STRUCTURAL ENGINEERING

OVERVIEW

Participants apply leadership and 21st century skills by collaborating with their team members to build a designated structure. Teams apply the principles of structural design and engineering through research, design, construction, destructive testing, and assessment to determine the design efficiency of a structure. Details about the structure and information related to it will be posted as a design brief on the TSA website under *Themes & Problems*. The on-site semifinalist problem is a variation of the pre-conference design brief posted on the TSA website.

ELIGIBILITY

One (1) team of two (2) individuals per chapter may participate.

SAFETY EYEWEAR

A. Participants are required to wear safety-approved eyewear during the on-site phase of this event.
B. Prescription eyewear needs to have side shields to be considered safety eyewear.
C. Should a team member remove the eyewear and fail to replace it, s/he will be reminded once.
D. If there is a second infraction, the team will be asked to leave the competition.
E. Sunglasses are not suitable.

TIME LIMITS

A. On-site structures (semifinalist teams only) must be started, completed, and checked in during the three (3) hours allowed for design and construction.
B. Semifinalist participants with time conflicts must present a written explanation of the conflict to the event coordinator at least one (1) hour before the construction time stated in the conference program. Work must begin during the time scheduled for the event.

ATTIRE

TSA competition attire is required.

PROCEDURE

PRE-CONFERENCE

A. Participants review the TSA Honor Statement for Competitive Events found in the General Rules and listed in the individual competitive event rules.
B. Participants access the design brief on the TSA website under *Themes & Problems*.
C. Participants conduct research and apply principles of structural design and engineering to their current structure.
D. Pre-built structures must be started and completed during the current school year.
E. All work must be completed by the team members only, and verified by the team's chapter advisor using the Team Verification form on the TSA website under *Themes & Problems*.
F. Participants render a full-size, three (3)-view (front, top, and right end) drawing (hand or computer- generated) of their structure.
G. The team develops a cuts part list of materials.

PRELIMINARY ROUND

On-site Destructive Testing of Pre-Built Structures

A. Participants report at the time and place stated in the conference program and check-in:
    1. Pre-built structure with a label that includes only the team number
    2. Documentation portfolio
    3. Pre-built structure and documentation portfolio in a plastic storage box. The plastic storage box size cannot exceed 12" tall, 16" wide, 18" long. The plastic box will protect the solution and contain the necessary documentation
B. Structures are assessed and undergo destructive testing.
C. Destructive testing of pre-built structures is not open for public viewing.
D. Destructive testing is completed using structural testing equipment, as designated by TSA.
E. When the destructive testing is completed, a list of twenty (20) semifinalist teams is posted.

SEMIFINAL ROUND

On-site Construction

A. The twenty (20) semifinalist teams participate in the on-site problem, which feature the construction and destructive testing of a designated structure to determine the ten (10) finalist teams.
B. Twenty (20) semifinalist teams report to the event area at the time and place stated in the conference program.
C. Teams are seated by a monitor.
D. The design problem is explained and directions for the construction problem is provided.
E. Teams have a three (3)-hour window when drawing begins and building stops, typically allotted as:
    1. Thirty (30) minutes to review the problem and create a sketch/drawing of their solution.
    2. Two and one-half (2 and ½) hours to review the problem and construct a solution.
F. During the building of the team's structure, construction regulations must be observed.
G. All work stops at the coordinator's signal. Teams that fail to comply with coordinator or monitor directions, after one (1) warning, will be issued a penalty of 20% of the team's total score.
H. Participants may leave early, but they must first complete check-out as directed.
I. Teams return all supplied items as directed, and clean and clear their work stations. Failure to do so will result in a 20% penalty deduction.
J. Teams must identify their structure with only their team ID number, using the label provided.
K. Structures are allowed to dry in a secure area until destructive testing time.

Destructive Testing

A. Structures are checked for rules violations and weighed before testing.
B. Destructive testing is completed by evaluators and is open for spectator viewing.
C. When all testing is completed, the greatest failure weight of all tested structures is recorded on the rating form, the efficiency rating of individual structures is calculated, and ranking is determined.
D. Subjective criteria are scored only after all destructive testing is completed using the provided rubric guideline. The subjective criteria are the team participation during semifinals, the pre-built drawing in the portfolio, and the portfolio.
E. The top ten (10) finalist teams are announced at the conference awards ceremony.

