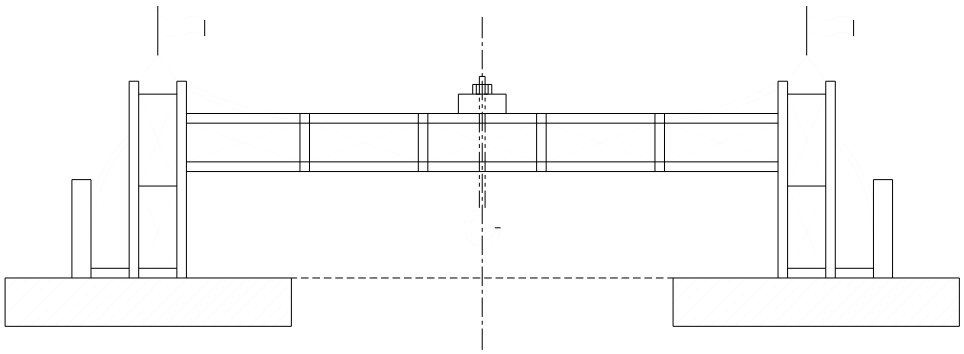
Elevated Bridge Event Commentary, September 13, 2008



This Commentary is intended to describe the intent of the event and the conduct of the competition. This is not an extension of the Rules. The official Rules govern if there are any discrepancies.

Elevated Bridge is a variant of the Bridge Building event. A real world model for the event would be a bridge over a road, river, railway, valley, or other viaduct requiring clear passage beneath, unencumbered by structural ties. Unlike most such bridges, the *Test Base* does not provide resistance to lateral thrust as in a bridge foundation, so the bridge itself must provide the rigidity. Another real world model would be a moveable hoist gantry such as may be found in industry and repair shops, in which a rigid frame with a hoist is positioned over some object to be lifted.

The previous rules for Bridge Building emphasized a truss side panel design with a top compression chord, straight bottom tension chord, intermediate chords, with all internal forces resolved axially along chord lines, so that the only external reaction from the *Test Base* is the vertical reaction at the bearing points. Elevated Bridge is intended to interrupt the bottom tension chord by requiring the bridge to span up and over a given minimum clearance space, while not permitting the *Test Base* to resist a side load. Thus, the bridge must either be designed as a rigid frame resisting internal bending moments at joints, or as a truss resisting the tensile load at the bottom chords somewhat indirectly. Elevated Bridge may be as simple as an old-style bridge with a box frame glued under each end to lift the horizontal portion of the bridge straight up, or it may be a fully triangulated truss, examples of which may be found in any Statics book, or it may be a rigid frame with a mixture of stiffened joints and trussing. There are multiple effective solutions. This should be buildable by all students at some level of proficiency.

In an effort to differentiate between Divisions B and C, the span and clearances have been increased for Division C. The Division B Rules require a 35.0 cm clear span (may not touch the *Test Base* within the 35.0 cm space), and the *Standard Minimum Clearance* required is only 10.0 cm long (in the direction of the span) x 10.0 cm. high. The Division B Rules should produce smaller and simpler structures. For Division C, the span is increased to 45.0 cm and the *Standard Minimum Clearance* is much longer, 25.0 cm, but only 7.5 cm

high. For both Divisions, an arbitrary maximum bridge height of 15.0 cm is imposed. The maximum height was chosen to require the designs to be more "bridge-like", and reduce the possibility of using a tall, "tower-like" design with legs extending directly from the *Loading Block* to the *Test Base*. Both Divisions have a limitation of 5.0 cm for the bearing space outside of the span boundaries. This is to ensure that no single bridge can meet the rules for both Divisions.

