Timber-Strong Design Build Competition

Architectural Engineering Group Senior Project Final Report

ARCE holics

TIMBER-STRONG DESIGN-BUILD COMPETITION

February 29, 2020

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Competition Description and Objective

The November 2019 Timber-Strong Design Build Competition, hosted by National Council of Structural Engineers Association (NCSEA), was developed by the American Wood Council (AWC), Simpson Strong-Tie Company Inc. (SST), and APA - The Engineered Wood Association (APA) to cultivate timber design, building, and sustainability experience for students. Participating students gained exposure to performance analysis, construction management, building practices, and project bid preparation while practicing as a design construction firm. In the process of this hands-on experience, students were expected to procure all building materials and tools themselves with some aid from sponsors. The goal of the competition was to provide meaningful insight and hands-on experience to students who will eventually become the next generation of industry professionals involved with sustainable design and construction.

The sponsors for this competition were: National Council of Structural Engineers Association (NCSEA), the American Wood Council (AWC), Simpson Strong-Tie Company Inc. (SST), APA - The Engineered Wood Association (APA), the Cal Poly SLO Architectural Engineering Department (ARCE), Lionakis, and C W Howe Partners Inc.

Sponsor Logos

More information about the competition rules and guidelines can be found in Appendix i.

Design, Construction, and Competition

Design began with exploring possibilities in building shapes and profiles. As the structural plan and elevations changed, the need for structural considerations became apparent. Due to arbitrary Factors of Safety imposed by the competition rules, floor heights were determined through a balance of shear wall height to base ratios, constructability, and functionality of floor heights. With the introduction of a possible client in Paso Robles, the structure evolved into a robust chicken coop with a curved roof and wall protrusion.

Structural system design began once the architectural form had been defined. Through investigation of balloon and platform framing, it was decided that balloon framing was the most reasonable choice given the competition demands to fabricate and erect the structure on site as quickly as possible. Balloon framing also gave the client flexibility to add or remove the floors per his chickens' demands. This framing method presented a problem with shear transfer from the floor system to the shear walls, and with some thought and much guidance and advice from practicing engineers, the detail in Figure 1 was developed. The Force Transfer Around Openings (FTAO) method was not used in designing shear walls. If it had been used, there may have been an opportunity for looser nailing patterns and no reductions to shear wall capacity due to height to base ratios. Balloon framing allowed for more efficient design and therefore a lighter structure.

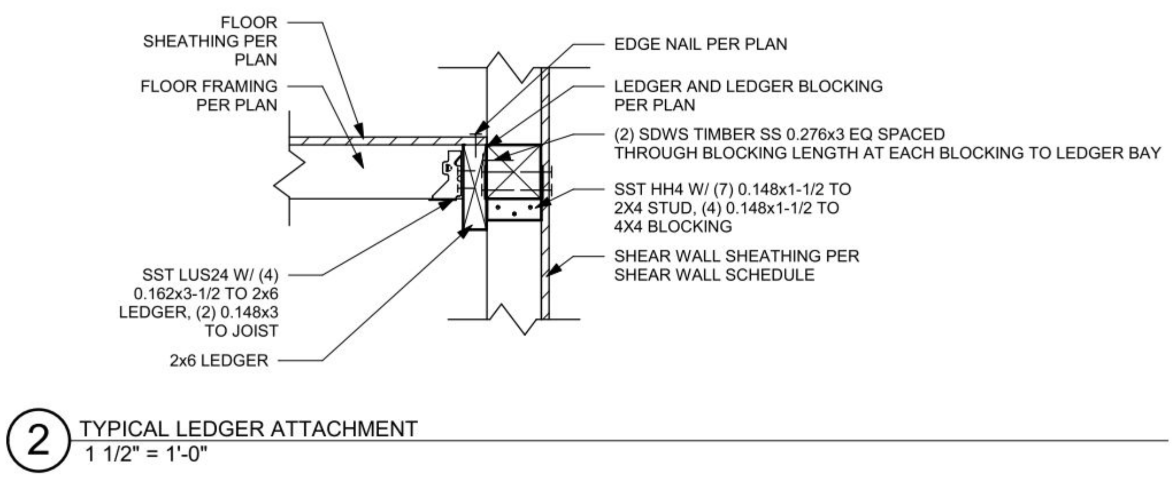
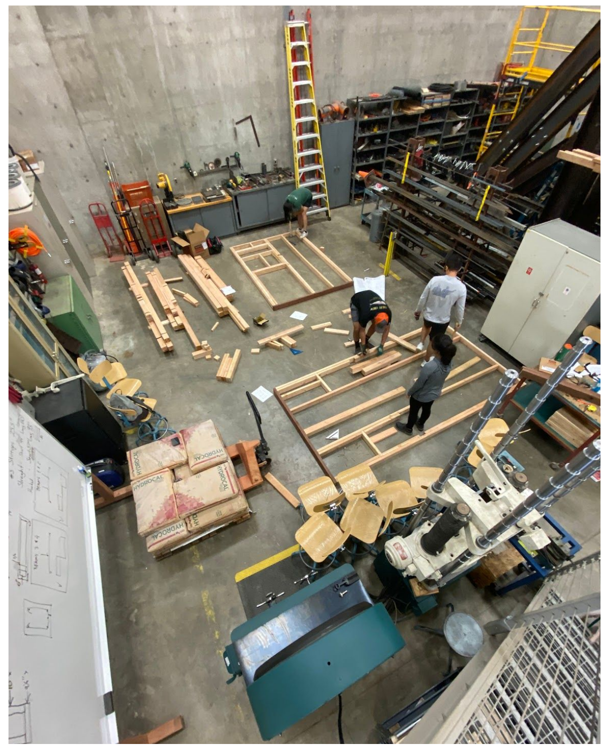


Figure 1. Shear Transfer Detail

Material saved from more efficiently designing the framing helped offset the added material needed for blocking and corner stud details. Despite all design simplicity and planning, one of the limiting factors to the structure was how inexperienced students could build a structure. Larger blocking members required more tolerance and could lead to out of-plumb- walls due to poor craftsmanship.

Construction took place in the High Bay facility in Building 21 Engineering West at Cal Poly SLO. The framing process was expedited with the use of a palm nailer, and the sheathing process even more so with the introduction of a nail gun. Once the panels were finished, they were assembled together in a practice build, where the sheathing overlapping with the perpendicular panel was nailed per structural drawing plans. As exciting as it was to finally finish building the structure per plan, it was even more exciting to realize that the corner detail (see Figure 2) prevented the structure to be taken apart into panels for future practice builds. Thus, the nail gun was replaced with a reciprocating saw to cut through all nails connecting the panels to each other, and many groans of a hard lesson learned echoed in High Bay.



