



**REVISION 1 – JANUARY 19, 2022**

Updates are shown in red

**TIMBER-STRONG DESIGN BUILD<sup>SM</sup>**

# TIMBER-STRONG DESIGN BUILD<sup>SM</sup>

## Previous Competition Winners

### 2021 ASCE PSWC

March 27<sup>th</sup> University of California, Los Angeles

1<sup>st</sup> Place: University of California, Los Angeles

2<sup>nd</sup> Place: California State University, Fullerton

3<sup>rd</sup> Place: University of Hawaii at Manoa

### 2020 PSWC

April 4<sup>th</sup> California State University, Fullerton

1<sup>st</sup> Place: California State University, Fullerton

2<sup>nd</sup> Place: University of California Los Angeles (UCLA)

3<sup>rd</sup> Place: California Polytechnic State University, San Luis Obispo (CPSLO)

### 2019 NCSEA SUMMIT

November 20<sup>th</sup> Disneyland Hotel, Anaheim, CA

1<sup>st</sup> Place: California Polytechnic State University, San Luis Obispo (ARCE CPSLO)

2<sup>nd</sup> Place: University of California Los Angeles (UCLA)

3<sup>rd</sup> Place: University of Kentucky (U of K)

### 2019 PSWC

April 6<sup>th</sup> California Polytechnic State University, San Luis Obispo, CA

1<sup>st</sup> Place: California Polytechnic State University, San Luis Obispo (CE CPSLO)

2<sup>nd</sup> Place: University of Arizona (UA)

3<sup>rd</sup> Place: University of California Los Angeles (UCLA)

### 2018 PSWC

April 13<sup>th</sup> Arizona State University, Tempe, AZ

1<sup>st</sup> Place: San Diego State University (SDSU)

2<sup>nd</sup> Place: Arizona State University (ASU)

3<sup>rd</sup> Place: University of California Irvine (UCI)

Honorable Mention: California State Los Angeles (CSLA)

This document, which is available at [Student Conferences, Symposia & Competitions](#) page of the ASCE Website, describes the Student Timber-Strong Design Build<sup>SM</sup> Competition and states the 2022 rules for the symposium. **Clarifications, which include any revisions to the rules, are published on the ASCE website prior to the competition and do not appear in this document although they are formal addenda to the rules.**

See the Request for Information (RFI) Section below for details on how to submit questions.

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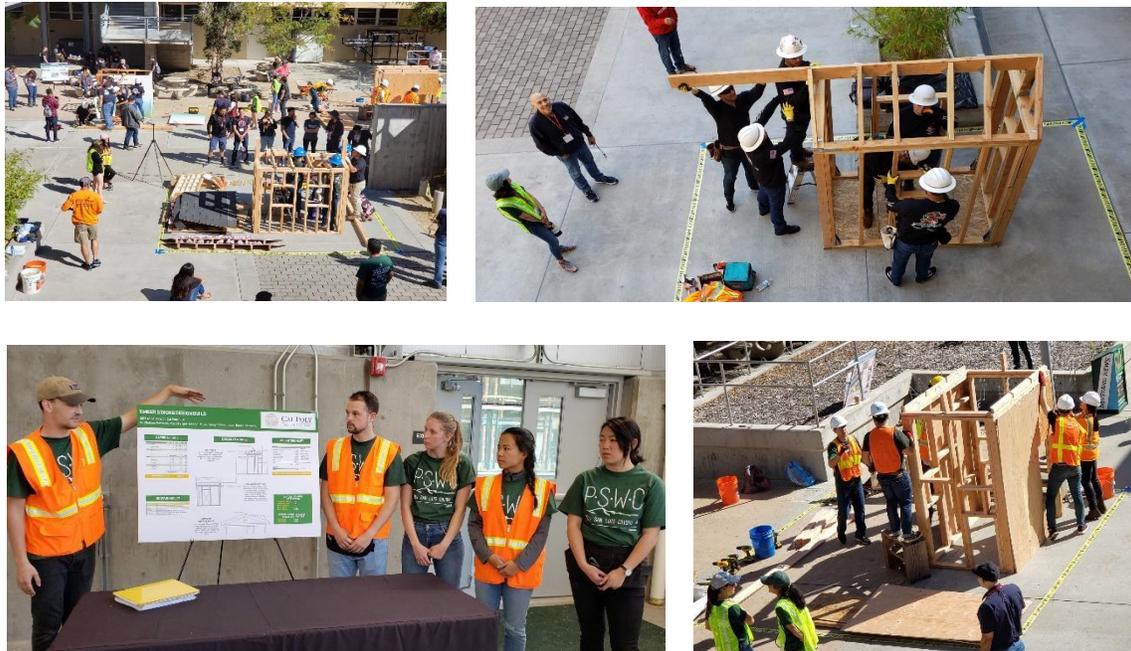
## WELCOME

The American Society of Civil Engineers (ASCE) and sponsors American Wood Council (AWC), Simpson Strong-Tie Company Inc. (SST), and APA – The Engineered Wood Association (APA) support and encourage the equitable opportunity for participation in the Timber-Strong Design Build<sup>SM</sup> (TSDB<sup>SM</sup>) Competition by all interested and eligible individuals without regard to race, ethnicity, religion, age, gender, sexual orientation, nationality, or physical challenges. Participation should be inclusive, open, and fair to all interested and eligible students. Welcome!

### Examples



### Examples of April 2019 TSDB<sup>SM</sup> Competition



# TIMBER-STRONG DESIGN BUILD<sup>SM</sup> COMPETITION

## 1.0 EVENT DESCRIPTION

The American Society of Civil Engineers (ASCE) and the sponsors American Wood Council (AWC), Simpson Strong-Tie Company Inc. (SST), and APA – The Engineered Wood Association (APA) are developing a student competition based on creating a sustainable, 2-story wood light-framed building (a.k.a. project). While other natural resources are rapidly depleting, wood is the only building material that grows naturally, is 100% renewable, and outperforms other building materials in overall carbon footprint reduction. As a result, AWC, SST and APA are seeking student teams to design and build an artistically creative building that is sustainable, aesthetically pleasing and structurally durable.

## 2.0 OBJECTIVE

The 2022 Timber-Strong Design Build<sup>SM</sup> (TSDB) Competition enables students to gain experience in performing crucial aspects of common structural engineering design and practice. Participating students will learn about the processes involved in professionally designing and proposing a project bid, which must be unique and not a replication of a previous year's design. Students will also gain exposure to the management and building practices used in construction environments. Through the performance of analysis, production of a building information model, preparation of a project bid, production of construction documents, and management of the construction process, each team is expected to act as a design-build construction firm while competing in a friendly environment. It is the goal of this competition to provide unique insights and hands-on experience for the next generation of structural engineers involved in sustainable design and construction.