There is no impound for the Elevated Bridge event. The competitors will arrive at the competition site with their bridge and present it to the judges for evaluation. Once the bridge is presented, it may not be altered or repaired by the competitors, so they should be certain all the little details (like team ID!) are complete. Judges must check the structure to confirm whether or not it complies with all of the specifications. Any violation will cause the bridge to be ranked in a second tier, below all bridges that meet all Rules. The judges must measure the mass and the maximum height of the bridge for scoring and possible tie breaking. Practice logs created by the students will not be collected or used in any part of the scoring or ranking.

The *Test Bases* are defined in the Rules so that existing Tower testing bases with span lines drawn across their widths may be used for this event, if available and if they are at least 55.0 cm long. *Test Bases* may also be specifically made for the event. The surface of the *Test Base* is to be smooth and free of ridges, rough areas, or pits in the *Bearing Zones*. At no time may the bridge rest against any edge of the *Test Base* for lateral support; this is described in the Rules as a violation, which will place the bridge in the second tier. (If future revisions of the event permit the *Test Base* to resist the lateral load from spreading of the bridges' bearing points, a ridge attached to the *Test Base* would not interfere with the Tower testing.) The same *Test Base* may be used for Division B and Division C, with the permitted *Bearing Zones* for each clearly marked on the surface.

When the bridge is set on the *Test Base*, the bearing ends of the bridge must be within the appropriate 5.0 cm wide *Bearing Zones* as defined for Division B or C. Per the Rules, the *Bearing Zones* are to be marked on the *Test Base* with lines. Since any line drawn on the *Test Base* will have a finite width, the ES must decide whether the lines are in or out of bounds. The Rules don't specify this; they only give a dimension. If the lines are out, then the ends of the bridge must not touch the lines; there should be "daylight" between the line and the point where the bridge touches the surface. If the lines are in, then the bridge could sit on the line, but must not touch the *Test Base* beyond the line. It will be easier for a judge to see a violation if the lines are out, but it will give the competitors a bit more leeway if the lines are in. In all cases, the *Loading Block* must be approximately centered on the *Test Base.*

The *Clearance Block* is simply a device to facilitate judging, and may be made of almost any solid, stable material. For that matter, the *Clearance Block* could simply be sight lines between panels set on each side of the bridge. The point is that a simple, physical means should be provided by the ES to confirm that the proper clearance exists, with no ambiguity. The clearance space must exist completely through the width of the bridge. The dimensions of the *Clearance Block* are listed as 10.0 cm long in the direction of the span, x

10.0 cm high measured from the surface of the *Test Base* for Division B, or 25.0 cm long x 7.5 cm. high for Division C. The Rules state that the *Clearance Block* may be any width (thickness) and shall be provided by the ES. If the *Clearance Block* is cut or milled out of a thin, flat material such as plywood, particle board, Lexan, metal plate, etc., the block must be stood on edge and slid through the bridge from side to side on a flat surface to confirm the clearance space. The bridge will then be placed on the *Test Base* for loading. If the *Clearance Block* is wide enough to span the opening in the *Test Base,* the block may be placed on the *Test Base* and the clearance confirmed by placing the bridge over it, in a ready-to-test position. The *Clearance Block* must then be removed in order to suspend the bucket. The competitors can do this themselves, and they can lift the bridge to remove the *Clearance Block*, and then re-set the bridge on the *Test Base*. The ES should be satisfied that the clearance still exists after setting up the bridge on the *Test Base* for loading.

The clearance is an initial condition. It is acceptable for a bridge to sag into the clearance space during loading. However, if a bridge sags so much that it contacts the *Test Base* between the lines defining the Clear Span, or if any part of the bridge sags into the opening in the *Test Base*, loading shall stop immediately, the bridge shall be considered to have failed, and the structural efficiency calculated based on the load at that point. It is acceptable for the bearing points of the bridge to slide outward during loading, even if the bridge touches the *Test Base* outside of the *Bearing Zone*; while this is not permitted as an initial condition, it is similar to sagging and not a failure under the Rules.

