

TRAC Cable-stayed Bridge Competition Guidelines  
Grades 11 and 12  
2012-2013

**The TRAnsportation 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 designed to be an extended activity created from the Transportation Research Activities Center or TRAC PAC. 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 GRADES 11 and 12**

**The Competition:**

The cable-stayed bridge competition is designed to be an extended activity created from the TRAC PAC Bridge Builder module. This event is designed to allow students the opportunity to develop a cable-stayed bridge that will be tested for strength-to-weight ratio. Student teams from grades 11 and 12 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 1, 2012**. [Please note there is a maximum limit of 5 competition entries per school.] TRAC Headquarters will send a TRAC Challenge Entry Kit to each team to begin their project. Only materials included in the kit supplied by TRAC Headquarters can be used in the construction of the bridge. The kit will be shipped by **December 3, 2012** and will include the following:

- Popsicle Sticks
- Balsa Wood
- Wood Glue
- String
- Power Draft CAD Software by Bentley Systems, Incorporated. A Power Draft CD will be sent to all participating teams; please use this software to complete your CAD drawing.

Other materials needed (must provide your own):

- Calculator
- School Supplies

After completing the project, each team is required to submit five (5) proposal copies to TRAC Headquarters. Do not send the bridge itself. The proposal must be postmarked no later than **February 22, 2013**. Winners will be notified by **March 18, 2013**. All entries become the property of AASHTO TRAC and will not be returned. From those proposals entered, three teams from this grade division will be chosen to attend the National TRAC Challenge Competition Finals at the AASHTO Spring meeting in **May 2013** in **Providence, Rhode Island**. At the Finals, teams will present a 10 minute PowerPoint presentation (points will be deducted for presentations greater than 10 minutes) and structurally test their bridges against teams from other states to determine the winning cable-stayed bridge.

### **Who Can Enter:**

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

### **The Problem:**

The goal of this competition is to develop a cable-stayed bridge that will carry as much weight as possible while weighing as little as possible (strength-to-weight ratio). For testing purposes, the bridge must have two towers and have a stable deck.

Each team is to design and conduct experiments to test for deck stability and strength-to-weight ratios, and then design a cable-stayed bridge resulting from those experiments. The teams are construct a cable-stayed bridge made only with the materials provided in the TRAC Challenge Entry Kit. As a part of the Design Competition, the team is required to develop a report portfolio describing the design, testing, and construction of the cable-stayed bridge.

Entries will be judged on quality of construction, use of materials, and creativity of bridge design. The bridges will be weighed before the competition and strength tested during the competition to calculate strength-to-weight ratio. Each cable-stayed bridge will be checked for design according to the rules.

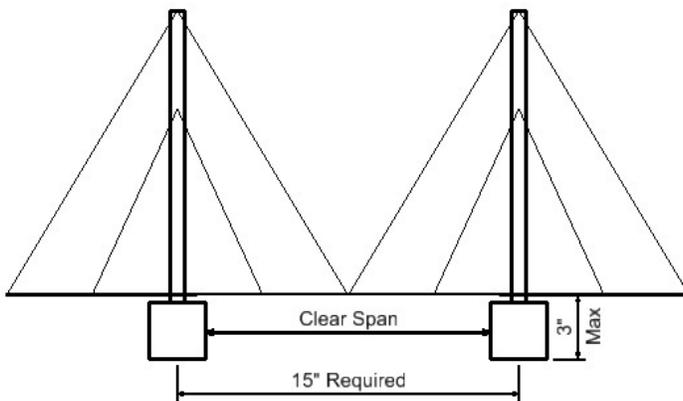
### **The Challenge:**

An engineer's job is to not only design a safe bridge to carry heavy loads, but also to make sure that it is cost effective (use less materials). To simulate this process, teams will use the following strength-to-weight ratio calculation to develop a cable-stayed bridge that has a low weight but holds a heavy load. Strength to weight ratio is determined by dividing the maximum load carried by the weight of bridge.