REGULATIONS AND REQUIREMENTS

Students will work to develop their leadership and 21st century skills in the process of preparing for and participating in this TSA competitive event. The development and application of those skills must be evident in their submission, demonstration, and/or communication pertaining to the entry.

PRE-CONFERENCE

A. Documentation Portfolio:
    1. Documentation portfolio is required and must be secured in a clear front report cover with the following single-sided, 8½" x 11" pages, in this order:
        a. Title page that includes the event title, the conference city and state, the year, and the team/chapter ID number; one (1) page
        b. Team Verification form; one (1) page
        c. Full-size, three (3)-view drawing of the structure (solution can be on 11" x 17" paper and folded as necessary)
        d. A cut parts list of the materials used in the construction of the structure.

PRELIMINARY ROUND

A. Pre-built structures and documentation portfolio must be completed prior to check-in.
B. The testing of pre-built structures is not open to spectators.

SEMIFINAL ROUND

A. Participants must provide and wear safety glasses for this portion of the event.

B. Participants are required to provide their own tool box (with identification [school name, address, and advisor cell phone number]), which should not exceed twenty (20) inches (508 mm) length x ten (10) inches (254 mm) width x ten (10) inches (254 mm) height. The box must contain all items needed to fabricate the solution.
   1. The following is a suggested list:
      a. Cutting devices; NONE may be electric
      b. Adhesives
         i. Aerosol and electric applicators are not allowed
         ii. A bottle of Uncure or Debonder is recommended
      c. Temporary fastening devices
         i. Straight pins
         ii. Clamps
         iii. Tape
      d. A cutting surface that prevents table-top marring (required)
      e. Rulers, straightedges, and/or measuring scales
      f. Abrasives sheets, sanding sponges, emery boards
      g. Marking devices (pens, pencils, etc.) and sharpener
      h. Sheet of wax paper, minimum 11" x 17"
      i. Pliers, wrenches, nut drivers, as needed
      j. Safety glasses and side shields, as required

C. Planning and fabrication supplies are provided by TSA. Teams are issued a packet of construction materials (such as a specific type of wood) to use for fabrication of the on-site designed structure once the team's drawing of the on-site solution is complete.
   1. Planning and fabrication supplies (these materials may not be part of the structure submitted for testing):
      a. 11" x 17" paper with ¼" grids for sketching the structure
      b. Pin board
      c. A sheet of wax paper
      d. Structure label

D. Teams that fail to comply with coordinator or monitor directions, after one (1) warning, will be issued a penalty of 20% of the team's total score.

E. Filming and the taking of photographs is prohibited during the viewing of structure, judging, and testing.

F. Subjective criteria is scored during or after semifinal construction.

G. In the event of a tie at the conclusion of the semifinal round, the solution that is higher on the 'on-site structure total points' will receive the higher placement on the top ten (10) finalist teams that will be announced at the awards ceremony.

EVALUATION

Evaluation is based on the compliance and design efficiency of a pre-built structure and an on-site structure (semifinalists only), both of which are destructively tested. Subjective criteria will be scored only after all destructive testing is completed.

Please see the official rating form for more information.

TSA HONOR STATEMENT

All work must be created and completed by individual competitors or teams. Plagiarism, the use of Generative Artificial Intelligence (GenAI) software, copyright violation, cheating, and falsification of information are prohibited. Participants may NOT use any generative artificial intelligence (GenAI) tools (e.g. ChatGPT, Google Gemini, GitHub Copilot, etc.). Any attempt to gain an unfair advantage will not be tolerated. Competitors at any level of TSA competition understand and agree to abide by the TSA Honor Statement.

If it is determined that a student violated the TSA Honor Statement, a rules violation of twenty percent (20%) will be incurred.

STEM INTEGRATION

This event has connections to the STEM areas of Science, Technology, Engineering, and Mathematics.

