3-day strength before doing so. This just happens to be the same strength as the 14-day acceptance strength, or 5000 psi. If only one set of samples is made and they are broken for an early break, we will have no acceptance sample to break at 14 days.

In summary:

- Always make a set of 14-day acceptance samples for Type 3 grout and **do not** use this set for an early break.
- If the contractor wants to place a load on the structure before 14 days, make an additional early break set.

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Videos:

New videos available:

Preparing Grout Cubes
A new video detailing the proper method for preparing, storing and transporting grout cubes has been uploaded to the NCDOT Communications YouTube site.

Skidmore-Wilhelm Setup
A new video detailing the proper method for preparing, storing and transporting grout cubes has been uploaded to the NCDOT Communications YouTube site.

Training:

Structure Bulletins are now archived on the Construction Unit website under Construction Resources.

If you have a topic you would like to see addressed in a future edition of the Structure Bulletin, please email us at either acochran@ncdot.gov or aearwood@ncdot.gov

TYPES OF GROUT

Grout Type	Description	Sample Requirements		
		Qty.	Age	Strength
Type 1	A cement grout with only a 3-day strength requirement and a fluid consistency that is typically used for filling subsurface voids.	1 set	3 days	3000 psi
Type 2	A non-shrink grout with strength, height change and flow conforming to ASTM C1107 that is typically used for foundations, ground anchors and soil nails.	1 set	28 days	5000 psi
Type 3	A non-shrink grout with high early strength and freeze-thaw durability requirements that is typically used in pile blockouts, grout pockets, shear keys, dowel holes and recesses for concrete barriers and structures.	1 set	14 days	5000 psi
Type 4	A neat cement grout with low strength, a fluid consistency and high fly ash content that is typically used for slab jacking.	1 set	28 days	1500 psi
Type 5 grout varies greatly from the other grout types. Samples are made using 6 X 12 cylinder molds.				
Type 5	A low slump, low mobility cement grout with minimal strength that is typically used for compaction grouting.	1 set	28 days	250 psi
NOTE: A "set" consists of three samples. If strength results are needed at earlier times, be sure to provide an extra set of samples for each earlier age that data is needed.				

Please write on the HiCAMS card the type of grout using the numerical designations above! For example, we frequently get cards that only state "Non-shrink grout." We have two types of non-shrink grout and they are tested at different ages so saying non-shrink grout is not descriptive enough.

PREPARING GROUT CUBES

AASHTO T106 "Standard Method of Test for compressive Strength of Hydraulic Cement Mortar (Using 50-mm or 2-in. Cube Specimens)" is the specification that governs how grout samples are made.

Grout cube specimens are made in 2-in. cube molds, with each mold fixture having no more than three compartments. Molds are preferably constructed of hard metal ($\geq$ 55 HRB) that does not react with the cement grout and are rigid to resist deflection while the cubes are formed. In reality, plastic molds are commonly used for field sampling, which are more prone to deflection and thus require careful use to ensure quality cubes are made.

Critical Step #1: Prepare the molds correctly to ensure leak tightness, if not, samples will lose moisture and may affect the compressive strength results. To prepare the molds, seal the mold halves by applying a coating of light cup grease, such as petroleum jelly, to the surfaces. Use sufficient grease to ensure a small amount is extruded from the joint when the halves are pressed together (be sure to remove the excess grease). Seal mold walls to the base plate using by applying petroleum jelly to the

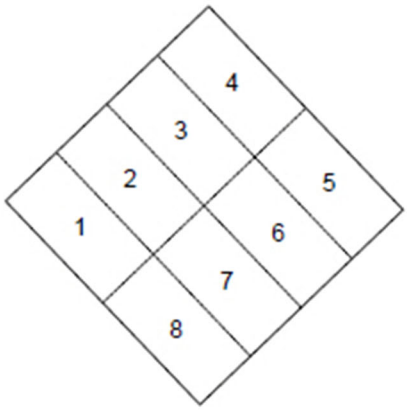
entire contact surface of the base, then clamp the base to the molds and wipe off the excess jelly. This is especially critical for the plastic molds as the base can bow creating a significant gap for moisture to escape between the mold halves and the base.

Spray the mold surfaces with a release agent or apply oil or grease using an impregnated cloth. Wipe away excess material with a cloth. Aerosol lubricants evaporate and may therefore need reapplication prior to placing the grout if applied long beforehand.

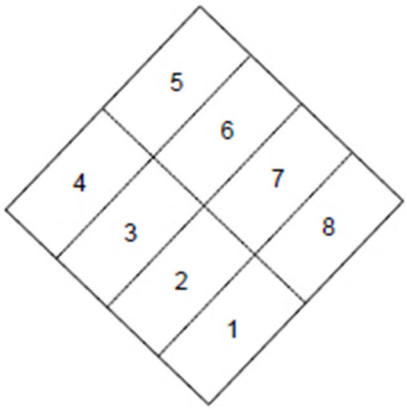
Critical Step #2: Begin molding the specimens within 2 min and 30 sec of completion of mixing the grout.

Critical Step #3: Grout should be added to the molds in two separate layers with each layer being tamped as described below. Apply the first layer to approximately half full in each of the cube compartments. For "plastic grout," tamp the grout in each compartment 8 times over 4 rounds, following the pattern shown in Figure 1, for a total of 32 times. Enough pressure should be applied while tamping to ensure consolidation of the first layer.

Figure 1 – Tamping Pattern for Grout Cube Consolidation



Pattern for Rounds 1 & 3



Pattern for Rounds 2 & 4

Once the first layer of grout has been tamped in each mold compartment, fill each mold with the top layer of grout and tamp as performed on the first layer. While tamping, grout will be forced out onto the top of the mold; reincorporate this grout into the second layer using the tamper or a gloved finger after each round of tamping. Once tamping has been completed, the grout should slightly overfill the molds. Use the same process for "flowable grout," except puddle each layer with a gloved finger five times to consolidate.

Strike off the top of each mold compartment with the flat side of a trowel at 90 degrees to the length of the mold. Next, draw the flat side of the trowel lightly over the cubes and along the length of the mold to level and smooth the surfaces. Cut off the grout to create a plane surface, flush with the top of the mold, by drawing the straight edge of the trowel in a sawing motion over the top of the mold.

Critical Step #4: Cover the freshly molded grout with a cover plate (if provided with the mold), or place the mold in a bag with a wet rag. Tie the bag to help retain moisture and place the samples in a secure location that includes protection from direct sunlight and freezing or excessively hot temperatures. Carefully demold the samples after a period of 24 ± 4 hours and wrap them with wet burlap or towels, then place the samples in a water-tight container and deliver them to the final curing location.