Rules for the fiber-reinforced concrete bowling ball competition

Student team

Only 1 team per school is eligible for this competition.
All members of a given team must be from the same school.
A team is limited to 2 to 8 students currently enrolled in a home school, high school, or an undergraduate college or university program.
Undergraduate students on cooperative or internship work assignment are eligible to compete.
Each team must have a supervising faculty advisor who will see that the team complies with the rules of the competition.
A faculty advisor and 2 student team members must be designated as primary contacts for each team.
At least one individual (faculty advisor or student team member) must be present at convention for each of the bowling ball tests.
Each team must submit files on time to be eligible for prizes.
ACI encourages ACI Chapters, schools, or locations to hold their own competitions to select teams for representation at this international competition.

Every student team may be assigned a Team Name.
The Team Name may be used for scheduling and other purposes during the competition.

Bowling ball specimen

Ensure an easily identified means of distinguishing between your bowling balls within your team.
Bowling balls may be painted.
Use none or up to 5 colors.
Epoxy-based paints are not allowed.
Teams can use letters, symbols, marks, and coloring for identification.
All identification is to be aesthetically pleasing.
Unacceptable markings and unacceptable depictions on the bowling balls will be penalized and may disqualify the student sponsorships from further competitions.
The head judges have final determination regarding what is unacceptable.

Bowling ball materials

The bowling balls can be constructed from the listed FRC Mixture, Concrete materials and Fiber reinforcement.
The bowling balls can be constructed with a Core and Distributed, Non-FRC Materials.
The bowling ball structure is identified by completing the submittal.
Concrete materials

Only the FRC Mixture materials listed in the Example and Design Submittals can be used.
Not all the materials listed are required to be used.
Patching, filling, or repair of honeycombed surfaces after casting is allowed.
Materials to correct the honeycombed surfaces must be selected from the exact same materials used in the Design submittal.

Fiber reinforcement

The bowling ball must be made with fiber reinforcement.
No other type of reinforcement is allowed.
Fiber suppliers from the ACI 544 Fiber Reinforced Concrete committee are listed for possibly supplying fibers.
Fiber suppliers are also listed in the website for the Fiber Reinforced Concrete Association. http://fiberreinforcedconcrete.org
The fiber-reinforced concrete mixture design shall include only 4 fiber materials as described by their respective ASTM specification as listed in the Design Submittal.
Do not use any other fiber materials.
Use 1, but no more than 2, of the 4 fiber materials listed.
The maximum length of the fiber is 60 mm.
The fibers may be used at any dosage or volume fraction.

Non-FRC materials

The bowling ball mass can be met with different materials and different densities than the listed FRC Mixture.
The Non-FRC Materials can be grouped together as a centered Core.
The Non-FRC Materials can also be homogeneously Distributed within the FRC Mixture.
The bowling balls may be solid with a homogeneous distribution of different density materials.
The Non-FRC Materials can both be used as a Core and Distributed.
The bowling balls may have multiple layers of different densities or one core with a different density.
Expanded polystyrene beads are an example of an acceptable homogeneously distributed Non-FRC Material.
A balloon filled with expanded polystyrene beads is an example of an acceptable core using 2 Non-FRC Materials.
The use of Non-FRC Materials is optional.
Use none or up to 4 Non-FRC Mixture Materials.
The Non-FRC Materials used are to be listed on the submittal with the respective volumes for Core and Distributed Non-FRC Materials.
Curing

Curing shall be at atmospheric pressure.
The curing temperatures shall not exceed the boiling point of water.
Use of a standard moist-curing room is permitted.

Bowling ball tests and competition

Each team shall bring 2 balls for the competition and testing at the convention.
Both balls will be used in the competition and based on the judges' selection.
The judge will select either ball for crushing or bowling.
Teams with bowling balls outside the test range or limits of the test may be disqualified from the Prize competition.
The head judges may allow the team with balls outside the range or limits to continue in the competition but are not required to do so.
Modification of entries shall not be permitted once they are accepted for the competition at check-in during the day of the competition.

Specifications Test (10% of each Category)

Each team must submit their forms and files for consideration for prizes.
Fill forms and files completely, correctly, and in a readable and timely manner.
Directions for filling forms and files are mostly self-explanatory with examples.
Compliance with these specifications and files and schedule will establish your score.