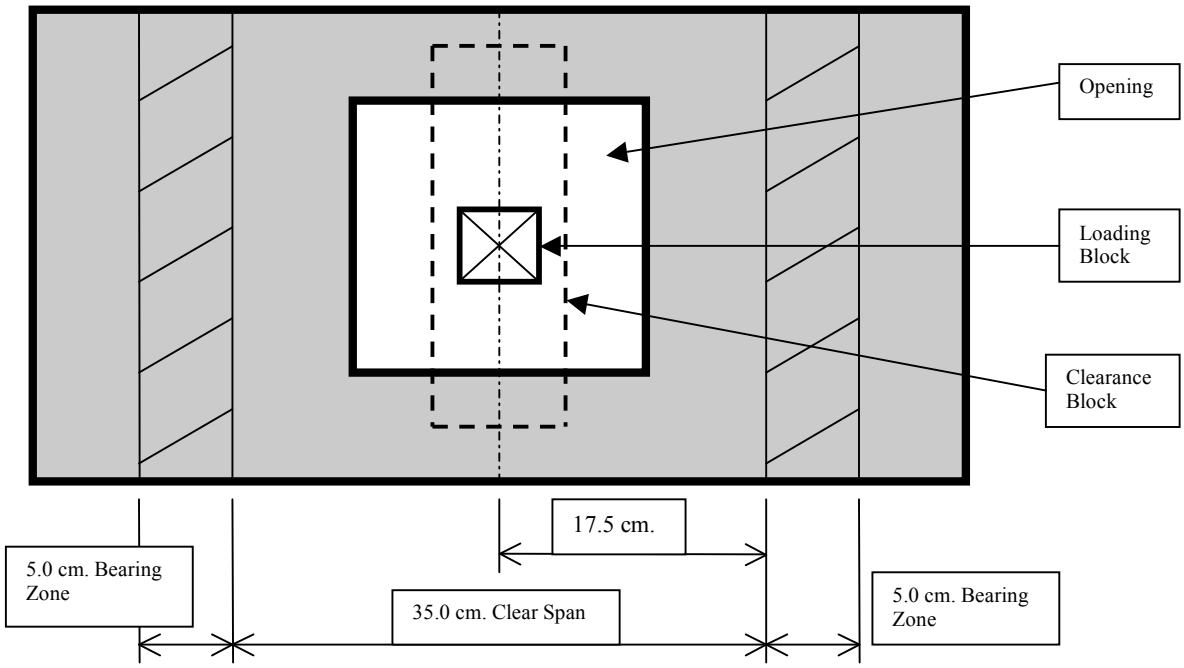
Judges must provide a solid, level, well supported *Test Base*, *Loading Blocks* and suspending hardware, bucket, and clean, dry, free flowing sand. If an alternate material is used it should have similar flow characteristics to dry sand and should be sufficiently fine grained to avoid a hammering effect on the bucket. There must always be at least 15.0 Kg of total load available for loading, preferably a little extra to account for any loss, spillage, or sand remaining in the tester. The Rules don't specify whether the loading of sand in the bucket is done by hand with scoops or by utilizing a gravity or mechanical sand delivery system; the intent is to allow methods which are readily available at all levels of competition. The use of specialized hydraulic testers, load cells, electronically controlled devices or similar equipment is not endorsed in the Rules.

Competitors should be expected to handle their structures at competitions, and judges should handle them as little as possible. Competitors should utilize the *Clearance Block* and then remove it, set up their bridge with the *Loading Block*, hardware, bucket, etc. Competitors may make adjustments to their set up until they begin adding sand; once loading is started, unless there is an error attributable to the judges, they should continue to load without further adjustment. Competitors may stabilize the bucket with their fingertips to prevent swinging or rotating of the bucket, provided they do not support any weight or place themselves at risk of injury. Judges may assist in loading or stabilizing the bucket if a competitor is working alone and requests help. If the bridge breaks, judges may decide whether extra sand was placed in the bucket after failure and remove the extra sand. Normal reaction time and the apparent intent of the competitors should be considered before penalizing them. The total load (bucket, sand, loading block, hardware, etc.) on the bridge should be weighed after testing regardless of whether the bridge breaks. Students

may remove their bridges after testing unless they wish to appeal the decisions of the judges.

