



7th fib Congress

Lisbon - 2026

Structural Concrete 2050 Towards Carbon Neutrality, AI Design, and Robotic Construction

Lisbon, June 15-19, 2026

www.fiblisbon2026.pt



STUDENTS' COMPETITION

Conception, Design and 3D-printing of a Cement-Based Structural Element



Regulation

March 2026

José Sena Cruz, György László Balázs, Costantino Menna,
Jaime Mata-Falcón, João Pacheco, Liberato Ferrara

1. INTRODUCTION

This document outlines the competition rules and schedule. Participants are strongly encouraged to read it carefully. Failure to comply with these rules will result in team disqualification. The competition aims to assess current ability in developing a structural element using additive manufacturing to meet specific requirements. The following sections provide detailed information about the competition.

2. OBJECTIVE

The objective of this competition is to **conceive, design and 3D-printing a cement-based structural element** that meets, simultaneously, the following specific requirements:

- i. **Lightweight** – it should be as light as possible;
- ii. A **target force** of 60 kN;
- iii. **Energy absorption** - it should absorb in flexure the maximum energy possible.

Each participating team must propose a structural element and provide a clear, formal, and scientific description of the principles and theoretical background supporting their solution. Innovation and creativity are key factors for success in this competition.

3. TEAMS

The following rules must comply:

- Each team must include up to three BSc, MSc or/and PhD students. All team members must be from the same institution, and no student may participate in more than one team.
- Each team must have a Supervising Institution Advisor (SIA) responsible for ensuring compliance with the competition rules. Each SIA can supervise only one team.
- Each team must designate one representative (either a team member or the SIA) to attend the *7th fib Congress 2026*, which is dedicated to this competition. The Congress will include two key moments:
 - (i) **Moment 1** – Presentation and testing of the models at the Structural Laboratory of Técnico (at 7 minutes walking distance from the Congress venue);
 - (ii) **Moment 2** – Announcement of the winners during the Closing Ceremony. All team members are strongly encouraged to participate at the Congress. Reduced registration fees will be available for all team members and not only for those presenting a paper.
- Members of the Scientific Committee of the *7th fib Congress*, as well as other Congress delegates may serve as SIA. However, members of the Organizing Committee of the Congress and members of the Jury of this competition are not eligible to serve as SIA.
- Each team must submit the following four elements:
 - i. **Registration form** – Included in this document.
 - ii. **Report-paper** – A formal and scientific description of the principles and theoretical background supporting the solution. The report must follow the paper format and guidelines of the *7th fib Congress*.

- iii. **PPT Presentation** – A presentation of the work carried out, in a free format, suitable for the dedicated competition session at the *7th fib Congress*. Each presentation should last 3 minutes.
- iv. **Video (MP4 format)** – A maximum 1-minute video recorded during the model's printing process. The video must show the printing at normal speed, with permissible cuts between different phases or layers.

After sending the registration form and receiving the confirmation of registration acceptance by e-mail, the team must submit the report-paper and the presentation up to **June 1st 2026**.

4. MATERIALS

The model must be produced using 3D-printing equipment and must be constructed using exclusively cement-based materials. Geopolymers, ceramics, or other materials are not permitted. The use of dispersed fibres (e.g. steel fibres) in the mix is not permitted. If necessary, discrete reinforcements (e.g. steel or composite bars) are permitted; however, these discrete elements must be applied during the printing phase. Manual placement of reinforcement is allowed. Any application of reinforcement must be documented in the report paper.

5. SPECIMEN'S GEOMETRY

The geometry is freeform, but the following geometrical restrictions apply (see also Figure 1):

- The model must fit within a maximum parallelepipedal envelope of **400 mm × 150 mm × 75 mm** (length × height × thickness). The tolerance permitted is ±5 mm.
- The zones Z1, with a geometry of 60 mm x 60 mm x 75 mm (length x height x thickness), must be solid. The zones Z2 can be solid or void.
- Flat bottom surfaces of zone Z1 (over the whole area of 60 mm x 75 mm) are required; mechanical adjustments using e.g. emeries are permitted. The tolerance permitted is ±1 mm.
- Flat top surface of zone Z1 (over the whole area of 60 mm x 75 mm) is required; mechanical adjustments using e.g. emeries is permitted. The tolerance permitted is ±1 mm.

