FIBERFORCE
abcpolymer concrete fibers

Technical Bulletin

Sampling & Fabricating FRC /FRS Test Specimen

INTRODUCTION

Herein we will provide a general tutorial for engineers, ready mix producers, contractors and commercial laboratory personnel on:

- Sampling of Fiber Reinforced Concrete (FRC)/Fiber Reinforced Shotcrete (FRS)
- Fabrication of FRC/FRS hardened concrete test specimens

Correctly sampling and testing the FRC/FRS is absolutely critical. If the FRC sample-gathering process, test specimen fabrication and testing are not conducted properly and precisely, the test results may not accurately reflect the finished product. If the finished product is not approved, this could result in significant penalties for the contractor, ready mixer and vendor. Please note that proper testing procedures are discussed in Technical Bulletin "XYZ."

For the purposes of this discussion, "Sample" and "Test Specimen" are defined as follows:

- A sample is a representative portion of the parent concrete or shotcrete generally recovered at the point of discharge from the mixing vessel at the jobsite. The ASTM Practice for Sampling Freshly Mixed Concrete is C172.
- A test specimen is fabricated from the sample extracted from the parent concrete or shotcrete. For hardened concrete tests of cast-in-place concrete the test specimens are typically manually fabricated cylinders and beams. For shotcrete the cylinders and beams are extracted from panels that have been shot.

SAMPLING & FABRICATION FACTORS AFFECTING TEST RESULTS

1. Fiber Orientation

One of the concerns with the three-dimensional/randomly distributed fibers in the concrete is that modification in the orientation of the fibers may occur when the FRC/FRS is consolidated in the mold. The FRC industry now considers it very critical how the FRC is placed in both the cylinder and beam molds. The concern is specific to fiber orientation and how the fibers reorient if individual scoops of FRC are introduced versus a single charge of FRC being dumped into the molds. Modifying the fibers' orientation can result in test results that are not representative of the parent concrete sampled. Thus the cylinders and/or beams fabricated could produce results that do not meet the required specifications.

ASTM/ACI and FRCA have eliminated one of the major culprits by discontinuing the use of the tamping rod to internally consolidate the concrete. ACI Committee 544 states that beams and cylinders shall be consolidated with external energy, like a rubber mallet or vibrating table. It states, "For concrete cylinders: Place fiber reinforced concrete in the mold and use the standard rubber mallet or another comparable instrument to strike the exterior of the mold to consolidate the concrete. A vibrating table may also be used to consolidate the FRC. For concrete beams: Recommended practice proposes that a single dumping of the FRC into the mold is needed to ensure that the fiber orientation is not disrupted." The reasoning behind this amendment focused on consolidating the concrete is to ensure that the "natural" fiber orientation is not modified in the cross-section, which could potentially alter the test results.

2. Fiber Distribution

Paramount to this whole process is ensuring that the fibers have been thoroughly distributed within the concrete or shotcrete matrix. Please see the Technical Bulleting titled "When and how should synthetic fibers be added to the concrete mix?" for more information on proper mixing instructions.

3. Sampling Procedures

The sampling and fabrication of specimens for laboratory prepared mixes as well as plant or field prepared mixes is considered part of this discussion, and both ASTM C192 (laboratory) and ASTM C31 (field) practices for making and curing test specimens are applicable. Sampling procedures are detailed and intended to be followed exactly step by step. Having the correct tools and molds is imperative.

It is important that the samples be representative of the fresh fiber reinforced concrete/shotcrete. For example, when testing FRS the samples for compression strength, flexural strength and post-first crack testing must be recovered from shotcrete test panels containing the parent material. The orientation of the ingredients, including the fibers, is different in a shotcrete-applied concrete than for a cast-in-place concrete. Therefore, to secure a true representative sample of the FRS, panels must be shot. Specifications can call for either or both vertical or overhead shot test panels. Test specimens are then sawed from the test panels. When shooting test panels with FRS the actual equipment and the certified nozzle man (certification is mandatory) must be part of the process.

4. Fabrication & Handling Procedures

Again, both ASTM C192 (laboratory) and ASTM C31 (field) practices for making and curing test specimens are applicable. The use of the modified fabrication and compaction process for FRC cylinder and beam specimens applies. Fabrication of test specimens shall follow the uniform practice established in the appropriate ASTM International standard, including the size and construction of the molds.

ADDITIONAL NOTES TO ENSURE CONSISTENT & ACCURATE TEST RESULTS

1. Changing the point at which the samples are extracted from the parent material can produce deviations in results produced; for example, taking some samples at the ready mix plant and then sampling at the project site.

2. Changing the field or laboratory technician who takes the sample and/or fabricates the test specimens and / or tests the specimens can produce variations in the results.

3. When macrosynthetic fibers, steel fibers or blends are specified to optimize the mix and to verify that all of the required engineering properties are achieved, it is mandatory that all of the ingredients approved for use on a given project be included in the trial mix. Changes in any of the ingredients in the mix, like the cement or admixtures, typically should require additional trial mixes. The cement compression strength can vary from silo to silo within a single vendor source. Variations can be much more pronounced if the cement's vendor source is changed. This is also true for the coarse and fine aggregate as well as the admixtures and/or additives.

4. Handling and storage of test specimens must be uniform to reduce variations in results. Field practice requires that test specimens be properly stored to ensure no loss of moisture or wild temperature swings. Test specimens must be removed to the laboratory for storage within 24 to 48 hours after they have been cast.

5. Follow the exact procedures for removing hardened concrete test specimens from storage and preparing specimens for testing. CAUTION! DO NOT ALLOW the test specimens to dry out.

6. Review the ASTM Standard Specification for Moist Cabinets, Moist Rooms and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes ... ASTM C511.

CONCLUSIONS

As shown above, it is paramount to consider the consistency in sampling the parent material, preparation of the test specimens, handling and aging of the test specimens, and testing of the test specimens. If any change or modification in the above processes, procedures and/or practices occurs, the resultant deviation in test results can be costly! The above notes reinforce the critical need for absolute consistency throughout the testing program. It is very easy to introduce erroneous data when details are ignored. We in the Fiber Reinforced Concrete industry believe that all parties are responsible in the process of securing accurate test results.