LEADERSHIP AND 21ST CENTURY SKILLS

This event provides opportunity for students to build and develop leadership and 21st century skills including but not limited to – Communication, Collaboration/Social Skills, Initiative, Problem Solving/Risk Taking, Critical Thinking, Perseverance/Grit, Creativity, Relationship Building/Teamwork, Dependability/Integrity, and Flexibility/Adaptability

TSA AND CAREERS

This competition has connections to one (1) or more of the careers below:

- Architect
- Civil engineer
- Engineering technician
- Mathematician
- Structural engineer
- Structural iron and steel work technician

Participant/Team ID# _____

STRUCTURAL ENGINEERING

2026 & 2027 OFFICIAL RATING FORM

MIDDLE SCHOOL

Judges: Using minimal (1-4 points), adequate (5-8 points), or exemplary (9-10 points) performance levels as a guideline in the rating form, record the scores earned for the event criteria in the column spaces to the right. The X1 or X2 notation in the criteria column is a multiplier factor for determining the points earned. (Example: an "adequate" score of 7 for an X1 criterion = 7 points; an "adequate" score of 7 for an X2 criterion = 14 points.) A score of zero (0) is acceptable if the minimal performance for any criterion is not met.

Go/No Go Specifications

- Before judging the entry, ensure that the items below are present; indicate presence with a check mark in the box.
- If an item is missing, leave the box next to the item blank and place a check mark in the box labeled ENTRY NOT EVALUATED.
- If a check mark is placed in the ENTRY NOT EVALUATED box, the entry is not to be judged.

☐ Team of two is present
☐ The structure is present, identified, and in its storage box
☐ The Team Portfolio is present and includes:
  ☐ The Team Verification form (completed)
  ☐ Three (3)-view drawing of the structure
  ☐ A complete cut parts list for the structure
☐ ENTRY NOT EVALUATED

PRE-BUILT STRUCTURE (On-Site Destructive Testing) – (40 points)

Indicate N for non-compliant or C for compliant, for each regulation in the Construction section. One non-compliant mark will result in the entry not being evaluated. Dimensional criteria will have a tolerance identified in the design brief.

Regulation	Noncompliant		Compliant	
Outside Width of Structure	The outside width of the structure is greater than the designated construction width.		The outside width of the structure is within the designated tolerance of the assigned construction width.	
Outside Height of Structure	The height of the structure is greater or less than the designated tolerance of the assigned construction height.		The height of the structure is within the designated tolerance of the assigned construction height.	
Inside Structure Width	The inside structure space, if provided in the design brief, is less than the required construction space.		The inside structure space, if provided in the design brief, is greater than the required construction space.	
Construction Materials	Material other than the correct construction material was used in the construction of the solution.		Only the correct construction materials are used in the construction of the solution.	
Substructure	Substructure, if allowed in the design brief, is not applied correctly.		Substructure, if allowed in the design brief, is applied correctly.	
Laminations	Laminations used in the construction of the solution fail to comply with the design brief.		Laminations used in the construction of the solution comply with the design brief.	
Coating of Materials	Coating of the construction materials with glue is present.		No coating of the construction materials with glue is present.	
Testing Rod and Block Clearance	The testing block and rod cannot be placed and passed through the center of the structure to allow for testing.		The testing block and rod pass freely through the center of the structure to allow for testing.	
			DISQUALIFIED	
			PRE-BUILT STRUCTURE APPROVED FOR TESTING	
			Record the mass (weight) of the structure (in grams to the nearest tenth of a gram) prior to testing.	

PRE-BUILT STRUCTURE (On-Site Destructive Testing) – continued					
Record the failure weight in pounds to the nearest tenth of a pound.					
Determine the efficiency (shown to three decimal places) by multiplying the failure weight (or adjusted failure weight, as applicable) by 4.54 and then dividing by the mass (weight) of the structure.					
1st: 40 Points	**2nd:** 39 Points	**3rd:** 38 Points	**4th**: 37 Points	**5th:** 36 Points	
6th: 35 Points	**7th:** 34 Points	**8th:** 33 Points	**9th:** 32 Points	**10th:** 31 Points	
11th: 30 Points	**12th:** 29 Points	**13th:** 28 Points	**14th**: 27 Points	**15th:** 26 Points	
16th: 25 Points	**17th:** 24 Points	**18th:** 23 Points	**19th:** 22 Points	**20th:** 21 Points	
PRE-BUILT STRUCTURE TOTAL POINTS (40 points)					

PRELIMINARY SUBTOTAL (40 points)	