## 3.0 AWARDS AND RECOGNITION

The winners of the Timber-Strong Design Build<sup>SM</sup> Competition shall be determined by compiling a team's total number of points from the report, BIM model, construction, presentation, and creativity portions of the competition. In addition to the top three teams receiving awards, the 1<sup>st</sup> place winning team will receive a travelling trophy which will reside at the winning team's college until the following year's competition where it will change hands to the next 1<sup>st</sup> place winning team.

### 3.1 BIM AWARDS AND RECOGNITION

The top three teams will receive awards based on compiling a team's total number of points from the report, BIM model, presentation, and creativity portions of the competition. Teams that are not able to participate in the construction of their design can participate through the BIM model. Teams that participate in the build and those that do not participate in the build are eligible for the BIM awards.

## 4.0 GENERAL RULES AND ELIGIBILITY REQUIREMENTS

### 4.1 RULE CHANGES AND PRECEDENCE

The Rules and Regulations (Rules) of the Timber-Strong Design Build<sup>SM</sup> Competition are updated each year. **Teams are strongly encouraged to read this document carefully and disregard previous editions from previous competitions.** Teams should not consider items such as rulings and interpretations made by judges in previous competitions and answers provided in previous interpretations of rules, as setting precedence for this year's competition.

### 4.2 GENERAL INFORMATION

To learn which Student Symposia are hosting this competition, visit the ASCE website <https://www.asce.org/communities/student-members/conferences>. Visit the Student Symposium hosts' websites (links are or will be on the ASCE student symposium's webpage) for registration information.

Each competing student chapter is invited to structurally design and model a light-framed wood structure. Through the design process, teams are required to create a preliminary design and a final bid report.

Each team is required to model the wood structure and construct the wood structure which was designed in the team report. Each team will ~~conclude with~~submit a presentation (see Section [6.0 PRESENTATION AND DISPLAY BOARD](#)).

The ASCE Student Chapter hosting the student symposium ("host") will coordinate with ASCE to provide each team captain with a unique link to ASCE's Cerberus ftp server where all electronic files will be uploaded. Upon registration, each team captain will need to request access to the Cerberus ftp server by contacting the host.

#### **Request for Information (RFI)**

Requests for information (RFI) should be sent to [student@asce.org](mailto:student@asce.org) with the subject line "TSDB Competition RFI". Clarifications will be posted on the [Timber-Strong Design Build Competition Collaborate Site](#) every other Friday starting September 24, 2021, until February 4, 2021. Each post will address the questions received from the previous two weeks through the Wednesday before 11:59 PM Eastern Time.

### 4.3 REGISTERED PARTICIPANTS

All team members and student chapters must be registered for the ASCE Student Symposium. There is no limit to the number of students who participate in the development of the report, building information model, and the visual aid, however, only 4-6 members should be designated as builders (see SECTION 4.3.1 ELIGIBILITY REQUIREMENTS).

#### 4.3.1 ELIGIBILITY REQUIREMENTS

Registered participants shall meet all the following requirements:

- a. Teams shall consist of undergraduate students enrolled during all or part of the current competition academic year. Each student must be a member of an ASCE Student Chapter in good standing and be a Society Student Member of ASCE.
- b. 4-6 members shall be designated as “builders” and include at least one female and one male.
- c. One builder of the team must be identified as the Team Captain.
- d. The team must have at least one underclassman (freshman/sophomore).
- e. The team **MUST** have a least one faculty advisor.
- f. Teams are encouraged (not required) to have a practicing structural engineer to mentor the team.

#### 4.4 ETHICS AND REQUIRED CONDUCT

This competition is to be conducted with the highest regard for ethical responsibility per [ASCE's Code of Ethics](#). All members of ASCE, regardless of their membership grade or job description, commit to all the ethical responsibilities in this Code. All ASCE members should make themselves familiar with ASCE's Code of Ethics.

All participants shall act professionally and respectfully at all times. Failure to act appropriately can result in sanctions, disqualifications, and loss of invitations to future competitions or Society-wide competitions. The inappropriate use of language, alcohol, or materials, uncooperativeness, or general unprofessional or unethical behavior will not be tolerated.

#### 4.5 SAFETY

Safety is the highest priority; activities that risk personal injury will not be tolerated. Competition safety officials may use their own discretion on determining a hazardous condition and provide suggestions for correcting the issue. If a team member cannot compete safely, they will be disqualified. The remaining team members may continue with the competition if the number of team members does not drop below 4 builders. Competition safety officials may take action which results in withdrawal of a team from competition for safety violations if they are not corrected once brought to the attention of the team. Judges are empowered to halt and prohibit any activity that competition safety officials deem hazardous. If the structure being built is deemed by competition safety officials to be unsafe to participants, judges, or spectators, it must be withdrawn from competition.

All participants are responsible for complying with all campus protocols and procedures including but not limited to COVID-19 guidelines related to in-person meetings, masking, social distancing, etc., at all times in connection with planning, preparation, or participation in the competition.

Given the continually changing environment surrounding COVID-19, virtual competition provisions are provided in the rules and may be activated in coordination with ASCE.

Students shall practice safe fabrication procedures and seek appropriate instruction and supervision (see section [9.0 CONSTRUCTION](#)). General construction safety standards for activities during this competition shall follow the standards set forth in OSHA Regulation Standards Number 1926. The following are the URL addresses to the OSHA Standards 1926:

<https://www.osha.gov/laws-regs/regulations/standardnumber/1926>

and CAL/OSHA Title 8 of the California Code of Regulations (T8 CCR)

<https://www.dir.ca.gov/samples/search/query.htm>

related to construction industry (Pocket Guide For the Construction Industry may be found at [https://www.dir.ca.gov/dosh/dosh\\_publications/constguideonline.pdf](https://www.dir.ca.gov/dosh/dosh_publications/constguideonline.pdf)).

Student teams are solely responsible for following these safety standards. (See [SECTION 5.4 BUILDING MATERIALS AND SAFETY GEAR](#)).

**Each Builder will need to take a free “Ladder Safety Training” course**

<https://www.laddersafetytraining.org/> and submit the certificate of completion.

