



# TECHNICAL BULLETIN 210

## PROPER TESTING FOR Compressive Strength

Five Star® Epoxy Grouts should be tested for compressive strength using 2" cube specimens made in brass or steel cube molds as directed in ASTM C 579, Method B.

The most critical aspect of testing epoxy grouts for compressive strength is the rate at which epoxy cube specimens are loaded. ASTM C 579 specifically designates two different load rates, but due to the high compressive strengths of Five Star Epoxy Grouts, only load rate II may be used to test them.

**Load Rate II:** 0.1 to 0.125 inches per minute crosshead speed x specimen height (2 inches) = 0.20 to 0.25 inches per minute for a 2-inch epoxy grout cube

Five Star Products, Inc. tests and reports compressive strength data based upon Load Rate II. It is required that testing facilities use Load Rate II when testing Five Star® Epoxy Grouts. If lab equipment cannot test to Load Rate II, contact Five Star Products.

The use of cylinders, plastic molds, plastic inserts, curing at temperatures below 69°F (21°C), and using a load rate other than Load Rate II will all result in lower compressive strengths being reported.

### A. Equipment Required for Testing

- 2" brass or steel cube mold (plastic molds or plastic inserts are not acceptable)
- Mold release agent
- Cooler or environmentally controlled room 69 - 77 °F (21 - 25 °C)
- Compression testing machine calibrated to Load Rate II
- ASTM C109 tamper or tongue depressor/metal spatula
- File
- Scale
- Scotch-Brite Pad
- Sharpie Marker
- Sample Record Book

If manually setting your compressive testing machine to Load Rate II, you'll need:

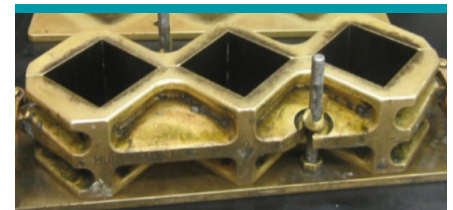
- Dial Gauge
- Mounting Hardware
- Stopwatch

### B. Test Time Tolerances

- 1 day ± ½ hour (from start time)
- 7 days ± 3 hours (from start time)
- 28 days ± 12 hours (from start time)

### C. Compressive Strength Requirement

- Refer to the project specifications.



A. 2"x2" Brass cube mold

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## D. Testing Procedure

### PREPARING THE CUBE MOLD

1. Spray the inside of the with mold with mold release agent and using a brush, spread the mold release agent evenly around the inside of the mold.
  - Do not use plastic molds, plastic inserts, or cylinders.
  - Do not use mold release agent to excess, which may change the shape of the cubes and affect strength.

### FILL THE CUBE MOLD WITH PREPARED EPOXY GROUT

2. Carefully fill the cube mold halfway with the epoxy sample.
  - If on the jobsite, do not sample from the 1st batch of the day.
  - Do sample or mix and prepare the epoxy grout close to your curing location.
3. Consolidate epoxy cube samples using one of two methods:
  - a. **Method 1:** Follow ASTM C109 tamping procedure for consolidation of first layer. Then fill mold full of epoxy grout and consolidate per ASTM C109 tamping procedure into first layer.
  - b. **Method 2:** Using a small spatula or tongue depressor, consolidate first layer by cutting/stabbing into grout and pulling material towards mold wall (5) times for each mold face. Then fill the mold full and consolidate similarly, ensuring strokes progress from the top layer into the bottom.
    - Be careful not to mix mold release material into epoxy sample during consolidation.
4. If needed, top off molds to ensure they are filled to a slight excess.
5. Screed the surface from the middle of the mold to the outside with an ASTM C109 tamper or a tongue depressor/spatula in the wide, flat, horizontal position. Remove any excess epoxy grout using a sawing motion while lightly pressing down to remove air. Repeatedly remove excess epoxy until the surface of the epoxy grout is flush with the top of the mold or has a slight crown. Then repeat this step from the middle of the mold to the outside in the opposite direction.
6. Clean off any excess material on the top of the mold.