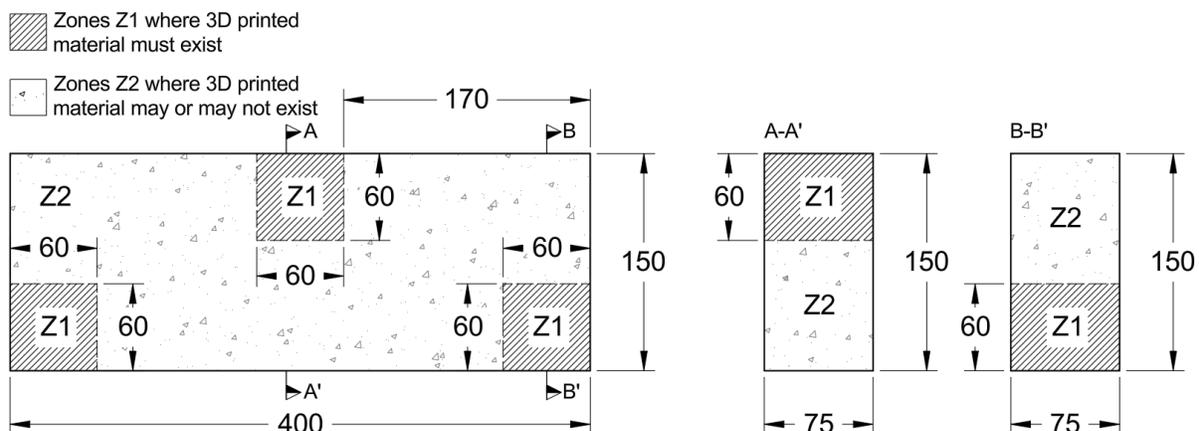


Figure 1. Geometry of the specimen: front view (left figure); section view (right figures).

Note: all dimensions in [mm]

6. TESTING PROCEDURE

The tests of the models will be conducted at the Structural Laboratory of Técnico, on **June 16th, 2026**. The models will be fixed at supports (S1 and S2, as shown in Figure 2) and subjected to a concentrated load (F), located on top at mid-span (S2, as shown in Figure 2). The boundary conditions are as follows (see also Figure 2):

Support	Displacements			Rotations		
	X - Fixed	Y - Fixed	Z - Fixed	X - Fixed	Y - Free	Z - Fixed
S1	X - Fixed	Y - Fixed	Z - Fixed	X - Fixed	Y - Free	Z - Fixed
S2	X - Free	Y - Fixed	Z - Fixed	X - Fixed	Y - Free	Z - Fixed

The vertical load F will be applied through a steel plate connected to a steel cylinder, to which an actuator will be linked. The test will be performed under displacement control at a rate of $33 \mu\text{m/s}$, controlled by the internal LVDT of the actuator. The load (F) will be recorded, as well as the mid-span vertical measured by internal LVDT of the actuator (Δ), in agreement with the details indicated in Figure 2. The test will stop when either (i) the model collapses, (ii) reaches a maximum displacement (Δ) of 10 mm, or (iii) the load (F) exceeds a threshold value of 100 kN.

The models will be installed in the testing equipment without any additional adjustment and/or inclusion of any additional material (paste, mortar, etc.).

