

1 **Rules for the fiber-reinforced concrete bowling ball competition**

3 **Student team**

5 Only 1 team per school is eligible for this competition.

6 All members of a given team must be from the same school.

7 A team is limited to 2 to 8 students currently enrolled in a home school, high school, or
8 an undergraduate college or university program.

9 Undergraduate students on cooperative or internship work assignment are eligible to
10 compete.

11 Each team must have a supervising faculty advisor who will see that the team complies
12 with the rules of the competition.

14 A faculty advisor and 2 student team members must be designated as primary contacts for
15 each team.

16 At least one individual (faculty advisor or student team member) must be present at
17 convention for each of the bowling ball tests.

18 Each team must submit files on time to be eligible for prizes.

19 ACI encourages ACI Chapters, schools, or locations to hold their own competitions to
20 select teams for representation at this international competition.

22 Every student team may be assigned a Team Name.

23 The Team Name may be used for scheduling and other purposes during the competition.

25 **Bowling ball specimen**

27 Ensure an easily identified means of distinguishing between your bowling balls within
28 your team.

29 Bowling balls may be painted.

30 Use none or up to 5 colors.

31 Epoxy-based paints are not allowed.

32 Teams can use letters, symbols, marks, and coloring for identification.

33 All identification is to be aesthetically pleasing.

34 Unacceptable markings and unacceptable depictions on the bowling balls will be
35 penalized and may disqualify the student sponsorships from further competitions.

36 The head judges have final determination regarding what is unacceptable.

38 **Bowling ball materials**

40 The bowling balls can be constructed from the listed FRC Mixture, Concrete materials
41 and Fiber reinforcement.

42 The bowling balls can be constructed with a Core and Distributed, Non-FRC Materials.

43 The bowling ball structure is identified by completing the submittal.

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47 Concrete materials

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49 Only the FRC Mixture materials listed in the Example and Design Submittals can be
50 used.

51 Not all the materials listed are required to be used.

52 Patching, filling, or repair of honeycombed surfaces after casting is allowed.

53 Materials to correct the honeycombed surfaces must be selected from the exact same
54 materials used in the Design submittal.

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56 Fiber reinforcement

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58 The bowling ball must be made with fiber reinforcement.

59 No other type of reinforcement is allowed.

60 Fiber suppliers from the ACI 544 Fiber Reinforced Concrete committee are listed for
61 possibly supplying fibers.

62 Fiber suppliers are also listed in the website for the Fiber Reinforced Concrete
63 Association. <http://fiberreinforcedconcrete.org>

64 The fiber-reinforced concrete mixture design shall include only 4 fiber materials as
65 described by their respective ASTM specification as listed in the Design Submittal.

66 Do not use any other fiber materials.

67 Use 1, but no more than 2, of the 4 fiber materials listed.

68 The maximum length of the fiber is 60 mm.

69 The fibers may be used at any dosage or volume fraction.

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71 Non-FRC materials

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73 The bowling ball mass can be met with different materials and different densities than the
74 listed FRC Mixture.

75 The Non-FRC Materials can be grouped together as a centered Core.

76 The Non-FRC Materials can also be homogeneously Distributed within the FRC Mixture.

77 The bowling balls may be solid with a homogeneous distribution of different density
78 materials.

79 The Non-FRC Materials can both be used as a Core and Distributed.

80 The bowling balls may have multiple layers of different densities or one core with a
81 different density.

82 Expanded polystyrene beads are an example of an acceptable homogeneously distributed
83 Non-FRC Material.

84 A balloon filled with expanded polystyrene beads is an example of an acceptable core
85 using 2 Non-FRC Materials.

86 The use of Non-FRC Materials is optional.

87 Use none or up to 4 Non-FRC Mixture Materials.

88 The Non-FRC Materials used are to be listed on the submittal with the respective
89 volumes for Core and Distributed Non-FRC Materials.

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93 Curing

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95 Curing shall be at atmospheric pressure.