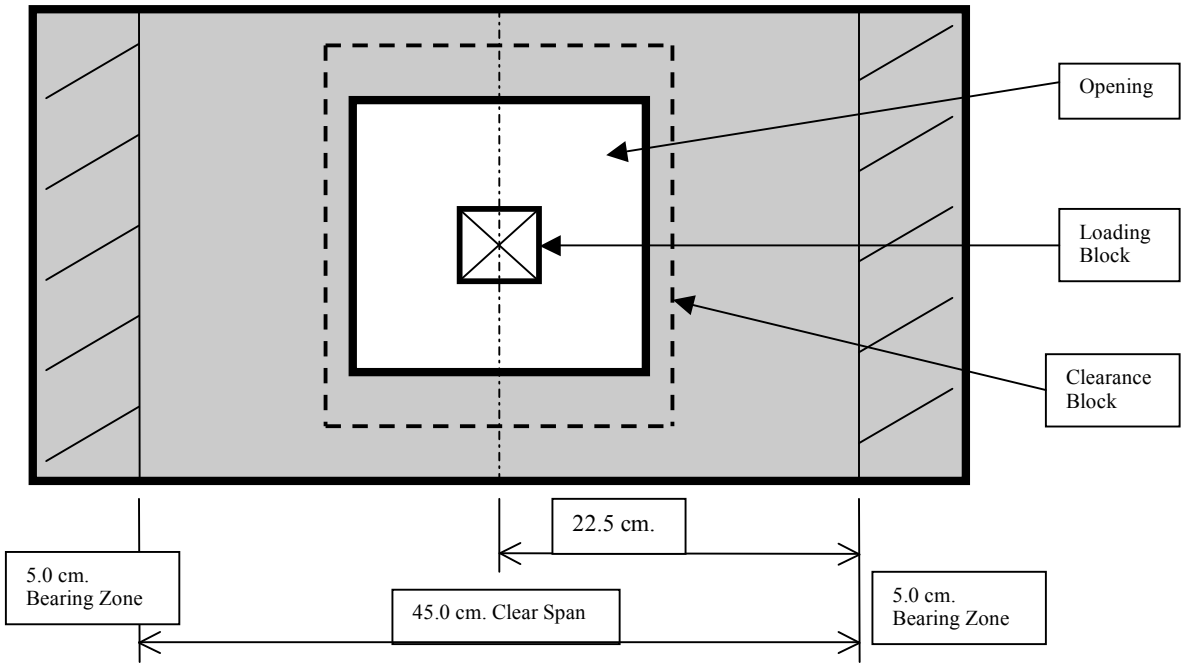
The Rules state that the competitors have 10 minutes for testing. Since there is no impound, weighing of the bridge and judging of the dimensions and materials must occur at time of testing. In most cases, there should be no problem getting everything done in ten minutes, but in fairness to the competitors the ten minutes should not include time used by the judges for measurements. Therefore, if a tournament is scheduled with competition times at ten-minute intervals, some slack time should be available each hour for judges to catch up if a competitor actually uses all ten minutes for set up and testing. After testing, bridges may be taken away by the competitors. Bridges will be kept at the competition site only if there is a dispute over the testing and a pending arbitration. No challenges can be proven or disproven once the bridge has left the competition site, and so no further arbitration will be allowed.

Test Base set-ups would look like this:



Division B

The Division B setup indicates two zones marked on the surface of a *Test Base* where the bridge will be supported. The location of a wide *Clearance Block* is shown in dashed lines, and would be removed before the bucket can be suspended. The location of the *Loading Block* is shown in the center of the opening. The bridge would be set on the *Test Base* spanning from left to right as drawn, set on the 5.0 cm *Bearing Zones*.



