BYU ENGINEERING
Civil & Construction Engineering

CAPSTONE

Timber-Strong Design Build Competition

Project ID: CPST-015

by:
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Capstone Final Project Report

Submitted to:
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Brigham Young University

Department of Civil and Construction Engineering
Brigham Young University

April 17th, 2024

Executive Summary

PROJECT TITLE: Timber-Strong Design Build Competition
PROJECT ID: CPST-015
PROJECT SPONSOR: ASCE
TEAM NAME: The Strategists Engineers

The objective of the Timber-Strong Design Build competition was to “design and build an artistically creative 2-story wood light-framed building that is sustainable, aesthetically pleasing and structurally durable”, according to ASCE. The guidelines for the competition were specified by ASCE and other competition sponsors. The project ran over five months, with deliverables due in four phases. The first phase, due January 26th 2024, was a written report. The written report was to include structural (lateral strength and gravity design) calculations, and sustainability calculations. Phase 2, due February 23rd, was the structural drawings and plans on how the structure would be built. Phase 3, due March 1st, included an oral and visual presentation. And Phase 4 was executing the plans and building the structure.

Due to unexpected challenges, our team did not enter the Timber Strong competition or build the structure. To maintain the spirit of the competition, and after discussion with our faculty mentor, we put our focus toward phases 1 and 2. We put extra effort in designing a creative building that looks nice, is durable, and environmentally sustainable. This was done by spending extra time designing the structure in revit and creating framing plans that clearly demonstrate how the building would be created. The structure uses minimal wood to reduce its environmental impact, and meets all the given strength specifications. The designed structure was calculated to withstand force applied on a cantilever beam, and gravity and lateral loads.

So while our team did not construct the structure, we designed and learned how to build a wood light framed structure and produced plans for future teams or clients to have the resources to be able to compete. We created a structure for future teams to see how the framing and calculations should be done to build a creative structure for the Timber Strong Design Build Competition.

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Introduction

During the completion of this Capstone project, we noticed the magnitude of the Timber-Strong Design Build competition itself became apparent. The competition's rules emphasize the importance of wood as a sustainable building material as it is completely renewable, and has superior performance in reducing carbon footprint compared to other materials. Consequently, students are encouraged to design a building that is not only artistically innovative but also sustainable, visually appealing, and structurally resilient. Moreover, in line with sustainability principles, the project is scheduled to be dismantled after the Intermountain Southwest Student Symposium and donated to be repurposed.

Our assignment was to design a structure measuring a maximum of 6’x6’x12’, adhering to the design outlined in the rules provided in Appendix B. Additionally, we needed to assemble a team of 4-6 builders. This building team was composed of our four team members, Savanna Thomsen (who competed with last year’s Timber Strong group), and Dawson Hone (a freshman interested in civil engineering). Our team proceeded with the structural computations, integrating the layout and constraints outlined in the rules. The lateral design calculations were undertaken by Tyler while the other three team members did the gravity calculations. These calculations were incorporated into the report which also included sustainability and budgetary assessments, along with team-related information.

After unforeseen costs involved with competing in the Timber Strong Competition, our team decided not to register. With this change of plans we moved forward with extra focus on the development of the structural drawings for our building. Tyler and Lexie composed the structural drawings in Revit. Lucky drafted a more detailed outline of our framing plans by digitizing the plans. Lexie spoke with her dad (who has a background in carpentry and engineering) and Tyler used his knowledge gained from asking Dr. Judd questions to confirm the soundness of these structural plans and the structural calculations.

The next stage of the Timber Strong project would have been to compete in the competition. Although we did not compete in the competition, we still ran into numerous challenges, both within and outside of the project design itself, and learned numerous principles. These challenges, principles, and the overall results of this project will be discussed in detail later in this document.

Schedule

The following is a basic timeline of events in the course of this project.

- Ladder safety certification completed
  - January 24, 2024
- Electronic files Phase 1 upload to ASCE's server
  - January 26, 2024
- Electronic files Phase 2 upload to ASCE's server
  - February 23, 2024
- Electronic files Phase 3 Presentation upload to ASCE's server
  - March, 2024
- Final RFI's uploaded to ASCE's server
  - 14 calendar days before Build Day

Assumptions & Limitations

The main constraints encountered in this project stemmed from the guidelines outlined in the competition's rules.

The primary calculation/design limitations given to us were as follows: d

- Roof system: The team shall determine the roof's slope. 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.
- 2nd floor system: The floor system shall cantilever 12 inches in one direction. Temporary shoring at the cantilevered floor system is required before completion of the build and during deconstruction.
- 2nd-floor cantilevered beam: A floor beam that cantilevers 4'-1" outside of the footprint to support the applied point load. The cantilevered floor beam may not occur on the same wall as a floor system cantilever. No counterweight other than the dead load of the structure is allowed to resist any overturning. Before Build Day, the exposed cantilever beam must be painted with high-visibility paint or covered with high-visibility wrap.
  2nd floor framed opening: one opening on the floor.
- 2nd-floor walls framed openings: minimum of four windows with one in each wall. The windows may be located anywhere on each wall.
- 1st-floor walls framed openings: minimum of three windows with one in each wall and one door in a wall with no windows.
- Lateral seismic load of E = 275 plf at the roof diaphragm and 225 plf at the floor of the diaphragm in both directions (not simultaneously).
- Roof wind uplift pressure W = 30 psf (no dead load is allowed to resist uplift pressures)
- We were required to use ASD calculations, and use calculation methods as laid out in ASCE 7-22, NDS 2018, and SDPWS 2021. The ASD calculation method assumes a constant factor of safety for all designs, regardless of load type.
- We were not allowed to use dead load to resist uplift.
- We had to specify hold-downs and anchors for our shear walls, based on the assumption of anchoring to a foundation. However, during the competition, anchoring to any foundation was prohibited. We were instructed to use ½" diameter anchor bolts.

These assumptions and limitations provided us with unique challenges that we had to overcome in order to come up with a design that worked within the boundaries set by Timber Strong. For example, the live roof load of 20 psf and the live floor load of 50 psf were not allowed to be taken into consideration for the design of the cantilever floor beam. Because we couldn't use this extra load to resist the overturning of the cantilever floor beam when it would be loaded, we had to design a thicker cantilever floor beam than we would have desired otherwise. In addition, each wall on each floor had to have either a window or a door. Because we wanted to make our building design aesthetically pleasing, we had differently sized and shaped windows on different walls and this resulted in us having to perform various shear wall calculations because the amount of wall available to resist the lateral loads varied from wall to wall. We also weren't allowed to use any dead weight of the roof joists to resist the roof uplift from the wind load of 30 psf. This resulted in having to size a bigger nail than we would have wanted otherwise. Finally, all calculations were to be done using the Allowable Stress Design (ASD) method and we had to familiarize ourselves with this method because in other classes or internships, we had used the Load and Resistance Factor Design (LRFD).

Design, Analysis & Results

Our project's design, analysis, and results can be shown through structural, sustainable, and budgetary calculations, as well as the architectural design of our structure. The first phase of the Timber Strong project was to design the structure for lateral and gravity loads given to us by the competition rules and produce a budget and carbon benefit of the components of the structure. This phase was completed using reference manuals to do hand calculations (for sections specified by the competition rules), excel, and WoodWorks. Examples of these calculations are provided in Figures 1-3 .Full calculations are provided in the submitted report in the appendix.

With respect to the lateral and gravity design, Figure 1 shows an example calculation of the roof joist anchorage. The Timber Strong rules stated that we had to anchor the roof joists to the building in order to resist a wind uplift load of 30 psf. We weren't allowed to use any dead weight from the roof joists to resist this wind load. We began by using simple statics to compute the total wind uplift load at each end of either of the two middle roof joists. We chose these roof joists because they experience a greater load than the roof joists on the ends of the roof. Once we knew how much uplift wind load was acting on the roof joist at either end, we searched for a truss screw on the Simpson Strong-Tie website that could resist this uplift load.

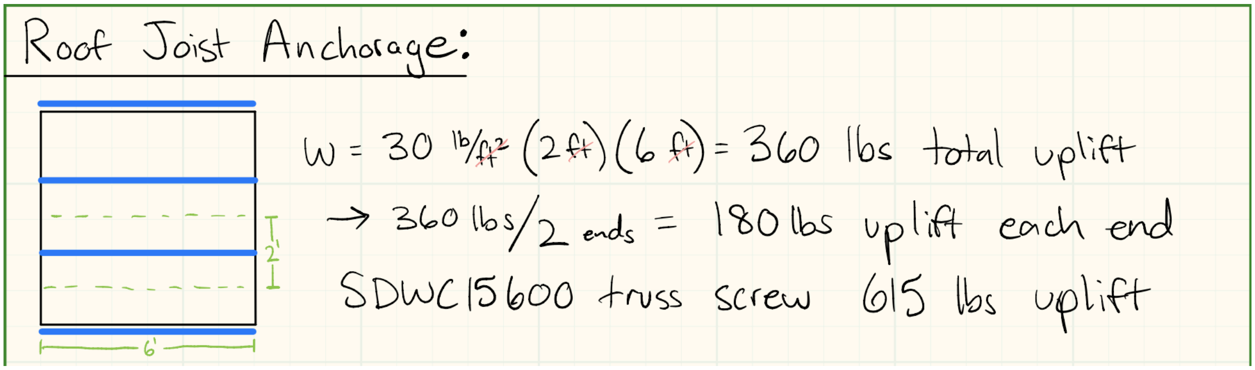


Figure 1 Example of structural calculations as completed by hand.

Figure 2 below shows the budgetary calculations for the light wood framed structure. The cost was calculated using the lengths of plywood as specified in the framing plans (see Figure 5), and unit costs were derived from Lowe's Hardware's website and the table of costs provided by ASCE in the Timber Strong guidelines page. The total cost to build our structure was calculated to be $1493.44. This would have been the amount of money we would petition to be provided by our sponsor, BYU's chapter of ASCE, if we had competed. In the same spreadsheet the total weight of the structure was also calculated. The structure would have weighed 701.6 lbs. This weight was used when calculating the gravity design and ensuring that the structure could stand on its own without toppling.

