IBRACON CONCREBOL 2014

1 OBJECTIVE

1.1 This contest intends to test the competitors' ability to develop construction methods and the production of lightweight homogeneous concrete with optimized strength parameters.

1.2 The proposed challenge is to build a sphere (BALL) of lightweight concrete able to roll in a straight path, within the materials and dimensions established in this Regulation.

1.3 This Regulation set the requirements to be attended in order to participate in this Contest, provides the guidelines to cast the specimen and defines the classification criteria. It also provides information about the offered awards by IBRACON to the winner teams in this challenge.

2 PARTICIPATION

2.1 In order to participate in this Contest, the teams must be composed by architecture, civil engineering or technology students from any states of Brazil or from other countries, since the students are enrolled in academic year in a program authorized by *Ministério da Educação* (MEC) or respective higher education organisms from foreign countries.

2.2 Each team must be composed by students from a single educational institution.

2.3 There is no restriction regarding the number of participants in each team.

2.4 It is allowed the inscription of at the most two BALLS per educational institution.

2.5 It is not allowed the participation of any member in more than one team.

2.6 Each team must be guided by a professor from the respective educational institution. This professor must ensure the team conformity with the rules established in this Regulation and sign the Responsibility Term (Annex 3) for the team participation in this competition.

3 TEAMS APPLICATION

3.1 The application must be carried out by the email concrebol@ibracon.org.br, until September 20, 2014.

3.2 At the registration, each team must submit the following documents:

a) Application Form properly filled in (Annex 1);

b) Technical Report properly filled in (Annex 2);

c) Responsibility Term signed by the team's supervisor professor (Annex 3);

4.1 The BALLS must be handled at the Convention Center of Natal / RN, where the 56th. Brazilian Concrete Congress takes place.

4.2 The handling shall be realized on October 7th, 2014, from 5pm to 8pm or on October 8th, 2014, until 10am.

4.3 As soon as the Organizer Committee receives the BALL, it must verify if the BALL meets the dimensional, form and mass requirements established in 5.2.1. The realization of these procedures must be accompanied by a member of each team. The noncompliance of these requirements disqualifies the team.

4.4 If the BALL is accepted by meeting the 4.3 requirements, the team will receive identification from the Organizing Committee that confirms its participation in the Contest and the BALL will be retained by the Commission until the moment of the tests.

4.4 It will not be accepted BALLS handled by thirds.

4.5 The date of the tests will be reported when the team handles the BALLS.

5 CASTING THE BALL

5.1 Materials

5.1.1 Portland Cement and cimentitious mineral admixtures

For the concrete proportioning, any type of Portland cement normalized by the Brazilian Association of Technical Standards (ABNT NBR 5732, ABNT NBR 5733, ABNT NBR 5735, ABNT NBR 5736, ABNT NBR 5737, ABNT NBR 11578, ABNT NBR 12989 or ABNT NBR 13116), currently commercialized, must be used. In the case of teams from foreign countries, it is allowed the use of Portland cement produced in the team's country, since the following information is declared in Technical Report: producer, class, type, origin and its Technical Standard.

It is allowed the use of cimentitious mineral admixtures normalized by ABNT, as silica fume (ABNT NBR 13956), metakaolin (ABNT NBR 15894) and other pozzolanic materials (ABNT NBR 12653). In the case of teams from foreign countries, the use of cimentitious admixtures shall be restricted to the similar standards in Brazil, and its characterization and Technical Standard must be informed.

It is not allowed the use of other types of binders (such as adhesives and polymers with organic origin), carbon nanotubes or any other material that is not provided in this Regulation.

NOTE: The concrete samples of the winner teams may be analyzed through specific tests to check the use of materials that are not provided in this regulation.

5.1.2 Aggregates

The used aggregates shall have stony nature, according to ABNT NBR 7211.It is forbidden the use of aggregates with other origins (metal, glass beads, etc.), with the exception of lightweight aggregates provided in ABNT NBR 7213 and pearls of expanded polystyrene.

5.1.3 Fibers

The use of fibers is forbidden.

The verification of the presence of any kind of fibers in the concrete (minerals, plant, metallic, propylene, polyethylene or other) will disqualify the team.

