

IBRACON Egg Protection Device Competition

APO 2014

1 OBJECTIVE

1.1 This competition intends to test the competitor's abilities to develop structural elements that are able to resist impact loads, taking the most out of reinforced concrete properties.

1.2 The proposed challenge consists of projecting and casting a Moment-resisting frame in reinforced concrete (APO), according to the model established in this Regulation, able to resist increasing impact loads during the dynamic loading test provided in this competition.

1.3 This structural element is denominated Egg Protection Device (APO), due to its function of protecting an egg placed under the Moment-resisting frame during the loading.

1.4 This Regulation establishes the requirements to be attended in order to participate in this competition, to cast the Moment-resisting frame (APO) and to realize the loading test. It also provides information about the offered awards by IBRACON to the winner teams.

2 PARTICIPATION

2.1 In order to participate in this competition, the teams must be composed by architecture, civil engineering or technology students from any state 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 at the most of two Moment-resisting frames (APO) 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 contest.

3 TEAMS APPLICATION

3.1 The application must be carried out by the email apo@ibracon.org.br, until September 20th, 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 HANDLING THE MOMENT-RESISTING FRAME (APO)

4.1 The Egg Protection Device (APO) 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 APO, it must verify its compliance with the dimensional, form and mass requirements, according to 5.3. 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 APO is accepted by meeting the 4.3 requirements, the team will receive identification from the Organizing Committee that confirms its participation in the competition and the Moment-resisting frame will be retained by the Commission until the moment of the tests.

4.5 It will not be accepted Moment-resisting frames (APO) handled by thirds.

4.6 The date of the tests will be reported when the team handles the Moment-resisting frames.

5 CASTING THE MOMENT-RESISTING FRAME

5.1 Materials

5.1.1 Portland Cement and cementitious mineral admixtures

For concrete proportioning, any type of Portland cement normalized by 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 cementitious mineral admixtures normalized by ABNT, as silica fume (ABNT NBR 13956), metakaolin (ABNT NBR 15894) and other pozzolanic



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materials (ABNT NBR 12653). In the case of teams from foreign countries, the use of cementitious 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 is 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.

5.1.5 Steel for longitudinal reinforcement

Steel wires or bars must be used, according to ABNT NBR 7480, with a diameter less or equal to 1.65 mm.

In the case of teams from foreign countries, the steel wires or bars must have diameter less or equal to 1.65 mm and follow the respective Technical Standard of the team's country, which must be informed.

It is not allowed the use of flat or corrugated plates made of any material.

5.2 Executive procedure

5.2.1 Longitudinal reinforcement execution

The longitudinal reinforcement must be composed by at most 10 steel wires or bars per transversal section (read 5.1.5), without amendments or undulations.

For reinforcement, the use of wires is restricted to tying bars on specific points (like bends to change directions, bar junctions and others). It is not allowed the use of strands (material generally used in prestressed concrete). Welding is not allowed.

Applying tension in reinforcement is allowed.

NOTES

- 1) The disposition and configuration of the reinforcements at Moment-resisting frame's sections will be evaluated after the rupture to verify the compliance with the requirements of this Regulation.
- 2) No arguments from reinforcement position deviation due to problems during concreting will be accepted.
- 3) The use of any material or procedure not provided in this Regulation will disqualify the team.
- 4) Metallic spacers will not be accepted.

5.2.2 Mounting the transversal reinforcement

It is allowed the use of at most 12 stirrups with a diameter less or equal to 1.2 mm all over the Moment-resisting frame, with the spacing defined by the team. It is obligatory the existence of spacing between the stirrups and they must be placed all over the Moment-resisting frame, not overlapped or concentrated at the same place.

The allowed types of stirrups are shown below.



Figure 1 – Allowed types of stirrups

NOTE: Each stirrup configuration presented will be counted as 1 stirrup and the using of any configuration/model that is not provided in this Regulation will disqualify the team, including the using of stirrups with more than 2 (two) stirrup legs.