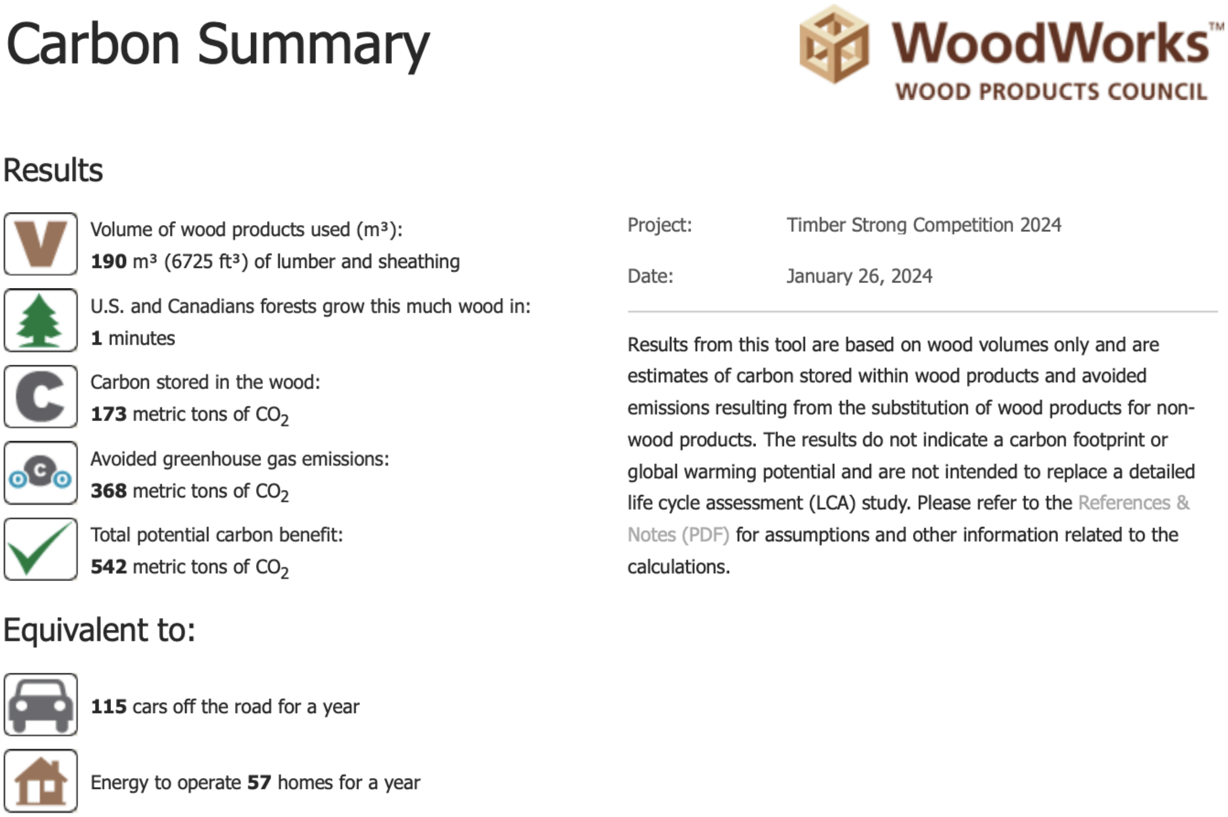
Another large aspect of the project is the environmental impacts of wood structures. With an emphasis on the importance of wood as a sustainable building material as it has superior performance in reducing carbon footprint compared to other materials and is a renewable resource, we calculated the potential carbon benefit that our wood structure had. To simulate a full-sized building, the amount of wood used for the design was multiplied by 100. This equals 190 m^3 of lumber and sheathing used. To calculate the carbon benefit of that amount of lumber, WoodWorks Carbon Calculator was used. The results can be found in Figure 3. Our structure, scaled by 100, has a total potential carbon benefit of 542 metric tons of CO_2. This carbon benefit is the amount of greenhouse gas emissions avoided by not using steel or concrete to build the structure. That amount of stored $C0_2$ is enough to power 57 homes for a year and equivalent to taking 115 cars off the road for a year. The website also calculated that the amount of wood used in this project is grown in US and Canada forests every minute. These calculations demonstrate that wood truly is a renewable resource, and reduces CO_2 in the air compared to steel or concrete.

Description	length (ft)	Qty	Unit	Unit Cost	Tot. Cost	unit weight (lbs)	Weight	Unit V (in^3)	Volume (in^3)	Volume (ft^3)	
Wall Framing (1st floor)											
2x4-8ft Wall Studs	5	12	pcs	5.85	70.2	5.825	69.9	315	3780	2.1875	
2x4-8ft Corner Posts	5	8	pcs	5.85	46.8	5.825	46.6	315	2520	1.458333333	
2x4-8ft Top/Sill Plates	6	4	pcs	5.85	23.4	6.99	27.96	378	1512	0.875	
2x4 Top/Sill Plates	5	4	pcs	5.85	23.4	5.825	23.3	315	1260	0.729166667	
4x8 1/2 cat. WSP		8	CS	22.85	182.8	15	120	2304	18432	10.66666667	
Floor System											
2x4 Rim Joist	0.5	30	LF	0.85	25.5	5.825		31.5	945	0.546875	
2x4-8ft Floor Joists	6	12	pcs	5.85	70.2	5.825		378	4536	2.625	
2x4-14ft Cantilever Beam		1	pcs	10.47	10.47	5.825		577.5	577.5	0.334201389	
4x8 1/2 Cat. WSP		5	pcs	22.85	114.25	15	65.625	2304	11520	6.666666667	
Wall Framing (2nd floor)											
2x4-8ft Wall Studs	5	12	pcs	5.85	70.2	5.825	69.9	315	3780	2.1875	
2x4-8ft Corner Posts	5	8	pcs	5.85	46.8	5.825	46.6	315	2520	1.458333333	
2x4 Top/Sill Plates	6	4	LF	5.85	23.4	6.99	27.96	378	1512	0.875	
4x8-1/2 Cat. WSP		8	pcs	22.85	182.8	15	120	2304	18432	10.66666667	
Roof Framing											
2x4-8ft Roof Rafters	7	8	psc	5.85	46.8	5.825		441	3528	2.041666667	
2x6-10ft Ridge Beam	10	1	pscs	8.56	8.56	16		630	630	0.364583333	
2x4 Blocking and Roof Fasci	7	40	LF	0.85	34	8.155		441	17640	10.20833333	
4x8-1/2 cat. wsp		10	pcs	22.85	228.5	15	48.75	2304	23040	13.33333333	
Lumber Subtotal					1208.08		666.595				
								Lumber Volume:		25.89149306	
Fasteners								for 100x		2589.149306	ft^3
8d Common Nails		1	box	27.44	27.44	5	5	Panels Volume:		41.33333333	
10d Common Nails		1	box	30.66	30.66	5	5	for 100x		4133.333333	ft^3
SD8x1.25 Screws		6	box	5.23	31.38	1	6	*rounded to nearest increment of 5			
SDWS 22300 Screws		2	box	12.74	25.48	1	2				
Fastener Subtotal					114.96		18				
Simpson Connectors											
A35 Framing Angles		30	pcs	0.47	14.1	0.25	7.5				
RTC2Z Ridge Plates		20	pcs	3.57	71.4	0.25	5				
LSSJ26JZ/LSSJ26RZ Jack Hanger		10	pcs	3.26	32.6	0.25	2.5				
CS22-R (25' length)		1	pcs	52.3	52.3	2	2				
Connector Subtotal					170.4		17				
Total Weight											
Totals				Cost of Materials	1493.44	Weight	701.595				

Amount of carbon stored: 173 metric tons of CO2

Total potential carbon benefit: 542 metric tons of CO2

Figure 2 Budget calculations as completed in Excel.


Carbon Summary

WoodWorks™ WOOD PRODUCTS COUNCIL

Results

Volume of wood products used (m³):
190 m³ (6725 ft³) of lumber and sheathing

U.S. and Canadians forests grow this much wood in:
1 minutes

Carbon stored in the wood:
173 metric tons of CO_2

Avoided greenhouse gas emissions:
368 metric tons of CO_2

Total potential carbon benefit:
542 metric tons of CO_2

Equivalent to:

115 cars off the road for a year

Energy to operate **57** homes for a year

Project: Timber Strong Competition 2024

Date: January 26, 2024

Results from this tool are based on wood volumes only and are estimates of carbon stored within wood products and avoided emissions resulting from the substitution of wood products for non-wood products. The results do not indicate a carbon footprint or global warming potential and are not intended to replace a detailed life cycle assessment (LCA) study. Please refer to the References & Notes (PDF) for assumptions and other information related to the calculations.

Figure 3 Sustainability calculations.

The second phase of the Timber Strong project consisted of creating architectural drawings of the design of our building. We accomplished this primarily through the program Revit where we created elevation views, plan views, and details showing how different components of the building would be constructed. These architectural drawings ultimately show a contractor what the building looks like, how the floor and roof are framed, and how to construct specific components of the building such as anchorage to the foundation. However, using a digitizing program, we also produced some drawings showing the wall framing more specifically. This includes how the wall will be framed around, underneath and on top of the window and door openings. The full set of architectural drawings are included in the Appendix of this report. Examples of our Revit elevation views and digitized framing drawings are shown in Figures 4 and 5.

In short, we designed a 2-story light framed wooden building that is structurally durable, sustainable, aesthetically pleasing, and prepared to be built. Our structure was calculated to withstand 30 psf wind with uplift pressure, can uphold weight on a cantilever beam with minimal deflection of the beam and can hold itself up. We calculated the amount of carbon stored in the wood to demonstrate the environmental benefits of using wood as a building material. And detailed drawings and plans of the structure to clearly show the building process of the structure.