5.1.4 Chemical Admixtures

It is allowed the use of admixtures according to ABNT NBR 11768.

In the case of teams from foreign countries, the use of chemical admixtures must be restricted to equivalents products in Brazil. The characterization and the Technical Standard of this product shall be informed.

5.2 Executive Procedure

5.2.1 BALL Characteristics

The BALL shall have spherical shape, diameter ranging from 207 mm to 240 mm and mass smaller or equal to 11 000 g (see 6.2 and 6.3).

5.2.2 Cure

The curing process can be chosen by the teams. It is allowed moist-cure at ambient temperature, thermo-controlled cure and other procedures, since described in the Technical Report.

5.2.3 Laboratory Procedures

The laboratorial procedures must follow the Brazilian Technical Standard (ABNT) requirements, when relevant.

5.2.4 Markings

It is allowed to identify the BALL with the logo or name of the team’s institution. If this identification is made by adhesive, it must be easy to remove. The Organizing Committee may request the removal or repositioning of this adhesive on the ball.

5.2.5 Homogeneity and finishing

The BALL shall be homogeneous, with the same composition throughout its mass.

The BALL cannot contain special cores and flat surfaces; it cannot be painted as well, under penalty of disqualification of the team.

6 TEST

6.1 Steps

The test consists of four steps, as described from 6.2 to 6.5:

- Step 1: diameter and volume of the BALL;
- Step 2: BALL mass and density of concrete;
- Step 3: BALL uniformity;
- Step 4: strength of concrete.

6.2 Step 1: diameter and volume of the BALL

For each BALL, three determinations of diameter must be realized. These dimensions will be realized by the Organizer Committee through different orthogonal planes.

The average diameter of the BALL must be between 207 and 240 mm and corresponds to the average of the three dimensions, realized with 1 mm accuracy. This value is used to calculate the final score to classify the teams.

Calculate the volume of the BALL, considering the average diameter, and register it in cubic meters (m^3).

6.3 Step 2: mass of the BALL and density of the concrete

The mass of the BALL shall be determined in balance with a resolution of 1g, and must be smaller than 11 000 g. This value is used to calculate the final score to classify the teams.

Calculate the density of the concrete used to prepare the BALL, considering the mass and the volume of the BALL (the volume is the one calculated in Step 1). The value of the density will be used in the event of a tie.

6.4 Step 3: uniformity of the BALL

At this step, the uniformity of the BALL will be evaluated according to its capacity to roll, going on a straight path (through a lane) and converting this movement to a “Goal”, considering the BALL starts the movement because of an initial force (a kick).

In order to provide an equal impulse to the BALLS, it will be used an equipment showed in Figure 1, that consists of a 20 kg mass pendulum, with a 80 cm lever arm, released at an angle of 37º (thirty seven degrees).