5.2.3 Curing

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

5.2.4 Laboratorial procedures

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

5.2.5 Markings

It is allowed to identify the Moment-resisting frame with the logo or name of the team's institution, since it is placed on the columns of the Moment-resisting frame. If this identification is made by adhesive material, it must be easy to remove. The



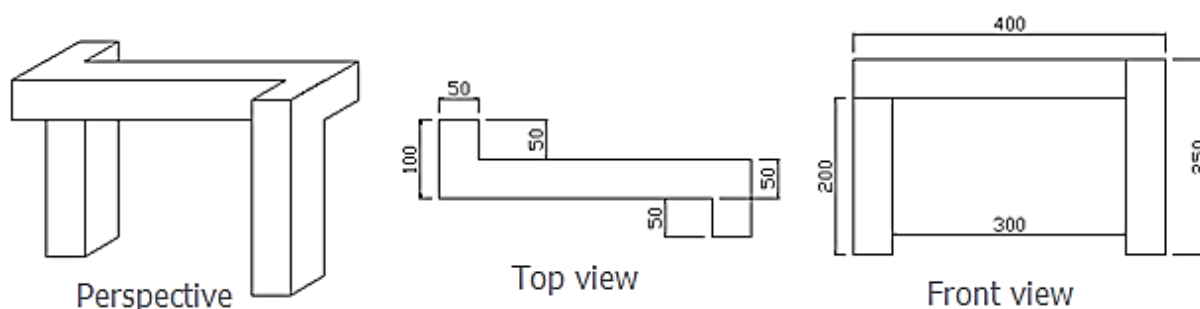
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Organizing Committee may request removal or reposition of this adhesive on the Moment-resisting frame.

5.3 APO: Characteristics, template position and template fixation

5.3.1 APO format and dimensions

The APO shall have its format and dimensions according to Figure 2.



NOTE All the dimensions have ± 1 mm tolerance

Figure 2 – APO format and dimensions

The superior surface of the APO cannot be taller than 250 mm, at any point, related to its base.

The APO must have a plane area (well-finished, without saliences or depressions) with at least 50 mm diameter, on the center of the superficial area, where the load will be applied.

Sanding is not allowed to adequate the Moment-resisting frame to the dimensions. It is not allowed exposed reinforcements.

5.3.2 Template

The dimensional accuracy is critical, especially bases' dimensions, since the Moment-resisting frame shall fit into the template (see Figures 3 and 4). The template is used in order to positioning and fixing the apparatus over the egg, guaranteeing its alignment in relation to the loading dispositive.

The APO that do not attend to the format and dimensions requirements provided on this Regulation will not fit into the Template and will automatically be disqualified.



Figure 3 – Photo of template with fixing ropes

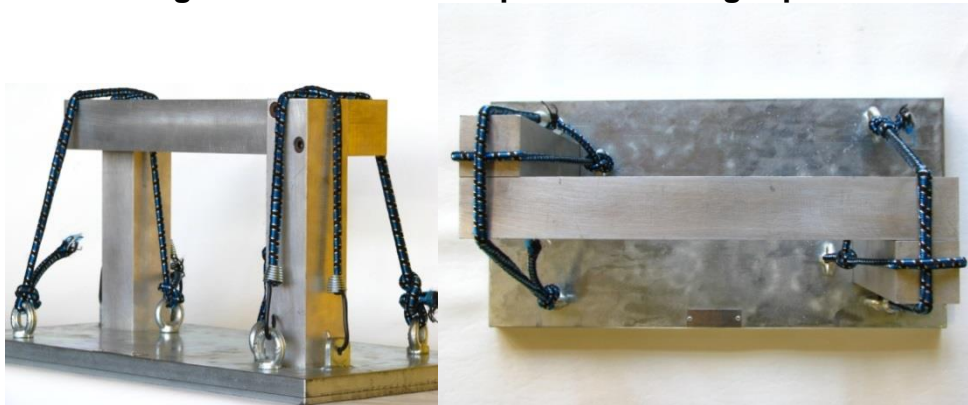


Figure 4 – Photo of APO fixed on the template

NOTE: The fixing dispositive (ropes) will be supplied to the teams by the Organizer Committee of the Competition at the time of preparation of each APO to realize the test.

