UHPC Student Competition

Website for Conference: www.uhpcsymposium.com

Student Competition Committee: The UHPC student competition committee is represented by academics and industry personnel who have interest in advanced cementitious materials and education.

- Dr. Sriram Aaleti, Co-Chair, The University of Alabama, Tuscaloosa
- Dr. Mohammed Alnaggar, Co-Chair, Rensselaer Polytechnic Institute
- Dr. Kacie D’Alessandro, Washington and Lee University
- Dr. Rafic El Helou, NRC Associate at FHWA
- Mr. Bill Kulish, Steelike Concrete®
- Dr. Marta Miletic, Auburn University
- Mr. Jimm Milligan, Bekaert®
- Mr. Matthew Offenberg, Owens Corning®
- Dr. Pinar Okumus, The State University of New York at Buffalo
- Dr. George Quercia, TAKTL®
- Dr. Ravi Ranade, The State University of New York at Buffalo
- Mr. Larry Rowland, Lehigh White Cement®
- Dr. Nathalie Roy, The University of Sherbrook, Canada
- Dr. Hartanto Wibowo, Iowa State University
- Dr. Jun Xia, Xi’an Jiaotong–Liverpool University, China

COMPETITION SYNOPSIS:

As part of the Second 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 is open to students across the world and requires finalists to attend the conference for winner selection. The basic premise of the competition is 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 as per the guidelines described later in the document. For this competition, UHPC is defined as concrete with fibers and a minimum compressive strength of 150 MPa (22 ksi) and tensile ductility.

The competition is comprised of two phases. Phase-I consists of a written report based on design/proposal regarding the competition, which is done at the competing team’s educational organization. The written report will be judged on content and presentation of design and analysis details. Based on the result of Phase-I report judging, up to 10 teams will be invited to participate...
in Phase-II of the competition, which includes onsite testing at the Symposium. Limited funding may be made available for student teams to offset some of the travel/conference costs, depending on availability of financial resources. The teams will be notified about funding availability (if any) closer to the Phase-II competition.

STUDENT TEAMS

A Student team can consist of up to a maximum of 4 students. All the members of a team must be enrolled in an undergraduate or graduate program at a University/college. Only one entry per team is permitted. A student representative from each team must be present at the onsite competition in order to compete. There will be a maximum limit of two teams per educational organization.

Each team must have a faculty advisor. A single advisor may work with multiple teams. The advisor provides advice and assistance to the student teams.

HOW TO ENTER

All teams are required to establish their participation in the student competition by either filling an online application form on the UHPC symposium student competition webpage (https://register.extension.iastate.edu/uhpc2019/student-competition/overview) OR by sending an email to uhpcsc@iastate.edu. The email must identify at least two members (if not all members) of the student team, faculty advisor and provide a permanent email and mailing address for contacting the team member. We encourage the teams to submit application indicating their interest in participation by January 31st, 2019.

TIMELINE

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notice to Universities and Students</td>
<td>June 15th, 2018</td>
</tr>
<tr>
<td>Phase-I</td>
<td></td>
</tr>
<tr>
<td>Universities Develop Projects</td>
<td>Fall 2018</td>
</tr>
<tr>
<td>RSVP (Application) date</td>
<td>January 31st, 2019</td>
</tr>
<tr>
<td>Submission of Written Report</td>
<td>March 15th, 2019</td>
</tr>
<tr>
<td>Judging Complete</td>
<td>April 12th, 2019</td>
</tr>
<tr>
<td>Notice to Finalists</td>
<td>April 15th, 2019</td>
</tr>
<tr>
<td>Phase-II</td>
<td></td>
</tr>
<tr>
<td>Attendance at Conference</td>
<td>June 2-5, 2019</td>
</tr>
<tr>
<td>Student On-Site Competition</td>
<td>June 4th, 2019</td>
</tr>
</tbody>
</table>

STUDENT RESOURCES

Teams are advised that the following companies have currently expressed willingness to donate limited supply of UHPC constitutive materials and premixes to competing teams on request. The student teams may have to pay for shipping cost of the materials. Please note that this list is not an exhaustive list of suppliers and student teams are not in any way required to use materials from
these suppliers. We will be adding more resources on the webpage, as we get interest from other material suppliers.