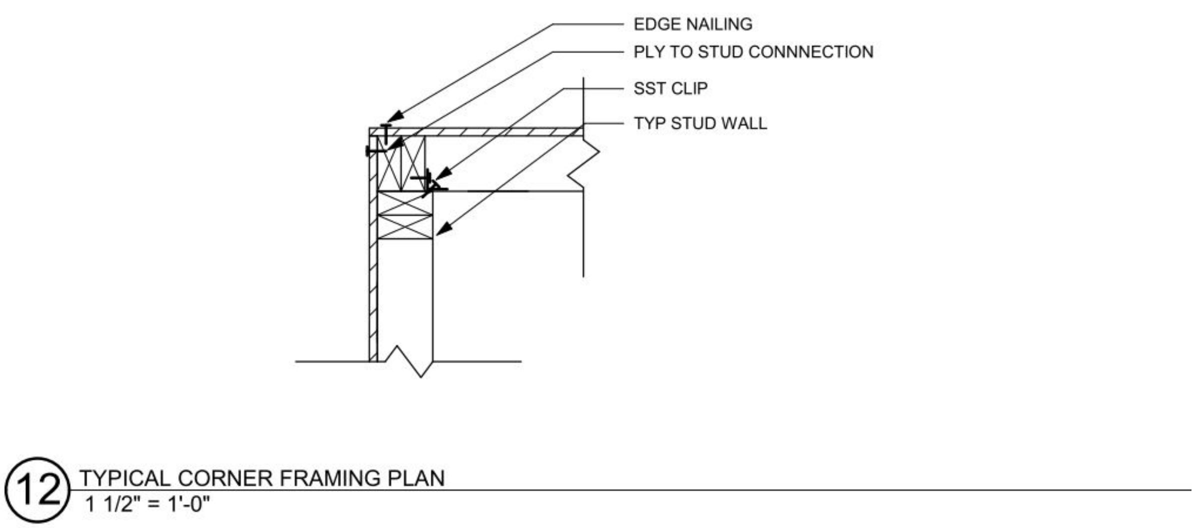


Figure 2. Corner Framing Detail

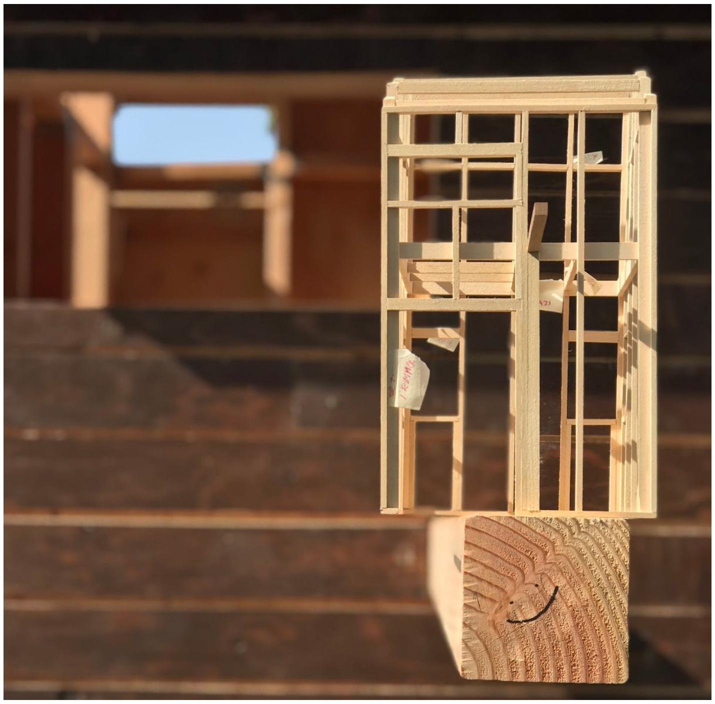
The day prior to the competition, the team transported the structure and tools to Anaheim. The panels were stacked with consideration to the order of wall lifting within the truck. The night prior to the competition, the team revealed their lack of preparation for any sort of presentation, but that was rectified with some late-night, early-morning resolve.

Competition day went smoothly; Once all four walls were up and fastened, floor joists dropped into pre-mounted hangers and the floor sheathing set in so that the roof framing and sheathing could begin progress. Two builders were support to pass tools and materials to the builders working on the floor and roof. After all roof blocking was in place, architectural finishes were attached as the roof sheathing was being nailed down. Architectural components of the structure included a framed-out protrusion, sponsor logos, and a large mustang logo.

Deconstruction was difficult as the nailing of the roof sheathing did not allow power tools clearance to undrill the hex head screws connecting the roof panel to the studs. After a considerable amount of time tediously hand-wrenching the screws, the roof panel was removed. There was concern about the team's ability to remove the structure within the allotted time due to our lagging progress with disconnecting the roof from the studs. However, once the roof was removed, the rest of the disassembly happened quickly and painlessly. The wall with the cantilever floor beam was slid out to allow the floor panel to be dropped out. Then, the remaining three walls were unfastened and hastily stacked in the truck for transport back to San Luis Obispo, out of consideration for the students with classes and midterms the next day.

Fully Constructed Structure featuring Sponsor Logos

Fully Constructed Structure featuring Cal Poly Mustang



The structure was evaluated on its architectural features, structural design, construction in accordance with structural drawings, and accuracy in the calculation of the cantilever beam deflection. The calculated beam deflection was within a hundredth of an inch of the actual deflection.

Team members who stayed behind to attend the evening reception celebrated first place with their faculty advisor Kevin Dong.

Post-Competition Phase

The structure was predetermined to be donated to a Paso Robles resident to be used as a chicken coop on a farm. The final arrangements for the structure were coordinated by the client, who rented a trailer, transported the panels to their property, and assembled the structure themselves. Excess screws and nails were also donated to the client for assembly. Figure 3 shows the client with the newly reassembled structure on their property.

Figure 3. Client with Structure

Global Impact

The global significance of this project's direct reach is limited to emerging engineering and related discipline students within the United States. The competition was offered at a national level, and the further possible extent of its reach would include students from the U.S. Territories Guam, Puerto Rico, Samoa, Virgin Islands, and Northern Mariana Islands.

When considered in a broader lens, the environmental impact of instilling sustainability considerations and resources to the next generation of industry professionals would have global significance by influencing how buildings and structures are designed and built. The exposure to wood as a 100% renewable resource that outperforms other building materials in overall carbon footprint reduction has ingrained the involved students with a mindfulness to its strengths, and encouraged an interest in more timber design with engineered wood products such as Cross Laminated Timber (CLT), Glue Laminated Timber (Glulam), and more.

