

TRAC-Suspension Bridge Competition
Grades 10, 11 & 12
Guidelines 2010-2011

The TRAnspiration and Civil Engineering (TRAC) Program

THE PURPOSE OF TRAC: The TRAC program is a new and inventive way of introducing students to the wide variety of career opportunities available in the field of engineering. The program teaches secondary students how to apply a variety of math and science concepts to common engineering problems occurring in transportation systems. The TRAC program is also designed to allow the students to identify and evaluate the social and environmental impacts associated with the development of new transportation systems within their communities.

PROGRAM DESIGN: TRAC is built around a set of tools and activities called the Transportation Research Activities Center or TRAC PAC 2. The TRAC PACs include electronic components to collect and analyze data, and software programs to graph results and test a series of models. The developed activities are designed to show students how to use the tools listed above to solve real-life problems associated with transportation.

COMPETITION FOR 10th, 11th and 12th GRADES

The Competition

The Suspension bridge competition is designed to be an extended activity created from the TRAC PAC2 Bridge Builder module. This event is designed to allow students the opportunity to develop a suspension bridge that will be tested for mechanics and for strength-to-weight ratio. Student teams will be competing against other TRAC student teams from across the country. Interested teams should fill out the attached application and submit it prior to the deadline of **November 30, 2010**. [Please note there is a maximum limit of 5 competition entries per school.]

TRAC Headquarters will send an information packet and kit to each team to begin their project. Only materials from the kit supplied by TRAC Headquarters can be used in the construction of the bridge. The kit will be shipped by **December 10, 2010** and will include the following:

- ❖ Popsicle Sticks
- ❖ Balsa Wood
- ❖ Wood Glue
- ❖ String (Two different weight/gauge)
- ❖ Power Draft CAD Software by Bentley Systems, Incorporated CD.

You must use the Power Draft Software.

Other materials needed (must provide your own):

- ❖ Calculator
- ❖ School Supplies

After completing the project, each team is required to submit a proposal and five (5) copies to TRAC Headquarters. Do not send the bridge itself. The proposal must be postmarked no later than **February 25, 2011**. Winners will be notified by **March 11, 2011**. All entries become the property of AASHTO TRAC and will not be returned. From those proposals entered, three teams from the 10th, 11th and 12th grade division will be chosen to attend the National TRAC Challenge Competition Finals at the AASHTO Spring meeting in **May 2011** in Las Vegas, NV. At the Finals, teams will present a PowerPoint presentation (no longer than 10 minutes or points will be deducted) and compete against teams from other states to determine the winning suspension bridge.

Who Can Enter:

- ❖ Only schools involved in the TRAC program can enter the competition.
- ❖ Students must be in 10th, 11th and 12th grades.
- ❖ Teams must be composed of three members, no less, no more.

The Problem:

The goal of this competition is to develop a suspension bridge and test the suspension bridge's effectiveness to carry as much weight as possible with concern for safety.

Each team is to design and conduct experiments to test for mechanics of operation and strength-to-weight ratios. The teams are to design and construct a suspension bridge made only with the materials provided in the TRAC Challenge Entry Kit. Each suspension bridge will be tested for mechanics of operation, strength, and design according to the rules. The bridges will be weighed before the competition to calculate Strength-to-Weight Ratio.

Each team is to design and conduct experiments to investigate the effectiveness of the design. Entries will be judged on ease of operation; snugness of fit; expansion and contraction; supports; use of materials; creativity; and originality of design. As a part of the Design Competition, the team is required to develop a report portfolio describing the design, testing, and operation of the suspension bridge.

The Challenge:

Using the following Strength-to-Weight Ratio, each team will develop a suspension bridge. Strength-to-weight ratio is determined by dividing maximum load by weight of bridge.