#### 4.6 SCHEDULE, DEADLINES, AND SUBMISSIONS

The following is a list of important dates related to the overall competition schedule, including deadlines for applicable submissions. Teams should consider this as only a partial list of dates (all dates are midnight (11:59 PM) in the time zone of the host unless noted otherwise).

The symposium host will coordinate with ASCE to provide teams with instructions for how to upload submittals via a unique link to ASCE’s Cerberus ftp server.

<u>Mandatory Task</u>	<u>Due Date</u>
All safety certificates and waiver form (to be provided by ASCE)	Prior to commencing any tasks
Electronic files Phase One upload to ASCE’s Cerberus ftp server (See <a href="#">SECTION 7.0</a> )	45 days prior to the day of the competition
Electronic files Phase Two upload to ASCE’s Cerberus ftp server (See <a href="#">SECTION 7.0</a> )	30 days prior to the competition
Team Captain’s meeting	Day before the competition
<del>Presentation &amp; Visual Aid (See <a href="#">SECTION 6.0</a>)</del> <del>* In the event of a Virtual Competition* In the event of a Virtual Competition</del>	Day of the competition <del>* Does not apply * 7 days prior to the competition</del>
Construction of Structure * In the event of a Virtual Competition	Day of the competition * Does not apply

<p>Electronic file Phase Three upload to ASCE’s Cerberus ftp server (See <a href="#">SECTION 7.0</a>)  * In the event of a Virtual Competition</p>	<p>Day of the competition (specific time TBD)  * 7 days prior to the competition</p>
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All Team Captains shall attend the Team Captain’s meeting where they will receive an overview of the competition day and they will be able to ask any last-minute questions.

## 5.0 BUILDING PROJECT

### 5.1 GENERAL

All proposed and modeled BIM structures and constructed structures shall be a 2-story structure with a footprint dimension of 6’ x 6’, which is measured to the outside face of wood stud wall. Wall sheathing, roof sheathing, roof eaves, and the cantilever floor beam may extend outside the footprint dimension (see **Figure 1**). The final deliverables shall contain the following:

1. Design and model a structurally efficient building system of wood light-framed construction.
2. The two-story structure shall include the following:
  - a. Roof system: The slope of the roof shall be determined by the team. The overall height of the structure shall not exceed 12 feet, measured from the highest point of the roof (ex. ridge beam) to the bottom of the structure.
  - b. 2nd floor system: A floor beam that cantilevers 4’ outside of the footprint to support the applied point load.
  - c. 2<sup>nd</sup> floor framed opening: **one** opening in the floor.
  - d. 2<sup>nd</sup> floor walls framed openings: minimum of **four** windows with one in each wall. The windows may be located anywhere on each wall.
  - e. 1<sup>st</sup> floor walls framed openings: minimum of **three** windows with one in each wall and **one** door in a wall with no windows. The windows may be located anywhere on each wall.

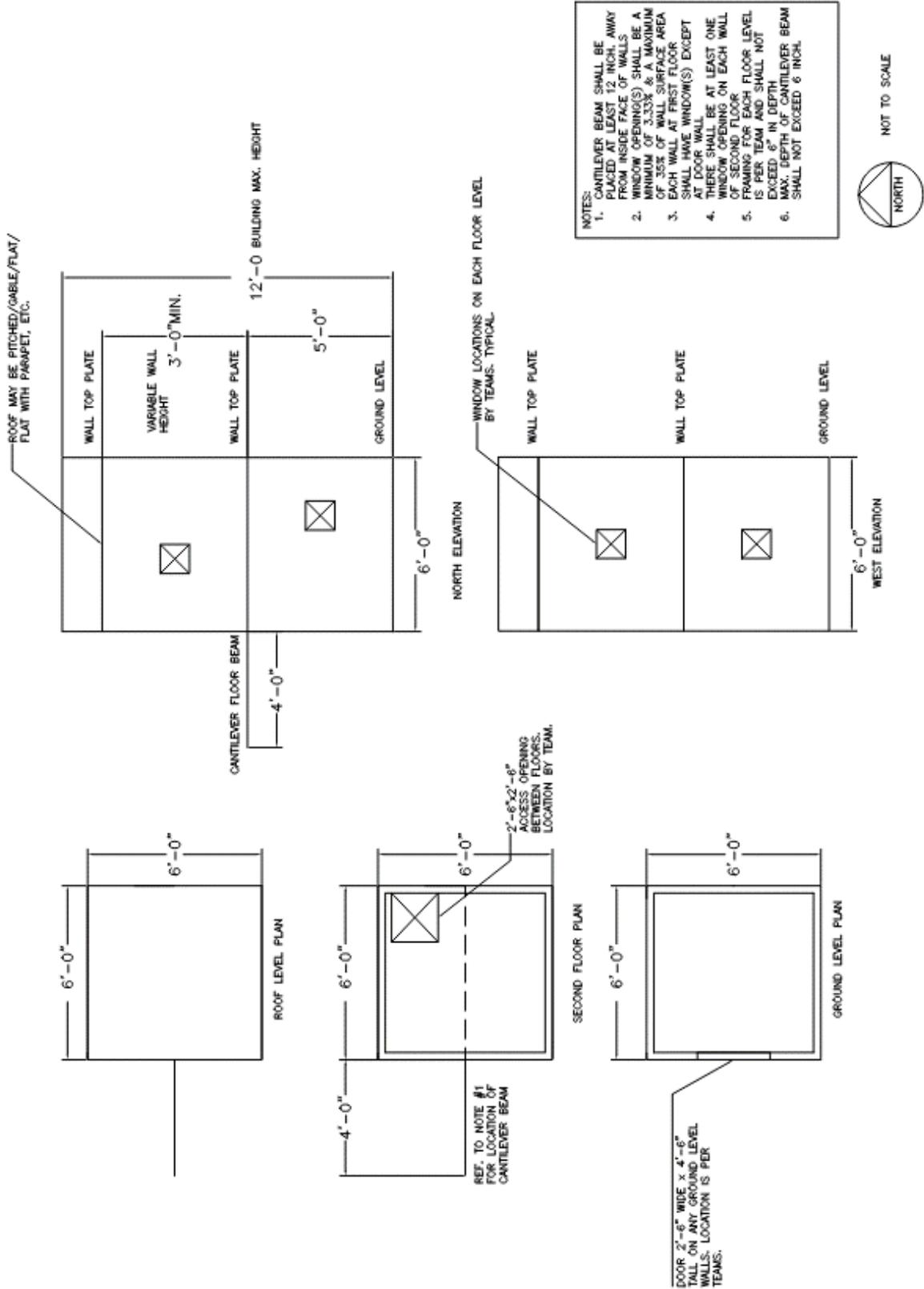


Figure 1.