Societal Impact

This first national Timber-Strong Design Build Competition was an outstanding feat of coordination between the sponsors, and its legacy lies in the participating students and surrounding communities.

The competition had a distinct intention to address gender representation in the industry. According to Catalyst, a global nonprofit dedicated to helping organizations accelerate progress for more women in workplaces, 19.7% of Bachelor's degrees are earned by women in postsecondary institutions in the United States. At least one participating builder was required to be female, and on the day of the competition, it was refreshing and encouraging to see a more equal ratio of men to women on the build site than in typical classroom settings. Seeing women in engineering and construction is important for students to normalize and can help their confidence in seeing role models and opportunities for all.

From a technical perspective, the introduction of wood design to engineering students who may otherwise not be able to experience this building material may lead to the development of more future engineers comfortable and confident in timber construction. Timber construction is an economic and accessible system that leads to cheaper housing, more jobs for local trades, and faster community development or rehabilitation. In the process of designing the structure, there were instances where our team briefly researched possible alternative structural solutions, such as using a Simpson Strong-Wall Shear Wall in place of our own constructed panels, or entertaining the idea of how our structure would be built and assembled if the panels were from CLT.

From another perspective, many of the structures built were disassembled and donated to the Childhood Cancer Foundation of Southern California, INC. Donated structures were intended to be repurposed as backyard playhouses for underprivileged children in need of new enrichment and environment that they would otherwise have difficulty accessing. Structures that were not donated to the Childhood Cancer Foundation of Southern California, INC, such as the Cal Poly SLO teams, were donated to local community members to serve its new life as a chicken coop. In past competitions, the structures built were disassembled and donated as material for animal shelters and other organizations. The interaction between donating students and the entity they donated strengthened the sense of community between the parties, be it with the cancer foundation or with local residents.

Cultural Impact

The cultural impact of this competition permeates from within the student outwardly to the society where their achievements serve. For students with limited access to learning about timber design in school, this project gave them invaluable exposure and experience to the processes of designing, analyzing, and constructing. With every year, another generation of students come closer to their professional life with wood construction as a skill, and this may eventually lead to more timber-constructed buildings in the future. As sustainability now needs to be urgently addressed, not only is a culture where engineers should know timber-construction important to the civilization they contribute to, but also a culture of using renewable resources and solutions where possible.

Environmental Impact

Wood is a renewable resource that outperforms other building materials in overall carbon footprint reduction owing to its ability to trap carbon. Its availability allows for less transportation emissions, more local jobs, and even reduced demand overall. The most effective approach to sustainability is reducing demand, be it demand of materials, tools, or energy.

Given this context, the more notable environmental impacts of this structure were in its repurposing in both its entirety and its components. The structure was donated to be repurposed as a chicken coop, and additional components, such as windows and trim, were installed by the client using parts from a previously demolished structure on their property. Leftover wood was trimmed to become blocking and a small step ladder to maximize the material. Scrap plywood sheets were ripped to create material for siding, and students donated their own leftover wood stain

Economic Impact

Wood construction is typically fast and efficient, and can also be done year-round. Building with wood does not require large tools, equipment, and job sites that would otherwise be difficult to accommodate steel fabrication or large scale concrete delivery. Prefabrication of panels makes expedites construction, and locally sourced wood makes delivery and turn around quick. Installation times are reduced and are typically less to install, with labor being more readily available as wood is a common and accessible building material.

Personal Reflections

Anna Luehrs

I have learned so many things through this project. This includes how to work with different people, the technical side of the project, and the actual building of the frame. I also learned how to cope when big mistakes were made.

The first thing that I learned was how to better work in a team and to see people's strengths. There were many people with different kinds of confidence levels with different kinds of topics. I had more confidence in calculations than in construction, but that does not mean that I did not help out in construction. I did not lead any specific part in the construction, but always helped and was there to work on the project. This was hard for me, since I wanted to be more involved in leading but did not have much experience prior to this in construction. This was a time for people who had a lot of knowledge or that their strength showed through during this part.

The second thing that I learned was about creating a new set of drawings and details as well as producing many calculations. This was a project where the group could decide the framing and decide how the building was going to look. This was different from any of the other projects I had done in previous classes. I learned a lot about the layout of sheets, how to call out specific elements of timber construction, as well as how to be as efficient as possible with details. The competition itself only asked for specific details, but more were done. I ended up working on many of the details, which helped me visualize how this would be constructed. Fast forward into the construction phase, the connections were not all done how we had drawn initially. This was a huge part of learning for me, since constructability within timber design was very new to me. This was a huge part of the project, so I now have a lot more information about what can be built, what is challenging to build, and what is not possible to build. In terms of the calculations, the calculation that was the most challenging but also the most rewarding was the deflection calculation. In the competition, this was worth a substantial amount of points. I knew that in the NDS for deflection, the modulus of elasticity changed due to the probability of the strengths of timber. I learned that this was accurate for this project but that it may not always be due to this probability curve.

The third thing that I learned a lot about was discussions with the client. I found the client on my own by having connections with members in the community of San Luis Obispo and the surrounding areas. Because of this, I found William, a student at Cuesta College whose family has a farm in Paso Robles. We discussed the possibility of him taking the structure after the project was complete. He mentioned that a greenhouse or a chicken coup would be beneficial, and with the dimensions required for the windows, the structure from the very beginning was going to be a chicken coup. This greatly influenced how we would design the base architectural facade on the outside as well as the roof. These

ideas were discussed with William to make sure that he and his family liked what the outside was done. There was also that the architectural pieces were added with screws, to make sure that William would be able to add or take away anything not necessary to the structures stability. This was a lesson learned because I had not thought about this at the beginning of the process, but it came together in the end.

The fourth thing that I learned a lot about was the actual construction of the frame. The construction phase was out of my element, but that did not stop me in trying to help with as much as I could. This opened my eyes to what is actually constructible and how to help in a supporting role to those who knew what exactly to do but needed help to make sure it got done in a timely manner.

Lastly, I learned a lot about what it means to not succeed in all aspects. In much of my coursework, I was always able to have things be completed the way that I planned but also that I was the only one affected by the work that I did. In this project, we as a group, had to work on things for ourselves but take care of the space we were working in. We messed up in cleaning up the space we were lucky to have and that was very difficult on me when I realized we had messed up. This messing up impacted someone else, which was very difficult for me to realize that I could not fix that. Due to this, I learned how to cope. I learned how to see my anxiety with this and realize that I could not fix this.

This senior project has opened my eyes to what is possible in the timber construction industry. It makes me excited about what is to come since I have just started to learn about the different possibilities. There were many ups and downs through this project, but I am proud of how it turned out. I worked on so many calculations, details, and worked hard on the construction. Some things were not my strong point, but I feel that as a team we were able to complete the project balancing people's strong and weak points.