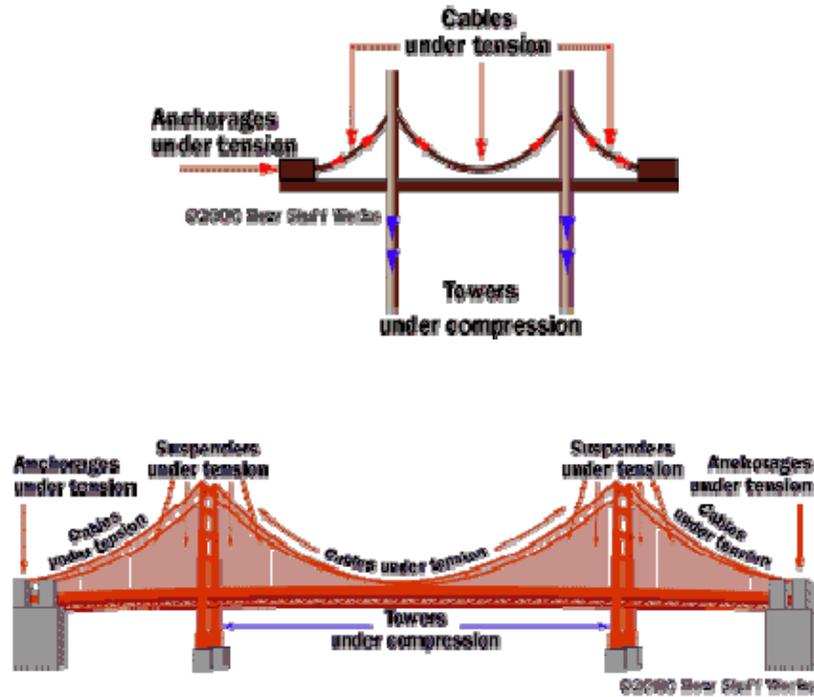
Example: Maximum load = 120.0 pounds
Bridge weight = 20.0 grams
Ratio = 2724.0
[(120 pounds x 454g/pound) / 20 g]

Specifications:

The balsa wood used to construct each suspension bridge must be only *ONE LAYER* thick. At the joints, the balsa wood bridge may need to be more than one layer thick. These joints may not be any more than 1/8" thick.

- ❖ Lamination is not permitted.
- ❖ The materials provided are the **ONLY** materials to be used when building the bridges. The use of additional material is permitted for decorations or visual aids.
- ❖ A car that is 2" w x 1" h must be able to drive across the bridge.
- ❖ Bridge will be tested by strength-to-weight ratio.
- ❖ The bridge must have no more than two (2) anchorages on each end.
- ❖ The bridge can have no more than and no less than two (2) towers.
- ❖ The towers can be up to 8 inches tall as measured from the roadway bed to the top of the tower. The bottom of the towers will sit on the bottom of the Pitsco Bridge tester between the vertical supports of the tester. See the dimensions of the Pitsco di2000 Structure Tester.
- ❖ The main cables strung from one tower to the other tower (the cable that forms the U-Shape in the example picture on page 4) can come no closer than 2 inches from the roadway bed at the lowest point of the each main cable.
- ❖ Total length of the bridge must be 15 inches in length.
- ❖ The bridge must have supports and anchorages suitable for placement on Pitsco di2000 Structure Tester information
- ❖ (<http://catalog.pitsco.com/store/detail.aspx?ID=2557&bhcp=1>).
- ❖ The clear span (i.e. open area with no physical obstructions) between the towers must be a minimum of 10 inches and a maximum of 11.5 inches apart.
- ❖ The center of the bridge must be open to make it possible for the rod of the Pitsco di2000 Structure Tester to fit.

Example for 10th, 11th and 12th Grade Suspension Bridge Competition



The bridge span must be a minimal of 10 inches and a maximum of 15 inches.

The towers can be up to 8 inches tall measured from road bed. You may only have 2 towers.

The towers will fit down into the tester.

Example for Testing Bridges

Thanks to Pitsco and How Stuff works for graphics. The Pitsco "Structure Tester" will be used for the bridge testing. (<http://catalog.pitsco.com/store/detail.aspx?ID=2557&bhcp=1>)



The bridge must be within these dimensions. Testing the bridge cannot be hindered in anyway. Please note that the block must fit onto the bridge without obstructions. The center of the bridge must be open to make it possible for the testing rod to fit. The height of the bridge cannot exceed 12 inches. At the time of the testing if any of these stipulations are not met, the bridge in question will be disqualified.

PREPARING FOR COMPETITION

Form a team of interested students or friends. Discuss the challenges and design specifications. Teams are limited to only three (3) students. Each team must have at least one teacher or other adult to help and advise, though a single adult may be advisor to more than one team.

Study the rules. The individual challenge documents and the grading criteria will give important information, which must be followed if your team is to achieve the best results. Failure to adhere to the rules could lead to penalties, or even disqualification. If any of the information is not clear, please call for additional help.

Plan the timing of the project. Ensure that everyone in the team knows the date for submission of the written report, and recognizes that this means that all major development work should be finished before this date.