## 5.2 STRUCTURAL DESIGN

Wood has been successfully used as a structural material for over 1300 years and the construction industry is on the verge of expanding the use of wood to high-rise under the 2022 International Building Code to up to 18 stories using mass timber construction. As a structural material that provides sustainability, strength, and resilience, each team will design the building per this section using wood products. The structural calculations shall be legible HAND calculations (non-computer analyzed) on the structure in **Figure 1**. All structural design will be done using the Allowable Stress Design (ASD) Method. The design must include the following:

### 5.2.1 STRUCTURAL DURABILITY-GRAVITY DESIGN

1. Vertical design loads
  - Roof Dead Load = calculated self-weight
  - Roof Live Load  $L_r = 20$  psf
  - Floor Dead Load = calculated self-weight
  - Floor Live Load  $L = 50$  psf
  - Point load at the end of the cantilever 150 lbs.
2. Design cantilever floor beam for shear and bending.
3. Deflection of cantilever
  - a. Calculate the predicted deflection assuming all applicable adjustment factors are equal to 1.0.
  - b. Beam deflection, after the load is applied, must be at least .5" and not greater than 1" as tested.
  - c. Calculate the entire weight of the structure.

### 5.2.2 STRUCTURAL DURABILITY-SEISMIC AND WIND DESIGN

1. Lateral Design Loads - the structure shall be designed and analyzed to resist seismic and wind loads based on allowable stress design (ASD) as follows:
  - a. Lateral seismic load of  $E = 275$  plf at the roof diaphragm and 225 plf at the floor diaphragm in both directions (not simultaneously).
  - b. Roof wind uplift pressure  $W = 23$  psf (no dead load is allowed to resist uplift pressures)
2. Lateral Design – the design shall include the following:
  - a. Seismic:
    - i. Roof diaphragm design (in-plane shear only) both directions including sheathing, chords, and collectors
    - ii. Floor diaphragm design (in-plane shear only) both directions including sheathing, chords, and collectors
    - iii. Shear wall design (in-plane shear and overturning)
    - iv. Anchorage to the foundation that includes anchor bolt and SST hold-downs to resist in-plane shear and overturning.
    - v. Factor of Safety (F.S.) for the diaphragm and shear walls (ratios of ASD unit shear capacity/ASD demand). Teams shall provide calculations to

the 1000<sup>th</sup> decimal place and include F.S. for each of the diaphragms and the shear walls and provide the average F.S. for the combined diaphragms and average F.S. for combined shear walls.

b. Wind Design:

i. Roof joist anchorage for the uplift wind load.

3. The ASD capacities for the diaphragm and shear walls shall be based on the [2015 Special Design Provisions for Wind and Seismic \(SDPWS\) standard](#).
4. Assume that the structure will be connected to a foundation with 1/2" diameter anchor bolts and SST hold-downs.

In all cases, the demand (load) on the structure shall not exceed the capacity (resistance) of the structure.

'Continuous Load Path' is another intended focus of this competition. How well a house or building can absorb energy from wind and seismic loading has much to do with 'Continuous Load Path'. A building absorbs seismic energy by connecting the horizontal roof and floor diaphragms to the walls. When ground motion produces inertial forces, these forces push on the roof (and floor) diaphragm in one direction and the walls hold back the roof in the opposite direction. This behavior is similar in a building absorbing wind energy. For the energy to be properly absorbed, the roof and floor diaphragms must be connected to the walls and the upper story walls are connected to the lower story walls. The lowest level walls are connected to the foundation. The roof connection to the walls must also account for the uplift forces due to wind. As an analogy, if the wind or seismic forces were electricity, it's the engineer's job to design a continuous path for that electricity to flow to the ground.

The following diagrams illustrates continuous load path through wood members, fasteners, and connectors:

