The Fifth International Concrete Dragon Boat Competition (ICDBC-2023) Rules and Regulations

1. Background

The Fifth International Concrete Dragon Boat Competition (ICDBC-2023), themed with 'Intelligent Sailing, Poetic Design', will be held around 22 June 2023 in Yueyang City, Hunan, China, where the great patriotic poet Qu Yuan drowned himself for his homeland. Participants are expected to design, fabricate, and race a maneuverable concrete dragon boat equipped with power and control system. This year's competition encourages students to design a self-driving concrete dragon boat, and to present the design concept with poems. It will provide students a unique opportunity to combine poetic culture and cutting-edge artificial intelligence, while testing their skills in terms of concrete mix design, hydrodynamic design, power and control system design and project management.

International Concrete Dragon Boat Competition is a multidisciplinary competition for undergraduate students, which is featured by professionalism, sportsmanship and entertainment. It has been successfully held for four times since 2019 by Zhejiang University, China. This year's event is organized by Central South University, China, and co-sponsored by American Concrete Institute and other academic and industrial organizations.

2. Competition overview

2.1 Competition program overview

In this competition, each team is required to design and fabricate a maneuverable concrete dragon boat prototype with the specified size and shape. The concrete dragon boat prototype shall be presented for evaluation and racing in outdoor water. The participating teams are highly encouraged to fabricate a concrete dragon boat prototype with self-driving ability.

This competition includes seven sub-competitions in terms of technical proposal, poster presentation, aesthetic design, the boat's load-carrying capacity test, material property test, spring race and slalom race. The ranking will be determined by the weighted sum of the team's score in the forgoing seven sub competitions. Winners will be awarded with prize and certificate.

2.2 Essential requirements

a) Size of the concrete dragon boat
b) Hull's self-weight and buoyance force calculation
c) Concrete mixture and reinforce design

d) Stability and anti-capsizing design, sealing and waterproof ability
e) Hull strength and stress analysis
f) Dragon boat CFD simulation

2.3 Design optimization

a) Hull shape optimization to reduce the fluid resistance.
b) Motor layout and control system optimization to improve stability, maneuverability, and technical innovation.
c) Aesthetic design (e.g., dragon boat decoration) and cultural creativity.

2.4 Key dates and venue

Time	Activity	Venue
March 10th – April 10th	Registration	Online
After registration – June 10th	Concrete dragon boat prototype manufacture	At the participating team's convenience
	Rules and regulations Q&A	Email
June 18th	In-person registration	Radisson Red Hotel, Junshan District, Yueyang City
June 19th – 20th	Opening ceremony / Competition / Awards ceremony	"Protect the Yangtze River" Exhibition Hall, Junshan District, Yueyang City

3. Eligibility

3.1 Registration eligibility

a) Participants should be full-time undergraduate students and register as a team. Each team is normally formed with 3-5 students and no more than 2 instructors. Up to 2 teams from a single university are allowed to register.
b) Registration and meals are **free.** Participants are responsible for their own travel and hotel expenses. Participants must submit registration information online at www.concretedragon.org.
c) Each student is only allowed to participate in one team, and each team should independently complete the design and manufacture of the boat prototype.
d) Each team can only submit one named boat prototype.
e) The participating teams should submit their works by the due time. Overdue will be automatically disqualified. During the competition, the participants shall not be replaced or added at will. If any participant cannot turn up, the competition will be accomplished by the other team members.

3.2 Manufacture requirements

a) As shown in Figure-1, the concrete hull structure (decorative faucet tail is not included) shall meet the following requirements: length (80.0cm-100.0cm), height (9.0cm-20.0cm), width (5.0cm-30.0cm). The shape of the hull is freely designed by the participating teams, however, in principle, it is required to conform to the shape of the dragon boat in the traditional sense.

b) Suggested materials: concrete, fiber reinforced cement composites, foam templates, water reducing agents, lightweight sands and aggregates, steel wire or steel bars, all kinds of fiber materials and products (e.g., GFRP). There is no limit to methods of hull fabrication. New construction technologies such as 3D printing are encouraged.