Keep records of meetings and working drawings carefully, and give members of the team responsibility for different sections of the final report.

Notes to Adults: TRAC would like to stress that **the work on all phases of the project is to be done by the students.** Adult assistance is to be limited to:

- ❖ Mentoring
- ❖ Basic guidance of the students
- ❖ Teaching engineering, mathematical and scientific principles applicable to the project
- ❖ Guiding students in research
- ❖ Assisting in the production of the report and preparation of the drawings
- ❖ Overseeing the manufacturing stages of the project

Guidance should be in the form of asking questions, (leading questions if necessary) to promote creative thinking by the students to identify the scientific and engineering principles involved.

Encourage students to consult library books and other resources to help with the project.

Encourage students to test and improve their designs. A good way to begin is for each student to design and/or construct a rough prototype. Test it and make improvements.

Scoring:

The information below gives an indication of what the judges are looking for in each section. Students should be aware that to get the maximum number of points, they need to fulfill all the criteria for each section.

I. PROPOSAL

- Criteria:**
- Content and organization.*** (Make sure your report portfolio contains all the sections outlined on page 6.)
 - Style and presentation*** (form, format, mechanics, and visuals);
 - Timeliness*** (Proposals received after the deadline will not be accepted.)

The written proposal should be typed, double-spaced using a size 12 font of either Arial or Times New Roman on 8.5 x 11 paper with all pages numbered, 1” borders all around.

II. DESIGN & CONSTRUCTION

- Criteria:** – *Safety and performance*
– *Creativity of structural design*
– *Quality of construction (use of materials)*
– *Ease of operation*
– *Snugness of fit at the draw supports*
– *Expansion and Contraction*
– *Drainage*
– *Originality*
– *Finish enhancements*

Judges will examine each entry to make sure it fits the specifications given in the rules (read this carefully).

III. ORAL PRESENTATION

Criteria: – *Explanation of Project 10 minutes maximum (Points will be deducted if time exceeds 10 minutes). A rubric has been provided for the presentation as a guide. (See page 9)*

IV. PERFORMANCE

- Criteria:** – *Achievement of performance goals*
– *Stability of construction*

Teams chosen to attend the 2011 TRAC Challenge Finals will present to a panel of judges comprised of chief engineers from each of the 50 states. Each team will be expected to make a PowerPoint presentation and be able to answer questions from the panel of judges about their entry. Supporting materials, such as a display board with photographs of the work in progress, can also be displayed. All CAD drawings used in the PowerPoint presentation must have been created using the Bentley Power draft CAD Software.

Teams chosen to attend the AASHTO Spring meeting will be expected to demonstrate to the panel of judges (and usually an interested audience), that their hard work resulted in an operational project that really works.

PROPOSAL FORMAT

This report should be presented in the following format:

I. Title Page. Include name of challenge, team name, and logo, name of school or organization, names of students, name of teacher or advisor.

II. Table of Contents.

III. Summary (abstract). Clearly and concisely stated. (No more than two pages)

IV. Introduction. Indicate the team name as well as the background of each member, information about the school and community.

V. Body. The main part of the report. This may be divided into several sections (such as Design, Development, etc). In general, this part should:

- a) Explain the reasons behind your design.
- b) Explain why you designed your entry the way you did?
- c) Explain the scientific principles behind your design.
Include Data Tables, Graphic Representation of Tests, and supporting Calculations page.
Include scaled drawings of drawbridge.
- d) Explain how you tested your design, and the improvements this led you to make.
- e) Describe the problems that you encountered in designing and building your product and how you solved these problems.

VI. Conclusions (and Recommendations). How successful is your project? What did you learn by taking part?

VII. Acknowledgments. List the names of the adults who assisted you in the project with a brief description of what they did. Include a certification, signed by all student team members and adults assisting, stating that: “We hereby certify that the majority of the ideas, design, and work was originated and performed by the students, with limited assistance by adults, as described above.”

VIII. Bibliography. List all references used, including Internet, books and magazines.

IX. Appendices — Should be introduced, integrated, and discussed in the body text. They should include:

- a. **Safety.** List the *general* safety procedures that were followed to make sure that no one got hurt. (Any *special* safety procedures that were needed should be described in the body of the report.)
- b. **Team members.** List the team members, with a short description of how each person helped to make the project a success. What special skills were learned or demonstrated?
- c. **Scheduling and Accomplishments.** Show on a time line, or similar method, how you scheduled your project. Include *brief* records of meetings, telling how you managed the schedule.
- d. **Daily Journal.** Progress reports of day-to-day work on the project, including date, performance and comments from each team member.