ON-SITE STRUCTURE (Qualification) – (40 points)				
For the ON-SITE STRUCTURE: Indicate N for non-compliant or C for compliant, in the Qualification and Construction sections below. In the Qualification section, one non-compliant mark will result in disqualification. In the Construction section, one non-compliant mark will result in the structure not being evaluated. Dimensional height criteria will have a tolerance identified in the design brief.				
Regulation	**Noncompliant**		**Compliant**	
Team of Two	Only one (1) team member is present.		Both team members are present.	
Safety Eyewear	Warnings about eyewear are issued.		No warnings about eyewear are issued.	
Structure Identification	The identification sticker is not attached.		The identification sticker is attached.	
Tools and Fabrication Supplies	Inappropriate tools or supplies are brought to the event.		Appropriate tools and supplies are brought to the event.	
ON-SITE STRUCTURE (Construction)				
Outside Width of Structure	The outside width of the structure is greater than the designated construction width.		The outside width of the structure is within the designated tolerance of the assigned construction width.	
Outside Height of Structure	The height of the structure is greater or less than the designated tolerance of the assigned construction height.		The height of the structure is within the designated tolerance of the assigned construction height.	
Inside Structure Width	The inside structure space, if provided in the design brief, is less than the required construction space.		The inside structure space, if provided in the design brief, is greater than the required construction space.	
Construction Materials	Material other than the correct construction material was used in the construction of the solution.		Only the correct construction materials are used in the construction of the solution.	
Substructure	Substructure, if allowed in the design brief, is not applied correctly.		Substructure, if allowed in the design brief, is applied correctly.	
Laminations	Laminations used in the construction of the solution fail to comply with the design brief.		Laminations used in the construction of the solution comply with the design brief.	
Coating of Materials	Coating of the construction materials with glue is present.		No coating of the construction materials with glue is present.	
Testing Rod and Block Clearance	The testing block and rod cannot be placed and passed through the center of the structure to allow for testing.		The testing block and rod pass freely through the center of the structure to allow for testing.	

ON-SITE STRUCTURE (40 points) – continued					
				DISQUALIFIED	
				ON-SITE STRUCTURE APPROVED FOR TESTING	
				Record the mass (weight) of the structure (in grams to the nearest tenth of a gram) prior to testing.	
				Record the failure weight in pounds to the nearest tenth of a pound.	
				Determine the efficiency (shown to three decimal places) by multiplying the failure weight (or adjusted failure weight, as applicable) by 4.54 and then dividing by the mass (weight) of the structure.	
1st: 40 Points	**2nd:** 39 Points	**3rd:** 38 Points	**4th**: 37 Points	**5th:** 36 Points	
6th: 35 Points	**7th:** 34 Points	**8th:** 33 Points	**9th:** 32 Points	**10th:** 31 Points	
11th: 30 Points	**12th:** 29 Points	**13th:** 28 Points	**14th**: 27 Points	**15th:** 26 Points	
16th: 25 Points	**17th:** 24 Points	**18th:** 23 Points	**19th:** 22 Points	**20th:** 21 Points	
				ON-SITE STRUCTURE TOTAL POINTS (40 points)	

SUBECTIVE CRITERIA (30 points)				Record scores in the column spaces below.
CRITERIA	Minimal performance	Adequate performance	Exemplary performance	
	1-4 points	5-8 points	9-10 points	
Team Participation On-Site (X1)	The majority of the construction is completed by one member of the team; the partner may be disengaged.	Both team members generally are engaged in the process, though one member may take on more responsibility than the other.	Both team members are actively involved in the construction; there is shared responsibility between team members.	
Pre-Built Drawing and Parts List (X1)	The submitted drawing was incomplete, not accurate, of proper quality, or was not to scale; a complete parts list was not included.	The submitted drawing was complete but lacked clarity, accuracy, or was of poor quality, the parts diagram was not complete or was incorrect.	The submitted drawing was complete, accurate, and to scale; the parts list was complete and accurate.	
Portfolio (X1)	Portfolio is unorganized and/or missing three (3) or more components; leadership and/or 21st century skills are not evident.	Portfolio includes most components and is generally organized; leadership and/or 21st century skills are somewhat evident.	All components of the portfolio are included in order, and content and organization are clearly evident; leadership and/or 21st century skills are clearly evident.	
			SUBECTIVE CRITERIA SUBTOTAL (30 points)	

Rules violations (a deduction of 20% of the total possible points for the above sections) must be initialed by the judge, coordinator, and manager of the event. Record the deduction in the space to the right.