Penalties will apply for missing the scheduled dates for Registration and Submittals.
Teams will receive 0.5-point penalty per day after Registrations are due.
Teams will receive 1.0-point penalty per day after Submittals are due.
Teams with 8.0-point penalties or more are not eligible for prizes.
Penalties will apply for Teams too early or too late for the scheduled times on the day of the Competition.

Before convention, the judges will evaluate the files.
Safe and professional behavior is expected in the competition.
Disruptive and unsafe behavior will be penalized in the scoring of the team.

Mass Test (10% of each Category)

Each bowling ball mass shall be 5.5 +/- 0.5 kg.
The judges shall weigh each ball to verify that it meets the mass requirements.
The mass of each ball will be measured and documented by the judges for adherence to the bowling ball mass consistency requirements set forth in these rules.
All balls will be weighed using the same scale of the judges’ choice.
The actual mass of the bowling ball in kg will be the Mass Test Score.
**Diameter Test** (10% of each Category)

The bowling ball shall be spherical.

The bowling ball shall measure $200 \pm 15$ mm diameter.

Each ball will be measured along three different axes arbitrarily selected by the judges for adherence to the bowling ball diameter consistency requirements set forth in these rules.

Three specific diameter measurements will be recorded (in millimeters) as the Diameter Test Score.

**Bowling Test** (30% of each Category)

The bowling apparatus (ramp and alley) will be provided at the competition.

One and only one team member can be identified as the “Team Bowler” and another team member will retrieve the bowled ball and return the ball to the Team Bowler.

The Team Bowler, with no assistance from any other members of the team, will position the test ball at the top of a V-shaped ramp and release it down the ramp onto a flat, non-oiled, hard-surfaced lane.

The Ramp is approximately 1470 mm long, 670 mm wide, and 620 mm in height to achieve a reasonable ball speed.

The bowling lane (or alley) will be approximately 1000 mm wide and 4000 mm long or longer.

Each team will “roll” and score modified frames of bowling.

Six standard-sized bowling pins will be used and will be positioned and spaced in a pattern chosen by the judges.

During the day of the competition, the judges will decide these details based upon the total number of teams for the competition:

1. Pin arrangement,
2. How many rolls per frame,
3. How many frames will be bowled, and
4. Horizontal adjustments to the ramp for aiming the ball.

The team’s score at the completion of the number of frames selected for the competition by the judges will be the Bowling Test Score.

The inclined ramp must be used to deliver the ball.

Under no circumstances is the ball to be thrown, launched, or catapulted down the alley toward the pins.

If the bowl rolls off the side of the alley prior to striking the pins, it is considered a gutter ball and no pins will be scored for that roll.

Once the bowling ball is released and begins its descent down the incline, the ball may not be chased after or interrupted as the ball is rolling.

Ball return will be by another team member.

No running or walking fast or throwing the balls as a return.
If a ball return is available, the ball return will be at a lower speed and angle and used in the same manner as the ball was introduced to the bowling lane. The resulting pin count will be recorded as the score for that ball. The judges will be responsible for setting the pins and recording the score. Further, judges will have the right to control the time for the bowling by imposing a time limit for the bowling portion of the competition to ensure that not too much time is spent aiming or adjusting for the ball roll or a maximum amount of time to accomplish the amount of rolls for the chosen number of frames. In this case and if the total allowed number of rolls are not completed at the expiration of the allowed time, the score attained during the time limit will be the team’s bowling score. No practice rolls will be given to any team or individual prior to the test. Any practice rolls on ACI equipment will result in team disqualification.

**Toughness Test (20% of each Category)**

If the applied load exceeds 70,000 pounds during any portion of this test, the Toughness Test Score will be zero (0). The test ball will be placed in a testing apparatus for controlled crushing. The load shall be applied to maintain a constant rate of displacement (crushing). During the day of the competition, the judges will decide the displacement rate based upon the total number of teams for the competition. The displacement rate will be set between 5.00 and 12.50 mm per minute. The load will be recorded for every 5 mm of crosshead displacement and the average of the five loads will be computed. The average load for these five displacement points will be the Toughness Test Score.

**Load Test (20% of each Category)**

The load will be applied until the crosshead displacement of the testing apparatus has traveled 25 mm. The load at 25 mm deflection is considered the final deformation load. This load is considered the Load Test Score.