

TOWERS



See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION:** Prior to the competition, teams will design and build a Tower meeting requirements specified in these rules to achieve the highest structural efficiency.
A TEAM OF UP TO: 2 IMPOUND: NO EYE PROTECTION: B MAXIMUM TIME: 6 minutes
2. **EVENT PARAMETERS:**
 - a. Each team is allowed to enter only one Tower, built prior to the competition.
 - b. All competitors must properly wear eye protection at all times. Competitors without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows, otherwise not be allowed to compete and be ranked in Tier 4.
 - c. The Event Supervisor must provide the Test Apparatus (4.).
3. **CONSTRUCTION PARAMETERS:**
 - a. The Tower must span a 20 cm x 20 cm opening on a Test Base (4.a.) and may be placed on the Test Base surface in any configuration such that the loading chain is suspended within 2.5 cm of the center of the opening in the Test Base. **Bonus points (6.b.) can be obtained by designing the Tower to span a 29 cm diameter circle, centered on the 20 cm x 20 cm opening of the Test Base. (No part of the tower may touch or be supported within the 29 cm circle).**
 - b. **The Tower must support the Loading Block (4.b.i.) a minimum of 50.0 cm (Div. B) or 60.0 cm (Div. C) above the Test Base. There is no maximum Tower height.**
 - c. The loading point on the Tower must be constructed to permit placement of the Loading Block (4.b.i.) and suspended chain (4.b.iii) on and through the Tower, to support the bucket (4.c.).
 - d. The Tower must be constructed such that only the Loading Block (4.b.i.) supports the chain and bucket.
 - e. The Tower may not be braced against any edge of the Test Base (4.a.) for lateral support at any time.
 - f. No portion of the Tower is allowed to extend below the top surface of the Test Base (4.a.) prior to testing.
 - g. The Tower must be a single structure, with no separate or detachable pieces.
 - h. The Tower must be constructed of wood and bonded by adhesive. No other materials are permitted.
 - i. **Wood is defined as the hard fibrous substance that makes up the greater part of the stems, branches, trunks, and roots of trees beneath the bark. Wood does NOT include: bark, particleboard, wood composites, bamboo or grasses, paper, commercial plywood, members formed of sawdust and adhesive, or paper labels.**
 - ii. There are no limits on the cross-sectional sizes of individual pieces of wood. Wood may be laminated without restriction by the team.
 - iii. Adhesive is defined as a substance used to join two or more materials together. Any commercially available adhesive may be used. Adhesives include, but are not limited to: glue, cement, cyanoacrylate, epoxy, hot melt, polyurethane and super glues. Adhesive tapes are not allowed.
 - i. Students must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org
4. **TEST APPARATUS:** Supplied by the Event Supervisor
 - a. The Test Base must be a solid, level surface as follows:
 - i. be at least 55 cm long x 32 cm wide.
 - ii. have a smooth, hard, low-friction surface (e.g. hardwood, metal, high-pressure plastic laminate) and be stiff enough that it does not bend noticeably when loaded.
 - iii. have a 20 cm x 20 cm square opening at its center.
 - iv. **have a 29 cm circle drawn on the surface, centered on the 20 cm x 20 cm square opening**
 - b. The Loading Block Assembly must consist of:
 - i. A square Loading Block measuring 5 cm x 5 cm x approximately 2 cm high with a hole no larger than 8 mm drilled in the center of the 5 cm x 5 cm faces for a 1/4" threaded eyebolt.
 - ii. 1/4" threaded eyebolt (1" nominal eye outside diameter), no longer than 3", and a 1/4" wing nut.
 - iii. A chain and S-hook that are suspended from the Loading Block Assembly.
 - c. An approximately five-gallon plastic bucket with handle and hook to be suspended from the chain.
 - d. Sand or other clean, dry free-flowing material (hereafter "sand").
 - e. Bucket Stabilizing Sticks – Two (2) stabilization sticks, each made up of a piece of 1/2" dowel approximately 18 inches long with a spring-type door stop screwed into one end. Refer to example on www.soinc.org
 - f. At the Event Supervisor's discretion, more than one Test Apparatus may be used.
5. **COMPETITION:**
 - a. **Check-In**
 - i. The structure height must be assessed by the Event Supervisor to assure it meets or exceeds the minimum Tower height (3.b.) in cm to the nearest 0.1 cm.



