# DIGITAL STRUCTURES



1. **DESCRIPTION:** Teams will design and test a Bridge using SkyCiv structural analysis software that meets requirements specified in these rules to achieve the highest structural efficiency while withstanding multiple vertical and lateral loads.

   **A TEAM OF UP TO:** 2 **EVENT TIME:** 45 minutes

2. **EVENT PARAMETERS:**
   a. Each participant may bring one stand-alone non-programmable, non-graphing calculator and unmarked scratch paper.
   b. This event will take place on an internet-connected computer with browser access to SkyCiv. Each team will need a SkyCiv license.

3. **CONSTRUCTION PARAMETERS:**
   a. The Bridge must be a single structure constructed by connecting members made of the material available when using the SkyCiv Science Olympiad add-on. The cross-section of individual members must be rectangular with minimum cross-sectional dimensions as specified in SkyCiv of 1.5 mm by 1.5 mm.
   b. The xz-plane ($y = 0$) will be defined as the Testing Base. All nodes of the Bridge must be on the non-negative-y side of the xz-plane prior to load testing. The Bridge must be supported using exactly four supports placed in the plane of the Test Base ($y = 0$); two must be "Horizontal Rollers in X" with x-coordinates $\geq 22.5$ cm and two must be "3D Pin Supports" with x-coordinates $\leq -22.5$ cm, without restrictions on z-coordinates.
   c. The Bridge must be designed to support multiple Area Loads, each in the negative y-direction over a 5.0 cm by 5.0 cm rectangular area.
      i. The number of Area Loads the Bridge must support is two for Regionals, three for State, and four for Nationals.
      ii. One Area Load must have nodes at ($x = \pm 2.5$ cm, $y = 10.0$ cm, $z = \pm 2.5$ cm) for Division B and ($x = \pm 2.5$ cm, $y = 15.0$ cm, $z = \pm 2.5$ cm) for Division C.
      iii. The other Area Load(s) will have nodes at coordinates specified by the Event Supervisor in the range ($-22.5$ cm $\leq x \leq 22.5$ cm, $0 \leq y \leq 10.0$ cm, $z = \pm 2.5$ cm) for Division B and ($-22.5$ cm $\leq x \leq 22.5$ cm, $0 \leq y \leq 15.0$ cm, $z = \pm 2.5$ cm) for Division C. The y-coordinates for all nodes in an Area Load must be the same.
   d. To simulate lateral loading, each of the four nodes of the Area Load in 3.c.ii. must have a Point Load in the positive-z direction with magnitude 5–25 N, the same magnitude for all Point Loads.

4. **THE COMPETITION:**
   a. The Event Supervisor will determine the coordinates, to the closest 0.1 cm, of nodes for the additional Area Load(s) (3.c.iii.) and the magnitude, to the closest 1 N, used for the Point Loads (3.d.). At the beginning of each session, the Event Supervisor will tell teams these parameters. The same parameters will be used for all teams at the tournament.
   b. Before receiving the event parameters from the Event Supervisor, students must turn on Competition Mode in the SkyCiv Science Olympiad add-on.
   c. After being told the parameters in 4.a. and prior to building, participants must submit their Estimated Load Supported to be used as a tiebreaker.
   d. Participants will have 45 minutes to build, test, and submit their Bridge in SkyCiv. Participants may test their Bridge any number of times.
      i. With Competition Mode enabled, the SkyCiv Science Olympiad add-on will not display scores. Participants are encouraged to use the "Solve" function to evaluate and improve their Bridge before submission.
   e. SkyCiv will load all Area Loads evenly and stop loading when failure occurs. Failure is defined as any member of the Bridge buckling or experiencing stress exceeding the parameters of that member.
   f. The maximum Load Supported across all Area Loads is 15,000 g.

5. **SCORING:**
   a. High score wins. Score = Load Score (g)/Mass of Bridge (g).
   b. The Load Score = Load Supported (4.e.) + Bonus.
   c. Bridges that have a Load Supported of 15,000 g will earn a Bonus of 5,000 g.
   d. Bridges will be placed in three tiers as follows:
      i. Tier 1: Holding any load and meeting all construction parameters and competition requirements

ii. Tier 2: Holding any load with any violations of the construction parameters and/or competition requirements
iii. Tier 3: Unable to hold any load and will be ranked by lowest mass

e. Ties are broken as follows:
   i. Estimated Load Supported closest to, without exceeding, the actual Load Supported
   ii. Ranked by lowest Bridge mass
f. Example score calculations:
   i. Device 1: Mass = 10.12 g, Load Supported = 12,134 g; Score = 1,199
   ii. Device 2: Mass = 12.32 g, Load Supported = 15,000 g + Bonus (5,000 g) = 20,000 g;
   iii. Score = 1,623

**Recommended Resources:** The Science Olympiad Store (store.soinc.org) carries a variety of resources to purchase for this event; other resources are on the Event Pages at soinc.org

**This event is sponsored by SkyCiv**