### PREPARE TO CURE YOUR SAMPLES

7. The curing location of your samples will either be the field or the lab. If curing under approximate field conditions, note the temperatures in the product's technical datasheet and store your samples in a cooler or insulated box until initial set or until the design strength is met.

If curing in the lab to replicate technical datasheet strength, samples should be cured according to the ASTM C579 temperatures of 69° to 77° F. Again, until initial set or until design strength is met.

- Do not transport your samples until they have reached initial set or per specification as required
8. Record each samples' product name, batch code, aggregate amount, start time, test date, and temperature.

### DE-MOLD THE CUBES

9. De-mold cube samples once curing time is complete.
10. File off any sharp edges on the cubes to eliminate surface imperfections. Such imperfections may affect compressive strength results.
11. Record the weight of each sample in your sample record book and on each cube with a sharpie.



D.3. Fill molds with second layer of epoxy grout, then consolidate to remove entrapped air.



D.5. Screed off excess grout.

#### PLASTIC MOLDS AND PLASTIC INSERTS ARE NOT TO BE USED

**ASTM C 579 requires that the samples be prepared in 2" x 2" brass or steel cube molds.**

*Five Star Products, Inc. (FSP) does not consider samples cast in plastic molds or plastic inserts to be representative of our products' performance. Data exists that shows the compressive strength test results will be lower if plastic molds or plastic inserts are used.*

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## D. Testing Procedure

### SETTING YOUR COMPRESSIVE TESTING MACHINE TO LOAD RATE II

The compressive strengths of Five Star Epoxy Grouts are published as tested per ASTM C579B Load Rate II of about 0.25"/minute. Before testing your cube, check to ensure your compressive testing machine is set up properly.

Compressive testing machines' position rates are either controlled by software or manually. For testing machines' position rates controlled by software, you should use the following described check with a dial gauge to confirm that the position rate is the required value. If the rate is off, program the software as needed to confirm the correct rate. If needed, contact the manufacturer of your test machine with additional questions.

For users who can manually control their machines, the position rate may be set by adjusting the fluid control valve to establish the ASTM C579B Load Rate II setting. You will measure the crosshead travel rate over 30 seconds using a dial gauge positioned appropriately on your compression testing machine.

12. Here are the instructions for setting your machine accordingly:

**Step 1:** *Open the hydraulic control valve to an estimated first trial position, situate the dial gauge under the load head, and allow the load blocks to contact the dial gauge.*

**Step 2:** *Turn on the machine and measure the travel rate over 30 seconds. Calculate and determine the resultant position rate. If not within the preferred range of 0.12 to 0.13 inches of travel in 30 seconds, adjust the valve as needed to obtain the correct approximate rate.*

13. Once the correct approximate rate is obtained, using the same process, take three more readings. Then average the results to confirm the machine valve setting is in the correct preferred range of travel.

A 4% variation from 0.125 inches is allowed in readings which can be as high as 0.13 and as low as 0.12 inches of travel in 30 seconds.

To summarize, the travel rate measured on the depth micrometer over 30 seconds should be approximately 0.125 inches so that over 60 seconds, it will equate to about 0.25 inches per minute as required by ASTM C 579B Load Rate II for a 2-inch epoxy cube.

To test using a derived stress or load rate, refer to "Position/Stress/Load Rate Settings For Strength Testing" on the next page.

### TESTING THE CUBE

14. Prepare to test one cube immediately. The 2nd cube is tested at 7 days, and the 3rd is held as a retained sample or can be tested at 28 days or post cure. Sample should be maintained at the ASTM C579 standard of 69 - 77 ° F (21 - 25 ° C).

15. Before testing a cube each time, ensure load blocks are clean and free of debris.

16. When placing a cube in the compression tester, remember:

1. Center it between the plates. Rotate the cube 90° with a corner – not flat side – pointed toward you.
2. Do not apply load to the original top or bottom cube surfaces. Only apply load to the side faces.