TOWERS (CONT.)

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- ii. Team members must place their structures on the scale for the Event Supervisor to determine the structure mass, in grams to the nearest 0.01 g.
 - iii. **The team must submit their Load Scored estimate for the load supported to be used as a tie breaker (6.e). Load supported includes the Loading Block Assembly, bucket and sand.**
 - iv. No alterations, substitutions, or repairs may be made to the structure after check-in for competition. Once teams enter the event area to compete, they must not leave or receive outside assistance, materials, or communication until they are finished competing.
- b. **Testing**
- i. The Event Supervisor must verify that the combined mass of the Loading Block Assembly, bucket and sand, is at least 15,100 g but no more than 15,200 g prior to testing.
 - ii. Team members will have a maximum of 6 minutes to setup their Tower and test it to maximum load, failure, or run out of time.
 - iii. Team members must place the Tower on the Test Base and assemble the Loading Block Assembly and bucket as required to load the Tower. Team members may disassemble the Loading Block Assembly if necessary. The bucket must be mounted to allow enough clearance above the floor for the bucket to tilt or the Tower to deflect.
 - iv. Team members must be allowed to adjust the Tower until they start loading sand. Once loading of sand has begun, the Tower must not be further adjusted.
 - v. **The Event Supervisor must verify that no part of the Tower's span touches or is within the 29.0 cm diameter circle for the Tower to qualify for the "Load Scored Bonus".**
 - vi. Team members must load the sand into the bucket and be allowed to safely and effectively stabilize the bucket from movement caused by sand loading. Direct contact with the bucket by team members is NOT allowed. Teams choosing to stabilize the bucket must use the bucket stabilization sticks (4.e.). Only the tips of the springs may touch the bucket.
 - vii. Loading must stop immediately when a failure occurs or when time expires. The Event Supervisor must remove any parts of the structure that have fallen into the bucket and remove any sand added after failure or time expiration.
 - viii. Towers that fail before supporting 15,000 g must be scored according to the actual weight supported at time of failure (6.a.), measured to the nearest gram or best precision available. Failure is defined as the inability of the Tower to carry any additional load, or if any part of the load is supported by anything other than the Tower. Incidental contact between the chain/eyebolt and the structure is not failure.
 - ix. Teams who wish to file an appeal must leave their Tower with the Event Supervisor.
 - x. **The Event Supervisor must verify with the team the correct recording of data on the team scoresheet.**
6. **SCORING:**
- a. The Load Scored is the measured load supported, including the Loading Block Assembly, bucket and sand, but may not exceed 15,000 g. The least possible Load Scored must be the mass of the Loading Block Assembly. Towers that cannot support the Loading Block Assembly must be ranked in Tier 4.
 - b. **Load Scored Bonus: Towers spanning the 29 cm diameter circle receive a 2,000 gram bonus.**
 - c. $\text{Score} = [\text{Load Scored (g)} + \text{Load Scored Bonus (g)}] / \text{Mass of Tower (g)}$
 - d. Towers must be scored in four tiers as follows:
 - i. Tier 1: meeting all the Construction Parameters and no Competition Violations.
 - ii. Tier 2: with one or more Competition Violations.
 - iii. Tier 3: with Construction Violations or both Competition and Construction Violations.
 - iv. Tier 4: unable to be loaded for any reason (e.g., cannot accommodate Loading Block, or failure to wear eye protection), and must be ranked by: 1. Lowest mass; 2. Tallest height.
 - e. Ties are broken by this sequence: **1. Load Scored estimate (5.a.iii) closest to actual Load Scored (6.a) without going over Load Scored, 2. Lowest Tower mass**
 - f. Example score calculations:
 - i. Tower 1: mass = 15.12 g, load supported = 12,134 g, Bonus = NO; Score = 802.5
 - ii. Tower 2: mass = 15.12 g, load supported = 12,134 g, Bonus = YES; Score = 934.8
 - iii. Tower 3: mass = 12.32 g, load supported = 13,213 g; Bonus = NO; Score = 1072.5
 - iv. Tower 4: mass = 12.32 g, load supported = 13,213 g; Bonus = YES; Score = 1234.8

Recommended Resources: Reference and training resources including the Tower DVD (TWRD) are available on the Official Science Olympiad Store or Website at www.soinc.org

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