Dolores Herrera

At the start of our senior project, my expectations were that we would do the work, have fun, and naturally learn in the process as this was my take on the "Learn by Doing" motto. The Timber Design-Build Competition was the perfect opportunity to demonstrate the learned principles from the classroom and tangibly build upon our knowledge. The challenge then was to design and bring that design to fruition. I knew that we had to hit the ground running with this project because we had a short amount of time for completion. My learning was triply accelerated with much guidance from professors and with a capable team. However, this project meant more than learning outside the classroom. It is a real world experience of being an architectural engineer and a glance into the future of the profession. I found it to be a privilege that not many undergraduate students come by. We had to pick up things that we otherwise never learned in our studies, such as staying organized and coordinating with each other to stay on schedule. We had to delegate tasks and play to our strengths, and we even challenged ourselves to stray away from otherwise ordinary design, both architectural and structural.

The lessons learned from our project proved that each of us has the necessary skills to take on timber design. As an engineer, one of the most invaluable skills I took away from this project was problem solving. With timber design, there are so many possibilities to get to an end result. There is no one way to execute a design, so having the insight to not only solve what is in front of you but also foresee any potential consequences is indispensable. This project took me outside my comfort zone in terms of construction, but it was worthwhile to follow it from start to finish. Translating drawings from paper to a full-scale structure is no simple task. The learning experience as an architectural engineer was going beyond the drawings and building the design because from the perspective of a structural engineer, exposure to construction may not be as in-depth. Being able to build something that I helped design gives me confidence in my future capabilities. Moreover, it increases my empathy with contractors in terms of constructability.

In addition, I learned that working in a team is perhaps the greatest win of all because you are not only surrounded by intelligent minds, but also people who have different perspectives and can thus formulate diverse solutions. As with any team, I found that we all had our strengths and weaknesses, but we quickly became interdependent. Trying to do one thing on your own was impractical and impossible to accomplish without frustrations. Another lesson that came with teamwork is that it is totally acceptable and even encouraged to ask for help. Inquiry, whether it be due to confusion, for clarification, or for assistance is key for success. Communication and constant inquiry between each other, with advisors, sponsors, and the National Council of Structural Engineers Associations (NCSEA) helped us accomplish our design with the utmost efficiency.

I highly enjoyed the Timber Competition as I got to see how schools from across the country took the same prompt and the same rules and came to different finished products. As stated before, participating in this competition was a privilege that not many engineering students can do or perhaps are aware of. The exposure of seeing how other schools design and build helped me develop a type of self-awareness that comes with structural design and construction. For example, no other school attempted balloon framing as we did, but we had the advantage of being on the West Coast as other schools had to fly their structural components to California. Transporting prefabricated walls that could be up to 12 feet tall is extremely difficult and expensive, moreso traveling across the country. I highly admire all of the schools who participated.

I would like to thank the National Council of Structural Engineers Associations (NCSEA), the American Wood Council (AWC), Simpson Strong-Tie Company Inc. (SST), and the Engineered Wood Association (APA) for hosting this incredible competition. I would also like to extend many thanks to our sponsors who made our project possible: the National Council of Structural Engineers Associations (NCSEA), Simpson Strong-Tie Company Inc. (SST), the American Wood Council (AWC), the Engineered Wood Association (APA), the Cal Poly Architectural Engineering Department, Lionakis, and C.W. Howe Partners Inc.

John Leone

In early November 2019, our Design Build team of six travelled down to Disneyland in Anaheim, CA with our prefabricated two-story wooden structure; our team was competing in the National Timber Strong Design Build competition. Using the proper calculations, drawings, and documentation the objective was to design, prefabricate, and construct this six-by-six, two-story timber project on-site in ninety minutes. To summarize the outcome, our team followed all guidelines and completed building within the given timeline earning us first place; nonetheless, there were many challenges, failures, and lessons learned leading up to this achievement.

The first challenge faced presented itself in the design phase. With no architecture students on the team, we struggled with finding a design that was aesthetically appealing while not becoming too difficult to construct. We worked around this by first designing an exterior facade we were comfortable with and then moved into the framing layout. By understanding the architectural result we were looking for, it became much easier to locate where to place our shear walls and openings. Another big decision that came with the design was how we would prefabricate our project to reduce our construction time. This led to the decision of balloon framing where we entirely pre-framed our four full-height walls so our only task was to stand them up and fasten together during the competition. This framing decision simplified the construction aspect by breaking down this large project into smaller sub-parts which helped speed up our build and ultimately allowed us to finish in time. There were a few other design setbacks that our team had to work around such as the framing plan for our curved roof since it served as more of a modern feature. These were more minor issues that we were able to solve quite swiftly and appropriately.

The next main area of difficulties came with the construction of the project as nobody on the team was too familiar with timber framing. As we moved into this phase, I had a good understanding of the framing at this point and prepared most of the members to assemble. Besides ensuring the cuts and dimensions were consistent with the drawings, there was not too much trouble framing the four walls of our project. The bigger issues came with the flooring and shear walls as these pieces ended up being a bit more difficult to cut with pristine accuracy. In the end we managed to get the correct walls, floor, and curved roof assembled so we started to move into practice builds; except when we went to disassemble the walls we realized we had nailed the panels together. This issue came more with the nature of this competition as it requires a structure to deconstruct and we overlooked that part as we were nailing on our shear walls. It ended up being a simple, yet time-consuming, fix as we had to Sawzall the three edges that were connected. Once we completed that the team was just left with a couple days to practice build so we knew our roles during the competition. I think we got through two complete practices and were able to smoothly run through the process towards the second. All in all, I believe we had prepared thoroughly for our roles in the project which immensely streamlined our on-site build.

Being on the newer side to Design Build and a first time competitor in the Timber Strong competition, I was definitely unsure of what to expect throughout the project; however, I found the design problem very interesting and was happy with the people on our team. I think we put together a diverse team and had a background where everyone was able to contribute using their own strengths. I think this was a major advantage to us as I noticed we had teammates who could carry the group at any point throughout the project and not just excel at either the design phase or construction phase. Additionally, the way our entire team was fully involved from the start to finish really helped ensure all members were up to speed and knew what stage we were in the process. I found it exciting to be able to be apart of the process from design through construction and have become more and more interested in Design Build because of the competition. While I still enjoy the design concepts and structural calculations we do through our coursework, I still like to be active and get the opportunity to physically work on the project that our team created. Overall, I think everyone on our team completed a successful structure, learned plenty of lessons along the way, and had the opportunity to explore an alternative application to Design Build.