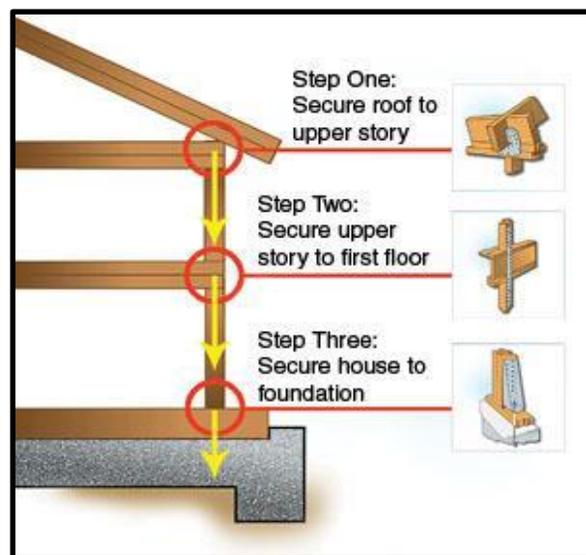


Figure 2. Continuous Load Path

Example: Continuous Load Path to Resist Uplift – Connection Points

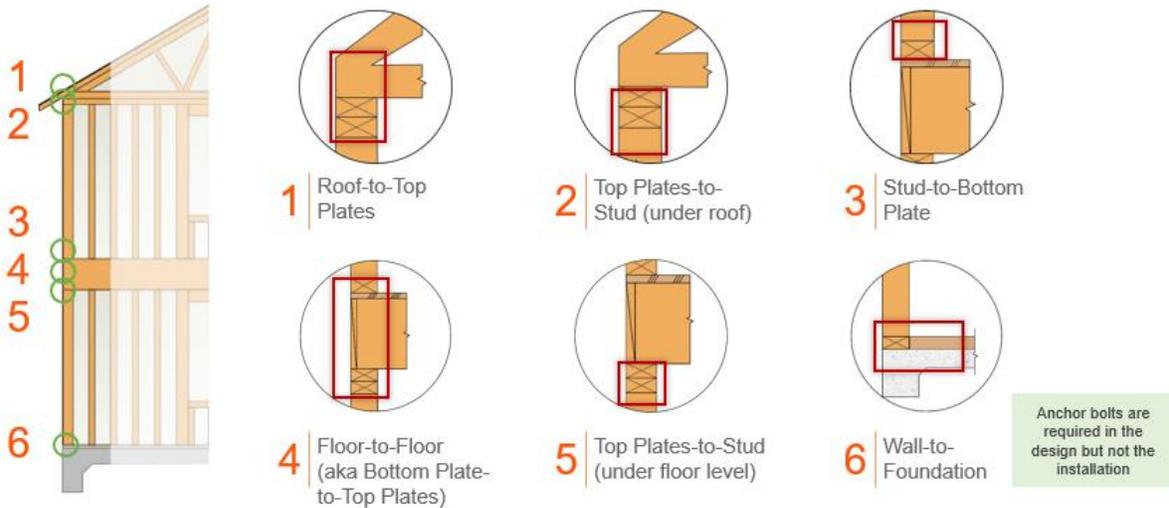


Figure 3. Continuous Load Path Resisting Uplift Forces

Example: Continuous Load Path to Resist In Plane – Connection Points

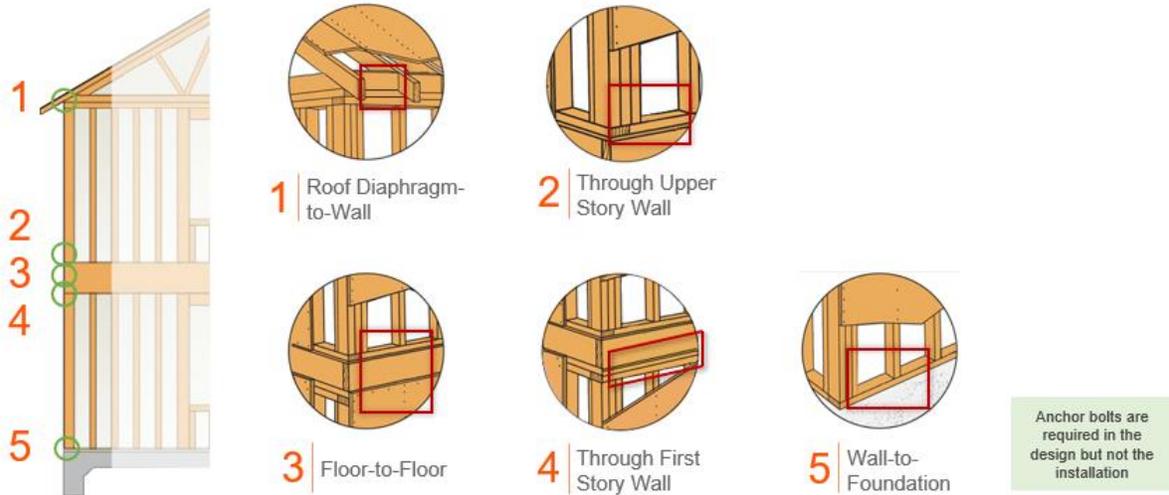


Figure 4. Continuous Load Path Resisting In-Plane Forces

Implementation of a continuous load path in the design and modeling of the structure in this competition will be a major focus. A Revit library of Simpson 2D & 3D connectors and fasteners will be available for use. The following link is for downloading the 'Drawing Finder for Revit Plugin' from the Simpson Strong-Tie website:

<https://www.strongtie.com/drawing/drawing-finder-for-revit>

This plugin allows the Revit user to insert Simpson products directly into the Revit model and drawings by pulling the most recent content from the Strongtie.com website. Note that there is also an installation instructions and best practices tutorial pdf file on the web page.

A wind unit uplift force will be given for calculation and teams will calculate the total uplift and appropriately connect the roof to the second level walls. Teams will be responsible to account for resisting that force to the foundation with fasteners, connectors, structure dead load, or a combination of the three. Hold-downs are to be designed and installed to anchor the structure to the foundation.

### **5.2.3 STRUCTURAL DRAWINGS**

22" x 34" drawings accurately depicting the structure that is designed including but not limited to:

- Framing plans
- Shear wall details
- Diaphragm and shear wall sheathing type and fastening
- Connectors, blocking, and fasteners for continuous load path
- Plan views, elevations, and cross-sectional details demonstrating continuous load path
- Anchorage to the foundation

### **5.3 SUSTAINABLE DESIGN**

Wood is a superior sustainable building material.

Wood is renewable, like any crop. Engineered wood products can use smaller trees from well-managed forests, saving old growth for future generations to enjoy. Forest land comprises about 33 percent of the total U.S. land area. Demand for more wood products encourages forest landowners to maintain healthy forest regeneration, which in turn helps absorb more greenhouse gases.

Manufacturing wood uses less energy than producing steel or concrete, reducing greenhouse gas and other air-polluting emissions related to construction. Wood sequesters carbon. By trapping the carbon removed from the environment during the trees' growth, buildings made with wood can continue to have a net benefit on the environment when compared to their steel and concrete counterparts.

To show how much the structure is sequestering, provide carbon footprint calculations which include:

Analyze the carbon footprint for 100x the building's structural framing volume to simulate an actual full-size building. Determine the amount of carbon stored in the two-story structure and the total potential carbon benefit using the WoodWorks Carbon Calculator tool found at <http://www.woodworks.org/carbon-calculator-download-form/>

**All input and output shall be provided in the report.**

## **5.4 BUILDING MATERIALS AND SAFETY GEAR**

### **5.4.1 MATERIALS**

All materials specified and used in the structure's construction shall be as follows. All framing shall be of sawn lumber (Douglas Fir (DF), Southern Pine (SP), Douglas Fir-Larch (DF-L), Hem-Fir (HF) or Spruce-Pine-Fir (SPF)) or engineered wood products. Wood structural panels are permitted to be used for the diaphragm and shear walls (structural insulated panels (SIPS) are not permitted). Connections shall be made with nails, screws, and steel connectors. Simpson Strong-Tie connectors and fasteners can be requested from Simpson Strong-Tie using the MATERIALS REQUEST form in [APPENDIX A](#)

### **5.4.2 CONSTRUCTION**

All supplies (materials, connectors, tools, etc.) to construct the structure shall be provided by each team. The construction supplies shall correspond to materials specified in the design and construction documents.

### **5.4.3 SAFETY GEAR**

Each team is responsible for bringing their own tools, safety gear, and personal protective equipment (PPE) including but not limited to construction hard hat, safety glasses, gloves (tips of gloves may not be cut off), closed toed shoes, long pants, etc. and long hair needs to be tied back for use at the construction site (see section [4.5 SAFETY](#)). NOTE: Power tools such as nail guns, power saws, cordless saws, reciprocating saws etc. are not permitted to be used at the competition. However, battery operated tools such as screwdrivers are permitted. NOTE: SST will donate connectors and fasteners (see section [APPENDIX A - MATERIALS REQUEST](#)). Additionally, SST will ship the connectors and fasteners to the teams prior to the competition. Teams will need to provide their own ladders.