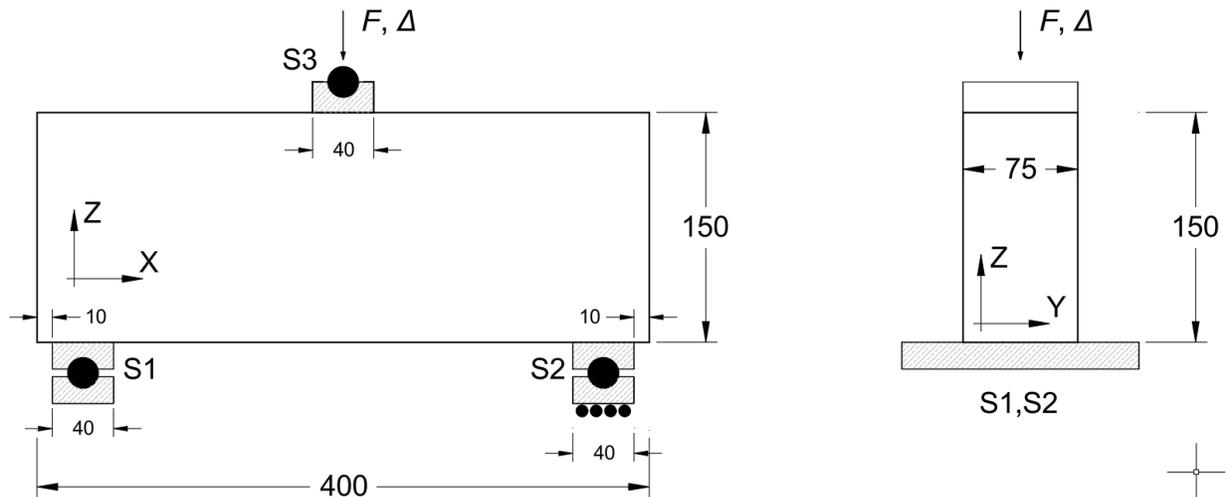


Figure 2. Test setup: front view (left figure); lateral view (right figure). Note: all dimensions in [mm]

The tests will be conducted in a streaming session. All the participants in the *7th fib Congress* will be invited to follow this event by streaming – the assigned auditorium will be indicated in the technical program of the Congress. However, it is mandatory that the designated representative of each team be present at Structural Laboratory of Técnico to present the model (PPT presentation sent – see Section 3) and to follow the whole test.

7. DELIVERY OF THE MODEL

The deadline for delivering the model is **04:00pm (Lisbon time) of June 15th, 2026**. The team can either deliver the model in person or send it by mail. In either case, the model must be delivered to:

A/C Prof. João Pedro Firmo
Laboratório de Estruturas e Resistência de Materiais
Students' Competition 7th fib Congress, Lisbon 2026
Department of Civil Engineering
Av. Rovisco Pais 1
1049-001 Lisboa
Portugal

8. CHRONOGRAM

The chronogram for the competition is the following:

- Reception of the registration forms: up to **October 1st, 2025**;
- Confirmation of registration acceptance: **October 20th, 2025**;
- Webinar 1 – Presentation of the facilities of each team to be used for the 3D printing of the cementitious materials and eventual clarifications about the regulation: **December 15th, 2025**;
- Webinar 2 – Progress of the work in terms of main challenges and achievements: **March 20th, 2026**;
- Reception of the paper-report, PPT presentation and MP4 video: **June 1st, 2026**;
- Reception of the model: **4:00pm (Lisbon time) of June 15th, 2026**;
- Test of the models: **June 16th, 2026**;
- Announcement of the winners: **June 18th, 2026**.

9. REPORTING

The report-paper must follow the template provided in the *7th fib Congress 2026* webpage. The presentation should feature the most relevant figures, results, and model aspects, whether they are already included in the paper or not. Consequently, the report-paper should include the following sections:

- Theoretical concepts and background;
- Model formulation and printing details;
- Model calculations (if applicable);
- Expected response, including failure mechanism;
- Conclusions.