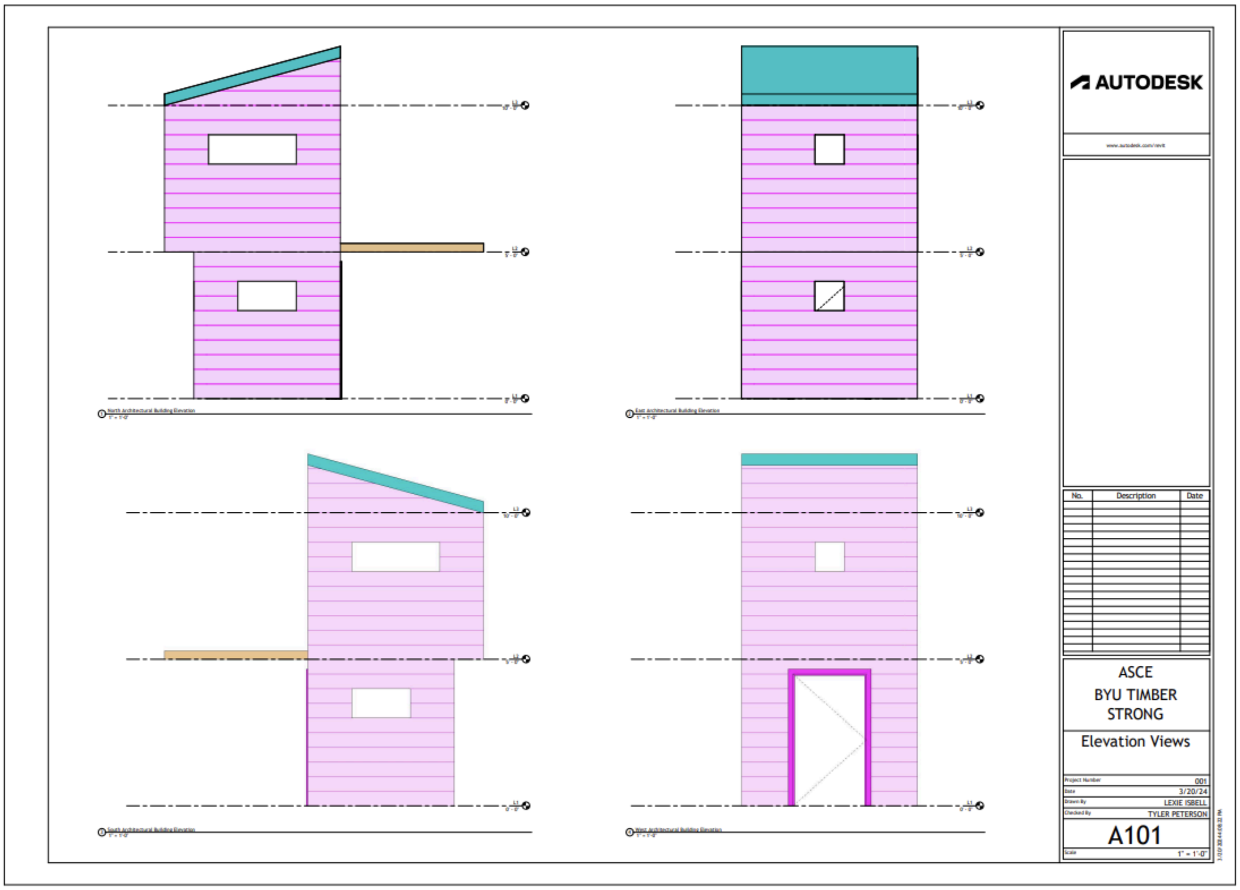


Figure 4 Example of Revit drawings generated for our structure.

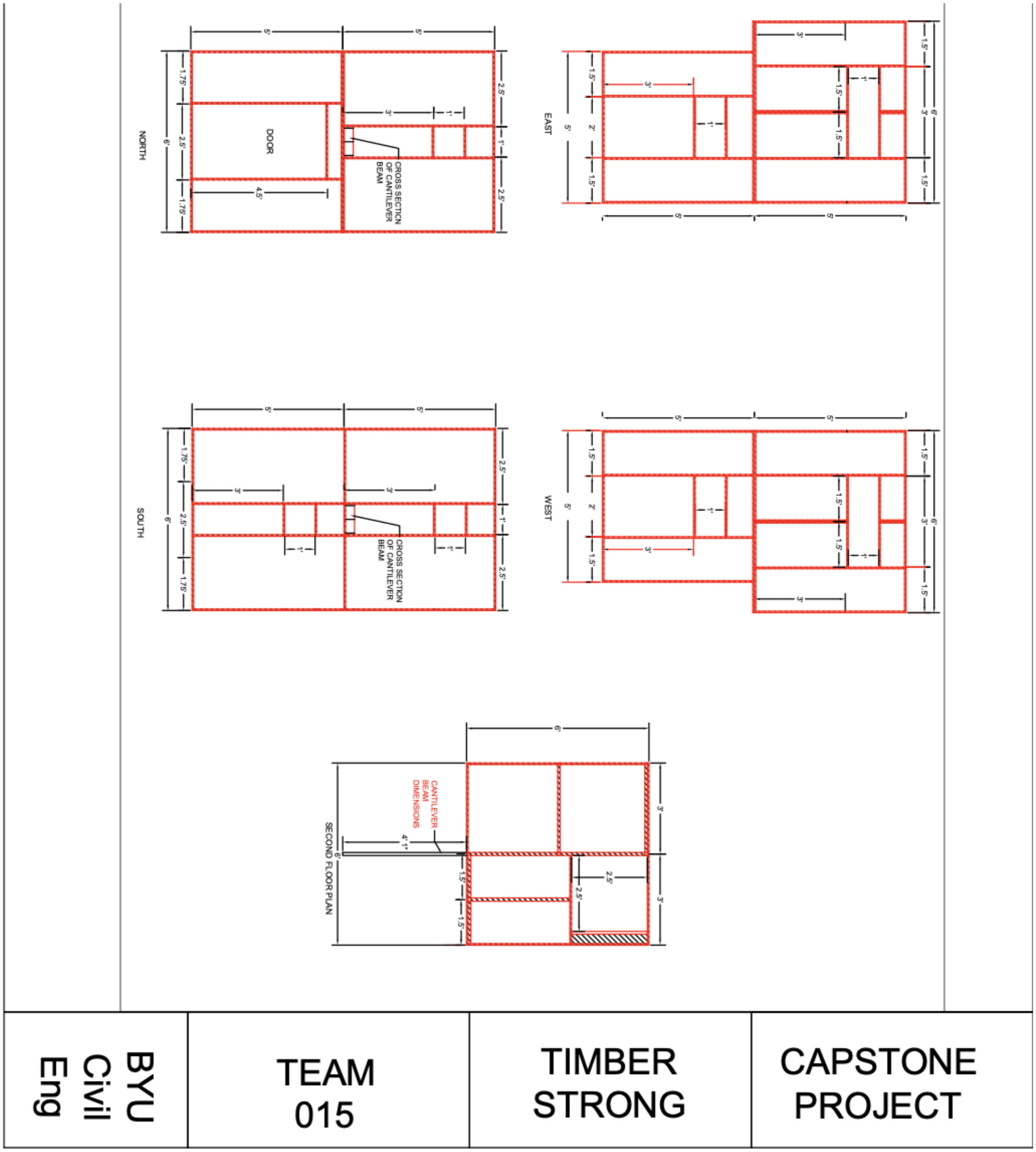


Figure 5 Framing plans created for the construction of our project.

Related Issues

One of the biggest challenges we encountered throughout this competition was the initial planning and setup. Initially, we were waiting for an additional mentor who had experience in structural engineering to help us with the design and calculation portion of the project. So for much of the first semester, we were at a standstill, waiting to see who the new structures professor would be. Once they came, Dr. Judd was able to be our mentor. Since Dr. Judd has experience in wood structures, he was able to assist us with the lateral and gravity calculations that were done in phase 2 of the project.

Another issue we faced was cost restraints. This revolved around the sponsors we needed to fulfill our construction budget. Not only was it a tedious and long process to be able to secure a sponsor, but unexpected expenses came up. There were fees linked to the registration of the physical competition. Due to this particular fee, each member would have been responsible for $70 out of pocket to enter the competition. This made it very difficult to move forward with the building portion of the competition, since our team did not have the funds to pay out of pocket. In the end, we decided that the cost to compete was too great and did not register for the competition.

Not competing brought many unique challenges. We decided that building the structure would not be practical without entering into the Timber Strong Competition, and the work we would have put into the building had to be compensated elsewhere. We decided to follow the requirements of the competition as closely as possible, without the construction portion. So we completed the necessary online ladder safety training and maintained the spirit of the competition by considering safety and environmental impacts of building wooden buildings. We also decided to put extra effort into the design and 3D model of our structure to accurately represent the design we would have built.

In summary, planning ahead, time constraints, and costs were our greatest challenges when working on the project. It is very important to figure out every and any expense required to ensure a final budget is accurate to the point where it will not be an issue at any point. Although we were not able to complete the physical build of this project we were all able to learn throughout this experience.

Lessons Learned

There were many lessons that we learned during this project, and throughout each phase of the competition. During the early design portions of the project, we learned about common calculations that are performed when structurally designing a wooden building. We learned common practices and building techniques to design framing plans for a structure. And possibly most important, we learned the importance of being prepared and communicating in a team. These concepts are discussed in more depth below.

The greatest lesson learned from participating in the design portion of the Timber Strong competition was performing lateral calculations by hand using a variety of resources. Tyler had previous experience doing lateral calculations working at a structural engineering firm in Provo. However, he was used to performing these calculations with the help of spreadsheets or softwares. Luckily, Timber Strong provided resources from companies like the Engineering Wood Association (APA) and American Wood Council (AWC). By using videos and examples provided on the websites of these companies, Tyler learned the process behind the spreadsheets he would use at work. For example, he learned that a simple perforated shear wall design approach is accomplished by solving for the unit shear in the wall, the percent of full-height wall sheathed, the percent of wall area openings, a shear capacity adjustment factor, the adjusted shear resistance provided by the sheathing we selected, and the uplift at the perforated shear wall ends. This process had to be completed five times to account for the different types of walls we had with different sized openings. Tyler's interpolation skills were challenged as well by using a table to solve for the shear capacity adjustment factor. Upon designing the diaphragms, shear walls, and roof joist anchorage, Tyler learned how to design a structure that could sufficiently resist both seismic and wind lateral forces.

Another lesson we learned regarding the structural calculations was the importance and use of factors of safety. We were required by Timber Strong to calculate a factor of safety for each lateral design component so that our final design was even more capable of safely resisting the lateral load requirements. Although these lateral calculations were done by hand, they still apply to the real world because they use design parameters given by ASCE and include factors of safety. We effectively designed a small building to withstand seismic and wind loads and would already be familiar with the inputs of spreadsheets at structural engineering firms because of this.

We also learned about the building process and environmental benefits of wood structures. Even without physically building the structure, we needed to learn how the construction process works when designing the framing plans. Lexie consulted with those knowledgeable in the construction field to gain a better understanding on how to design wood framing and build a structure. We researched standard distances between trusses to design a floor that is safe to walk on, and learned standard practices when framing walls. This knowledge will transfer well when we want to take on future projects in our homes or in the workforce. From performing the carbon footprint calculations, we also learned about the benefits of using wood products. We hope to take our knowledge of the benefits of using wood structures with us into our careers to encourage others, and to be environmentally friendly in construction ourselves.