## **5.5 BUDGET**

A primary consideration with any project is the budget and making sure the costs are tracked. Each team will provide a budget which includes an itemized list of the cost of materials based on

estimates for the materials used to design their structure and document how the costs were estimated. The budget shall be itemized and included in the report using a spreadsheet provided by the host. See [APPENDIX A - BUDGET FORM](#) for example.

## 5.6 REPORT

### 5.6.1 REPORT CONTENTS

Each team's report must include:

- a. Table of Contents
- b. All team members' names, cell phone numbers and email addresses including the faculty advisor. Additionally, identify the team "Captain" and the 4-6 members who are designated as the "Builders".
- c. The name, telephone number, email address and title of the faculty advisor.
- d. Structural design calculations (Section [5.2 STRUCTURAL DESIGN](#))
- e. Sustainable design calculations (Section [5.3 SUSTAINABLE DESIGN](#))
- f. The budget (Section [5.5 BUDGET](#)) including references for the estimated material costs - unit price.
- g. Statement of how the team will remove the structure from the site and 2-3 methods of recycling or disposal of the materials after the competition (Section [9.0 CONSTRUCTION](#)).
- h. Statement that all team members have read and understand the rules including section [4.5 SAFETY](#) in addition to the referenced OSHA and CAL/OSHA documents.
- i. Certificate of completion for the Ladder Safety Training (see section [4.5 SAFETY](#))
- j. All the host and sponsor logos (ASCE, AWC, APA & SST)
- k. The report shall be signed and dated by at least one (1) team captain and one (1) faculty advisor certifying that the information is valid.

## 6.0 PRESENTATION AND VISUAL AID

Each team's visual aid shall be 30" tall x 40" wide with a foam-core base and include the following items:

Visual aid:

1. Drawings, graphics, text, photos, etc. that summarize and illustrate the significant aspects of the project. The visual aid must at least contain:
  - a. Student chapter and team member names
  - b. Graphics and snapshots of the structure
  - c. Factor of Safety for the diaphragm and the shear walls
  - d. Design features
  - e. Total calculated carbon stored in structure and the total potential carbon benefit

- f. Total material cost of the structure
  - g. Total calculated weight of the structure
  - h. Logos of all the host and sponsors (ASCE, AWC, APA & SST)
2. The visual aid shall be shown ~~shall be shown~~ on an easel (provide your own 60" or taller easel) near the structure at the building site during construction or a designated area by the host.

Presentation:

1. Using ~~the visual aid~~ PowerPoint presentation, each team will give record a presentation about their project ~~on the day of the competition and submit it with the Phase Two submission.~~
2. All members of the builder team must participate in the presentation.
3. Each team will have 10 minutes maximum for the presentation.
4. Each team is responsible for video recording their presentation which shall be uploaded into the team's ASCE Cerberus ftp server folder ~~immediately after the TSDB<sup>SM</sup> Competition at Phase 2.~~

\*In the event of a virtual competition a PowerPoint or slide shall replace the visual aid as part of the virtual team presentation.

## 7.0 ELECTRONIC FILES

Each team shall upload their electronic files into the ASCE Cerberus ftp server folder provided by the host. The team folder shall have **separate** folders for each submittal phase shown below. The files will be uploaded in three phases per SECTION 4.6 SCHEDULE, DEADLINES, AND SUBMISSIONS into the team folder as follows:

Phase One:

1. Project report (Submit in PDF form.)

Phase Two:

2. Structural drawings (Submit in PDF format on 22" x 34" sheet size. Drawings contained in one file. Separate sheets will not be accepted. AutoCAD files will not be accepted.)
3. BIM Model and associated 3D graphics as needed to appropriately convey complete load path.
4. Presentation recording ~~Visual aid~~ (PPT file)
5. Photos and/or videos of any pre-fabrication, etc.

Phase Three:

6. Photos and/or videos of the competition itself
- 6.7. ~~Visual aid including the team presentation.~~

**All teams must have all materials in the folder by the deadline or the team will have points deducted from their score.**

## **8.0 BUILDING INFORMATION MODEL (BIM)**

**The team members will model the entire building superstructure per the design shown in their submitted report, structural drawings, and visual aid.** Teams that do not model the structure to the specifications outlined within the report, structural drawings and visual aid will be subject to a scoring penalization (see section [10.0 SCORING](#)). The structure shall be modeled using only wood members (see section [5.4.1 MATERIALS](#)).

### **8.1 GENERAL**

The completed model must provide a complete load path for gravity, wind, and seismic loads, and all loads shall be resolved into the foundation.

The BIM will be judged based on completeness of the model (including all structural framing materials and connectors), visually demonstrating the continuous load path, accurately calculating the materials cost, and accuracy of the model according to the team report. To be considered complete, all structural members must be modeled in three dimensions (see [10.7 BIM: 70 POINTS](#)).

Please refer to section [10.0 SCORING](#) for any other scoring concerns.

## **9.0 CONSTRUCTION**

**The team members designated as “builders” (see [4.3 Registered Participants](#) ) will construct the entire playhouse per the design shown in their submitted report, structural drawings, and display board.** The team’s faculty advisor must be present during the construction of the playhouse. Teams that do not construct the structures to the specifications outlined within the report, structural drawings and display board will be subject to a scoring penalization (see section [10.0 SCORING](#)). The structure shall be constructed using only wood members (see section [5.4.1 MATERIALS](#)).

### **9.1 GENERAL**

In wood light frame construction, it is a common practice to construct walls, floors, and roofs offsite and deliver these fabricated panels (also referred to as “components”) to the jobsite for erection. This process is referred to as ‘Panelization’. It is the intent of this competition for teams to construct the wall panels offsite and deliver them to the competition site for erection. Roof and floor framing shall be done onsite (so judges can observe the roof and floor construction) but is to be constructed such that it can be easily disassembled. This panelization process replicates real-world construction. For this reason, we require the use of screws for connecting the components (i.e., wall components, floor components) together. This is not to be confused

with the general wood nailing and sheathing nailing (using code prescribed nail sizes) in the assembly of the panels and sheathing done offsite. The screws make the deconstruction of the structures into stacks of panels on pallets much easier. The structural drawings must identify and specify the screw size and location for erecting and connecting the panels together. This adds an extra bit of planning and design to the structure in considering erection and disassembly of the panels. Disassembly and building removal are an important part of construction in this competition.

The roof and floor structural framing members are allowed to be pre-cut prior to the competition date. No prefabrication may be done at the building site prior to the start of the competition.