Lilliann Lai, Team Captain

Having witnessed the trial and error of the previous Timber-Strong team, I had my apprehensions about what obstacles our team would encounter this year. I expected myself to learn time management, scheduling, and coordination through the process of the competition preparation. Yet, nothing could prepare me for how intimately and painfully familiar I became with shear-wall calculations, my frustrations at my initial attempts at delegation, and the bittersweet feeling of finally solving a problem that I knew was completely due to negligence, inattention, or ignorance of our team. My most meaningful areas of growth were in time management as a leader, leadership overall, and confidence.

I did not realize that team captain in itself had so much time commitment, and so when I delegated calculations evenly to team members, I would often be staying back much later than any of my peers because I had to provide support and administration in addition to my calculations. Eventually, I learned to delegate more tasks to others, even if it seemed that I was contributing less in the moment. Spreadsheets tracking hours, the quantity and cognitive intensity of tasks, and regular task lists kept the project moving and distributed, even if it was sometimes a week behind my intended schedule. I also learned to compromise and strategically evaluate situations for worth. My leniency for mistakes such as miscut members, broken drill bits, or failed solution attempts increased, but my tolerance for lack of proactivity, excuses, and perceived lack of work ethic between team members dangerously waned. Different people needed different amounts of guidance in different stages of the project. Balancing my team's strengths and weaknesses was a dynamic process that changed with availability, injuries unrelated to the project, and personal capacity, and at times we simply lacked confident manpower.

It was difficult to assume some of the more unsavory aspects of leadership, such as addressing qualms or dissatisfaction. Everyone worked hard and contributed their share, but time did not always result in quality. It is always hard to hear what you have done isn't satisfactory despite the many hours you've dedicated, and there was a large range in what each individual person considered "a good job". Structural design and drawing quality had a strong positive relationship with time, where as design and aesthetic choices needed time for trial and error. I am glad that the team members all had a strong sense of integrity and did what they could to contribute their share. Confidence was an aspect that was unexpectedly a controlling factor in the progress of our work. It almost felt better to be ignorant and feel confident in being wrong because pacing would be unaffected. Students who felt confident self-initiated in whatever facet they were comfortable in, and students who were confident in themselves were more likely to pursue and extract more benefit from new experiences. I lacked confidence in my leadership, and the team suffered initially from my hesitations. I trusted my team as a whole, and eventually learned when to provide guidance and when to allow struggle for growth.

I also learned to have fun as a team captain. I enjoyed foreseeing a conflict and seeing if my peers could catch it, or purposely contriving complications by proposing "solutions" that would solve one problem while creating another. Little did I know, I was not as sharp as I thought and we ultimately did create problems without even realizing. I did sense that I was a source of frustration because of my intention to elicit critical or creative thinking, but by this point the power had gone to my head and I was an unstoppable force. By some turn of events, this ego trip also gave me the confidence to speak up and make executive decisions in spite of what my more vocal team members believed. In trying to channel my academic advisor, I pushed my team members to go as above and beyond as we reasonably could, and the hard work paid off with many lessons learned and all fingers intact.

The most challenging aspect of the competition was not the calculation, construction, or sleepless nights. My coursework prepared me well for the design and sleep deprivation, and my work experience provided a decent foundation to frame. Taking responsibility for the mistakes our team made in our work-space gave me a reality check; Not all wrongs can be made right, and in our situation, we had severely burdened and undermined our shop technician's ability to do his job on an extremely critical concrete-testing day. In seizing first place nationally, we hurt a huge supporter of our project through our unintended negligence, and experiencing that interaction helped me be mindful of my words, people's body language, and the privileges I have to people's time and help.

The commitment and dedication the senior team members devoted to this project cannot be understated, and all of them had their opportunities to shine. Audrey Luu, a second year Architectural Engineering major, and Jonathan Lin, a third year Construction Management major, were imperative to the success of the team and their contributions in construction, moral, and media made our achievements possible. Their earnest enthusiasm and tenacity make them indispensable team members, and I couldn't ask for better. I am also grateful to the many architectural engineering classmates who were completely uninvolved with the project but helped me regardless, namely my friend Tony Nguyen, who helped me in cutting plywood, carrying material, and unloading the structure in the dead of night, and the cast of other students conveniently available come time to unload building material shipments.

Citations

Catalyst, *Quick Take: Women in Science, Technology, Engineering, and Mathematics (STEM)* (June 14, 2019).

Timber-Strong Design Build[SM] Competition

Rules & Objectives

as of 9/4/2019

November 12, 2019

Disneyland® Hotel · Anaheim, CA

NCSEA Structural Engineering Summit

National Council of Structural Engineers Associations

AMERICAN WOOD COUNCIL

SIMPSON Strong-Tie

APA THE ENGINEERED WOOD ASSOCIATION

Timber-Strong Design Build^{SM}

Previous Competition Winners

2019 PSWC

1st Place: California Polytechnic State University, San Luis Obispo (CPSLO)
2nd Place: Arizona State University (ASU)
3rd Place: University of California Los Angeles (UCLA)

2018 PSWC

1st Place: San Diego State University (SDSU)
2nd Place: Arizona State University (ASU)
3rd Place: University of California Irvine (UCI)
Honorable Mention: California State Los Angeles (CSLA)

This document, which is available at http://www.ncsea.com/timber/, describes the Student Timber-Strong Design Build[SM] Competition and states the 2019 rules for the conference. **Clarifications, which include any revisions to the rules, are published on NCSEA Basecamp and do not appear in this document although they are formal addenda to the rules. (Each student team will receive a link to Basecamp upon receipt of their school's registration.)** Basecamp will also be the place to request clarifications and other find other information.

Contents

WELCOME

The host National Council of Structural Engineers Association (NCSEA) 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 Student Timber-Strong Design Build^{SM} (TSDB^{SM}) 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^{SM} Competition




Timber-Strong Design Build^SM Competition

NCSEA National Conference 2019

1.0 Event Description

The host National Council of Structural Engineers Association (NCSEA) 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 sustainable, 2-story wood light-framed children's playhouses at Disneyland Park in Anaheim, California. 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, NCSEA, AWC, SST and APA are seeking student teams to design and build a playhouse that is sustainable, aesthetically pleasing and structurally durable. In the interest of sustainability, the playhouses must be deconstructed/disassembled for repurposing and donated for repurposing at the end of the competition.

2.0 Objective

The 2019 Timber-Strong Design Build^SM (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 preparation of a project bid, the performance of analysis, 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 insight 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^SM Competition shall be determined by compiling a team's total number of points from report, construction, presentation and creativity portions of the competition. The 1st 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 1st place winning team. Other awards may be award as well.

Each team shall receive a commemorative certificate for their participation in the Timber-Strong Design Build[SM] Competition.

