



# FIRST INTERNATIONAL INTERACTIVE SYMPOSIUM ON UHPC

## STUDENT COMPETITION

**Website for Conference:** [www.uhpc2016.com](http://www.uhpc2016.com)

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**Timeline:**

- Notice to Universities and Students      January 10, 2016

**Phase I**

- Universities Develop Projects              Spring 2016
- Submission of Written Report              Due April 1, 2016
- Judging Complete                              By April 22, 2016
- Notice to Finalists                              May 1, 2016

**Phase II**

- Attendance at Conference                      July 18-20, 2016
- Student On-Site Competition                      July 19, 2016



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### Competition Synopsis:

As part of the 1st International Interactive Symposium on Ultra-High Performance Concrete (UHPC), a companion student competition will be held to grow interest in the area of UHPC amongst engineering and architecture students. The student competition will be open to students across the world, but will require finalists to attend the conference for winner selection.

The basic premise of the competition will be the design of an aesthetically pleasing and structurally efficient flexural beam made out of UHPC (proprietary or self-developed mix designs) that will be evaluated per the guidelines below.

The competition will be comprised of two phases. Phase I will consist of a written report based on work done at the competing team's educational organization. The written report will be judged on content and presentation of research findings and up to ten teams will be invited to participate in Phase II of the competition; onsite testing at the Symposium.

Student teams can consist of up to 4 students per team; all members of the team must be enrolled in an undergraduate or graduate program. Each student team must have a supervising faculty advisor. A student representative from the team must be present at the competition in order to compete. There will be a maximum limit of two teams per educational organization.

### Student Deliverables:

As part of the competition, the student teams must first submit a written report that will be reviewed and judged. Not more than 10 teams will be invited to compete at the on-site competition during the UHPC Symposium in Des Moines, Iowa on July 19, 2016. The selected teams will be required to present a poster at the conference, which will also be evaluated and included in deciding the winner.

### Written Report:

The written report (12 pages or less) must include the following:

1. A description of the shape of the final element produced and summary of the decision process used to establish the final geometry of the element. Drawings are strongly recommended for this part of the report.



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2. Ultra High Performance Concrete has a minimum specified compressive strength of 150 MPa (22,000 psi). Physical testing results including:
  - a. Compressive strength results of the average of (3) 3x6 cylinders as described in Appendix A.
  - b. Flow test results per ASTM-C1437 - Standard Test Method for Flow of Hydraulic Mortar.
  - c. **Note:** Team reports may include additional testing information such as flexural strength. If the teams decided to do flexural testing, use the standard four point bending test with an 18 in. long prism with 3 in by 3 in cross-section.
3. Explanation of the mixture design used. Note: teams may use a proprietary mixture or develop their own mix. Mixture fiber content is limited to 3% by volume. No additional reinforcement will be allowed.

Teams are advised that the following companies have indicated a willingness to supply materials to competing teams on request:

- Bekaert Fibers - Jimm Milligan, [jimm.milligan@bekaert.com](mailto:jimm.milligan@bekaert.com)
  - Burgess Metakaolin - Tony Prisland, [tony.prisland@burgesspigment.com](mailto:tony.prisland@burgesspigment.com)
  - Elkem Silica Fume - Tony Kojundic, [tony.kojundic@elkem.com](mailto:tony.kojundic@elkem.com)
  - Headwaters Resources - Craig Wallace, [cwallace@headwaters.com](mailto:cwallace@headwaters.com)
  - Huber Carbonates - Lane Shaw, [lane.shaw@huber.com](mailto:lane.shaw@huber.com)
  - Imerys Carbonates - Rick Erman, [Rick.Erman@imerys.com](mailto:Rick.Erman@imerys.com)
  - ITW Engineered Polymers - Ben Warren, [baw@itwep.com](mailto:baw@itwep.com)
  - Lafarge Ductal® - Gaston Doiron, [gaston.doiron@lafargeholcim.com](mailto:gaston.doiron@lafargeholcim.com)
  - Lehigh White Cement - Larry Rowland, [lrowland@lehighcement.com](mailto:lrowland@lehighcement.com)
  - The Steelike™ Concrete System - Bill Kulish, [Bill@steelikeconcretemix.com](mailto:Bill@steelikeconcretemix.com)
  - Technical Silica Company - Jon Gavant, [Jonathan@technicalco.com](mailto:Jonathan@technicalco.com)
4. Predicted performance based on calculations or historical data.
  5. Additional information that the team deems important to include in the report.