**Typically Five Star Epoxy Grouts break at between a 4-6% strain. At load rate II, the material will break between 20 and 30 seconds. This is calculated as follows: 4% strain on a 2" cube equals .08 inches. This strain divided by the 0.25 inches per minute load rate equals .32 minutes which equals 19.2 seconds. If it takes longer than 30 seconds for the sample to break, there is a likely an issue with how your compressive testing machine is set. Increase the load rate or the stress rate until the sample breaks in less than 30 seconds. By doing so, you can be sure that the test machine is running at load rate II even when loaded.**

17. Record the compressive strength in pounds per square inch by dividing the load at failure by the cross-sectional area.  $CS = F \div A$ , where CS is the compressive strength, F is the force or load at point of failure and A is the initial cross-sectional surface area. For more information, refer to ASTM C579 B.

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## E. Derived Position/Stress/Load Rate Settings for Strength Testing

One of the most critical aspects of testing epoxy grouts for compressive strength is the rate at which epoxy cube specimens are loaded. See Figure 1 for a general representation of how stress rate affects the observed compressive strength of an epoxy grout. Five Star publishes the compressive strength of most epoxy grouts as tested per ASTM C579B Load Rate II of about 0.25"/minute. This is a position rate, and not a direct equivalent to a stress or force rate, and often laboratories are not able to operate their test machines by position rate. It is our endeavor to provide guidance as to how to check a manually operated machine for the correct position rate, or in lieu of this, how to use the best approximate stress or force rate instead of position rate if not able to accomplish.

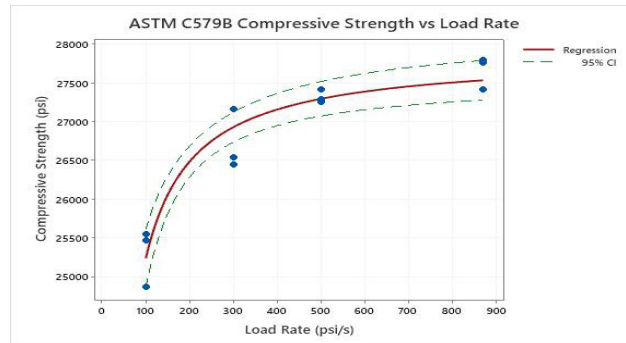


Figure 1 – Compressive Strength vs Stress Rate

There are two recommended rates of testing for determining the compressive strength of epoxy grout two-inch cubes.

- 1) The preferred method for the rate of testing of epoxy grout two-inch cubes is per ASTM C579B Load Rate II which calls for a maximum position rate of 0.25"/min. For users who can manually control their machines, the position rate may be set up/checked as noted below in the section on how to manually determine ASTM C579B Load Rate II. If the position rate is not possible to work with for the compression testing machine being used, the following derived stress rate is advised:
- 2) i. The typical strain to failure of an example epoxy grout is about 4%. For a two-inch cube this represents about 0.08". The time it would take to fracture a cube for a block rate of 0.25"/min would be equal to:

$$0.08"/0.25"/\text{min} = 0.32 \text{ min} [60 \text{ s/min}] = 19.2 \text{ s.}$$

- ii. For a nominal stress of 23,000 psi, the associated stress rate for this is calculated as:

$$23,000 \text{ psi}/19.2 \text{ s} = 1198 \text{ psi/s} \approx 1200 \text{ psi/s.}$$

- iii. The load rate (if needed) would be determined by multiplying the stress rate by the cross-sectional area of the two inch cube as:

$$1200 \text{ lb/in}^2/\text{s} [4 \text{ in}^2] = 4800 \text{ lb/s.}$$

This will break the cube in similar approximate time as per the position rate of 0.25"/min for the ASTM C579B standard for its prescribed Load Rate II.

Measure and record the approximate time from the initial loading to failure of the cube.

Note and record any instantaneous (if possible) and effective (calculated over the duration of the test) stress/load rates that may be noted by the equipment.

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