

CCAT Roof Design and Construction Guide

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TABLE OF CONTENTS

PROJECT OVERVIEW	3
ABSTRACT	3
PROJECT	3
CURRENT SCENARIO.....	3
PROPOSED SOLUTION	4
ROOF DESIGN.....	5
BUDGET/MATERIALS	6
PROTOTYPES.....	7
<i>PROTOTYPE 1</i>	7
<i>PROTOTYPE 2</i>	7
SUGGESTED CONSTRUCTION	8
SITE NOTES AND PREPARATIONS	8
PREPPING/ DECONSTRUCTION OF SITE	8
CONSTRUCTION	9
<i>HOW TO BUILD A ROOF BASED ON THE DESIGN</i>	9
<i>ADDITIONS</i>	10
PHOTO EXAMPLES.....	10
CONCERNS AND POTENTIAL ISSUES	12
NEXT STEPS	12
BIBLIOGRAPHY	13

Abstract

The Campus Center for Appropriate Technology (CCAT) is in need of covering an exposed area to protect it from rain and making it a year-round space for activities and an outdoor classroom. This guide walks through the budget, steps of prototyping and constructing a roof that will meet CCAT's needs and similar projects of the like. Some concerns and solutions are addressed, and it is hoped that this guide will relay the next steps of the roof needed at CCAT.

Project Overview

Project

The Campus Center of Appropriate Technology (CCAT) is looking to update their outdoor kitchen area. The main upgrade desired is a new roof over the entire area, from the edge of the green shed to the edge of the rocket bench. Doing this will provide an area to have outdoor cooking and outdoor classes during any weather event and time of year. The goal is to provide guidance through prototypes and design structures to move this project forward into the hands of CCAT members in the future. All of the design elements and suggestions made in this guide are open to adjustments or alterations given certain scenarios during design and construction.

Project Goals:

- Provide year-round outdoor area for CCAT
- Protect water sensitive amenities such as the limestone bench and the cob oven.
- Create a safe structure with a long-life span
- Create more potential for future appropriate technology projects such as rainwater catchment or solar.

Current Scenario



Image 1: Location of expected roof in current state.

As of right now the outdoor kitchen area is fully exposed except for the live roof covering the cobb oven, as seen above. This leaves a lot of potential issues. The previous roof that was there, although small, provided some protection from the rain for the cobb oven and people. Now, with that coverage being gone, it is entirely exposed. Moving forward, the goal is to have this entire area photographed to be covered by a roof.

Proposed Solution

Simply said the solution for this exposed area is a roof. This construction guide provides CCAT with a stepping point on suggested next actions on building a roof for the outdoor kitchen. Both this document, the project Appropedia page, and multiple prototypes can be used as resources for future participants of this project.

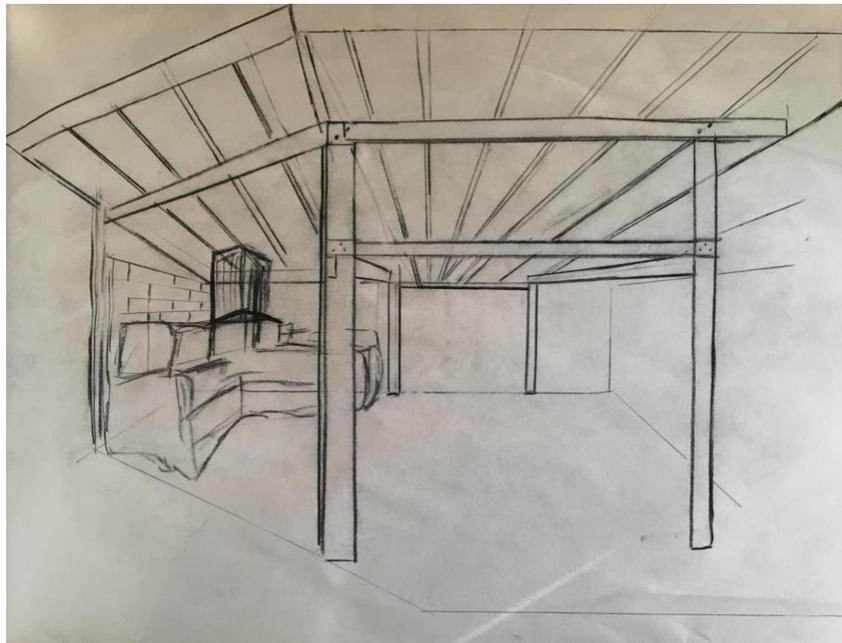


Image 2: Drawing of proposed roof

Above is a drawing of the proposed design of the roof. To thoroughly reflect CCAT's mission statement it is suggested that all materials are sourced sustainably and not used in excess. The goal of this roof is creating a space for shelter and education with minimized effect to the surrounding environment. Using existing features, such as the back wall, will be a great way to minimize materials used and keep a low cost for this project. Features like the live roof and the chimney behind the limestone bench are strongly encouraged to be removed to accommodate for the most straightforward and functional roof given the space of the outdoor kitchen. Following is a design structure suggested to create a safe and long-lasting roof design using materials as sustainably sourced as possible. There are two main approaches suggested for construction. One is construction on top of the already standing concrete wall on the back of the outdoor area.