Another lesson learned was that of the importance of communication and preparedness as a team. These were the largest areas in which we struggled severely and had the most room for improvement. Regarding communication, we rarely had a team meeting where all four team members attended the meeting. This resulted in at least one team member always being disoriented concerning where we were at in the phase of the project we were working on. As we often completed tasks right before they were due, it was extremely difficult to get all team member's full participation in order to successfully complete the task. This happened because it was near impossible for all four of us to communicate with each other when the deadline for the current task was the night of. As a result, we compiled often sloppy work which had to be redone later on, resulting in even more work and falling even more behind. We learned that this could have been prevented had we communicated properly and timely about the tasks we needed to complete.

Concerning this "timely" communication, we were rarely sufficiently prepared for the tasks we had to complete. Both phase one and phase two were submitted right before the deadline and the majority of the work for those phases were done a couple days prior to the deadline. Like the poor communication, this resulted in tasks that weren't done correctly or even efficiently. We had to spend more time than we would have otherwise and felt a lot more stress with each task that had to be done. Perhaps even worse than this, our preparedness resulted in us missing the opportunity to participate in the actual construction of our project at IWS. We tried to register the night registration was due and an abundance of new issues popped up as we did. Likely because we already had problems communicating, we were unable to reach a consensus as a team and sign up for the competition. Had we done our research and prepared beforehand, we could have resolved the same issues sooner and more efficiently.

We lost the opportunity to build our team chemistry and bond at the competition and realized what we should have done far too late. This serves as a lesson that we should conscientiously strive to build communication skills as soon as we become aware that they are lacking. In addition, we should have spent more time and effort last semester in order to thoroughly prepare for the tasks we had at hand this semester.

Given these reflections, we know that we should carry this knowledge into our future careers. When given a task, we should prioritize communicating on a consistent basis with all team members present and make something, such as a vision board, in order to plan ahead.

Conclusions

By participating in the design portion of the Timber Strong competition, we learned the significance of reviewing the competition rules and guidelines prior to performing the required calculations and analysis. We were exposed to gravity, lateral, sustainable, budgetary, and architectural design components as a result of this project. Because we ultimately designed a very small house to resist certain loads, we learned about the process by which our own homes were designed and constructed to resist the loads they would experience. Throughout the two semesters of Capstone, we learned the importance of communication and preparedness as a team. We recognized our flaws and reflected on how we could improve in the future or if given a chance to redo the Timber Strong project. We hope to apply the lessons learned in our future careers as we work on a variety of projects with new team members.

Recommendations

These suggestions are intended for future organizers and participants of the Timber Strong Design-Build competition at BYU.

- TIMELINE: We recommend that calculations be begun in December and that they be reviewed by all members of the team to verify accordance with competition rules before the submission deadline. Calculations should be reviewed by the framing expert on the team. As soon as calculations are completed, the framing and Autocad experts should work together to generate the Autocad and framing plans, which, in the future, should be completed in Autocad and submitted as one document.
- TEAMS: It is advised that each team participating in future Timber Strong Design-Build competitions ensures the inclusion of individuals capable of fulfilling at least one of the following roles when not doing any construction work:

    - One expert in calculations and design, who has completed the timber design course and maintains a collaborative relationship with the timber design professor.
    - One proficient in Autocad, possessing prior experience in the program and capable of generating comprehensive and visually appealing plans.
    - One skilled in framing, with practical expertise in framing techniques and familiarity with standard tools, layouts, and materials.
- BUDGETING: Have budgets and sponsors figured out as soon as possible. Between costs for registering for the competition and material costs, it is advised to be prepared to pay these costs and not let unexpected fees come up.

Appendix A: Resumes

Tyler Peterson

tylrp5@gmail.com - 626-210-9549 - https://www.linkedin.com/in/tylrp5

Education

B.S. Civil Engineering, *Brigham Young University* June 2018 - December 2024
Provo, UT

- GPA: 3.80 / 4.0

Professional Experience

Structural Engineering Intern, *Epic Engineering* January 2022 - Currently
Provo, UT

- Design 100% of the structural aspects of buildings and homes to meet hundreds of customers' needs
- Draw and specify details to ensure the construction of the project is carried out as intended
- Compile all calculations and drawings into one written report to be submitted for review by P.E.

Cataloger's Assistant, *BYU Library* September 2021 - January 2022
Provo, UT

- Fixed or flagged thousands of errors in the system each month
- Imported thousands of new or existing records into the system each month

Warehouse Worker, *BYU Store* July 2018 - April 2019
Provo, UT

- Managed all current and incoming inventory in the warehouse
- Gathered thousands of items in order to replenish the store's stock

Leadership

Volunteer, *Church of Jesus Chris of Latter-day Saints* May 2019 - August 2021
Buenos Aires, Argentina

- Developed communication skills talking to people in the street and at their doors
- Taught other volunteers necessary skills and led them in adjusting to a different culture

Skills

- Excel | EnerCalc | Revit | RISA 3D | BlueBeam | AutoCAD | Spanish | ArcGIS | ForteWeb | BCCalc

Lexie Isbell

(801) 616-8007 · lexie.isbell@gmail.com · linkedin.com/in/lexie-isbell

EDUCATION

Brigham Young University - Fulton College of Engineering Jan 2020 - Apr 2024
B.S. Civil Engineering w/ Structural Emphasis: Provo, UT
- GPA 3.43
- Received BYU College of Engineering Scholarship
- Member of Women in Engineering Club
- Applicable Coursework:
    - Global Leadership
    - Structural Analysis
    - Engr Draft w/ CAD Apps
    - Statics and Dynamics

EXPERIENCE

TSi Geotechnical Inc Jul 2023 - Aug 2023
Technician Intern Kansas City, MO
- Operated 5+ geotechnical machines to test soil and concrete samples
- Performed daily laboratory testing on samples to measure strength of the materials
- Enforced safety regulations in field
- Observed construction projects for up to 10 hours to ensure safety and quality in field

HHI May 2021 - Aug 2021
Construction Procurement Intern Ogden, UT
- Collaborated with 15+ companies to discus project details and quotes
- Initiated phone calls daily
- Collected up to 20 quotes for construction divisions 3-14 for projects
- Assisted in forming bids on government, commercial, and military construction projects

J&E Wholesale Outlet Apr 2020 - Aug 2020
Retail Associate Sikeston, MO
- Provided pricing for 80+ merchandise a day
- Organized and sorted products up to 50lbs
- Communicated with coworkers and customers to make a friendly environment

VOLUNTEER EXPERIENCE

Full-Time Volunteer Jan 2022 – Jun 2023
The Church of Jesus Christ of Latter-day Saints Charlotte, NC
- Designed, conducted, and instructed training meetings for 100+ peers and representatives
- Planned and reported daily, weekly, and monthly goals to increase productivity 30%
- Offered weekly humanitarian aid and community service

ACHIEVEMENTS & INTERESTS

- Certified to operate nuclear gages and other equipment
- Member of National Honor Society
- Experience with AutoDesk Products
- Love the outdoors (hiking, soccer, pickleball, etc.)

Lucky Bahati

(703) 814-0780 · bahatilucky85@gmail.com · linkedin.com/in/lucky-bahati

EDUCATION

Brigham Young University Apr 2024
Bachelor of Science: Civil Engineering and Mathematics Provo, UT

- GPA 3.69
- Clubs: American Society of Civil Engineers (ASCE), Institute of Transportation Engineers (ITE)
- Languages: English, French, Swahili, Spanish

RELEVANT EXPERIENCE

IMEG May 2023-Present
Civil Engineering Intern Fairfax, VA

- Assists Project Managers and Professional Engineers with engineering calculations
- Reviews site plans and other project documents for accuracy purposes
- Collaborates with civil designers in land planning and drafts water profiles and other relevant drawings
- Conducts site visits with the surveying team in data collection

WEITZ May 2022-Aug. 2022
Project Engineer Intern Leesburg, VA

- Assisted Project Engineers and Managers in carrying out daily meetings
- Filled RFI's and submittal for coordination purposes
- Lead safety and other trainings for subcontractors' new hires

Brigham Young University, BYU Apr. 2021-Present
Research Assistant Provo, UT

- Lead the switch from html language to readthedoc platform for the research website
- Executes and tests python code for groundwater and flow analyses
- Reviews relevant literature to further the research topic under the supervision of doctoral candidates.

Head Teaching Assistant- Hydraulics and Fluids Flow Theory

- Supervises 4 teaching assistants in their assigned duties
- Assists the professor in materials reviews, quality control and grading purposes
- Holds office hours to help with content understanding and mastery by students

LEADERSHIP AND VOLUNTEERING EXPERIENCE

BYU- African Cultures and Languages Association (ACLA) Aug. 2023-Present
President Provo, UT

- Organizes activities pertaining to African languages and cultures to further inclusion and diversity

BYU- Student Advisory Council Aug. 2023-Present
Team Lead Provo, UT

- Heads a team of 5 students in an effort to better student employment on BYU campus

Denisse Alejo

(559) 373-7690
Dalejojuarez04200@gmail.com
www.linkedin.com/in/denisse-aj

Brigham Young University
Civil and Construction Engineering

EDUCATION

Brigham Young University — (Provo, UT)

December 2024

- Bachelors in Civil and Construction Engineering

ENGINEERING EXPERIENCES

Provo City — *Engineering Intern* (Provo, UT)

May 2022 - Current

- Successfully developed design projects including road design, striping plans, and extensive city research projects
- Experienced field work and team building through surveying, road tabbing, and 30+ traffic studies and warrants throughout Provo city

BYU — *Navajo Nation Building Aid* (Page, AZ)

October 2022 - November 2022

- Community volunteer project aimed to increase residential safety and accessibility at Reservations with new developmental plans

ADDITIONAL EXPERIENCES

Alder — *Retention Specialist* (Orem, UT)

August 2021 - May 2022

- Managed high volumes of Inbound/Outbound calls
- Coached 600+ clients, supervised 300+ accounts, and managed negotiated solutions to retain and renew customers

Loft — *Sales Lead Manager* (Chandler, AZ)

September 2020 - January 2021

- Provided exceptional client service and transactional functions
- Led and trained teams of 4 members as manager on duty while opening and closing with high security responsibilities

Wells Fargo — *Credit services* (Chandler, AZ)

May 2020 - September 2020

- Handled high-volume calls while providing informed guidance catered to every client in Spanish and English
- Handled highly sensitive information and processed credit card applications

ENGINEERING SKILLS

- AutoCAD
- ArcGIS Pro
- Revit
- Civil 3D
- Excel - VBA
- Field Surveying
- Spanish Fluency
- Resourceful