**The walls and floor may use fabricated panels. For safety due to lifting and ladders, the roof must be constructed on-site (non-panelized).**

The structure is not allowed to be anchored to the construction site area and it is the team's responsibility to provide adequate measures (counterweight) to resist overturning loads as a result of the applied cantilever loading. The completed structure must provide a complete load path for gravity and seismic loads. NOTE: The wind load does not need to be considered beyond the anchorage of the roof rafter into the walls. No counterweight other than the dead load of the structure is allowed to resist any overturning.

Construction on-site during the competition will be judged based on the time of construction, accuracy of construction, continuous load path, materials cost, and accuracy of construction according to the team report.

Please refer to section [10.0 SCORING](#) for any other scoring concerns.

## **9.2 SITE REQUIREMENTS AND CONSTRAINTS**

All teams will be provided with a 24' x 24' area known as the "construction site" as defined by clearly marked lines on the ground to construct their structure. The construction site limits will be measured from the inside of the boundary marker. All sites will be located on relatively level surfaces however, it may not be completely flat.

A hard copy of the report and structural drawings (see section [5.2.3 STRUCTURAL DRAWINGS](#)) must be on the construction site and available for the judges to view during the build. The presentation display board must be shown near the construction site while the building is being constructed.

## **9.3 BUILDING CONSTRAINTS**

The construction process will be timed for each team. A maximum of **1.5 hours** will be allotted for each team's construction.

1. All team members must always be wearing all the safety gear in the construction site (see Section [5.4 BUILDING MATERIALS AND SAFETY GEAR](#))
2. All construction materials (including framing members, fasteners, connectors, tools, etc.) must remain in the construction site during the entire construction process. Point reductions shall apply for violations (see Section [10.0 SCORING](#)).
3. All team members and their building materials and tools shall be set up within the construction site prior to the start time.
4. No construction shall start within the construction site prior to the start time.
5. The team is not allowed to start constructing their project on the construction site until the time starts recording by the judge/timer.
6. Time will begin being recorded after all builders hold their hands above their heads and the captain states to the judge/timer that they are ready to begin.
7. No additional building materials and tools may be added to the construction site after the start time. However, teams are allowed to be provided with water for nourishment.
8. Prior to erection of the second floor walls and roof, the first floor walls and second floor shall be completely constructed.
9. The team will tell the judge when they are ready for review of the structure. The judges shall be allowed time to review the structure, prior to application of any finish materials (veneer, siding, etc.) that would impede or hide observation of the nailing, connections, details, or overall load path of the structure. The timer will stop the clock while the judges are reviewing the structure and during this time, builders are not allowed to step out of the construction site. Once the judge has finished, the timer will restart the clock using the same process when it was originally started.
10. Upon completion of the assembly of a team's structure, all team members will set down all their tools, materials, etc. and the Team Captain will signal to the timer/judge that the team has completed the building and the timer will stop the clock. Once the clock is stopped all team builders must exit the construction site.
11. Team builders will receive a penalty for exiting the construction site prior to completion of the structure (see Section [10.0 SCORING](#)).
12. Once the team has completed the construction, the judges will measure the deflection before the load is applied and after the load is applied.
13. Only the judges are allowed in the construction site during the measurement of the deflection.
14. Each team is responsible for taking pictures of the completed structure which shall be uploaded into the team's ASCE Cerberus ftp server folder immediately after the TSDB<sup>SM</sup> Competition.

## 9.4 BUILDING REMOVAL AND CLEAN UP

Once the competition has ended, the completed structures shall be deconstructed safely and removed from the competition site. . After building the structure ~~and the team presentation,~~ each team is responsible for removal of **ALL** materials used for the project including but not limited to scrap wood, tools, fasteners (nails, screws, etc.) etc. It is very important that each team make a clean sweep of the site and surrounding areas to make sure that **ALL** materials are removed immediately following the ~~display board presentation~~team's building session. Points will be deducted from the team's score if the construction site is not completely clean and/or if any building materials are left after the structure is removed.

Each team shall define in the report the plans for removal of the building and all materials. Potential recycling or disposal of the project materials should be determined prior to the competition. Each team is responsible for removing the building and all materials from the site. The host has the option to remove any remaining structural debris from the site and bill the responsible school.

## 10.0 OVERALL SCORING

Scoring will be based on the team's report, BIM, presentation, and construction of their building. In the instance of a tie, the teams involved will receive the same place and score. For example, if two teams tie for second place in Sustainability in Report, both will receive 18 points.

Scoring is as follows:

<u>Section</u>	<u>Maximum Points</u>
Strength and Durability Analysis in Report	130
Sustainability in Report	18
Costs	20
Creativity & Aesthetics (BONUS)	20
Presentation	11
Submission Requirements	19
BIM	70
<b>Design Points Possible</b>	<b>288 (+5 bonus points)</b>
<u>Construction</u>	<u>Maximum Points</u>
Consistency/Accuracy	130
Load Path	
Completion of Structure	
Build Time (BONUS)	
<b>Construction Points Possible</b>	<b>130 (+5 bonus points)</b>
<b>TOTAL POINTS POSSIBLE</b>	<b>418 (+10 bonus points)</b>

**10.1 STRENGTH AND DURABILITY ANALYSIS IN REPORT: 130 POINTS**

Points will be awarded for the most durable structure based on the performance to withstand the wind lateral and vertical loads, as well as the structural efficiency of the overall structure.

Design Factor of Safety 6 points each, 12 points possible

Points will be rewarded based on the design factor of safety (F.S.) for the design of the diaphragms and the shear walls.

Points will be awarded to the teams that get closest to 1.500 as possible without being less than 1.500. If the F.S. is less than 1.500, zero points will be awarded.

Maximum scores are as follows:

- Roof and Floor Diaphragms 6 points
- Shear Walls 6 points

Completeness and Accuracy of the structural calculations 55 points

Points will be awarded based on the structural analysis, completeness, and correctness.

Structural Drawings: 48 points

Points will be awarded based on the completeness and accuracy of the drawings.

Deflection: 15 points

Points will be awarded based on ratio of calculated predicted deflection from the report to actual deflection measured in competition. In order to qualify for these points, the cantilever deflection must meet the requirements of [SECTION 5.2.1 STRUCTURAL DURABILITY-GRAVITY DESIGN](#).

**10.2 SUSTAINABILITY: 18 POINTS**

Points will be awarded for the most sustainable structure based on the calculated carbon sequestration and potential carbon benefit in the report.