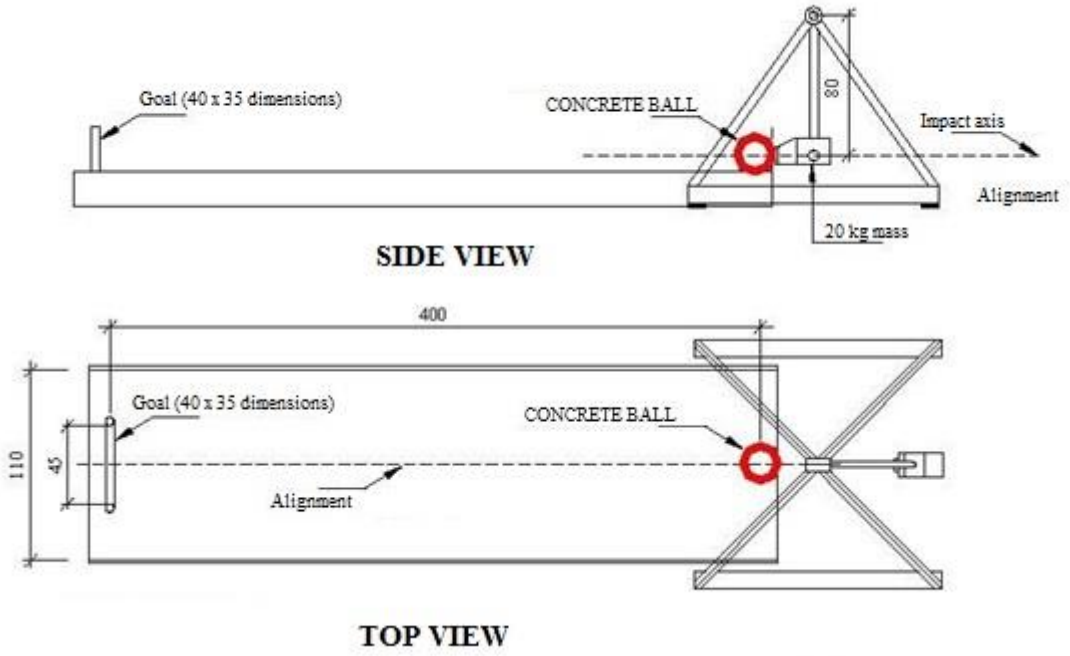

FIGURE 1 – Impulse equipment, Track and Goal

The concrete BALL shall be placed over the penalty mark (marked on the track) and, at the time of the test, be driven as shown in Figure 2.

To obtain the highest score, the BALL must run through the 4m length track and enter the Goal (Figures 1 and 2).

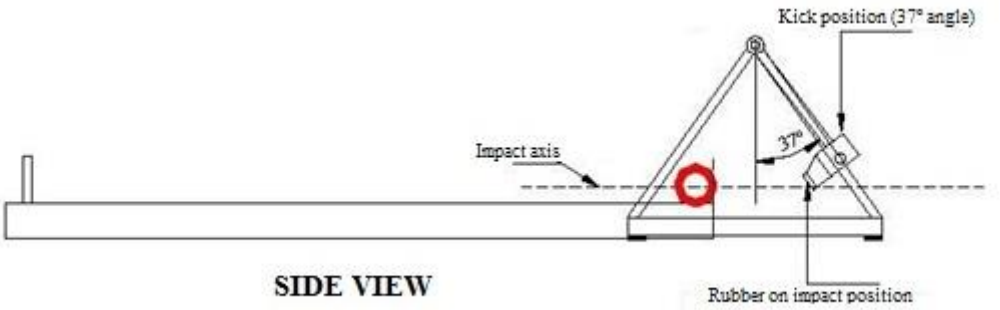

FIGURE 2 – Equipment on position to kick the BALL

The Figures 1 and 2 show the dimensions of the track and the goal, as well as its alignment considering the axis of impact point on the BALL.

To each BALL, the team will have only one chance to try to score the Goal.

Independently of the success of the shot, it will be attributed a C_1 coefficient, according to Table 1, and it will be part of the final score, to elect the winner team of the Contest.

Table 1 – C_1 Coefficient values according to the Goal

Event	C_1
The shot is converted to a Goal	**1,00**
The shot is not converted to a Goal	**0,60**

It will be considered a Goal when more than a half of the ball crosses the line that limits the track from the Goal area.

Each team must choose one of its members to be the Captain, who will be responsible for the position of the ball on the penalty mark. It is not allowed to lean on the track during the positioning.

6.5 Step 4: Concrete Strength

After the realization of Steps 1 to 3, the BALL will be submitted to a compressive load under a (0,45 ± 0,15) MPa/s loading velocity. The maximum breaking load (*F*) obtained shall be registered with three decimal places, in kiloNewtons (kN).

This value is used to calculate the final score to classify the teams.

The final score (PF) of each BALL shall be calculated by the following equation:

$$PF = \frac{4.\pi.r^3 F}{3.M}.C_1$$

Where:

PF is the value of the final score;

F is the maximum load registered in the compressive strength test, in kiloNewtons (kN)

r is the radius of the BALL, calculated as a half of the average diameter obtained in Step 1 (see 6.2), in meters (m);

M is the mass of the BALL, in kilograms (kg);

C_1 is the uniformity coefficient, determined by the capacity to convert the BALL movement to a Goal over the equipment provided in this Regulation (Table 1).

The value of the final score will be presented with a four decimal places accuracy.

7 RANKING OF THE TEAMS

7.1 Crescent ranking by results

The ranking of the teams will be based on the final score of the tested BALLS, in a descending order.