ENGINEERING COURSES

- Engineering Drafting with AutoCAD
- Engineering Applications of GIS
- Environmental Engineering
- Transportaion Engineering
- Soils Mechanics
- Hydraulics and Fluid Theory
- Geology/Engineering Geology

Appendix B: Basic Layout from Rules

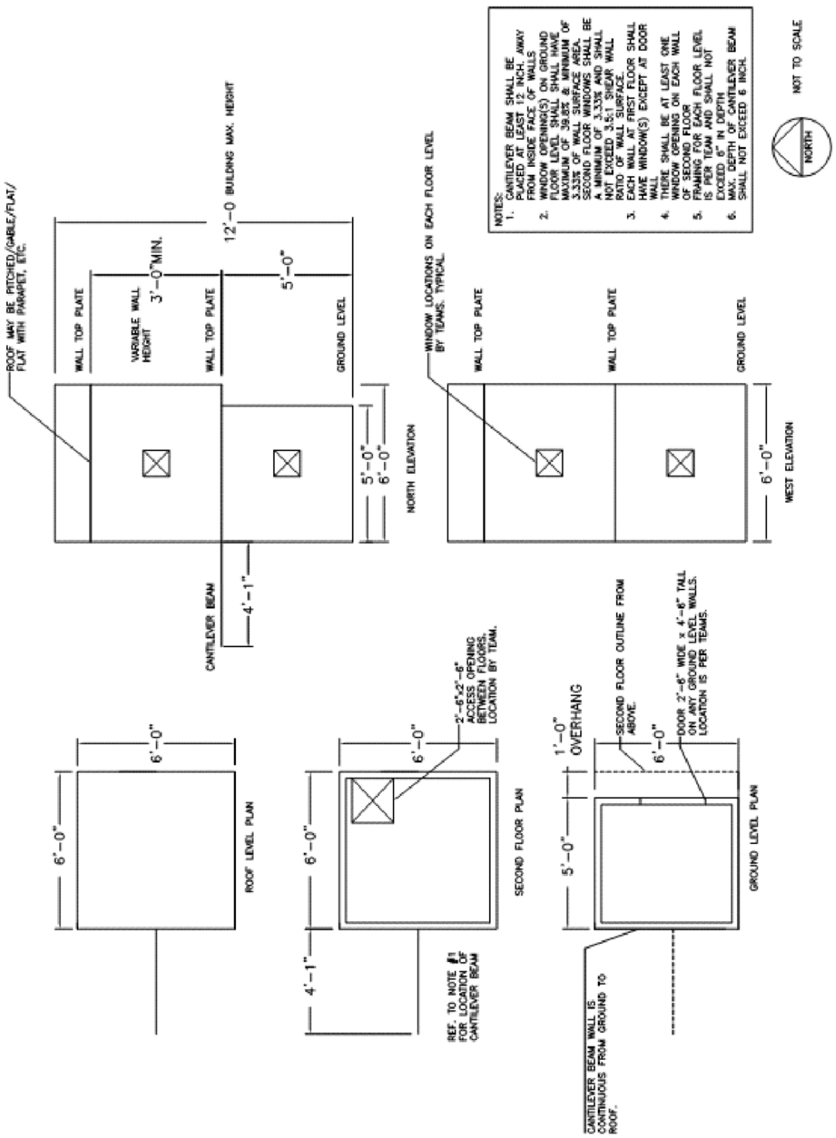


Figure 1

Appendix C: Phase 1 Report

Each team's report must include:

Table of Contents:

Team Composition Information:

Tyler Peterson (captain, builder) - (626) 210-9549 - tylerp22@byu.edu
Lucky Bahati (builder) - (703) 814-0780 - lb833@byu.edu
Lexie Isbell (builder) - (801) 616-8007 - lji23@byu.edu
Denisse Alejo Juarez (builder) - (559) 373-7690 - daj82@byu.edu
Savannah Thomsen (builder) - (208) 539-4810 - savthom@byu.edu
Dawson Hone (builder) - (509) 655-7068 - dhone1@byu.edu
Clifton Farnsworth (faculty advisor) - (801) 422-6494 - clifton_farnsworth@byu.edu
Johnn Judd (mentor) - (801) 422-6333 - johnn_judd@byu.edu

Team History:
For Timber Strong last year we built the structure in competition according to building code. While this was effective in relating the competition build to real life, it led to our team's build time being longer than many other teams. We also learned a lot about working together and catering each person's skills to best benefit the team as a whole. Nathan had a lot of experience with framing in the past, which was valuable to the build process. Stephen had a lot of common sense knowledge that proved to be valuable in making split second decisions. Ava also knew a lot about framing and building efficiently, which proved valuable during the competition. And Emma had amazing coordination skills that ensured we didn't miss any competition requirements. Combining everyone's abilities into one team made for a great project! I would also add, the preparation and practice we did before competition made everything run a lot smoother when we were under time pressure.

Pictures below

Cantilever floor beam for shear and bending
Choose a 2 by 8
$I\ =\ 47.66\ in^4$
$E\ =\ 4100\ MPa$
Since it is an overhang beam, we will use
$\Delta\ =\ \frac{Pa^2}{3EI}(L\ +\ a)$ with $a\ =\ 4.1\ ft$ (overhang), $L\ =\ 6\ ft$ (length) $P\ =\ 150\ lb$ and E and I are given above.
So, with these conditions,

$$\Delta\ =\ \frac{150\cdot(49.2)^2}{(4100\cdot1.45\cdot10^{-4}\cdot10^6)\cdot47.66}(121.2) = 1.55$$ inch deflection which is **too** high

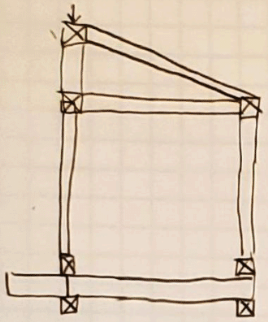
We then change it to a **2 by 10**. The only constant changing is the $I\ =\ 98.93\ in^4$
So, the new deflection is $\Delta\ =\ 0.74\ in$. Which falls within the range.
However, as the max size we can use is 2 by 6, we will need to glue **two 2 by 4** together to meet the requirement. So, the new is $I\ =\ 111.48\ in^4$ (for 4 by 8). Here is the source for the I values used. https://www.naffainc.com/x/IRC2000/TABLES/Properties-SawnLumber.htm
So, the new deflection is
$\Delta\ =\ \frac{150\cdot(49.2)^2}{(4100\cdot1.45\cdot10^{-4}\cdot10^6)\cdot111.148}(121.2)\ =\ 0.66$ which falls within range.

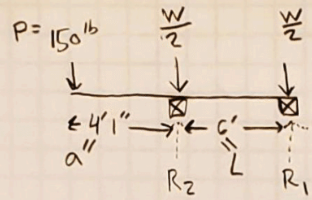
9.5 Building Removal and Clean Up
Upon completion of the competition, the BYU Timber Strong Team will safely deconstruct the structures, and stack the panels on pallets. We will then transport said material back to BYU campus where the material can be repurposed in our Materials lab or donated to a local charity in Provo, Utah.

Special thanks to our sponsors,

ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS

BRIGHAM YOUNG UNIVERSITY FOUNDED BYU 1875 PROVO, UTAH





$R_1 = \frac{Pa}{L}$

$R_2 = \frac{P}{L}(L+a)$

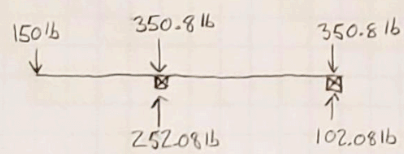
$W_{structure} = 701.6$ lb
$P = 150$ lb
$a = 49$ in
$L = 72$ in

- Is the weight of the structure enough to hold the building in place?

$R_1 = \frac{(150\ lb)(49\ in)}{(72\ in)} = 102.08\ lb$

$R_2 = \frac{(150\ lb)}{(72\ in)}\left((72\ in)+(49\ in)\right) = 252.08\ lb$

$\frac{W_{structure}}{2} = \frac{701.6\ lb}{2} = 350.8\ lb$



The weight of the structure pressing and pulling downwards exceeds the lift caused by the force applied to the cantilever beam. The structure will not topple.

Roof dead load = 5 x 9.75 lb = 48.75 lb

live load = L_r = 20 psf

floor dead load = 121.125 lb = (1st fl) 8x = 5 x 12 x 5 (2nd fl) 8x = 5 x 15 x 7

= 37.5 = 65.625

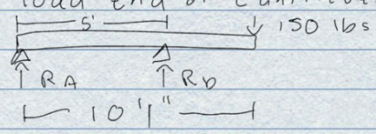
8x = 6 x 12 x 2

= 18

tot = 121.125 lb

live load = L = 50 psf

Point load end of Cantilever floor beam 150 lbs =



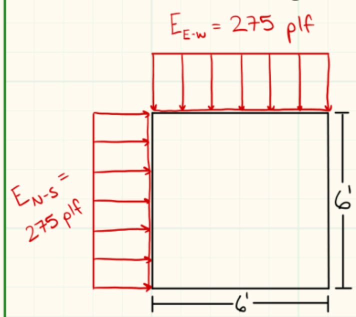
R_A = 150 lbs − R_D

M_A = 150 × 121"

= 0.66723 kN × 3.0734

= 2.05066 kN/m

Roof Diaphragm Design:



Maximum diaphragm shear:

$$V_{N\text{-}S} = \frac{wL}{2B} = \frac{275\ \text{lb/ft}\,(6\ \text{ft})}{2(6\ \text{ft})} = 137.5\ \text{plf}$$

$$V_{E\text{-}W} = \frac{wL}{2B} = \frac{275\ \text{lb/ft}\,(6\ \text{ft})}{2(6\ \text{ft})} = 137.5\ \text{plf}$$

Maximum chord force:

$$T_{N\text{-}S} = C_{N\text{-}S} = \frac{wL^2}{8B} = \frac{275\ \text{lb/ft}\,(6^2\ \text{ft}^2)}{8(6\ \text{ft})} = 206.25\ \text{lb}$$

$$T_{E\text{-}W} = C_{E\text{-}W} = \frac{wL^2}{8B} = \frac{275\ \text{lb/ft}\,(6^2\ \text{ft}^2)}{8(6\ \text{ft})} = 206.25\ \text{lb}$$