4.0 General Rules and Eligibility Requirements

4.1 Rule Changes and Precedence

The Rules and Regulations (Rules) of the Timber-Strong Design Build[SM] 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 of this year's competition.

4.2 General Information

General information on the competition as well as registration information for the Competition is located on the NCSEA website (www.ncsea.com/timber).

Each of the Universities are invited to structurally design and construct 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 construct the wood structure which was designed in the team report at the "construction site". Each team will conclude with a display board presentation (see Section 6.0 Presentation and Display Board).

NCSEA will provide each team captain with a link to cloud folders where all electronic files will be uploaded. To gain access to online submission platform. Upon registration each team Captain will be given access to cloud folders which will require its own registration and login.

4.3 Registered Participants

All team members must be registered for the NCSEA 2019 Summit. A maximum of **15 teams** may participate. The FIRST 15 teams that meet all the eligibility requirements, will be admitted to compete in the competition. There is no limit to the number of students who participate in the development of the report and the

display board, however, only the 4-6 members designated as builders (see Section 4.3.1 Eligibility Requirements) may register and attend the competition. Substitutions will be allowed up to the time of on-site registration. However, at least 80% of the team members shall not vary throughout the competition. In other words, 80% of the team members that start the competition will be the same team members that complete all portions of the competition prior to registration on-site. No substitutions shall be permitted after on-site registration has been completed.

4.3.1 Eligibility Requirements

Registered participants shall meet all the following requirements:

a. Be an undergraduate student majoring in engineering, architectural engineering or engineering technology during the 2019-2020 academic year. Students do not need to be enrolled during the entire year (e.g., students graduating in December, or students not in school during the fall term but in school for the spring term.) Students that graduate during the academic year and have begun graduate studies during the same academic year are eligible to compete;
b. Be members of an NCSEA Member Organization Younger Member or Student Member or American Society of Civil Engineers (ASCE) AEI or SEI Student Chapters in good standing
c. Each University may enter only one team per department (max. two teams per University)
a. In the interest of collaboration, universities with more than one American Society of Civil Engineers (ASCE) Student Chapters are encouraged to combine into one team
d. 4-6 members shall be designated as “builders” and include at least one female and one male.
e. One builder of the team must be identified as the Team Captain.
f. The team must have at least one underclassman.
g. The team must have at least one male and one female.
h. The team **MUST** have a least one faculty advisor. The faculty advisor shall accompany the teams to the competition and be present during the construction of the building.

4.4 Spirit of the Competition

The judges and/or NCSEA may take disciplinary action, including warnings, point deductions, or disqualification of a team or entry for inappropriate use of materials, language, alcohol, uncooperativeness, or general unprofessional behavior or unethical behavior of team members or persons associated with a team. The

judges and/or NCSEA have the final authority to determine what constitutes a violation of the "Spirit of the Competition" and may take appropriate action towards point deduction or disqualification.

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.

Students shall practice safe fabrication procedures and seek appropriate instruction and supervision (see section **8.0 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). Student teams are solely responsible to follow these safety standards. (See section **5.4 Building Materials and Safety Gear**).

4.6 Schedule, Deadlines, and Submissions

The following is a list of important dates related to overall competition schedule, including deadlines of applicable submissions. Teams should consider this as only a partial list of dates.

Mandatory Task	**Due Date**
Intention to Compete and registration	September 16, 2019
Electronic files Phase One upload to a cloud folder provided by NCSEA (See Section 7.0)	October 14, 2019
Requests for SST connectors and fasteners See Appendix A	October 14, 2019

Requests for stipends See Appendix A	October 14, 2019
All waiver form(s) See Appendix B	October 14, 2019
Electronic files Phase Two upload to a cloud folder provided by NCSEA (See Section 7.0)	October 28, 2019
Captain's meeting	November 11, 2019 (Afternoon or Evening)
Presentation & Display Board after each build session (See Section 6.0)	November 12, 2019
Construction of Structure	November 12, 2019
Electronic file Phase Three upload to a cloud folder provided by NCSEA (See Section 7.0)	November 12, 2019, 4:30 pm (Pacific Time)

All team Captains shall attend the Captains 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 constructed structures shall have a footprint dimension of 6'x6', 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 structure shall contain the following:

1. Design and build 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^{nd} floor framed opening: **one** opening in the floor.
    d. 2^{nd} floor walls framed openings: min. **three** windows. The windows may be located anywhere.
    e. 1^{st} floor walls framed openings: min. **three** windows and **one** door.