- e. **Tools and Machines.** List and describe any special tools or machines that were used.
- f. **Working Drawings.** Include working drawings not contained in the design section.
- g. **Judging:** The members of the American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on Highways (SCOH) will do the judging.

Awards:

Teams chosen to attend the AASHTO Spring meeting will compete for savings bonds of:

First Place Team: \$1,500
Second Place Team: \$900
Third Place Team: \$600

Each team that sends in a Proposal will receive a Certificate of Participation from TRAC Headquarters.

SCHEDULE

- Applications due **November 30, 2010**.
- Packets will be sent to teams by the TRAC office by **December 10, 2010**.

Packets will include:

- ❖ Popsicle Sticks
 - ❖ Balsa Wood
 - ❖ Dowel Rods
 - ❖ Wood Glue
 - ❖ String (Two different weight/gauge)
 - ❖ Power Draft CAD Software by Bentley Systems, Incorporated. The software is available for download at Power Draft. All CAD drawings must use this software.
 - ❖ Information packet
- Proposals are due **February 25, 2011** (do not include the drawbridge).
 - Notification of finalists by **March 18, 2011**.
 - Finals will be held at the AASHTO Spring meeting in **Las Vegas, NV in May 2011**.

Contact:

Tequamech Tadesse, TRAC Coordinator
AASHTO
444 North Capitol Street, N.W.
Suite 249
Washington, DC 20001
(202) 624-3624
(202) 624-7788 Fax
ttadesse@ashto.org

**TRAC SUSPENSION BRIDGE COMPETITION
2010-2011
APPLICATION
Grades 10, 11 & 12**

Return to Tequamech Tadesse by November 30, 2010

We have read the challenge documents and the guide to entry, and we want to register.

Name of Adult Advisor:	
Team Name:	
Team Member Names & Grade Levels:	1
	2
	3
School or Group:	
Address:	
Work Phone:	
Home Phone (Optional):	
Cell Phone (Optional):	
Fax Phone:	
Email Address (Required):	
Other:	

If you do not know your team members' names by the due date, submit all other information and submit the team members' names asap. NOTE: Each leader working with different teams at the same school should send a separate registration form for each team. Copy this form as necessary.

Return completed form to: *Tequamech Tadesse
AASHTO/ TRAC Program
444 North Capitol Street, N.W., Suite 249
Washington, D.C. 20001
Fax: (202) 624-7788
Email: ttadesse@ashto.org*

**TRAC SUSPENSION BRIDGE COMPETITION
GUIDELINES 2010-2011**

Oral PowerPoint Presentation: Bridge Competition

Team Name _____

NOTE: This is a rubric for to help for the preparation of the presentation. Oral presentation will count

CATEGORY	4	3	2	1	0
Content	Covers topic in-depth with details and examples. Subject knowledge is excellent.	Includes essential knowledge about the topic. Subject knowledge appears to be good.	Includes essential information about the topic but there are 1-2 factual errors.	Content is minimal OR there are several factual errors.	Did not fulfill assignment requirements.
Mechanics	No misspellings or grammatical errors.	Three or fewer misspellings and/or mechanical errors.	Four misspellings and/or grammatical errors.	More than 4 errors in spelling or grammar.	Did not fulfill assignment requirements.
Organization	Content is well organized using headings or bulleted lists to group related material.	Uses headings or bulleted lists to organize, but the overall organization of topics appears flawed.	Content is logically organized for the most part.	There was no clear or logical organizational structure, just lots of facts.	Did not fulfill assignment requirements.
Oral Presentation	Interesting, well-rehearsed with smooth delivery that holds audience attention.	Relatively interesting, rehearsed with a fairly smooth delivery that usually holds audience attention.	Delivery not smooth, but able to hold audience attention most of the time.	Delivery not smooth and audience attention lost.	Did not fulfill assignment requirements.
Presentation	Well-rehearsed with smooth delivery that holds audience attention.	Rehearsed with fairly smooth delivery that holds audience attention most of the time.	Delivery not smooth, but able to maintain interest of the audience most of the time.	Delivery not smooth and audience attention often lost.	Did not fulfill assignment requirements.
Sources	Source information collected for all graphics, facts and quotes. All documented in desired format.	Source information collected for all graphics, facts and quotes. Most documented in desired format.	Source information collected for graphics, facts and quotes, but not documented in desired format.	Very little or no source information was collected.	Did not fulfill assignment requirements.
Attractiveness	Makes excellent use of font, color, graphics, effects, etc. to enhance the presentation.	Makes good use of font, color, graphics, effects, etc. to enhance presentation.	Makes use of font, color, graphics, effects, etc. but occasionally these detract from the presentation content.	Use of font, color, graphics, effects etc. but these often distract from the presentation content.	Did not fulfill assignment requirements.
Timeliness	10 minutes or less.	10 points OFF for each minute (or additional partial minuets) over	10 points OFF for each minute (or additional partial minuets) over	10 points OFF for each minute (or additional partial minuets) over	10 points OFF for each minute (or additional partial minuets) over