5.3.3 Mass

The maximum mass of the APO must be 4 000 g (four thousand grams). It is not allowed any tolerance for this value. The mass checking will be realized at the time of APO's receiving.

6 TEST

6.1 Preparing the APO for dynamic loading test

Only registered APOs, in other words, those which present mass and dimensions according to the Regulation, will be tested.

Before the start of the test, the APO must be set on the template through the dispositive shown in Figures 3 and 4. After it a boiled egg will be placed under the APO.



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6.2 Application of impact forces

The dynamic loading of the APO will be realized by releasing a metallic cylinder, with 50 mm diameter and 15 kg mass, of crescent heights, starting by the height of 1.0 m. If the APO resists to the first impact, then the cylinder will be released at 1.5 m height, and the next height will be increased in 0.50 m, successively, until it reaches 2.5 m. Therefore, the cylinder will be released on the following heights: 1.0 m; 1.5 m; 2.0 m; 2.5 m.

The loading will be realized progressively, until the egg is damaged by the impossibility of the APO to keep protecting it. In this final situation, the egg can be damaged because of the ultimate carrying capacity of APO, or by detachment of pieces of the APO, that may hit the egg.

NOTE If it is determined by the Organizer Committee that the egg is damaged because of vibrations during the test (and not because of factors related to the APO), the egg will be replaced by a new egg and the loading will proceed.

The maximum energy resisted by the APO before damaging the egg (load x height) will be the sum of the partial energies to each loading.

If the APO resists all impact loads, the test will be repeated up to three times the greatest load (dropped cylinder maximum height of 2.5 m).

If failure is not verified, the test will be finished after the third loading of 2.5 m height and it will be considered resisted loading will be the maximum foreseen in this Contest.

The Organizer Committee will be responsible for realizing the test. It is obligatory the presence of a member of each team to accompany its development.

After the conclusion of all tests, the teams will be asked to take back their respective tested Moment-resisting frames. The Organizer Committee may retain any Moment-resisting frame for checking.

7 SCORE AND RATINGS CRITERIA

7.1 Rating ascending by results

The rating of the teams will be realized considering the final score of each tested APO, in descending order.

NOTE Therefore, the APO with highest score will receive the best rating.

The rating will continue until all the APOs have been rated.

The team whose APO support the highest energy before damaging the egg will be considered winner. The second and third places will be from the teams with APOs rated in this sequence.

Teams who registered more than one APO will be rated considering the APO with the best score. In this case, the APO 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 APOs 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 between teams with the same impact energy, it will be considered winner the APO with the lowest mass. During the realization of the test, the mass of each APO will be known only for the team who 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 Moment-resisting frames, 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 apo@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 highest scores will receive, during the awards event of the 56th Brazilian Concrete Congress, the plaques relative to the reached result on this competition.

ANNEX 1
APPLICATION FORM
APO 2014 COMPETITION
NATAL/RN - 2014

Educational Institution				
	Name	E-mail	Registration n.	Ibracon's membership n.
Team members				
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.



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**ANNEX 2
TECHNICAL REPORT
APO 2014 COMPETITION
NATAL/RN - 2014**

Educational Institution:

Material properties 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 Moment-resisting frame's execution process		
Molding date		(day/month/year)
Temperature and curing process		°C
Summarize how the concrete, the concrete molds and the reinforcements were prepared. Attach photos and project with the transversal and longitudinal types of reinforcements.		



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**ANNEX 3
RESPONSIBILITY TERM**

**APO 2014 COMPETITION
NATAL/RN - 2014**

**TO
INSTITUTO BRASILEIRO DO CONCRETO
A/C: APO 2014 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 IBRACON Competition – APO 2014 Organizer Committee this Responsibility Term in which I declare that the Moment-resisting frames (APOs) 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)