- Bekaert Fibers - Jimm Milligan; jimm.milligan@bekaert.com
- Owen Corning – Matthew Offenberg; Matthew.Offenberg@owenscorning.com
- Lehigh White Cement - Larry Rowland; lrowland@lehighcement.com
- The Steelike™ Concrete - Bill Kulish; Bill@steelike.com
- Lafarge Ductal® - Gregory Nault, gregory.nault@lafargeholcim.com
- TakTL - George Quercia, george.quercia@taktl-llc.com
- COR-TUF UHPC, Division of ICCS, LL; Doug@cor-tuf.com; Douglassedarling@gmail.com
- Eiffage BSI®, Christian Clergue, Christian.CLERGUE@eiffage.com
- Dura Concrete Canada Incorporated, Philip Loh, philip@facca.com
- Boral, Fly Ash – Craig Wallace, cwallace@boral.com
- Elkem Silicon Materials, Undensified Silica Fume – Tony Kojundic, tony.kojundic@elkem.com
- Huber Carbonates, Ground Limestone – Bobby Bergman – bobby.bergman@huber.com
- Imerys Carbonates, Ground Limestone – Anna Landreville – anna.landreville@imerys.com
- Optipozz Metakaolin – Tony Prisland, tony.prisland@burgesspigment.com
- Technical Silica Company, Undensified Silica Fume – Jon Gavant, Jonathan@technicalco.com

THE UHPC ELEMENT REQUIREMENTS

1. The UHPC element can be a beam or arch, three sided or hollow, or any other shape as long as it will fit cleanly within an 8 in. x 8 in. x 39.5 in. (200 mm x 200 mm x 1000 mm) long box. The minimum length of the element should be 37.5 in. (950 mm).
2. The maximum weight of the specimen is 45 lbs. (20 kg).
3. The UHPC element can be designed with proprietary UHPC mixes or any other UHPC mix developed by the student teams. The UHPC mix should contain at least 1% fiber and at max 4% of fibers by volume. There is no limit on type of fibers used.
4. The UHPC element must be designed as a simply supported span of 36 in. (915 mm) center-to-center of bearing with load applied at the center of the span. The UHPC element will be loaded at an approximate rate of 0.1 in. /minute (2.5 mm/minute) or less at the midspan of the specimen until reaching ultimate load, then continuing until failure or until the total load has decreased by 25%.
5. The UHPC element can consist of tension longitudinal mild steel reinforcement, meeting ASTM A615 or A706 requirements. The maximum area of mild steel reinforcement allowed is 0.35 in². Reinforcement must be completely embedded in the beam and should have at least 0.5 in. clear cover.
6. The UHPC element shall be designed to withstand (not to fail) a minimum load of 12 k. The failure capacity of the sample should be limited to 16 k. See judging criteria for more details.
7. Bearing pads and/or bearing plates, not exceeding 1.5 in. in width (along the span), may be used at supports and/or under the load.
8. The failure capacity of the sample is defined as the maximum load measured during testing.
9. Teams will be judged on both appearance and performance. High marks will be given for graceful and efficient UHPC elements.
STUDENT DELIVERABLES

As part of the competition, In Phase-I of the competition, the student teams must first submit a written report that will be reviewed and judged. Based on the results of Phase-I, not more than 10 teams will be invited to compete at the on-site competition during the UHPC Symposium in Albany, NY on June 4th, 2019. The teams invited for the onsite competition will be required to present a poster at the conference, which will also be evaluated and included in deciding the winner of the competition.

PHASE I – WRITTEN REPORT:

The written report should be a single file in PDF file format and must be submitted via E-mail to uhpcsc@iastate.edu by the deadline (March 15th, 2019). The report should be limited to a maximum of 12 pages. The report should have at least an inch margins in all directions, must use font size of 11 points or larger. A minimum of one line spacing should be used. The written report must contain all of the following elements:

1. A cover page with the name of the school, the team members, the faculty advisor. If a school submits more than one entry, the teams shall be numbered. The cover page is not counted towards the report page limit.

2. A description of the shape of the final element produced and summary of the decision process, design calculations used to establish the final geometry of the element. Drawings of the cross section(s) and elevation of the beam, showing the reinforcement are strongly recommended.