25% of the total team score for the competition. The remaining 75% will be determined by the outcome of the testing.

Proposal Assessment Suspension Bridge Competition

Report Format

- Typed (1 point)
- Double Spaced (1 point)
- 12 Point Font (Arial or Times New Roman) (1 point)
- All pages on 8.5 x 11 paper (1 point)
- Information is in the proper order (1 point)
- All pages are numbered (1 point)
- Style and presentation (3 points)
- Mechanics (3 points)
- Visuals (3 points)

Score ____/ 15 points

Design and Construction

- Achievement of design specifications (15 points)
- Creativity of design (15 points)

Score ____/ 30 points

Report Presentation

- Title page (1 point)
- Table of Contents (1 point)
- Summary (no more than 2 pages) (5 points)
- Introduction (3 points)
- Body
 - o Sections identified (3 points)
 - o Reason behind the design (2 points)
 - o Why that design was chosen (3 points)
 - o Scientific principles of the design (3 points)
 - o Drawings (10 points)
 - o Testing and improvements (5 points)
 - o Problem solving techniques (5 points)
- Conclusion
 - o Recommendations (3 points)
 - o Success of the project (3 points)
 - o What was learned by taking part (3 points)
- Acknowledgements
 - o Adults involved (2 points)
 - o Description of what the adults did (2 points)
 - o Certification and signatures (5 points)
- Bibliography (10 points)
- Appendices
 - o Safety procedures (1 point)
 - o List of team members and their description of duties (3 points)
 - o Specific skills of team members (3 points)
 - o Schedule and Accomplishments on a timeline (5 points)
 - o Records of meetings and management of schedule (5 points)
 - o Daily Journals (progress report of day to day work on the project including dates, performance and comments from each member) (15 points)
 - o Tools and machines used (1 point)
 - o Working drawings (3 points)

Score ____/ 115 Points

TOTAL SCORE: _____/160 Points

PROPOSAL ENTRY FORM
TRAC SUSPENSION BRIDGE COMPETITION 2010-2011
Grades 10, 11 & 12

Return to Tequamech Tadesse by **February 25, 2011**

Enclosed you will find the Report Portfolio for:

Name of Adult Advisor

Team Name

Team Members Name & Grade Levels

School or Group

Address

Work Phone

Home Phone

Cell Phone

Fax Phone

E-mail address

Other

Return completed form to:

*Tequamech Tadesse
AASHTO/ TRAC Program
444 North Capitol Street, N.W., Suite
249
Washington, D.C. 20001
Fax: (202) 624-7788
Email: ttadesse@ashto.org*

FINAL SCORING

Group Name

Presentation Points
(The judges' points)

Strength to weight ratio:

180 pts 1st

120 pts 2nd

60 pts 3rd

Total Points:

TRAC SUSPENSION BRIDGE COMPETITION 2010-2011
Suggestions and Helpful Hints

1. Students should be prepared for questions at the end of the presentation. These questions may be concentrated in the following topics. However, note that the judges are free to ask any question about any topic. Therefore, each team should be prepared.
 - a) Choice of design
 - b) Advantages/disadvantages of drawbridges
 - c) Civil engineering careers related to drawbridges
 - d) Safety
 - e) Impacts of drawbridges
 - f) Lessons Learned
2. Stay organized and keep track of time limits.
3. If you have a question, **ASK** and you can contact Tequamech Tadesse at (202) 624-3624
4. Contact your DOT engineers. They will answer many of your questions.
5. Check out other working drawbridges in your area or around the world.

6. RESEARCH

7. RESEARCH

8. RESEARCH