Division C

The Division C setup indicates two zones at each end of the *Test Base* on which the bridge will be supported. The location of a wide *Clearance Block* is shown in dashed lines, and would be removed before the bucket can be suspended. The location of the *Loading Block* is shown in the center of the opening. The bridge would be set on the tester spanning from left to right as drawn, set on the 5.0 cm *Bearing Zones*.

The following are sample checklist/scoresheets that could be used at tournaments, or to prepare for competition, or for practice structures. Scoresheets should contain pertinent judging criteria and a place to record the readings from mass balances or scales. On these sample scoresheets, marking "Y" for one or more of the "Violations" will place the bridge in tier 2 and marking "Y" for one or more of the "Loading Problems" will place the bridge in tier 3. Tournament scoresheets should be retained as source data for verification of the summary scoring spreadsheet submitted to the tournament's scoring officials. It is not necessary to record the final Structural Efficiency on the scoresheet unless the scoresheet is to be given to the competitors after the tournament.

2009 Elevated Bridge B

Team Number: B__ Team Name: _____ Rank: _____

Student Names: _____ Final Score: ____

Do not write below this line.

Violations

1. Does not have Clear Span of 35.0 cm	Y	N
2. Bridge touches surface of the Test Base outside of Bearing Zone before loading	Y	N
3. Bridge braces against an edge of the Test Base for lateral support	Y	N
4. Actual Clearance under Bridge < 10.0 cm long x 10.0 cm high	Y	N
5. Bridge is higher than 15.0 cm	Y	N
6. Bridge has separate or detachable pieces	Y	N
7. Bridge constructed of material besides wood and glue	Y	N
8. Use of particleboard, wood products, bamboo, paper, commercially laminated wood, etc.	Y	N
9. Pieces of wood > ¼" x ¼" in cross-section dimension or dowels > ¼" in diameter used	Y	N

Loading Problems

10. Bridge does not support a loading block on or within the bridge structure	Y	N
11. Loading point on the bridge does not permit placement of a chain or threaded eyebolt	Y	N
12. Bridge cannot be loaded	Y	N

Others

13. Participation Points Only (ie. **Safety spectacles with side shields were not worn,** etc.)	Y	N
14. Disqualified (notify the team and their coach as soon as possible)	Y	N

Bridge Measurement

15. Bridge height (in cm)	_____
16. Mass of bridge (in grams)	_____
17. Load supported (in grams)	_____

2009 Elevated Bridge C

Team Number: C__ Team Name: _____ Rank: _____

Student Names: _____ Final Score: ____

Do not write below this line.

Violations

1. Does not have Clear Span of 45.0 cm	Y	N
2. Bridge touches surface of the Test Base outside of Bearing Zone before loading	Y	N
3. Bridge braces against an edge of the Test Base for lateral support	Y	N
4. Actual Clearance under Bridge < 25.0 cm long x 7.5 cm high	Y	N
5. Bridge is higher than 15.0 cm	Y	N
6. Bridge has separate or detachable pieces	Y	N
7. Bridge constructed of material besides wood and glue	Y	N
8. Use of particleboard, wood products, bamboo, paper, commercially laminated wood, etc.	Y	N
9. Pieces of wood > ¼" x ¼" in cross-section dimension or dowels > ¼" in diameter used	Y	N

Loading Problems

10. Bridge does not support a loading block on or within the bridge structure	Y	N
11. Loading point on the bridge does not permit placement of a chain or threaded eyebolt	Y	N
12. Bridge cannot be loaded	Y	N

Others

13. Participation Points Only (ie. **Safety spectacles with side shields were not worn,** etc.)	Y	N
14. Disqualified (notify the team and their coach as soon as possible)	Y	N

Bridge Measurement

15. Bridge height (in cm)	_____
16. Mass of bridge (in grams)	_____
17. Load supported (in grams)	_____

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