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

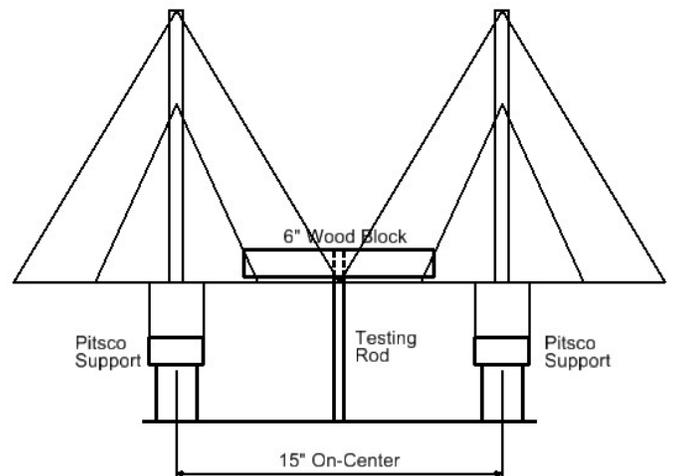
## Specifications:

- The materials provided in the kit are the **ONLY** materials to be used when building the bridge structure; however, additional materials may be used for decorations or visual aids.
- Lamination (gluing two pieces of wood along their longitudinal length to increase strength) is not permitted. Acceptable joints are: butt joints, miter joints, and notched joints.
- The **distance on-center between the towers must be 15 inches**.
- There shall be **no more than 3 inches of clearance** underneath the bridge span; however, the bridge span shall not touch the Pitsco Support.
- **A clear span must be maintained between the towers.** The bridge towers shall not be connected to each other. The tower bases shall not be connected to each other.
- A block of wood that is **2 inches wide by 1 inch high** must be able to be pushed smoothly across the bridge deck.
- **Pitsco supports will be placed at 15 inches on center.** The bridge supports can only make contact with the top of the Pitsco supports. The bridge supports may be longer than the Pitsco supports, but not wider. Pitsco support dimensions are 4.5 inches wide by 1.75 inches long.
- If any other parts of the bridge are in contact the tester, there will be a deduction in score for not following specifications.
- **The bridge deck must allow a 5/8" testing rod to pass through** and attach to a 6" block of wood for strength testing as seen in the picture to the right and the diagram below.



Bridge Dimension Detail

Not representative of required design  
Use only for dimension reference



Tester Detail

## Scoring:

The information below gives an indication of what the judges are looking for in each section.

- I. **BRIDGE PROPOSAL** (See Page 10 for Assessment)  
Students should be aware that to get the maximum number of points (150), they need to fulfill all the criteria for each section.

- A. **Proposal Format:** 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.
- B. **Timeliness:** Proposals received after the deadline will not be accepted.
- C. **Proposal Presentation:** Report portfolio must contain all the sections outlined below:

**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, team members as well as the background of each member.

**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 why you designed your cable-stayed bridge the way you did.
- b) Explain the scientific principles behind your design.
- c) Include Data Tables, Graphic Representation of Tests, and supporting Calculations page.
- d) Describe the challenges you encountered in designing your bridge.
- e) Include scaled drawings of preliminary and final cable-stayed bridge designs.
- f) Explain how you tested your design, and the improvements this led you to make.
- g) Describe the challenges that you encountered in building your cable-stayed bridge and how you solved these problems. Include safety precautions, building methods, etc.

**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.** They should include:

**A. 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 scheduled.

**B. Daily Journal.** Progress reports of day-to-day work on the project, including date, performance and comments from each team member.

## II. BRIDGE COMPETITION FINALS (See pages 11 and 12 for scoring sheets)

Teams chosen to attend the 2013 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. Teams will be expected to demonstrate to the panel of judges that their hard work resulted in an operational project that really works. 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. Judges will examine each entry to make sure it fits the specifications given in the rules. The criteria below outline the competition fundamentals:

### A. BRIDGE DESIGN & CONSTRUCTION:

- Meets competition specifications
- Deck stability
- Creativity of structural design
- Quality of construction
- Originality
- Finish enhancements

B. ORAL PRESENTATION: *Explanation of Project*. 10 minutes maximum (Points will be deducted if time exceeds 10 minutes). A rubric on page 11 has been provided for the presentation as a guide.