c) Concrete dragon boat hull structure must be made of concrete except the skeleton. Cement based materials should be at least 50% by weight. If the boat hull is made of plastic products, acrylic board, wood and other prohibited materials, the team will be disqualified from the competition.

d) The hull of the boat prototype should be decorated by the participating teams to preferably achieve the image of the dragon boat as shown in Figure-2.

e) Each team should design, manufacture or purchase the power engine and control system including multi-channel remote control equipment, sensors, motors, batteries, etc, at their own cost.

f) Participating teams are encouraged to compose poems to explain the design concept of the dragon boats. They are also encouraged to develop and use autonomous navigation technology to manifest the theme of 'Intelligent Sailing, Poetic Design'. Cultural and technical creativities should be explained in technical proposals and poster presentations.

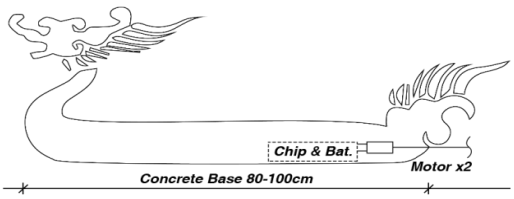

Figure-1. Schematic of the concrete dragon boat

Figure-2. Pictures of the concrete dragon boat manufactured in previous competitions

3.3 Technical proposal and poster

✧ **Technical proposal:**

The files should be no more than 10 pages in font size 12 and submitted in PDF format. The content and specific requirements are detailed in the technical proposal template which can be accessed at www.concretedragon.org/download/.

✧ **Poster:**

The poster should be printed in portrait layout with 60x80cm size by the participating teams and taken to the venue themselves.

✧ **Short videos:**

The participating teams should record a 2-minute video presentation including but not limited to the design and manufacture of the dragon boat.

✧ **File naming format**:

All files shall be named in the format of "university - dragon boat name", for example: "Central South University – Endeavor".

3.4 Important dates

✧ **June 10th, 2023**

Before 23:59, June 10th, the participating teams should submit a zipped file containing the technical proposal, short video, and poster to concretedragon@csu.edu.cn. The subject of the email and the attachments should be named as "university - dragon boat name", for example: "Central South University – Endeavor".

✧ **June 18th, 2023**

Before 22:00, June 16th, the participating teams should register in person at Radisson Red Hotel, Junshan District, Yueyang City and submit the hard copies of technical proposals and posters, and concrete specimens to the organizing committee. The draw and grouping will be taken place at the same day, followed by collecting the competition sequence number and competition site inspection.

✧ **June 19th, 2023**

The opening ceremony will be held at 9:00 am on June 17th. After that, the aesthetic design evaluation, poster presentation, hull load-carrying capacity test, material strength test, and sprint course will be taken place in the designated area in accordance with the draw and grouping results.

✧ **June 20th, 2023**

Starting from 8:30 am, June 18th, participating teams will have the slalom course in the designated venue according to the competition sequence number. After the competition, the staff will calculate the total scores of all teams on the spot and announce the winning teams. The award and closing ceremony will be held at 11:00 am.

4. Competition rules

4.1. Technical Paper Evaluation

The evaluation committee will score the technical papers submitted by each

participating team. The total score of this part is 20 points.

4.2 Aesthetic Design Evaluation

Each participating team will place their dragon boats (with competition sequence numbers displayed) in the designated area. The evaluation committee will score the aesthetic and artistic qualities as well as the structural rationality of the dragon boat. The total score of this part is 10 points.

4.3 Poster Presentation

Each participating team will post their posters in the designated area. The evaluation committee will review the posters and ask questions about their poster. Each team must assign one team member to explain the design concept and technical features of their dragon boat and answer questions. The evaluation committee will evaluate the score based on both the poster quality and the answers to the questions. The total score of this part is 10 points.

4.4 Load-carrying Capacity Test

Before the competition begins, the size of each dragon boat (excluding decorations) will be measured, and the structure of the main body of the dragon boat will be inspected to confirm whether it meets the requirements.

a) The weight of each boat (including the power device, signal receiver, and decorations) will be measured and recorded as W1.
b) Each team will select one member to place their concrete dragon boat in a water tank. After ensuring the stability of the boat, weights will be loaded onto the boat until the water surface reach the top surface of the dragon boat. The boat should maintain stability for more than 20 seconds. The total weight of the added weights will be recorded as W2.
c) The staff will calculate the load-to-weight ratio R = W2/W1. Scores will be assigned based on the R value. The total score of this part is 10 points.