Indicate the rule violated: _____

SEMIFINAL SUBTOTAL (70 points)

To arrive at the TOTAL score, add any subtotals and subtract rules violation points, as necessary. **TOTAL** (110 points)

Comments:

I certify these results to be true and accurate to the best of my knowledge.

JUDGE

Printed name: _____ Signature: _____

STRUCTURAL ENGINEERING EVENT COORDINATOR INSTRUCTIONS

PERSONNEL

A. Event coordinator

B. Judges

1. Preliminary round to evaluate pre-built structures, two (2) or more
2. Semifinal round, to qualify structures after construction, two (2) or more
3. Semifinal round, destructive test judges, two (2) or more
    a. One (1) to weigh the structure, record structure weight, and record failure weight
    b. One (1) to bring the structure to the testing location, position the structure on the testing device, operate the tester, and then remove and store the structure following testing

C. Construction monitor, one (1) per twenty teams

D. Timekeeper, one (1)

MATERIALS

A. Coordinator's packet, containing:

1. Event guidelines, one (1) copy for the coordinator and for each judge
2. TSA Event Coordinator Report
3. Stick on labels for identifying entries

B. Twenty (20) blank stick on labels for the semifinal round

C. Testing equipment, provided by TSA

D. Sample structures for both testing sessions that can be used to demonstrate the testing procedure and to determine that the testing equipment is working properly.

E. Evaluation and recording equipment

1. Gram scale (3-decimal place calculation)
2. Tape measure or 2' ruler
3. Evaluation gauges (rulers)

F. Site requirements

1. Construction session
    a. Tables and chairs suitable for cutting and gluing
    b. Work area, at least 2' x 3' for each team (suggested space is two (2) teams per 6' x 2' or 8' x 2' area)
    c. One (1) chair per participant
    d. Tables for equipment check-out and check-in
    e. Tables and chairs for evaluators
    f. Secured area for drying entries and storing supplies
2. Testing session
    a. Tables for storage of structures
    b. Table for weighing
    c. Table for testing
    d. Table for recording
    e. Tables for storage of failed structures
    f. Chairs for spectators
    g. Barricade to separate testing area from spectators
3. Semifinalist team packets provided by TSA containing construction materials and instructions.
    a. Construction tools per team, to be used and returned to the event coordinator or helpers after construction:
        i. Pin board as supplied, but generally a one-foot by two-foot (1' x 2') piece of fiber or foam board
        ii. Grid paper, ¼" x ¼" grid on 11" x 17" paper for structure sketch (to remain with the completed structure when turned in)
        iii. Wax paper to cover the pin board (to remain with the completed structure when turned in)
        iv. Label for structure
    b. Construction materials – balsa as needed for each team
    c. Instructions

RESPONSIBILITIES

A. Prepare the structure problem statement (including any necessary related information) for posting on the TSA website.

AT THE CONFERENCE

A. Attend the mandatory event coordinator's meeting at the designated time and location.

B. Report to the CRC room and check the contents of the coordinator's packet.

C. Review the event guidelines and check to see that enough personnel have been scheduled.

D. Check to see that all event equipment and materials have been secured.

E. One (1) hour before the event is scheduled to begin, meet with judges/assistants to review time limits, procedures, regulations, evaluation, and all other details related to the event. If questions arise that cannot be answered, speak to the event manager before the event begins.

F. Ensure the judges have access to the online judging system.

EVENT CHECK-IN

A. Check in participants at the time and place stated in the conference program.

B. Participants check in:

1. The pre-built structures
2. The documentation portfolio

C. Anyone reporting who is not on the entry list may check in only after official notification is received from the CRC.

D. Late entries are considered on a case-by-case basis and only when the delay is caused by events beyond participant control.

E. Requirements for attire do NOT apply during check-in, only on the first day of the conference.

PRELIMINARY ROUND/PRE-BUILT STRUCTURE

A. Coordinate and manage the on-site testing of pre-built structures, the recording of results, and the determination of the twenty (20) semifinalist teams.