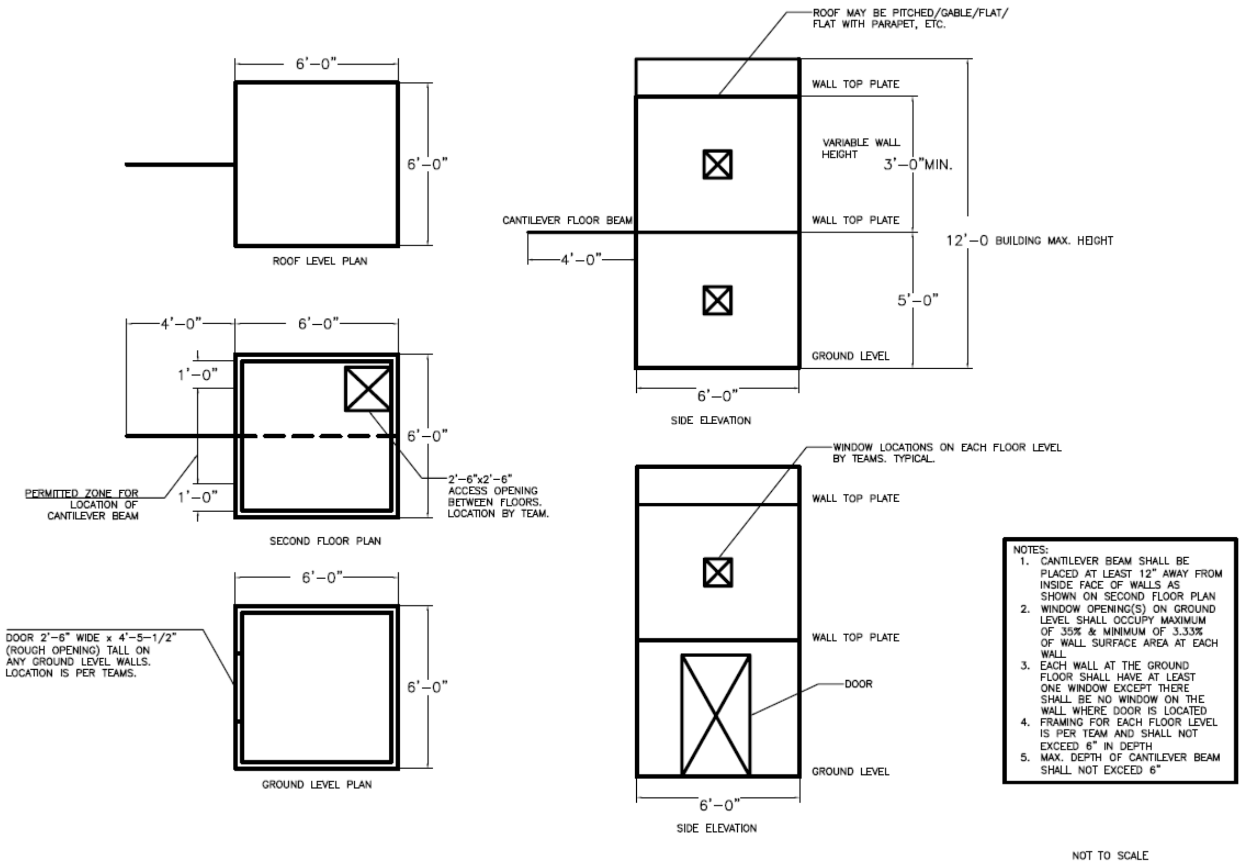


Figure 1.

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 2021 International Building Code to up to 18 stories using mass timber construction. As structural material that provides sustainability, strength, and resilience, each team will design the building per this section using wood products (see section **5.4 Building Materials & Safety Gear**). 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. Must include the following:

5.2.1 Structural Durability-Gravity Design

1. Vertical design loads
   Roof Dead Load = calculated self-weight

Roof Live Load = 20 psf
Floor Dead Load = calculated self-weight
Floor Live Load = 40 psf
Point load at the end of the cantilever 150 lbs.

2. Design 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. This predicted deflection from the report will be compared to the actual deflection measured at the competition.
    b. A vertical point load will be applied at the end of the cantilever floor beam after the construction phase. Deflection will be measured at the loading point.
    c. Beam deflection, after the load is applied, must be at least .5” and not greater than 1”.
    d. 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 as follows
    a. Lateral seismic ASD load of W = 100 plf at the roof diaphragm and 150 plf at the floor diaphragm in both directions (not simultaneously).
    b. Wind uplift load W=50 plf
2. Lateral Design – the design shall include the following:
    a. Seismic:
        i. Roof diaphragm design (in-plane shear only) both directions
        ii. Floor diaphragm design (in-plane shear only) both directions
        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 for the diaphragm and shear walls (ratios of nominal/ASD actual). Teams shall provide calculations to the 1000th decimal place and include the average F.S. for the diaphragms and the 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 standard.
4. Assume that the structure will be connected to a foundation with typical anchor bolts and SST hold-downs.

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

5.2.3 Structural Drawings

24” x 36” drawings accurately depicting the structure that is designed including roof and floor framing plans and shear walls (see **section 8.1 General)** and include but not limited to:

- Framing members
- Diaphragm and shear wall sheathing type and nailing
- Connectors, blocking, and fasteners for continuous load path
- Fasteners for connecting panels together.

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 total U.S. land area. Demand for more wood products encourages forest land owners 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 & Safety Gear

All supplies (materials, connectors, tools, etc.) to construct the structure shall be provided by each team. All framing shall be of sawn lumber 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.

Absolutely NO chemicals will be allowed on the Disneyland property including the building construction site.

Each team is responsible for bringing their own tools and safety gear 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: Nail guns and power saws are not permitted to be used at the competition. NOTE: Simpson Strong-Tie will donate connectors and fasteners (see section **5.5 Budget**).

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 the receipts for the materials used to design their structure. The budget shall be itemized and included in the report using a spreadsheet provided by NCSEA via Basecamp. See Appendix A for example.

Each participating team may receive donations and has the option to use an allotment of Simpson Strong-Tie (SST) products (total maximum retail value of $300.00).

Additionally, to encourage participation, American Wood Council, APA-The Engineered Wood Association and Simpson Strong-Tie are offering a stipend to qualifying teams of $700.00 max. per team, to offset the travel, materials and t-shirts. If teams use the money to purchase t-shirts, the shirts shall contain all host and sponsor logos (NCSEA, AWC, APA & SST).

Teams will need to request the stipend and/or the connectors/fasteners by completing and submitting the request forms (see Appendix A) which will be posted on the NCSEA Basecamp.

If materials are donated (including the SST products), an estimated cost of the donation shall be obtained from the donor and included in the budget. If there is

no receive for other than donated material, the team must provide an estimate of the cost and document how the costs were estimated.

The Budget will be graded with respect to the provided receipts or the estimate provided. **Without proof of receipts or clear documentation on how the estimates were derived, the calculated cost will not be accepted.**

5.6 Report

5.6.1 Report Contents

Each team's report must include:

a. Table of Contents
b. All team member names and email address. Additionally, identify the 4-6 members who are designated as the "builders".
c. The name and contact information 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 material costs scanned receipts and estimates if applicable.
g. Statement of how the team will remove the structure from the site and 2-3 methods of recycling or donating the structure after the competition (Section **8.0 Construction**).
h. All the host and sponsor logos (NCSEA, AWC, APA & SST)

6.0 Presentation and Display Board

Each team's presentation display board must be 30" tall x 40" wide with a foam-core base.

On the board:

1. Drawings, graphics, text, photos, etc. that summarize and illustrate the significant aspects of the project. The board must at least contain:
   a. University and team member names
   b. Graphics and/or photos 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. Arrangement for removal of structure

i. Logos of all the host and sponsors (NCSEA, AWC, APA & SST)

2. The display board shall be shown on an easel near the structure at the building site during construction or a designated area by the organizers.

Presentation:

1. Using the display board, each team will give a presentation using the display board, about their project upon completion of the construction of their structure.
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 cloud folder immediately after the TSDB[SM] Competition.

7.0 Electronic Files

Each team shall upload their electronic files into the NCSEA cloud folder. The files will be uploaded into three phases per Section 4.6 Schedule, Deadlines, and Submissions into the team folder as follows:

Phase One:

1. Project report

Phase Two:

2. Structural drawings
3. Picture or graphic of completed presentation display board
4. Photos and/or videos of any pre-fabrication, etc.

Phase Three:

5. Photos and/or videos of the competition itself 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 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 **9.0 Scoring**). The structure shall be constructed using only wood members (see section **5.4 Materials**).

8.1 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 in panel form to place on a shipping pallet. This panelization process not only replicates real-world construction, but also makes it easy for disassembly and reassembly by the charity organization. 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.