C. PERFORMANCE: *Achievement of performance goals and stability of construction*. Bridges will be weighed at the beginning of the competition and tested on Pitsco structural tester. Results will be used to calculate strength-to-weight ratio.

### Awards:

Teams chosen to attend the AASHTO Spring meeting will compete for gift cards 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.

## 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.

## BRIDGE COMPETITION SCHEDULE

- 1) Applications due **November 1, 2012**.
- 2) Packets will be shipped to teams by the TRAC office by **December 3, 2012**. Packets will include:
  - Popsicle Sticks
  - Balsa Wood
  - Wood Glue
  - String
  - Power Draft CAD Software by Bentley Systems, Incorporated. All CAD drawings must use this software.
  - Information packet
- 3) Proposals are due **February 22, 2013** (do not include the cable-stayed bridge).
- 4) Notification of finalists by **March 18, 2013**.
- 5) Finals will be held at the AASHTO Spring Meeting in **Providence, Rhode Island** in **May 2013**.

**APPLICATION  
TRAC CABLE-STAYED COMPETITION 2012-2013  
Grades 11 and 12**

**Return to Tequamech Tadesse by November 1, 2012**

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

Name of Adult Advisor \_\_\_\_\_

Team Name \_\_\_\_\_

Team Members Name & Grade Levels

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

School or Group \_\_\_\_\_

Address \_\_\_\_\_

Work Phone \_\_\_\_\_ Home Phone \_\_\_\_\_

Cell Phone \_\_\_\_\_ Fax Phone \_\_\_\_\_

E-mail address (required) \_\_\_\_\_

NOTE: Each leader working with different teams at the same school should send a separate application form for each team. Copy this form as necessary. If you do not have the team members' names by the due date, just state that on the application and send that information when it is available.

***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*

PROPOSAL ENTRY FORM  
TRAC CABLE-STAYED BRIDGE COMPETITION 2012-2013  
Grades 11 and 12

**Return to Tequamech Tadesse by February 22, 2013**

*Enclosed you will find the Report Portfolio for:*

Name of Adult Advisor \_\_\_\_\_

Team Name \_\_\_\_\_

Team Members Name & Grade Levels

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

School or Group \_\_\_\_\_

Address \_\_\_\_\_

Work Phone \_\_\_\_\_ Home Phone \_\_\_\_\_

Cell Phone \_\_\_\_\_ Fax Phone \_\_\_\_\_

E-mail address (required) \_\_\_\_\_

*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](mailto:ttadesse@ashto.org)*

**PROPOSAL ASSESSMENT**  
**TRAC CABLE-STAYED COMPETITION 2012-2013**  
Grades 11 and 12

Proposal Format

- |   |            |                         |
|---|------------|-------------------------|
| <input type="checkbox"/> Typed                                    | (1 point)  |                         |
| <input type="checkbox"/> Double Spaced                            | (1 point)  |                         |
| <input type="checkbox"/> 12 Point Font (Arial or Times New Roman) | (1 point)  |                         |
| <input type="checkbox"/> All pages on 8.5 x 11 paper              | (1 point)  |                         |
| <input type="checkbox"/> Information is in the proper order       | (1 point)  |                         |
| <input type="checkbox"/> All pages are numbered                   | (1 point)  |                         |
| <input type="checkbox"/> Style and presentation                   | (3 points) |                         |
| <input type="checkbox"/> Mechanics                                | (3 points) |                         |
| <input type="checkbox"/> Visuals                                  | (3 points) | Score _____ / 15 points |