B. Decisions about rules violations must be discussed and verified with the judges, event coordinator, and CRC manager to determine either:

1. To deduct 20% of the total possible points or
2. To disqualify the entry

The event coordinator, judges, and CRC manager must initial either of these actions on the rating form.

C. Submit semifinalist results to the CRC for posting.

D. Assemble semifinalist packets of construction materials and directions for the twenty (20) on-site semifinalist teams.

SEMIFINAL ROUND

Team Check-in for On-site Construction

A. Check-in will begin at the time noted in the conference program and will continue until all teams arriving on time have been checked in and seated. The event begins at the posted time.

B. Both members of a team must be present during check-in.

C. No team is allowed to begin late unless its members have complied with the following: Participants with time conflicts must present a written explanation of the conflict to the event coordinator at least one (1) hour before the construction time stated in the conference program.

D. Work must begin during the timeframe scheduled for this portion of the event.

On-site Construction

A. Assign team construction locations.

B. When all teams are seated, distribute instructions and review these, as well as any details for the assigned structure.

C. Teams are allowed a maximum of three (3) hours to complete their structure:

1. Thirty (30) minutes of this time is allotted for completing the design drawing.
2. Two and one-half (2½) hours, is allotted for actual construction.

D. When a team notifies a monitor that the required sketch is complete, and the monitor confirms this, the team receives a materials packet and may begin the on-site construction phase of the event.

E. No additional supplies are provided during the event.

F. Call time at the end of the allotted three (3)-hour timeframe. All teams must stop working at this point.

G. All work stops at the coordinator's signal. Failure to comply with instructions will result in a penalty of 20% to the team's total score.

Team Check-out

A. Establish the procedure for check-in and recording of finished structures.

B. Designate an area for storage, and allow for the return of construction materials.

C. Coordinate the return and removal of all supplied items and ensure that teams clean and clear their work stations. Deduct a 20% penalty for teams that do not comply.

D. Teams check in excess supplies as directed by the monitors.

E. Ensure that teams identify their structure with only their team ID number, using the label provided.

F. Teams place their structures in the storage area with the sketch as directed by the monitor. The structure must be identified with the team number only (using the label provided in the materials packet).

G. Once check-out is complete, all participants leave the competition area. Participants may leave early, but they must complete check-out as directed.

H. The structures are secured by the monitor and allowed to dry for a minimum of twelve (12) hours.

Destructive Testing

A. After the structures have dried, judges report at the time and place stated in the conference program.

B. Judges test each structure and score the results.

C. Judges score the Subjective Criteria for semifinalists after destructive testing has taken place.

EVALUATION

A. Check (with assistance from judges) all structures for regulations compliance. Structures that are in compliance are tested without penalty.

1. Weigh all structures before testing and record the weight on the evaluation rubric.
2. Use the testing device, designated by TSA, to test each structure. (A specific testing block or attachment for the structure may be necessary for the on-site problem.)
3. Apply an increasing load to the structure, via the test block or attachment, until the structure fails.
4. Record the greatest failure weight on the rubric. This weight is the greatest weight recorded (of all the tested structures) during testing before they fail.
5. Determine each structure's efficiency by the greatest failure weight x 4.54, divided by the weight of the structure in grams; round off the efficiency to three (3) decimal places and record it on the rubric.
6. The highest numeric efficiency determines the winner. In the case of an efficiency tie, the greatest weight held by the tied entries determines the winner.

B. Structures will not be tested if:

1. A non-compliance construction regulation violation was determined before testing.
2. The structure cannot be placed on the tester.
3. The testing attachment cannot be properly placed within or on the structure.
4. Straight pins are left in the structure.
5. There is a failure of a participant to wear safety eyewear and/or to follow safe practices.
6. Laminations fail to comply with the guidelines as specified in the current year's challenge.
7. Failure to use each of the materials specified in the current year's challenge.

C. Manage, with assistance from judges, the destructive testing of all structures that were not officially tested due to non-compliance.

D. Discuss rule violations (e.g., 20% deduction, disqualification) and have all relevant parties initial the rating form.

E. If necessary, manage the security and removal of materials from the event area.

F. Semifinalist teams may pick up their structures at a time determined by the event coordinator.