Balsa Dam Competition

Overview
The Balsa Dam competition offers students the chance to challenge their knowledge of structural and hydraulic principles. Students will need to design and construct a dam structure using balsa wood. Judging will be based on structural efficiency, flow rate of the tested model, and quality of the submitted design report.

Objective
The objective of the competition is to design and build a 3-dimensional dam structure conforming to specific criteria as outlined in the Building Envelope section. The model will be tested to determine a specific flow rate of 1 gallon per minute (gpm). Testing will stop after the structure has allowed for all the water in the “reservoir” to flow through the dam or when the structure fails.

In addition to the structural/hydraulic test, teams are required to submit a 750 to 1000 word report outlining the materials, design, analysis, and construction process implemented in building the model. Reports will be assessed and given a score on a scale of 0 to 100 points.

Both the structural/hydraulic test outcome and the final report grade will be determined to form a final score as per the Judging and Scoring section. The highest scores will determine the winners. In the event of a tie, the winner will be determined according to the Judging and Scoring section.

Eligibility
Each team may consist of up to three (3) undergraduate students and, at most, one (1) graduate student or faculty advisor for a maximum total of four (4) members. Each team will have one team captain, who will be designated to submit the design report and the finalized structure. Only one (1) dam design will be allowed per university. Though identical dams may be built, only one (1) can be submitted for judging and testing. All competing dams must meet all design specifications. Failure to meet any of these requirements will result in a point deduction as described in the Judging and Scoring section.
Logistics
An electronic final draft of the report (PDF format) will be due on March 1st, at 11:59:59 p.m. EST. Each team shall submit their dam at the time of registration on Thursday, March 19, 2015 along with a hard copy of the report. Each dam must have the university's name written with a permanent black marker along the length of one or multiple members.

Design reports must be e-mailed to ASCEconference2015@gmail.com, with the university name and “Balsa Dam” in the subject line, no later than the specified date. A hard copy of the report is required in order to receive award any points for the report portion of the competition. Aside from minor cosmetic changes, the building design as presented in the electronic copy of the report must be the same as that presented in the hard copy and in the model submitted for testing.

Materials and Limitations

Balsa Wood
All model members must be made of common balsa wood. A, B, or C grain types can be used for different members in any combination. Dry balsa density should be no greater than 15 lbs/ft³. Specialized or treated balsa wood is NOT allowed. Basswood or other types of wood are NOT allowed.

All members must have a nominal cross section no larger than 0.5 x 0.5 in ± 0.025 in. The length of any member must meet the required lengths as shown in the Building Envelope section.

Glue
Only one type of glue per structure will be allowed. Dam members must be bonded using one (1) glue from the following list of products:

1. Elmer's® White or Wood Glue
2. Titebond® Original, I, II, or III Wood Glues
3. Weldbond® Glue
4. Gorilla® Original or Wood Glue.

Note: Slight variations on these products such as Elmer's Wood Glue Max or Elmer's Wood Craft Glue are allowed.
Building Envelope
The dam MUST fit in its entirety between the two brackets of the testing apparatus, as described below.

The dam will sit between two brackets that are 8 inches apart, as shown in Appendix A, Figures 1 and 2. Each side of the dam will fit into a 1” by 2” bracket. The sides of the dam that sit in the brackets must be 1” by 2” to get an accurate flow rate.

The bottom of the dam must also be 1” by 2” so that it will slide into the bracket and to get an accurate flow rate.

As the building envelope suggests, the dam must be 12” long to ensure accurate flow rates. There is no maximum height of the dam. As illustrated in Figure 2, the openings for the dam must be between the 2” line and the 7” line. There will be no openings below the 2” line, as that is the space that the dam will sit in the bottom brackets. There will be no openings above the 7” line.

Design Limitations
Aside from the building envelope, the structure must NOT provide any supporting members to keep the dam upright, as the provided brackets will provide the support needed to keep the dam upright.

Testing Procedure
The order in which the balsa dams will be tested shall be determined by the judges. Teams will be notified in advance of the testing order.

At a minimum, the team captain must be present on testing day. The team captain will be solely responsible for placing the structure into the loading position on the supporting base. The rest of the loading procedure will be carried out by the judges. Once the dam is set into place, no more adjustments are allowed in positioning the dam in the loading frame. Each dam will be tested for flow rate. Any overflow that occurs will result in a deduction of points.