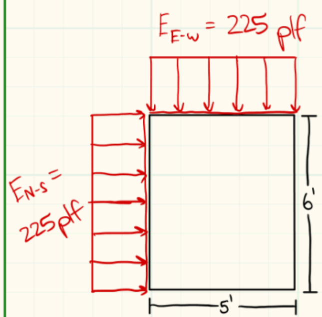
$V_{allowable}$ = 420 plf / 2.8 = 150 plf > 137.5 plf   Case 1

5/16 Category Rated Sheathing 6d @ 6" O.C. (Table 4.2C)

2x4 top plate for chord force: $T' = F_t A = 825\ \text{lb/in}^2\,(5.25\ \text{in}^2) = 4331\ \text{lbs}$

$F.S. = \frac{150}{137.5} = 1.091$ $C' = F_c A = 1650\ \text{lb/in}^2\,(5.25\ \text{in}^2) = 8663\ \text{lbs} > 206\ \text{lbs}$

Floor Diaphragm Design:



Maximum diaphragm shear:

$$V_{N\text{-}S} = \frac{wL}{2B} = \frac{225\ \text{lb/ft}\,(6\ \text{ft})}{2(5\ \text{ft})} = 135\ \text{plf}$$

$$V_{E\text{-}W} = \frac{wL}{2B} = \frac{225\ \text{lb/ft}\,(5\ \text{ft})}{2(6\ \text{ft})} = 93.75\ \text{plf}$$

Maximum chord force

$$T_{N\text{-}S} = C_{N\text{-}S} = \frac{wL^2}{8B} = \frac{225\ \text{lb/ft}\,(6^2\ \text{ft}^2)}{8(5\ \text{ft})} = 202.5\ \text{lb}$$

$$T_{E\text{-}W} = C_{E\text{-}W} = \frac{wL^2}{8B} = \frac{225\ \text{lb/ft}\,(5^2\ \text{ft}^2)}{8(6\ \text{ft})} = 117.2\ \text{lb}$$

$V_{allowable}$ = 420 plf / 2.8 = 150 plf > 135 plf   Case 1

5/16 Category Rated Sheathing 6d @ 6" O.C. (Table 4.2C)

2x4 top plate for chord force: $T' = F_t A = 825\ \text{lb/in}^2\,(5.25\ \text{in}^2) = 4331\ \text{lbs}$

$F.S. = \frac{150}{135} = 1.111$ $C' = F_c A = 1650\ \text{lb/in}^2\,(5.25\ \text{in}^2) = 8663\ \text{lbs} > 203\ \text{lbs}$

Average F.S. for diaphragms = $\frac{1.091 + 1.111}{2} = 1.101$

4.1.4.1 – For seismic design of diaphragms and shear walls, the ASD allowable shear capacity shall be determined by dividing the nominal shear capacity by the ASD reduction factor of 2.8 (AWC 2021 SDPWS)

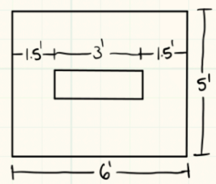
Shear Wall Design E-W Roof (Perforated Approach):

E = 275 plf @ roof

$V = 275\ lb/ft\ (6\ ft)/2 = 825\ lbs$

Height/width ratio = 5:1.5

$2b/h = 2(1.5)/5 = 0.6$



1. Unit shear in the wall

   $\Sigma b_i = 0.6 \times (1.5 + 1.5) = 1.8\ ft$

   $v = 825\ lbs / 1.8\ ft = 458.33\ lb/ft$

2. Percent of full-height sheathed

   $A_{fhs}/A_{wall} = 1.8\ ft / 6\ ft = 0.3 \rightarrow 30\%$

3. Percent of wall area openings

   $A_o/A_{wall} = (3\ ft \times 1\ ft)/(6\ ft \times 5\ ft) = 0.1 \rightarrow 10\%$

4. Table 4.3.5.6 Shear Capacity Adjustment Factor, $C_o = 1.00$

5. Adjusted shear resistance

   $V_{allowable} = 1290\ plf / 2.8 \times 1.00 = 460.7\ lb/ft > 458.33\ lb/ft$

   15/32 Category Rated Sheathing 10d @ 4" O.C. (Table 4.3A)

6. Uplift at perforated shear wall ends (hold-downs)

   $H = 825\ lbs\ (5\ ft)/(1.00 \times 1.8\ ft) = 2{,}291.67\ lbs$

   CS14 2,490 lbs

$F.S. = \frac{460.7}{458.3} = 1.005$

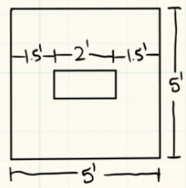
Shear Wall Design E-W Floor (Perforated Approach):

E = 225 plf @ floor

V = 225 lb/ft (6 ft)/2 = 675 lbs

Height/width ratio = 5:1.5

$2b/h = 2(1.5)/5 = 0.6$



1. Unit shear in the wall

   $\Sigma b_i = 0.6 \times (1.5 + 1.5) = 1.8$ ft

   v = 675 lbs/1.8 ft = 375 lb/ft

2. Percent of full-height sheathed

   A_{fhs}/A_{wall} = 1.8 ft/5 ft = 0.36 → 36%

3. Percent of wall area openings

   A_o/A_{wall} = (2 ft × 1 ft)/(5 ft × 5 ft) = 0.08 → 8%

4. Table 4.3.5.6 Shear Capacity Adjustment Factor, C_o = 1.00

5. Adjusted shear resistance

   $V_{allowable}$ = 2435 plf /2.8 × 1.00 = 869.6 lb/ft > 833.33 lb/ft (375 + 458.33 floor above)

   19/32 Category Rated Sheathing 10 d @ 2" O.C. (Table 4.3A)

6. Uplift at perforated shear wall ends (hold-downs)

   H = 675 lbs (5 ft)/(1.00 × 1.8 ft) = 1,875 lbs + 2,291.67 lbs (floor above)

   = 4,166.67 lbs

$F.S. = \frac{869.6}{833.3} = 1.044$

HDU4-SDS2.5 4,565 lbs

5/8" dia. F1554 GR 36 Heavy Hex Bolt embed 5" w/ (10) 1/4 × 2 1/2 SDS

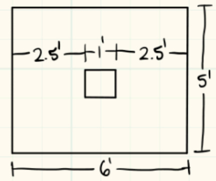
Shear Wall Design N-S Roof (Perforated Approach):

E = 275 plf @ roof

$V = 275\ lb/ft\ (6\ ft)/2 = 825\ lbs$

Height/width ratio = 5:2.5

$2b/h = 2(2.5)/5 = 1.0$



1. Unit shear in the wall

$\Sigma b_i = 1.0 \times (2.5+2.5) = 5\ ft$

$v = 825\ lbs / 5\ ft = 165\ lb/ft$

2. Percent of full-height sheathed

$A_{fhs}/A_{wall} = 5\ ft / 6\ ft = 0.83 \rightarrow 83\%$

3. Percent of wall area openings

$A_o/A_{wall} = (1\ ft \times 1\ ft)/(6\ ft \times 5\ ft) = 0.03 \rightarrow 3.3\%$

4. Table 4.3.5.6 Shear Capacity Adjustment Factor, $C_o = 0.97$ *interpolated

5. Adjusted shear resistance

$V_{allowable} = 505\ plf / 2.8 \times 0.97 = 174.9\ lb/ft > 165\ lb/ft$

5/16 Category Rated Sheathing 6d @ 6" O.C. (Table 4.3A)

6. Uplift at perforated shear wall ends (hold-downs)

$H = 825\ lbs\ (5\ ft)/(1.00 \times 5\ ft) = 825\ lbs$

CS22 845 lbs

$F.S. = \frac{174.9}{165} = 1.093$

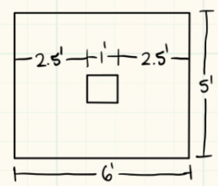
Shear Wall Design N-S Floor (Perforated Approach):

E = 225 plf @ floor

V = 225 lb/ft (6 ft)/2 = 675 lbs

Height/width ratio = 5:2.5

2b/h = 2(2.5)/5 = 1.0



1. Unit shear in the wall

   $\Sigma b_i = 1.0 \times (2.5+2.5) = 5$ ft

   v = 675 lbs/5 ft = 135 lb/ft

2. Percent of full-height sheathed

   A_{fhs}/A_{wall} = 5 ft/5 ft = 1.0 → 100%

3. Percent of wall area openings

   A_o/A_{wall} = (1 ft × 1 ft)/(6 ft × 5 ft) = 0.03 → 3.3%

4. Table 4.3.5.6 Shear Capacity Adjustment Factor, C_o = 1.00

5. Adjusted shear resistance

   $V_{allowable}$ = 870 plf/2.8 × 1.00 = 310.7 lb/ft > 300 lb/ft (135 + 165 floor above)

   15/32 Category Rated Sheathing 10d @ 6" O.C. (Table 4.3A)

6. Uplift at perforated shear wall ends (hold-downs)

   H = 675 lbs (5 ft)/(1.00 × 5 ft) = 675 lbs + 825 lbs (floor above)

   = 1,500 lbs

F.S. = $\frac{310.7}{300}$ = 1.036

HDU2-SDS2.5 3,075 lbs

5/8" dia. F1554 GR 36 Threaded rod w/ simpson set-xp epoxy embed 8" w/ (6) 1/4 × 2 1/2 SDS

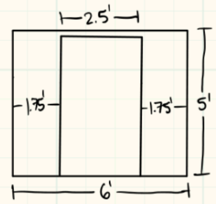
Shear Wall Design N-S Floor (Perforated Approach):

E = 225 plf @ floor

V = 225 lb/ft (6 ft)/2 = 675 lbs

Height/width ratio = 5 : 1.75

2b/h = 2(1.75)/5 = 0.7



1. Unit shear in the wall

   $\Sigma b_i = 0.7 \times (1.75 + 1.75) = 2.45$ ft

   v = 675 lbs/2.45 ft = 275.5 lb/ft

2. Percent of full-height sheathed

   $A_{fhs}/A_{wall} = 2.45$ ft/5 ft = 0.49 → 49%

3. Percent of wall area openings

   A_o/A_{wall} = (ft × ft)/(6 ft × 5 ft) = 0.03 → 3.3%

4. Table 4.3.5.6 Shear Capacity Adjustment Factor, C_o = 1.00

5. Adjusted shear resistance

   $V_{allowable}$ = 1290 plf / 2.8 × 1.00 = 460.7 lb/ft > 440.5 lb/ft (275.5 + 165 floor above)