Input Included	5
Carbon Footprint x100 correctly	5
Total Carbon Footprint (see below 8 pts. max)	8
8 pts. Total Carbon Footprint < 200 Metric Tons of CO2	
7 pts. 200 Metric Tons of CO2 < Total Carbon Footprint < 300 Metric Tons of CO2	
6 pts. 300 Metric Tons of CO2 < Total Carbon Footprint < 400 Metric Tons of CO2	
5 pts. 400 Metric Tons of CO2 < Total Carbon Footprint < 500 Metric Tons of CO2	
4 pts. Total Carbon Footprint > 500 Metric Tons of CO2	

### 10.3 COSTS: 20 POINTS POSSIBLE

Donor Documentation or estimate	5
Itemized Costs (quantity, unit costs)	5
Cost (see below 10 pts. Max.)	10
10 pts. Costs < \$550	
8 pts. \$550 < Costs < \$650	
6 pts. \$650 < Costs < \$750	
4 pts. \$750 < Costs < \$850	
2 pts. Costs > \$850	
If no receipts or other documentation are provided, the team get's zero points.	

### 10.4 CREATIVITY/AESTHETICS: 20 POINTS

Points will be awarded by the judges for creativity and aesthetically pleasing structure. Judges will award 1-20 points.

Bonus points for top 3

- 5 points for first place
- 4 points for second place
- 3 points for third place

### 10.5 PRESENTATION: 11 POINTS

### 10.6 SUBMISSION REQUIREMENTS: 19 POINTS

Points will be awarded for:

Visual aid: 9 points

Report requirements: 10 points in total

### 10.7 BIM: 70 POINTS

Points will be awarded based on the BIM as follows:

Accuracy of model: 30 points

Load path: 20 points

Complete Structure: 20 points

Overall structure completion according to the drawings, connectors, anchors, hold-downs placement, cladding etc.

## 10.8 CONSTRUCTION: 130 POINTS

Safe, accurate, and timely construction.

### 10.8.1 CONSTRUCTION BUILD TIME BONUS

Top five teams that have built the structure accurately and have the fastest construction time:

Bonus points for top 5

- 5 points for first place
- 4 points for second place
- 3 points for third place
- 2 points for fourth place
- 1 point for fifth place

## 10.9 ADDITIONAL POSSIBLE POINTS DEDUCTED AND/OR DISQUALIFICATION:

### SECTION 5.1 GENERAL

- 5 points will be deducted for structures, excluding the cantilever, that are larger than 6' w x 6' w x 12' h dimensions.

### SECTION 4.5 SAFETY

- If there are any safety violations as identified by Safety Officials, the team must correct the issue(s) or they will be disqualified.

### SECTION 4.6 SCHEDULE, DEADLINES, AND SUBMISSIONS AND SECTION 7.0 ELECTRONIC FILES

- Teams will have 10 points deducted if the team folder does not contain the required files for Phase One by the submission deadline.
- Teams will be disqualified if the team folder does not contain the required file for Phase One by Phase Two submission deadlines.
- Teams will have 8 points deducted if the folder does not contain the required electronic files for Phase Two.
- Teams will have 2 points deducted if the folder does not contain the required files for Phase Three.

### SECTION 9.3 BUILDING CONSTRAINTS

- 5 points will be deducted for each instance that materials, tools, or builders are out of bounds.

### SECTION 9.4 BUILDING REMOVAL AND CLEAN UP

- 5 points will be deducted if anything is left in the construction site after the structure has been removed.

Other:

- Structure failure results in a disqualification.

## 11.0 ADDITIONAL INFORMATION

- Teams may submit questions as explained in the RFI Section above.
- All judges should be present at this Team Captain's meeting.
- All electronic entries/pictures and videos entries shall become the sole property of the host, American Society of Civil Engineers, and the sponsors: American Wood Council, Simpson Strong-Tie and APA-The Engineered Wood Association. Host and sponsors reserve the right to use or publish all entry material in publications, social media, etc. By entering, the Entrants grant a royalty-free license to the American Society of Civil Engineers, American Wood Council, Simpson Strong-Tie, and APA – The Engineered Wood Association to use any material submitted. Such a right includes publication of photographs and names of award recipients without compensation to Entrants.
- Final judging shall be completed on the day of the competition.



**BUDGET FORM (SAMPLE)**

**TIMBER-STRONG DESIGN BUILD**

**MATERIALS COST ESTIMATE**

Description	Quantity	Unit	Amt	Unit Cost	Total
<b>Wall Framing</b>					
2x2 Wall Studs	40.5	LF			
2x4 Corner Posts	18	LF			
2x2 Top Plate	18	LF			
2x2 Bottom Plate	18	LF			
Total 2x4x8'			10	\$ 3.25	\$ 32.50
<b>Roof Framing</b>					
2x4 Roof System	16	LF			
2x6 Ridge Beam	12	LF			
4x8x7/16" Sheathing	25	SF			
Total 2x4x8'			2	\$ 3.25	\$ 6.50
Total 2x6x12'			1	\$ 11.17	\$ 11.17
Total 4x8x7/16" Sheathing			1	\$ 17.45	\$ 17.45
<b>Wall Sheathing</b>					
4x8x7/16" wsp	70	SF			
4x8x7/16" wsp	32	SF			
Total 4x8x7/16" Sheathing			2	\$ 17.45	\$ 34.90
<b>Lumber Subtotal:</b>					<b>\$ 102.52</b>
<b>Fasteners</b>					
10d Nails (5lb Box)			1	\$ 13.57	\$ 13.57
8d Nails (5lb Box)			1	\$ 13.57	\$ 13.57
SD8x1.25 Screws (100 Count Box)			1	\$ 9.98	\$ 9.98
<b>Fasteners Subtotal:</b>					<b>\$ 37.12</b>
<b>Simpson Connectors</b>					
A35 Framing Angles and Plates			6	\$ 0.90	\$ 5.40
RTC2Z Ridge Tie Connectors			6	\$ 4.98	\$ 29.88
RTB22 Ridge Tie Connectors			28	\$ 1.30	\$ 36.40
LSSJ26JZ/LSSJ26RZ Jack Hanger			4	\$ 5.35	\$ 21.40
A21 Angle			10	\$ 0.36	\$ 3.60

CS22-R (25' length)

1	\$	21.97	\$	21.97
<b>Connectors Subtotal:</b>			<b>\$</b>	<b>118.65</b>
<b>Total Materials Cost:</b>			<b>\$</b>	<b>258.29</b>

\*It is the user's responsibility to verify the accuracy of the calculations.