Proposal Presentation

- |   |             |                          |
|---|-------------|--------------------------|
| <input type="checkbox"/> Title page                                     | (1 point)   |                          |
| <input type="checkbox"/> Table of Contents                              | (1 point)   |                          |
| <input type="checkbox"/> Summary (no more than 2 pages)                 | (5 points)  |                          |
| <input type="checkbox"/> Introduction                                   | (3 points)  |                          |
| <input type="checkbox"/> Body   |             |                          |
| <input type="checkbox"/> Sections identified                            | (2 points)  |                          |
| <input type="checkbox"/> Reason behind the design                       | (2 points)  |                          |
| <input type="checkbox"/> Scientific principles of the design            | (3 points)  |                          |
| <input type="checkbox"/> Tables, Graphs, Calculations                   | (10 points) |                          |
| <input type="checkbox"/> Design challenges                              | (5 points)  |                          |
| <input type="checkbox"/> Drawings                                       | (10 points) |                          |
| <input type="checkbox"/> Testing and improvements                       | (5 points)  |                          |
| <input type="checkbox"/> Problem solving techniques                     | (5 points)  |                          |
| <input type="checkbox"/> Conclusion                                     |             |                          |
| <input type="checkbox"/> Recommendations                                | (3 points)  |                          |
| <input type="checkbox"/> Success of the project                         | (3 points)  |                          |
| <input type="checkbox"/> What was learned by taking part                | (3 points)  |                          |
| <input type="checkbox"/> Acknowledgements                               |             |                          |
| <input type="checkbox"/> Adults involved                                | (2 points)  |                          |
| <input type="checkbox"/> Description of what the adults did             | (2 points)  |                          |
| <input type="checkbox"/> Certification and signatures                   | (5 points)  |                          |
| <input type="checkbox"/> Bibliography                                   | (10 points) |                          |
| <input type="checkbox"/> Appendices                                     |             |                          |
| <input type="checkbox"/> Schedule and Accomplishments on a timeline     | (5 points)  |                          |
| <input type="checkbox"/> Records of meetings and management of schedule | (5 points)  |                          |
| <input type="checkbox"/> Daily Journals                                 | (15 points) | Score _____ / 105 Points |

Design and Construction

- |   |             |                         |
|---|-------------|-------------------------|
| <input type="checkbox"/> Achievement of design specifications | (15 points) |                         |
| <input type="checkbox"/> Creativity of design                 | (15 points) | Score _____ / 30 points |

TOTAL SCORE: \_\_\_\_\_ / 150 Points

**GUIDELINES**  
**TRAC CABLE-STAYED COMPETITION 2012 – 2013**  
**Oral PowerPoint Presentation: Bridge Competition**

Team Name \_\_\_\_\_

NOTE: This is a rubric for to help for the preparation of the presentation. Oral presentation has a possible score of 25 points. Each category will be judged on a scale from 1 to 5 points.

CATEGORY	5 ●————●	4 ●————●	3 ●————●	2 ●————●	1 ●————●	Sub-Score
<b>Content</b>	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 requirements	_____/5
<b>Mechanics</b>	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 requirements	_____/5
<b>Organization</b>	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 requirements	_____/5
<b>Presentation</b>	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 requirements	_____/5
<b>Attractiveness</b>	Makes excellent use of font, color, graphics, effects, etc. to enhance the presentation.	Makes good use of font, color, graphics, effects, etc. to enhance to 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 requirements	_____/5
<b>Total Sub-Score</b> _____/25 <b>Over 10 Minutes: (-5 points)</b> _____ <b>TOTAL SCORE</b> _____						

**FINAL SCORING**  
**TRAC CABLE-STAYED COMPETITION 2012-2013**  
Grades 11 and 12

**Group Name**

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**Judges Score: Presentation Points** \_\_\_\_\_ / 25

**Strength to weight ratio:** \_\_\_\_\_ / 75

- **1<sup>st</sup> Place: 75 points**
- **2<sup>nd</sup> Place: 65 points**
- **3<sup>rd</sup> Place: 55 points**

**Deductions for not meeting competition specifications:** \_\_\_\_\_  
(15 points for each specification not followed)

**Total Points:** \_\_\_\_\_ /100

**TRAC CABLE-STAYED BRIDGE COMPETITION 2012 - 2013**  
**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 cable-stayed bridges
  - c) Civil engineering careers related to cable-stayed bridges
  - d) Safety
  - e) Impacts of cable-stayed bridges
  - f) Lessons Learned
2. Stay organized and keep track of time limits.
3. If you have a question, ASK. 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 cable-stayed bridges in your area or around the world.
6. RESEARCH