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### On-site Physical and Aesthetic Testing:

Teams invited to attend and compete at the Symposium must bring two types of specimens to the competition for on-site testing:

1. Three 2 in. x 2 in. cubes for compressive strength testing.
2. The structural element intended for flexural strength testing.
  - a. This can be a beam or arch, three sided or hollow, or any other shape as long as it will fit in the testing equipment:
    - i. the element must fit cleanly within an 8 in. by 8 in. by 39.5 in. (200 mm by 200 mm by 1000 mm) long box, where the length is not less than 37.5 in. (950 mm).
    - ii. the maximum weight of the specimen is 44-pounds (20 kg)
  - b. Samples will be judged according to the ratio of sample weight to maximum applied load ratio. The specimen will simply supported with an assumed span length of 36 in. (915 mm) and load will be applied at mid-span.
  - c. Judging will also be based on displacement:
    - i. Due to its nature, UHPC will take a load and then will give a bit. After it gives it will increase up to its ultimate strength then yield.
    - ii. The beam structure will be loaded at an approximate rate of 0.1-in./minute (2.5 mm/minute) at the midspan of the specimen until reaching ultimate load, then continuing until failure or until the total load has decreased by 25%.

Teams will be judged on both appearance and performance. High marks will be given for graceful and efficient UHPC elements. The flexural strength component will be based on a ratio of weight-to-strength. Scoring is given below.

### Poster:

Teams shall provide a poster to present their project to Competition Judges and Symposium attendees. The poster shall be no greater than (48 in. x72 in.).

### Scoring:

A breakdown of the scoring is as follows:

1. Written Report – 75 points



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### 2. Compressive Strength – 25 points

Points will be assigned as a ratio of the following benchmarks:

Samples achieving 22 ksi (150 MPa) will receive a minimum of 20 points.

Samples achieving 26 ksi (175 MPa) will receive a minimum of 25 points.

Samples not reaching 22 ksi (150 MPa) will lose 1 point for every 0.15 ksi (1MPa) below 22 ksi (150 MPa).

### 3. Flexural Strength – 75 points

Samples will be judged according to the ratio of ultimate (maximum) load sustained to specimen weight. The team with the highest ratio of strength to weight will score 50 points. Teams will score 5 points less in descending order of rank.

### 4. Deflection – 50 points

The samples will be judged based on the maximum deflection at the mid-span, of the specimen corresponding to the load drop of 25% of peak load. The team with the highest deflection will score 50 points. Teams will score 5 points less in descending order of rank.

### 5. Aesthetics – 50 points

### 6. Poster – 50 points

### 7. Additional Discretionary Category – 10 points

#### Prizes:

1. \$500 – first place team + certificate
2. \$250 – second place team + certificate
3. \$100 – third place team + certificate
4. Participation certificates for other competitors
5. Prize of \$250 for best report, \$250 for best poster

#### Questions:

Any questions regarding the competition should be directed to [uhpc2016@iastate.edu](mailto:uhpc2016@iastate.edu).



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### Appendix A – UHPC Compression Testing Procedure

#### Compressive Strength

1. Determine the compressive strength of cylindrical specimens made from UHPC in accordance with Test Method ASTM C39/C39M, with the exceptions described in this section.
2. Determine the compressive strength of cube specimens made from UHPC in accordance with Test Method ASTM C109/C109M, with the exceptions described in this section.
3. Only 75 mm diameter x 150 mm long cylindrical or 50 mm x 50 mm x 50 mm cube specimens shall be used for compressive strength testing of UHPC.
4. Prior to testing, all cylinders shall be end ground such that neither end of test specimens shall depart from perpendicularity to the axis by more than 0.5° (approximately equivalent to 1 mm in 100 mm). The ends of compression test specimens (cylinders or cubes) that are not plane within 0.050 mm shall be ground to meet that tolerance.
5. The diameter used for calculating the cross-sectional area of the cylindrical test specimen shall be determined to the nearest 0.1 mm by averaging two diameters measured at right angles to each other at about mid-height of the specimen.
6. The dimensions used for calculating the cross-sectional area of the cube test specimen shall be determined to the nearest 0.1 mm by averaging 6 measurements, 3 at right angles to each other (at each edge and center of the cube) at about mid-height of the specimen.
7. *Rate of Loading*—the load shall be applied at a rate of movement (platen to crosshead measurement) corresponding to a stress rate on the specimen of 1.0 +/- 0.05 MPa/s (Note 6). The designated rate of movement shall be maintained at least during the latter half of the anticipated loading phase.

NOTE 6— Conventional load rates as specified in Test Method ASTM C39/C39M would require approximately 15 – 20 minutes to complete a test.