4.5 Material Test

Each participating team must prepare four concrete material specimens for static and impact tests (the concrete specimen size should be 10.0cm long, 2.0cm wide, and 1.0cm thick), as shown in Figure 3. The specimens must use the same specifications and proportions of reinforcement, fiber-reinforced materials, and concrete materials as the dragon boat. If any other materials are found in the specimens, the team's material test competition score will be cancelled. During the test, the staff will randomly select two specimens for static tests and one specimen for impact tests. Please use a marker to indicate the participating university, dragon boat name, and the front and back sides of the specimen.

✧ **Static Load Test**

The static load test will be conducted by gradually increasing the load, with each level of loading ranging from 50g to 500g. The participating team can choose the loading levels and apply the load by themselves. The load should be held for 30 seconds before

the next level of loading is applied until the specimen fails (the maximum deflection exceeds 20% of the span). The average of the maximum loads from the tests will be taken as the static load capacity. The total score for the static load test is 5 points.

✧ **Impact Test**

The impact test will be conducted by dropping a 100g weight from an initial height of 20.0cm. If the test is successful, a second test will be conducted with a 20.0cm increase in the drop height. The drop height will be increased until the height reaches 100.0cm. After each impact test, the total residual deformation should not exceed 20% of the span, and the specimen will be considered successful if there is no crack. The total score for the impact test is 10 points. Two points will be added when the specimens survived with each 20.0cm increase in drop height. Full score will be given to the team if the drop height reaches 100cm.

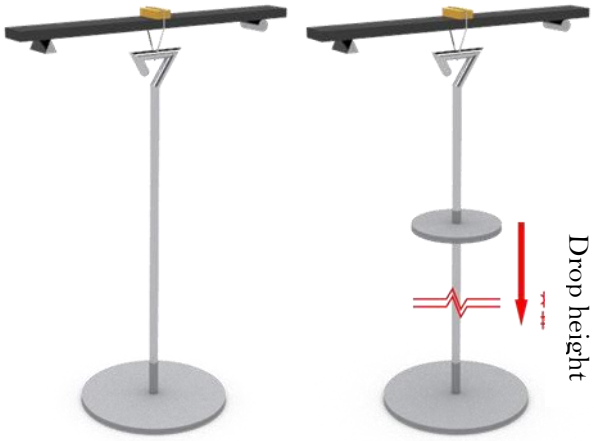

Figure-3. Loading test device schematic (Left: static load (recommended); Right: Impact)

4.6 Sprint course

Each team will be afforded the opportunity to demonstrate the racing capabilities, handling performance, and durability of their prototype model. This will be accomplished by a series of races focused on assessing both straight-line speed and turning capabilities under various conditions. Two different types of races are to be held (weather conditions permitting): i.e., the slalom course and the sprint course, both of which are to be held in the lake near the exhibition hall.

The sprint course consists of a 100-meter-long straight route. The participating teams will be grouped by draws. Each sprint course consists of two teams, and the winner is the team which first crosses the finish line. The winning team will be advanced to the next round, facing another winning team from the same group. The schedule for the sprint course can be found in Figure-4. During the sprint course, the boat operators from the participating teams shall standing at the starting point, placing the dragon boat in the designated area. Once the starting signal is given, the boat shall be manually controlled or autonomously navigated to the finishing line. The race time for each dragon boat will be recorded by staff at the finishing line. The score will be given

according to the ranking of time consumption. The champion prize, runner-up prize and third-place prize will be awarded for this individual competition.

Figure-4. Schematic diagram of sprint course

Note: The schedule of the sprint course will be adjusted by the organizing committee in accordance with the number of participating teams. If too many teams are involved, a preliminary race will be set. Detailed information of the competition schedule will be released one-week in advance via email.