3. A narrative about the UHPC mixture design, including proportions, measured flow and 28-day compressive strengths. The student teams are allowed to use proprietary UHPC mix or can develop their own mix. For this competition, UHPC is defined to have a minimum compressive strength of 150 MPa (22,000 psi) and contains fibers. Physical testing results including:
   a. Compressive strength results of the average of three (3) 3 in. x 6 in. (75 mm x 150 mm) or 2 in. x 2 in. cubes or 2 in. X 4 in. cylinders using testing procedure described in ASTM C1856/C1856M – 17.
   c. Tensile testing results for mild-steel reinforcement (if used), such as yield strength, elastic modulus, tensile strength etc.
   d. Team reports may include additional testing information such as flexural strength. If a team decides to conduct flexural testing, use the standard four point bending test with an 18 in. (450 mm) long prism with a 3 in. by 3 in. (75 mm by 75 mm) cross-section.

4. Predicted performance of the UHPC element based on calculations or historical data. This should include calculated/expected cracking load, peak load and corresponding deflections under the load point. The teams are encouraged to include a brief narrative/calculations about how they arrived at their predicted values. Any additional information that the team deems important can be included in the report.

5. Student teams are encouraged to provide brief narrative about sustainability measures of their UHPC mix (if any) and/or element design (if any) in the report. This will be evaluated separately from the main competition.
PHASE II - ONSITE TESTING:

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

1. Three 2 in. (50 mm) cubes for compressive strength testing.
2. The structural element intended for flexural strength testing.

All the student teams invited to the onsite competition shall bring a poster to present their project to competition judges and symposium attendees. The poster shall be no greater than 48 in. x 72 in. (1220 mm x 1830 mm). Also, the student teams should submit a short video (duration less than 10 min.) showcasing team’s preparation for various aspects of competition.

JUDGING CRITERIA

Each entry will be judged in relationship to all other entries. The entries will be judged in the following categories and breakdown of the scoring is as follows:

1. Phase-I Written Report (75 points)
2. Compressive Strength (25 points): The 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 2.5 points for every 0.15 ksi (1 MPa) below 22 ksi (150 MPa)
3. Design Accuracy (75 points): All entries should hold at least 12 kips and should not hold more than 16 kips. All the entries that meet this criteria will receive 25 points. The remaining 50 points, the team with the highest rank will score 50 points. Teams will score 5 points less in descending order of rank.
   - The entries that do NOT support 12 kip, will be subjected to 5 points penalty for each kip or part of the kip less than 12
   - The entries that hold more than 16 kips will lose 2 points for every kip or part of the kip more than 16.
4. Lowest Weight and Reinforcement Ratio (50 points): All the entries will be judged and ranked based on following two factors.
   a. Ratio of ultimate (maximum) load sustained to specimen weight
   b. Ratio of Maximum load to combined reinforcement ratio. The reinforcement ratio is defined as ratio of volume of the fibers plus mild-steel reinforcement and volume of the concrete

The team with the highest rank will score 50 points. Teams will score 5 points less in descending order of rank.
5. Measured Deflection (50 points): All the entries will be judged based on the measured deflection corresponding to 12 kips and maximum deflection obtained 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. In case of the tie, the teams with lower deflection at 12 kips will be given higher rank. Teams will score 5 points less in descending order of rank.

6. Prediction Accuracy (25 points): All the entries will be judged based on the accuracy of their predictions for peak load and deflections reported in Phase-I. Teams will score 2.5 points less in descending order of rank.

7. Aesthetics (50 points).
8. Poster (50 points)
9. Video (30 points)

PRIZES
Sponsors make prizes possible. Prizes will be awarded to the top three teams. The value of the prize awarded is based on the entry's placement in the competition. Prizes are also offered for the best report, best poster and best video.

1. Team placed First will be awarded $600 Check + Winner Trophy + Certificate
2. Team placed Second will be awarded $300 Check + Certificate
3. Team placed Third will be awarded $200 Check + Certificate
4. Team with a sustainable design will be awarded $100 Check + Certificate
5. All teams invited to Phase-II competition will be provided with Certificate of participation.

BEST REPORT
The judges will select a “Best Report” winner for the Phase-I report that best demonstrates student learning, creativity of design, application of sound engineering, and excellence in presentation. The winner will be awarded $150 Check and a Certificate.

BEST POSTER
All the teams invited for the Phase-II of the competition is required to present a poster at the symposium. The posters will be judged by the symposium attendees and the competition committee. The “Best Poster” winner will be awarded $150 Check and a Certificate.

BEST VIDEO
Students are encouraged to submit a short video (duration less than 10 mins) highlighting student experiences, mix designs, beam designs, material testing, and fabrication. A prize will be awarded for the most creative and entertaining video. The winner will be awarded $100 Check and a Certificate.

QUESTIONS
Any questions regarding the competition should be directed to uhpcsc@iastate.edu.