Bridge Design Competition

Bridge Problem Statement

- A century-old bridge that crosses a river valley in a mountainous region must be replaced.

- The bridge carries heavy truck traffic to and from mines that are the basis for the economy of this rural region, as well as providing access and emergency services to residences.

- A quick replacement is necessary because no other crossing is available for miles.

Bridge Design Competition

Bridge Problem Statement

- The Tennessee State Department of Transportation (TDOT) has requested design/build proposals for replacing the existing bridge.

- Any appropriate type of bridge will be considered, but TDOT has specified wood as the material because of its availability and ease of construction.

- The bridge must carry specified patterns of traffic and wind loads without exceeding deflection limits. In order to expedite environmental approvals, no piers may be used in the river.
Bridge Design Competition

**Bridge Problem Statement**

- The stone abutments of the existing bridge are in good condition and will serve for the new bridge, provided that no lateral thrust or uplift is applied to the abutments.

- TDOT will not permit modifications of the existing abutments.

- The new bridge, when complete, must be supported only by the existing abutments; for example, stays and anchorage to the riverbanks are prohibitive.

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**Bridge Problem Statement**

- Your company's design/build proposal is among those that TDOT has deemed responsive.

- TDOT has asked each competing firm to submit a 1:20 scale model to demonstrate its concepts.

- To facilitate the testing of scaled models, chipboard will be used instead of wood.
Bridge Design Competition

**Bridge Problem Statement**

- TDOT will evaluate the models by multiple criteria including efficiency and economy.
- The contract will be awarded to the company that submits the best model.

**Safety**

- Safety has the highest priority.
- Judges are directed to disqualify bridges that cannot be safety constructed or load tested using the abutments and other equipment provided.
- Collapse or deflection in excess of limits specified in these rules will result in disqualification.
Bridge Design Competition

**Scoring**

- Categories of competition are efficiency and economy.

- The efficiency of a bridge is measured by the sum of the normalized weight and deflection ($SNWD$).

- The $SNWD$ is computed as:

  \[ SNWD = \text{Penalized Weight (lb.)} + 25 \text{ lb./in.} \times \text{Mid-Span Vertical Deflection (in.)} \]

- The unit weight of chipboard is: 0.03 lb./in$^3$

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**Cost**

- The total cost of the model must not exceed $3.50.

- If the cost of the bridge exceeds the upper limit, an additional weight penalty will be imposed as follows:

  \[ \text{Penalized Weight} = \text{Bridge weight (lb.)} + (\text{Cost} - $3.50) \times 10 \text{ lb./$} \]

- The unit cost of chipboard is: $0.05$/in$^3$
Bridge Design Competition

Bridge Construction Rules

1. Bridges must be constructed using standard medium-weight chipboard panels. The cardboard can be cut and glued together to developed any section required by the design team.

Chipboard panels should have a thickness between 0.050 to 0.100 in.

2. Any type of glue is allowable.

3. Members of the bridge may be built-up for multiple layers of cardboard to form any thickness and shape required for the design. Individual cardboard sheets cannot be coated or treated in any way.
Bridge Design Competition

**Bridge Construction Rules**

4. The bridge must be designed to fit on the support. Members must span between the tops of the supports. Members may brace off only the top surfaces of the support. Members may not brace off the sides or the horizontal bottom of the support.

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**Bridge Design Competition**

**Bridge Construction Rules**

4. The beam span is 20 in. (remember to allow additional length to account for the supports). The minimum width of the beam is 2 in. The maximum width of the beam is 4 in.
Bridge Design Competition

Bridge Construction Rules

5. The actual bridge will be composed of multiple beam sections; however, for scale model testing only one beam section is required.

![Bridge Structure Envelope
Bridge Deck Envelope (5 in.)
2 ft.
20 in.
1.5 in.]

Bridge Design Competition

Bridge Construction Rules

5. All bridges must support one load case.

A uniform load of 300 lb. is distributed over the center 6 in. of the bridge.

![300 lb.]
Bridge Design Competition

Bridge Construction Rules

5. All bridges must support one load case.

Deflection will be measured at the mid-span of the bridge.

6. The traffic deck may be no more than 5 in. high and must span the entire length of the bridge.

7. Each team may submit only one bridge.

8. Bridge performance will be measured by a SNWD. The team with the lowest SNWD will be awarded the contract.
Bridge Design Competition

Bridge Report

- A written report is required for each wood bridge submitted for evaluation.
- The content and quality of the report will account for 75% of the project score.
- The remaining 25% of the project grade will be determined by the strength of the bridge based on the sum of normalized total weight and deflection ($SNWD$).

Bridge Design Competition

Bridge Report

There are two strength criteria for bridges:

1. All bridges must a $SNWD$ of not more than 10 (20% all-or-nothing - bridges with a $SNWD < 10$ receive 20 points; bridges with a $SNWD > 10$ receive no points)

2. The bridge with the lowest $SNWD$ is awarded full points (5%) and the remaining bridges will be awarded scores commiserate with their performance (first place will be awarded 5 points, second place 4 points, third place 3 points, etc.).
Bridge Design Competition

Bridge Report

If a bridge does not meet the construction rules, listed below, the submitting student will receive no bridge points.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
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<tbody>
<tr>
<td>October 24, 2019</td>
<td>Rules and instructions</td>
</tr>
<tr>
<td>December 3, 2019</td>
<td>Final report due and bridge testing</td>
</tr>
</tbody>
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Questions?