   15/32 Category Rated Sheathing 10d @ 4" O.C. (Table 4.3A)

6. Uplift at perforated shear wall ends (hold-downs)

   H = 675 lbs (5 ft)/(1.00 × 2.45 ft) = 1377.6 lbs + 825 lbs (floor above)

   = 2,202.6 lbs

F.S. = $\frac{460.7}{440.5}$ = 1.046

HDU2-SDS2.5 3,075 lbs

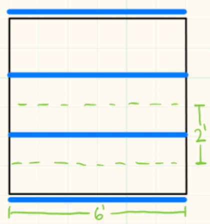
Average F.S. for shear walls

= $\frac{1.005 + 1.044 + 1.093 + 1.034 + 1.046}{5}$

= 1.045

5/8" dia. F1554 GR 36 Threaded rod w/ simpson set-xp epoxy embed 8" w/ (6) 1/4 × 2 1/2 SDS

Roof Joist Anchorage:



$W = 30\ \text{lb/ft}^2\ (2\ \text{ft})(6\ \text{ft}) = 360\ \text{lbs}$ total uplift

→ 360 lbs / 2 ends = 180 lbs uplift each end

SDWC15600 truss screw 615 lbs uplift

Cost Calculations

Description	length (ft)	Qty	Unit	Unit Cost	Tot. Cost	unit weight (lbs)	Weight	Unit V (in^3)	Volume (in^3)	Volume (ft^3)	
Wall Framing (1st floor)											
2x4-8ft Wall Studs	5	12	pcs	5.85	70.2	5.825	69.9	315	3780	2.1875	
2x4-8ft Corner Posts	5	8	pcs	5.85	46.8	5.825	46.6	315	2520	1.458333333	
2x4-8ft Top/Sill Plates	6	4	pcs	5.85	23.4	6.99	27.96	378	1512	0.875	
2x4 Top/Sill Plates	5	4	pcs	5.85	23.4	5.825	23.3	315	1260	0.729166667	
4x8 1/2 cat. WSP		8	CS	22.85	182.8	15	120	2304	18432	10.66666667	
Floor System											
2x4 Rim Joist	0.5	30	LF	0.85	25.5	5.825		31.5	945	0.546875	
2x4-8ft Floor Joists	6	12	pcs	5.85	70.2	5.825		378	4536	2.625	
2x4-14ft Cantilever Beam		1	pcs	10.47	10.47	5.825		577.5	577.5	0.334201389	
4x8 1/2 Cat. WSP		5	pcs	22.85	114.25	15	65.625	2304	11520	6.666666667	
Wall Framing (2nd floor)											
2x4-8ft Wall Studs	5	12	pcs	5.85	70.2	5.825	69.9	315	3780	2.1875	
2x4-8ft Corner Posts	5	8	pcs	5.85	46.8	5.825	46.6	315	2520	1.458333333	
2x4 Top/Sill Plates	6	4	LF	5.85	23.4	6.99	27.96	378	1512	0.875	
4x8-1/2 Cat. WSP		8	pcs	22.85	182.8	15	120	2304	18432	10.66666667	
Roof Framing											
2x4-8ft Roof Rafters	7	8	psc	5.85	46.8	5.825		441	3528	2.041666667	
2x6-10ft Ridge Beam	10	1	pscs	8.56	8.56	16		630	630	0.364583333	
2x4 Blocking and Roof Fasci	7	40	LF	0.85	34	8.155		441	17640	10.20833333	
4x8-1/2 cat. wsp		10	pcs	22.85	228.5	15	48.75	2304	23040	13.33333333	
Lumber Subtotal					1208.08		666.595				
								Lumber Volume:		25.89149306	
Fasteners								for 100x		2589.149306	ft^3
8d Common Nails		1	box	27.44	27.44	5	5	Panels Volume:		41.33333333	
10d Common Nails		1	box	30.66	30.66	5	5	for 100x		4133.333333	ft^3
SD8x1.25 Screws		6	box	5.23	31.38	1	6	*rounded to nearest increment of 5			
SDWS 22300 Screws		2	box	12.74	25.48	1	2				
Fastener Subtotal					114.96		18				
Simpson Connectors											
A35 Framing Angles		30	pcs	0.47	14.1	0.25	7.5				
RTC2Z Ridge Plates		20	pcs	3.57	71.4	0.25	5				
LSSJ26JZ/LSSJ26RZ Jack Hanger		10	pcs	3.26	32.6	0.25	2.5				
CS22-R (25' length)		1	pcs	52.3	52.3	2	2				
Connector Subtotal					170.4		17				
Total Weight											
Totals				Cost of Materials	1493.44	Weight	701.595				

Amount of carbon stored: 173 metric tons of CO_2

Total potential carbon benefit: 542 metric tons of CO_2

Douglas Fir 2x4	1.165	lb/linear ft
2x6x10	16	lb
2x4 Volume	5.25	in^2 x length

Carbon Calc Inputs		
Lumber Species:	100% Doglas-fir-larch	
Construction Type:	Light-Framed	
Lumber Volume:	2590	ft^3
Panels Volume:	4135	ft^3 Plywood

Certificate of Completion

is hereby granted to:

Tyler Peterson

to confirm that they have completed

Stepladder Safety

1/25/2024

Score: 100

AMERICAN LADDER INSTITUTE

LADDER SAFETY TRAINING

www.laddersafety.org

Certificate of Completion

is hereby granted to:

Lexie Isbell

to confirm that they have completed

Stepladder Safety

1/24/2024

Score: 100

AMERICAN LADDER INSTITUTE

LADDER SAFETY TRAINING

www.laddersafety.org

Certificate of Completion

is hereby granted to:

Lucky Bahati

to confirm that they have completed

Stepladder Safety

1/24/2024

Score: 100

AMERICAN LADDER INSTITUTE

LADDER SAFETY TRAINING

www.laddersafety.org

Certificate of Completion

is hereby granted to:

denisse alejo

to confirm that they have completed

Stepladder Safety

1/24/2024

Score: 90

AMERICAN LADDER INSTITUTE

LADDER SAFETY TRAINING

www.laddersafety.org

Certificate of Completion

is hereby granted to:

Savannah Thomsen

to confirm that they have completed

Articulated Ladder Safety

1/11/2023

Score: 95

AMERICAN LADDER INSTITUTE

LADDER SAFETY TRAINING

www.laddersafety.org

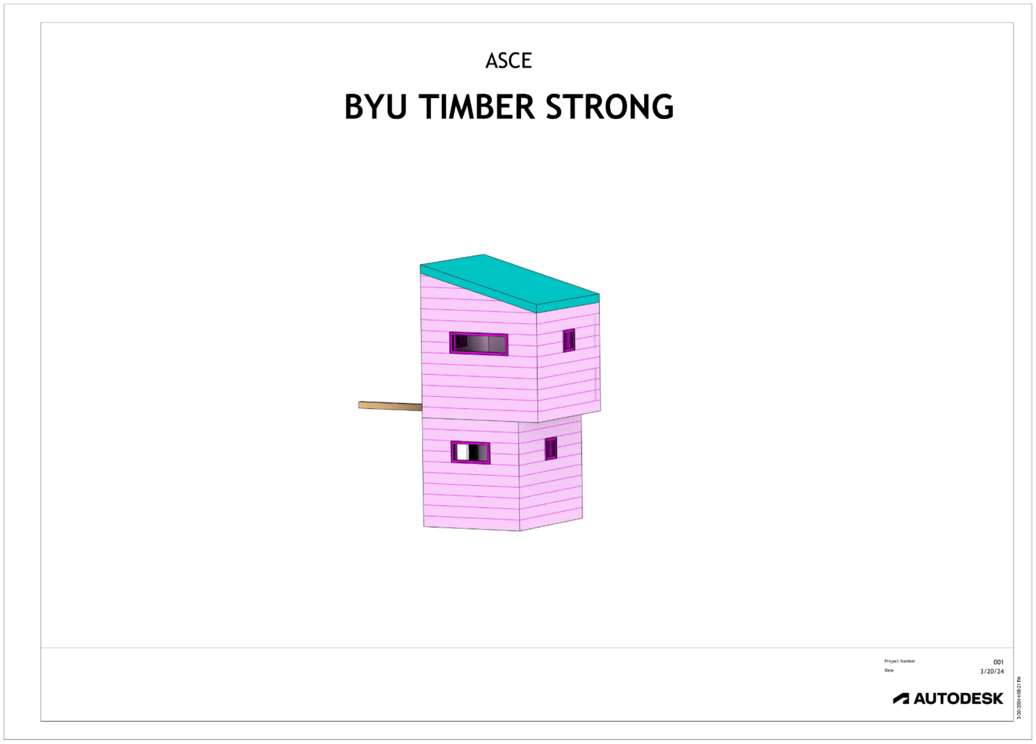
All team members have read and understand the rules including SECTION 4.5 in addition to the referenced OSHA documents.