Please send all the information to Prof. José Sena Cruz by email: jose.sena-cruz@civil.uminho.pt

10. EVALUATION

The objective of the competition is to reach the lowest score possible in the following testing evaluation scheme. The evaluation will consider three main aspects: (i) lightness, (ii) load-carrying capacity, and (iii) energy absorption. The final classification score, C , of each team will be the value obtained with the following formula:

$$C = C_w + C_{Fmax} + C_{F-\Delta}$$

where:

- $C_w = \frac{w}{8000}$, where w is the mass of model, in [g];
- C_{Fmax} takes into consideration is the maximum load (F_{max}) registered during the test, in [kN] as follows:

F_{max}	C_{Fmax}	F_{max}	C_{Fmax}
< 50 kN	2,0	$60 \text{ kN} \leq F_{max} < 62 \text{ kN}$	1,0
$50 \text{ kN} \leq F_{max} < 52 \text{ kN}$	1,8	$62 \text{ kN} \leq F_{max} < 64 \text{ kN}$	1,2
$52 \text{ kN} \leq F_{max} < 54 \text{ kN}$	1,6	$64 \text{ kN} \leq F_{max} < 66 \text{ kN}$	1,4
$54 \text{ kN} \leq F_{max} < 56 \text{ kN}$	1,4	$66 \text{ kN} \leq F_{max} < 68 \text{ kN}$	1,6
$56 \text{ kN} \leq F_{max} < 58 \text{ kN}$	1,2	$68 \text{ kN} \leq F_{max} < 70 \text{ kN}$	1,8
$58 \text{ kN} \leq F_{max} < 60 \text{ kN}$	1,0	$\geq 70 \text{ kN}$	2,0

- $C_{F-\Delta} = \frac{600}{\int F \cdot \Delta}$, where $\int F \cdot \Delta$ is the area under the curve force-displacement ($F - \Delta$), in [kN·mm], up to the failure displacement with an upper limit of 10 mm for Δ , and a cut-off 70 kN for any F higher than this value.

In the event of a tie, the jury members will also consider the scientific quality of the report paper.

11. AWARDS AND DISSEMINATION

The competition includes two types of awards: (i) **cash prizes** and (ii) an **award for the most innovative solution**.

The **cash prizes** will be attributed to the three teams with the lowest values of C score, as follows:

- 1st prize: 1.500 € (**lowest value** of C);
- 2nd prize: 750 € (**second lowest** value of C);
- 3rd prize: 300 € (**third lowest** value of C).

The **award for the most innovative solution** will be attributed to the team best graded by the jury, considering the following equally-weighted criteria: (i) aesthetic quality, (ii) uniqueness/originality, (iii) highlighting a unique and/or innovative feature on the use of 3D-printing solutions, and (iv) technical merit as described in report-paper.

The competition results, namely the list of winners and a summary of the proposals submitted, will be published in the Newsletter of *fib*, as well as at the Congress webpage. This publication will give visibility

and emphasize the most creative and innovative aspects of the proposed models by the participating teams to predict the response of the models, as well as the analysis of the models adopted.

Furthermore, the top **5 ranked** teams (the five teams with the five lowest values of C) and the awarded team for the most innovative solution will be invited to develop a joint journal paper for publication in the *Structural Concrete Journal*, the official journal of *fib*, the International Federation for Structural Concrete.

Certificates of Honourable Mention will be granted by the Organizing Committee to the participating teams that, although not ranked in the three winning positions, will be selected for having submitted outstanding proposals considering the main evaluation parameters above-mentioned.

12. JURY

José Sena Cruz (chairman), University of Minho

György László Balázs, Budapest University of Technology and Economics

Costantino Menna, University of Naples Federico II

Jaime Mata-Falcón, Universitat Politècnica de València

João Pacheco, Instituto Superior Técnico, University of Lisbon

Liberato Ferrara, Politecnico di Milano

Disclaimer: *The competition is designed to foster scientific knowledge and encourage teamwork, with rules carefully created to ensure equal conditions for all participants. However, the jury reserves the right to disqualify any team at any stage of the competition if their actions are deemed contrary to the spirit of fair play—particularly if they exploit gaps in the rules to gain an unfair advantage or achieve results that would not otherwise be attainable. Should any doubt arise, please contact the chairman of the competition (jose.sena-cruz@civil.uminho.pt) and/or ask for clarifications during the webinars.*