NOTE Therefore, the BALLS with highest scores will receive the best ratings.

The classification will proceed until all the BALLS have been rated.

It will be considered the winner the team which the BALL obtains the highest final score. The second and third places will be from the teams with BALLS rated on this sequence.

Teams who registered more than a BALL will be rated by the BALL with the best performance. In this case, the BALL with the lowest score of each team will be disregarded.

The noncompliance of this Regulation disqualifies the team, even after the ending of the Congress. The BALLS of the five best rated teams may be collected for verification as to its compliance.

Disqualified teams will have its procedures evaluated by the Judging Commission and may be prevented from participate for one or two editions of this contest.

7.2 Tiebreaker

In the event of a tie for final score, the winner team will be the one which the BALL has the lowest density. During the realization of the event, the mass of each BALL will be known only from the team that prepared it and the Organizer Committee.

8 ORGANIZER COMMITTEE

The Organizer Committee is formed by IBRACON members that represent the region of the event and the National Coordination. The members of the Organizer Committee will be revealed during the 56th Brazilian Concrete Congress 2014.

The Organizer Committee is responsible for receiving and verifying the BALLS, realizing the tests and evaluating the compliance with this Regulation.

The divulgation of results will be made by IBRACON's Board of Directors on the awards event of the 56th Brazilian Concrete Congress.

More information can be reported to the Organizer Commission by the e-mail concrebol@ibracon.org.br.

9 PRIZES

The team that win first place will be awarded a prize of R$ 3.000,00 (three thousand Reais). The three teams with higher scores will receive, during the awards event of the 56th Brazilian Concrete Congress, the plaques relatives to the reached result on this contest.

ANNEX 1

APPLICATION FORM

11th CONCREBOL COMPETITION
NATAL/RN - 2014

Educational Institution				
Team members	**Name**	**E-mail**	**Registration n.**	**Ibracon's membership n.**
Professor mentor			--	
Team's Captain				

At the time of registration, attach the logo of the educational institution and the team photo to this Application Form.

ANNEX 2
TECHNICAL REPORT
11th CONCREBOL COMPETITION
NATAL/RN - 2014

Educational Institution:

Material proprieties of concrete components						
Material	Identification/ type/brand	Precedence/ producer	Density kg/m^3	Maximum dimension of the aggregate mm	Fineness modulus of the aggregate	Observations
Cement						
Water						
Aggregate 1						
Aggregate 2						
Aggregate 3						
Cimentitious admixture 1						
Cimentitious admixture 2						
Admixture 1						
Admixture 2						
Attach the Technical Report of the used cement						

Composition of concrete	
Material	Quantity kg/m^3
Cement	
Water	
Air-entrained	
Aggregate 1	
Aggregate 2	
Aggregate 3	
Cimentitious admixture 1	
Cimentitious admixture 2	
Admixture 1	
Admixture 2	

Concrete properties			
Determination	Used method (Technical Standard)	Value	Unit
Slump			mm
Compressive Strength			MPa

Information about the BALL's execution process		
Molding date		(day/month/year)
Temperature and curing process		^{o}C
Summarize how the concrete and the concrete molds was prepared. Attach photos and project.		

ANNEX 3
RESPONSIBILITY TERM

11th CONCREBOL COMPETITION
NATAL/RN - 2014

TO
INSTITUTO BRASILEIRO DO CONCRETO
A/C: 11th CONCREBOL ORGANIZER COMMITTEE

RESPONSIBILITY TERM

I, ... (Name of the mentor professor), RG ....., (CI, CREA or CAU)....., Mentor Professor of the team ....., from .....(Name of education institution)....., send to the 11th IBRACON Competition – CONCREBOL 2014 Organizer Committee this Responsibility Term in which I declare that the BALLS registered in this competition are in conformity with the respective Regulation.

I certificate that all the registered students are architecture, engineering or technology students of this education institution.

I also declare to be aware that any noncompliance with the Regulation will disqualify the team, that will have its procedures evaluated by the Judging Commission and may be prevented from participate for one or two editions of this competition.

....., ... 2014.
(Full name and signature of the mentor professor)
(Registration number on respective education institution)