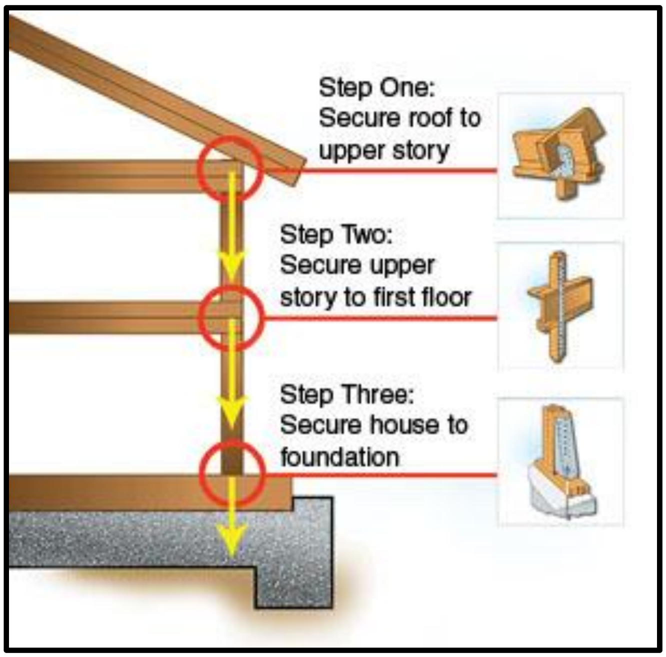
The structure is not allowed to be anchored to the construction site area and it is the team's responsibility to provide adequate measures (counterweight) to resist overturning loads as a result of the applied cantilever loading. The completed structure must provide a complete load path for gravity and 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 **9.0 Scoring** for any other scoring concerns.

‘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 diagram illustrates continuous load path through wood members, fasteners, and connectors:



Implementation of a continuous load path in the design and construction of the structure in this competition will be a major focus. Simpson connectors and fasteners will be available for specification and use. A wind uplift force will be given for calculation and teams will calculate the 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. Holdowns are to be designed and installed to

“theoretically” anchor the structure to the foundation, but no anchoring to the ground or paving is required or allowed.

8.2 Site Requirements and Constraints

All teams will be provided with a 20’ x 20’ area known as the “construction site” as defined by clearly marked lines on 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. The presentation display board must be shown near the construction site while the building is being constructed.

8.3 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**)
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 **9.0 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. 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.

9. Upon completion of the assembly of a team's structure, all team members will set down all their tools, materials, etc. and the 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.
10. Team builders will receive a penalty for exiting the construction site prior to completion of the structure (see Section **9.0 Scoring**).
11. Once the team has completed the construction, the judges will measure the deflection before the load is applied and after the load is applied.
12. Only the judges are allowed in the construction site during the measurement of the deflection.
13. Each team is responsible for taking pictures of the completed structure which shall be uploaded into the team's cloud folder immediately after the TSDB[SM] Competition.

8.4 Building Removal and Clean up

Once the competition has ended, the completed structures shall be deconstructed, panel by panel, and the panels stacked on pallets to be donated for charity. After building the structure and the team presentation, each team is responsible for removal of **ALL** materials used for the project to include 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. 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 will coordinate with the NCSEA organizers prior to the competition and define in the report the plans for removal of the building and all materials. Potential reuse or recycling of the project materials should be determined prior to the competition. Possible solutions include donating to Childhood Cancer Foundation or other charitable organizations or researching other options at: http://reusewood.org/. The competition host has the option to remove any remaining structural debris from the site and bill the responsible school.

If teams choose to donate their dissembled building's to Childhood Cancer Foundation (CCF), NCSEA and SST will coordinate with CCF to facilitate the donation directly to CCF immediately after the competition.

9.0 Overall Scoring

Scoring will be based on the team's report, construction and presentation 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 build time, both will receive 20 points.

Scoring is as follows:

Section	**Maximum Points**
Strength and Durability Analysis in Report	50
Sustainability in Report	10
Construction/Load Path	40
Presentation and Display Board	20
Creativity/Aesthetics	10
Total	**130**

9.1 Strength and Durability Analysis in Report: 50 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 10 points
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 5 points
- Shear Walls 5 points

Completeness and Accuracy of the structural calculations 10 points

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

Structural Drawings: 10 points
Points will be awarded based on the completeness and accuracy of the drawings.

Deflection: 20 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

9.2 Sustainability: 10 points

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

9.3 Construction/Load Path: 40 points

Points will be awarded based construction of the building at the jobsite, as follows:

Accuracy of construction: 9 points

Load path: 17 points

Complete Structure: 9 points

Materials Cost: 5 points
Material costs will be graded with respect to the provided receipts or documentation of the estimates. See Section 5.5 Budget. Without proof of receipts or documentation of the estimates if applicable, the cost calculated will not be accepted.

Bonus Points - Time: 5 points
A maximum of 5 points will be awarded to the top five teams that have built the structure accurately and have the fastest construction time.

9.4 Presentation and Display Board: 20 points

Points will be awarded for:

Presentation: 12 points

Display Board: 8 points

9.5 Creativity/Aesthetics: 10 points

Points will be awarded by the judges for creativity and aesthetically pleasing structure. Judges will award 1-10 points.

Bonus points for top 3

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

9.6 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 NCSEA 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 the Phase Two submission deadline.
- 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 8.3 Building Constraints

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

Section 8.4 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.

10.0 Additional Information

- Teams may submit questions as explained through NCSEA Basecamp.
- All judges should be present at this Team Captain's meeting. All safety volunteers shall be present.
- All electronic entries/pictures and videos entries shall become the sole property of the host: NCSEA 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 National Council of Structural Engineers Association, American Wood Council, Simpson Strong-Tie, and APA – The Engineered Wood Association to use any material submitted. Such 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.

Appendix A Team Forms

Materials Request

SIMPSON
Strong-Tie

Connectors/ Fasteners for NCSEA
Please return to:
www.strongtie.com

Quantity	SKU #	Description

NCSEA National Council of Structural Engineers Associations

Budget Form (Sample)

Timber-Strong Design Build

Materials Cost Estimate

Description	Quantity	Unit	Amt		Unit Cost		Total
Wall Framing							
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
Roof Framing							
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
Wall Sheathing							
4x8x7/16" Plywood	70	SF					
4x8x7/16" Plywood	32	SF					
Total 4x8x7/16" Sheathing			2	$	17.45	$	34.90
	Lumber Subtotal:					**$**	**102.52**
Fasteners							
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
	Fasteners Subtotal:					**$**	**37.12**
Simpson Connectors							
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
	Connectors Subtotal:			**$**	**118.65**
	Total Materials Cost:			**$**	**258.29**

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

Appendix B Forms

TBD

Appendix C Judges' Score Sheets

TBD