96 The curing temperatures shall not exceed the boiling point of water.

97 Use of a standard moist-curing room is permitted.

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99 Bowling ball tests and competition

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101 Each team shall bring 2 balls for the competition and testing at the convention.

102 Both balls will be used in the competition and based on the judges' selection.

103 The judge will select either ball for crushing or bowling.

104 Teams with bowling balls outside the test range or limits of the test may be disqualified
105 from the Prize competition.106 The head judges may allow the team with balls outside the range or limits to continue in
107 the competition but are not required to do so.108 Modification of entries shall not be permitted once they are accepted for the competition
109 at check-in during the day of the competition.

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111 Specifications Test (10 % of each Category)

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113 Each team must submit their forms and files for consideration for prizes.

114 Fill forms and files completely, correctly, and in a readable and timely manner.

115 Directions for filling forms and files are mostly self-explanatory with examples.

116 Compliance with these specifications and files and schedule will establish your score.

117

118 Penalties will apply for missing the scheduled dates for Registration and Submittals.

119 Teams will receive 0.5-point penalty per day after Registrations are due.

120 Teams will receive 1.0-point penalty per day after Submittals are due.

121 Teams with 8.0-point penalties or more are not eligible for prizes.

122 Penalties will apply for Teams too early or too late for the scheduled times on the day of
123 the Competition.

124

125 Before convention, the judges will evaluate the files.

126 Safe and professional behavior is expected in the competition.

127 Disruptive and unsafe behavior will be penalized in the scoring of the team.

128

129 Mass Test (10% of each Category)

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131 Each bowling ball mass shall be 5.5 +/- 0.5 kg.

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133 The judges shall weigh each ball to verify that it meets the mass requirements.

134 The mass of each ball will be measured and documented by the judges for adherence to
135 the bowling ball mass consistency requirements set forth in these rules.

136 All balls will be weighed using the same scale of the judges' choice.

137 The actual mass of the bowling ball in kg will be the Mass Test Score.

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139 **Diameter Test** (10% of each Category)

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141 The bowling ball shall be spherical.

142 The bowling ball shall measure 200 ± 15 mm diameter.

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

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

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

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

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

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

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

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

161

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

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

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

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1-Pin arrangement,

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2-How many rolls per frame,

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3-How many frames will be bowled, and

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4-Horizontal adjustments to the ramp for aiming the ball.

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

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175 The inclined ramp must be used to deliver the ball.

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

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

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

182

Ball return will be by another team member.

183

No running or walking fast or throwing the balls as a return.

184 If a ball return is available, the ball return will be at a lower speed and angle and used in
185 the same manner as the ball was introduced to the bowling lane.

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187 The resulting pin count will be recorded as the score for that ball.

188 The judges will be responsible for setting the pins and recording the score.

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190 Further, judges will have the right to control the time for the bowling by imposing a time
191 limit for the bowling portion of the competition to ensure that not too much time is spent
192 aiming or adjusting for the ball roll or a maximum amount of time to accomplish the
193 amount of rolls for the chosen number of frames.

194 In this case and if the total allowed number of rolls are not completed at the expiration of
195 the allowed time, the score attained during the time limit will be the team's bowling
196 score.

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198 No practice rolls will be given to any team or individual prior to the test.

199 Any practice rolls on ACI equipment will result in team disqualification.

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

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203 If the applied load exceeds 70,000 pounds during any portion of this test, the Toughness
204 Test Score will be zero (0).

205 The test ball will be placed in a testing apparatus for controlled crushing.

206 The load shall be applied to maintain a constant rate of displacement (crushing).

207 During the day of the competition, the judges will decide the displacement rate based
208 upon the total number of teams for the competition.

209 The displacement rate will be set between 5.00 and 12.50 mm per minute.

210 The load will be recorded for every 5 mm of crosshead displacement and the average of
211 the five loads will be computed.

212 The average load for these five displacement points will be the Toughness Test Score.

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

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216 The load will be applied until the crosshead displacement of the testing apparatus has
217 traveled 25 mm.

218 The load at 25 mm deflection is considered the final deformation load.

219 This load is considered the Load Test Score.