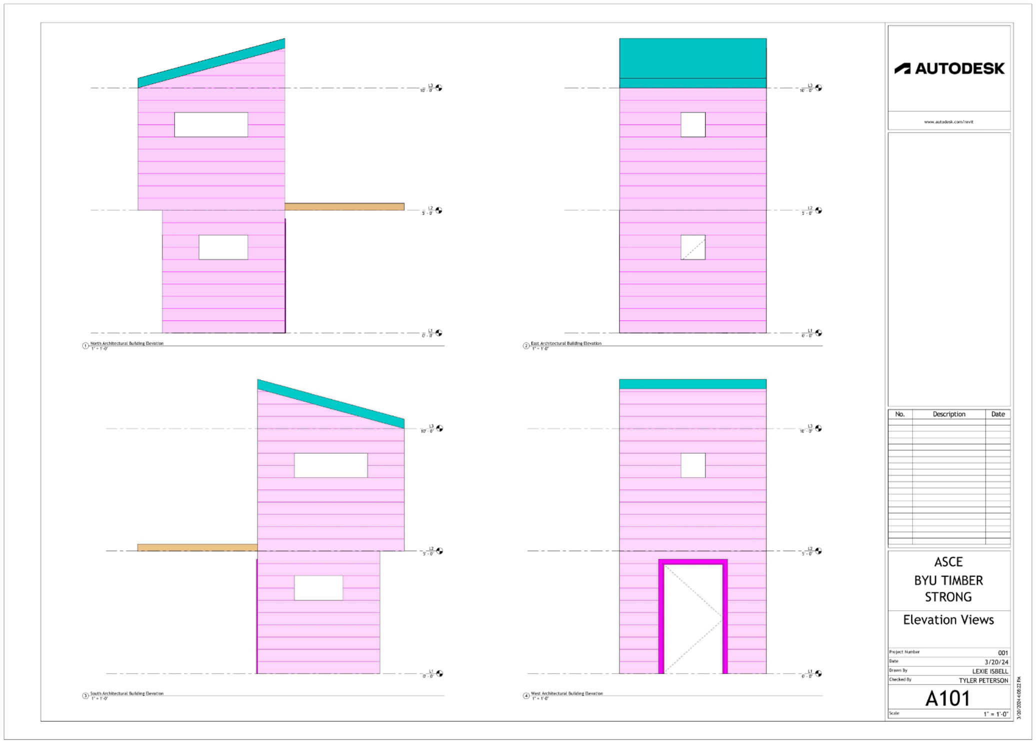
1/26/24

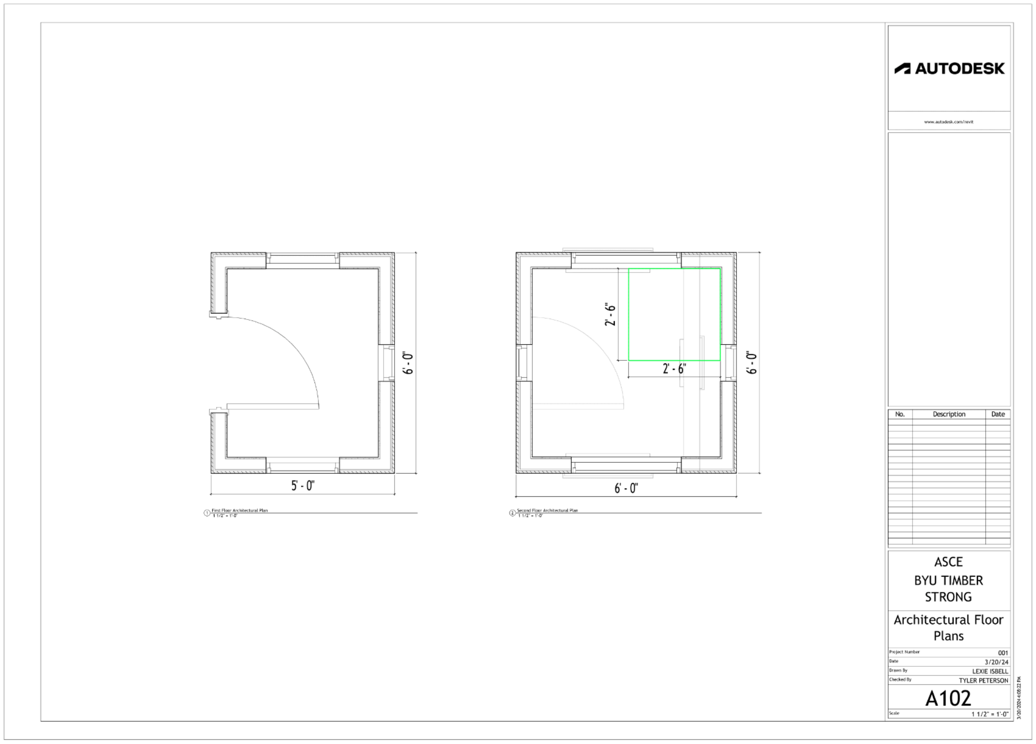
1/26/24

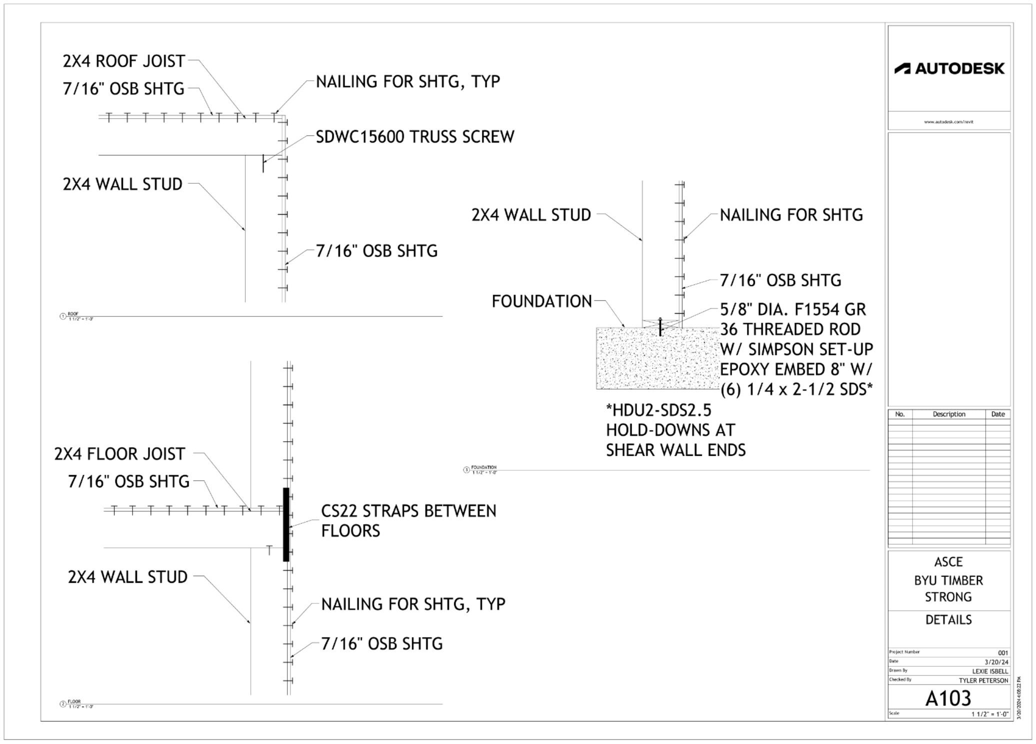
Appendix D: Phase 2 Drawings and Framing Plans

BYU Civil Eng	TEAM 015	TIMBER STRONG	CAPSTONE PROJECT


ASCE
BYU TIMBER STRONG
Project Number 001
Date 3/20/24
AUTODESK


AUTODESK
No.
Description
Date
ASCE
BYU TIMBER STRONG
Elevation Views
Project Number 001
Date 3/20/24
Drawn By LEXIE ISBELL
Checked By TYLER PETERSON
A101
Scale 1" = 1'-0"


AUTODESK
6' - 0"
5' - 0"
2' - 6"
2' - 6"
6' - 0"
6' - 0"
No.
Description
Date
ASCE
BYU TIMBER
STRONG
Architectural Floor Plans
001
3/20/24
LEXIE ISBELL
TYLER PETERSON
A102
1 1/2" = 1'-0"


2X4 ROOF JOIST
7/16" OSB SHTG
NAILING FOR SHTG, TYP
SDWC15600 TRUSS SCREW
2X4 WALL STUD
7/16" OSB SHTG
2X4 WALL STUD
NAILING FOR SHTG
7/16" OSB SHTG
FOUNDATION
5/8" DIA. F1554 GR 36 THREADED ROD W/ SIMPSON SET-UP EPOXY EMBED 8" W/ (6) 1/4 x 2-1/2 SDS*
*HDU2-SDS2.5 HOLD-DOWNS AT SHEAR WALL ENDS
2X4 FLOOR JOIST
7/16" OSB SHTG
CS22 STRAPS BETWEEN FLOORS
2X4 WALL STUD
NAILING FOR SHTG, TYP
7/16" OSB SHTG
AUTODESK
No.
Description
Date
ASCE
BYU TIMBER
STRONG
DETAILS
001
3/20/24
LEXIE ISBELL
TYLER PETERSON
A103
1 1/2" = 1'-0"

Appendix E: Phase 4 Visual Aid

BYU ENGINEERING
Civil & Construction Engineering

CAPSTONE

CCE-CPST-0 15 **Timber Strong Competition 2024**

Team members: Denisse Alejo Juarez, Lucky Bahati, Lexie Isbell, Tyler Peterson

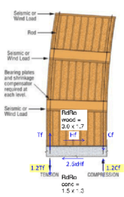
April 3, 2024

Motivation and Concept

The Timber-Strong Design Build Competition is based on **creating a sustainable, 2-story wood light-framed building**. 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. Our goal was to design and build an artistically creative building that is sustainable, aesthetically pleasing and structurally durable. The competition enables students to gain experience in performing crucial aspects of common structural engineering design and practice. Participating students learn about the processes involved in professionally designing and proposing a project bid as well.

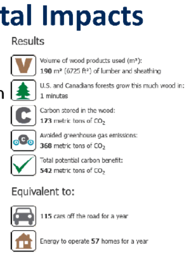
Lateral Design

The structure was designed and analyzed to **resist seismic and wind loads** based on allowable stress design (ASD). The roof and floor diaphragms had to be designed including sheathing, chords, and collectors. The shear walls were designed to resist in-plane shear and overturning. Anchorage to the foundation had to be designed including anchor bolt and SST hold-downs to resist in-plane shear and overturning. In addition, roof joist anchorage was designed to resist the uplift wind load.



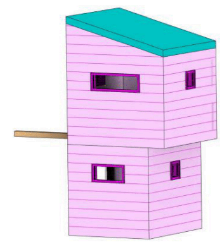
Carbon Stored and Environmental Impacts

To simulate a full-sized building, the amount of wood used for the framing plans was multiplied by 100. This equals **190 m³ of lumber** and sheathing used. That much lumber stores 173 metric tons of CO_2 and has a **total potential carbon benefit of 542 metric tons of CO_2**. That's enough to power 57 homes for a year and equivalent to taking 115 cars off the road for a year!



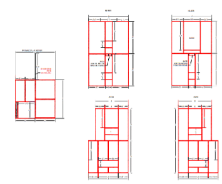
Visual Design

Our focus was creating a building that was **aesthetically pleasing and creative**. To do this we decided to base our structure off the 2023 hit film, Barbie! Our design includes a slanted roof to replicate a sleek modern home, and lots of pink! Our building was intended to be bright, colorful, and playful.



Framing Plans

The design of the structure adheres the dimensions set forth by the ASCE- Timber Strong Competition with the flexibility in design. We used 2 x 6 and 2 x 8 boards to meet the requirements. The 2 x 8 cantilever was made to stick out the building to withstand loading without the structure collapsing.



Gravity Design

The ceiling on the first floor is completely flat while the top floor has a slanted roof that changes the weight distribution of the structure. Everything from the slanted roof and the 2 x 8 cantilever altered the gravity design of our structure.