4.7 Slalom course

The slalom course is to be held in the lake near the exhibition hall, which consists of a two-laps race. The race order will be determined according to competition sequence numbers. The operator of each boat should stand at the starting point. Once the starting signal is given, the boat shall be manually controlled or autonomously navigated to move around the obstacles, following the race line (e.g., the first lap is O-shaped, and the second lap is S-shaped, as shown in Figure-5). The race time for each dragon boat will be recorded by staff at the finishing line. Note that the team who fails to complete the slalom course in 3-minute will be disqualified automatically. Each team has two chances, the shortest complete race time between the two races will be assigned as the final race time. For the slalom course, the total score will be 20 points, in which 15 points will be dependent on the rank of race time, and the remaining 5 points will be dependent on the capabilities of passing obstacles.

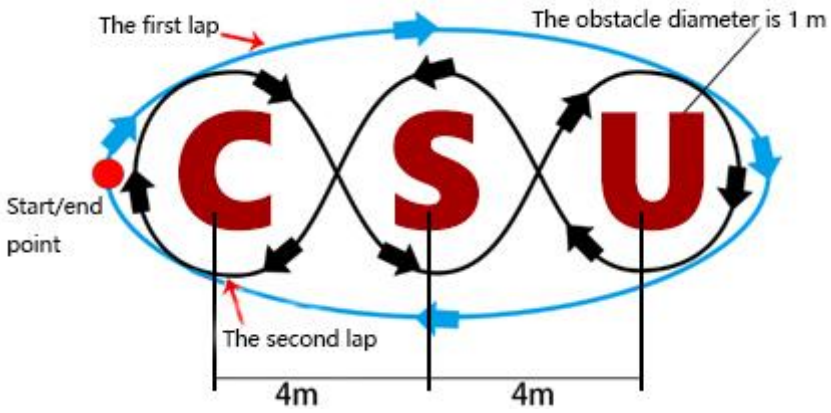

Figure-5. Illustration of the slalom course

Notes:

a) Starting the boat before the launching of the signal gun is considered as a violation. The team with two accumulated violations will be disqualified for the sprint course.

b) If the participating team cannot turn up on the due time because of their own reasons, this team will be disqualified automatically.

c) The route of the sprint course is about 100-m long. The racing routes will be separated by floating buoys. Each boat shall remain on its racing route. Otherwise, the corresponding team will be disqualified for the sprint course.

d) If the boat model suspends or sinks during the race due to technical issues, the staff will salvage the boat.

e) In case of any situation beyond the rules and regulations, it is suggested to consult the organizing committee.

5. Scoring criteria

Item	Criteria	Total score: 100
Aesthetic design	Aesthetics、Artistry、Structural rationality	10
Poster presentation	Design concept, concrete design, hull design and analysis, power and control system design, technical innovation	15
Technical proposal	Shape and geometry details, structural performance and calculation, concrete mixture introduction, control system, aesthetics, boat CFD simulation, and other relevant boat data sheet. (More details can be found in the technical proposal template)	20

Hull load-carrying capacity	Load-carrying capacity to self-weight ratio	10
Material property	Static test (5) Impact test (5)	10
Slalom course	Time consumption (15) obstacle crossing performance (5)	20
Sprint course	Time consumption	15

6. Awards

A panel of experts will evaluate and award the winning teams. The awards include:

- ✧ **Winner of ICDBC-2023** (1 team), a trophy, certificate of honor and bonus of 5,000 CNY;
- ✧ First prize (3 teams), certificate of honor and bonus of 2,000 CNY each;
- ✧ Second prize (6 teams), certificate of honor and bonus of 500 CNY each;
- ✧ Third prize (10 teams), certificate of honor and bonus of 200 CNY each;
- ✧ Best innovation award (several), certificate of honor;
- ✧ Best **technical proposal** award (several), certificate of honor;
- ✧ Best **technical presentation** award (several), certificate of honor;
- ✧ Cultural Inheritance award (several), certificate of honor;
- ✧ **Sprint race champion** (1 team), certificate of honor and bonus of 2.000 CNY;
- ✧ **Sprint race runner-up** (1 team), certificate of honor and bonus of 1,000 CNY;
- ✧ **Sprint race third place** (1 team), certificate of honor and bonus of 500 CNY.

7. Contact

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Concrete Dragon Boat Organizing Committee Secretariat

7 March, 2023