Percent error will be based on the desired flow rate for the competition and each team’s actual flow rate.
The testing frame may be outfitted by the event organizers with brackets to hold the dams in place and apparatuses to test the flow rate. The dams will be placed in the testing apparatus and a specific amount of water will be placed in a reservoir behind the dams. The amount of water placed behind the dam will range from a minimum of one (1) gallon to a maximum of five (5) gallons. Each team’s dam will be tested using the same amount of water. A timer will start when the water in the reservoir starts to flow through the dam and stop when all the water has been removed from the reservoir. The time it takes for all the water to flow through the dam along with the amount of water specified to flow through the dam will be used to calculate flow rate. Teams will be notified of the final testing setup at least (1) month before the competition.

If there are any discrepancies on the team’s actual flow rate, the panel of judges will agree on a final verdict. All rulings are final. It will be the judges’ duty and responsibility to judge the teams fairly and consistently.

**Design Report Guidelines**

The design paper must contain 750 to 1000 words and must include the following:

1. Introduction
   a. Name of university
   b. Names of individual team members and academic status (Fr., So., Jr., Sr., Dr.)
   c. Captain name and contact information: email address and phone number

2. Material Description
   a. All items purchased that were used in the construction of the balsa dam must be listed. The location where each of these items was purchased should also be noted. Include items that were used in the construction but not purchased specifically for the competition (previously owned materials, equipment, donation, etc.). Unless the original location of purchase is known, record the location for these items as “N/A.”
   b. Balsa Description
      i. Grain type and grade.
      ii. Sample density calculation (\( \rho = \frac{m}{V} \)) explicitly indicating mass and volume of any given piece of 0.5 x 0.5in (max) wood used in construction.
      Material properties that may be relevant.
iii. A count of all members used in the final dam design.
iv. Estimated linear footage of wood used in the final design.
c. Adhesive Description
   i. Material properties that may be relevant.
   ii. Explanation of adhesive selection.

3. Methodology
   a. Explanation of the design process and the approach used
      i. Describe any other designs that may have been considered.
      ii. State any assumptions that were made during the design.
   b. Explanation of the construction process
   c. Estimated flow rate of the dam that is to be tested:
      i. Explanation as to how this estimate was established (complete guesses are acceptable).
      ii. Describe any testing procedures and results if applicable.

4. Design Description and References:
   a. CAD Drawings
      i. Fully sketched and dimensioned elevation
      ii. Fully sketched and dimensioned plan view
   b. Optional
      i. CAD: Details showing connections/typical sections
      ii. No more than four (4) pictures of team members working on the competition indicating a progression of events.
      iii. Pictures of completed dam (no more than two (2) pictures).
      iv. References and specifications (not to be included in the 1000 word limit for the paper).

Judging
Judging will be performed by three (3) judges. Additional judges may be selected to ensure that all judging is fair and consistent throughout the competition. There will be a minimum of three (3) judges for the competition, and at least two (2) judges will preside over the competition at all times.

It will be the judges’ duty and responsibility to judge the teams fairly and consistently.
Scoring
The scoring for the design paper will be based on completeness, organization, detail, adherence to requirements, and accuracy of estimates/numbers/figures. The dam presented in the paper should reflect the design of the exact model being tested. Any changes to the design presented will result in deductions in points for accuracy of the paper. Judges have the right to determine the deductions based on the severity of misrepresentation. The estimated flow rate will not affect the accuracy of the paper. The rubric of the design paper will be as follows:

<table>
<thead>
<tr>
<th>Design Paper Scoring Rubric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
</tr>
<tr>
<td>Material Description</td>
</tr>
<tr>
<td>Methodology</td>
</tr>
<tr>
<td>Design Description</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

The total score will be calculated as follows:

\[(100 - \% \text{ error}) + \text{Design Report Score} - \text{Deductions}.\]

The university with the highest score will win the competition.

In the event of a total score tie, the judges will pick a winner based on aesthetics and overall construction quality.

Deductions and Disqualifications
The following table will be used for accounting for deductions. All deductions are cumulative.

<table>
<thead>
<tr>
<th>Infraction</th>
<th>Deductions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam Violates Height Restriction</td>
<td>DQ</td>
</tr>
<tr>
<td>Member Violates Length Restriction</td>
<td>DQ</td>
</tr>
<tr>
<td>Dam Violates Envelope Restriction</td>
<td>DQ</td>
</tr>
<tr>
<td>Openings occur in illegal zone</td>
<td>50 points / instance</td>
</tr>
<tr>
<td>Any Glue Violations</td>
<td>25 points / instance</td>
</tr>
<tr>
<td>Overflow</td>
<td>0.1 lb = 1 Point</td>
</tr>
</tbody>
</table>
Appendix A

Figure 1

Area 1 is the region of acceptance. Anywhere else cannot have openings.

Figure 2