Second is a design that has a free-standing structure if building on the wall is not feasible or out of the budget.

Roof Design

Budget/Materials

The following budgets are for both design options. This budget is just a suggestion. It is likely there will be other materials, tools, features, etc. that may need to be applied to the future roof. It is anticipated that the money would come from either facilities management, CCAT funding or fundraising.

Alternative 1

Quantity	Material	Source	Cost (\$)	Total (\$)
10	2x6x14 Rafters	Local	\$12.00	\$120.00
3	6x6x12 Post	Local	\$45.00	\$135.00
3	6x6x10 Beam	Local	\$36.00	\$108.00
2	2x6x10 Blocking	Local	\$15.00	\$30.00
2	6x6 Simpson ties	Local	\$15.00	\$30.00
1	6x6x12 Post	Local	\$45.00	\$45.00
1	6x6x16 Beam	Local	\$62.00	\$62.00
1	1/2 x 8 Carriage Bolts & Nuts 25 pack	Local	\$67.00	\$67.00

1	10 x 4 in. screw thousand pack	Local	\$115.00	\$115.00
1	Standing Seam Metal Roof	Local	\$500.00- \$1,000.00	\$500.00- \$1,000.00
Total Cost				\$1,212-\$1,712

Table 1: Alternative 1 budget

Alternative 2

Quantity	Material	Source	Cost (\$)	Total (\$)
3	6x6x12 Post	Local	\$45.00	\$135.00
10	2x6x14 Rafters	Local	\$12.00	\$120.00
2	2x6x10 Blocking	Local	\$15.00	\$30.00
3	6x6x10 Beam	Local	\$36.00	\$108.00
1	6x6x16 Beam	Local	\$62.00	\$62.00
1	1/2 x 8 Carriage Bolts & Nuts 25 pack	Local	\$67.00	\$67.00
1	10 x 4 in. screw thousand pack	Local	\$115.00	\$115.00
2	6x6 Simpson ties	Local	\$15.00	\$30.00

10	8x8x16 Cement Blocks	Local	\$1.50	\$15.00
3	3/8"x 20' Rebar	Local	\$4.00	\$12.00
14	Cement Bag	Local	\$6.00	\$84.00
1	Standing Seam Metal Roof	Local	\$500.00- \$1,000.00	\$500.00- \$1,000.00
Total Cost				\$1,331-\$1,830.00

Table 2: Alternative 2 budget

Prototypes



Images 3 & 4: Cardboard prototype of the CCAT roof

Alternative 1

This alternative is designed to have the roof structure partially built behind the concrete wall. Instead of creating a stem wall to be the supporting object, three 6x6 posts roughly 2 ft. tall to extend above the 6 ½ ft wall and about 8 ft. apart will be dug into the soil that's behind the existing cement wall that stretches 15 ½ feet. The advantage of this proposed alternative is that the extra money and time needed to create a stem wall won't be necessary. One future concern is the water catchment system that is built behind the wall. To ensure this alternative can be built, please contact Michael Fisher (Head of Facilities Management).

Alternative 2

This alternative is designed to have the roof structure partially built on the existing cement wall by adding a stem wall to create the necessary height that is needed for the roof. The stem wall will provide the necessary height while the sill plate and beam that is attached on top after creating the stem wall, will be the support. This alternative will mimic the stem wall made by the previous construction of the Green shed. This will allow consistency in the construction of the space by keeping the aesthetic the Green shed provides.

Suggested Construction

The following steps are the suggested construction measures for putting up the roof. The instructions are open to altering and interpretation. This guide is intended for the use of CCAT and other projects that are like the scenario at CCAT. The goals of this construction is to balance practicality, aesthetic and function. Keeping this area covered will allow CCAT to do many more things in this area and will also provide plenty of appropriate technology opportunities.

Site Notes and Preparations

The team's biggest achievement this semester was the creation of a high-quality site map, and although it is not a huge accomplishment, it is a valuable tool. On top of the site map, a 1-inch 3D scale model was made. This 3D tool was great because it enabled the team to see how the roof components fit in real life. In the modeling process, several different methods of modeling were attempted: Sketch-up, ACAD, physical sketches, and cardboard modeling. The easiest and most appropriate was beer boxes taped to a scrap piece of wood. The thin cardboard was easy to work with and shape and was widely available as trash. When the site and roof was built as a 3D model, it was easy to see the pitfalls of the proposed product.

The most creative phase of this project was the design process, meeting with CCAT several times to see exactly what they needed and wanted from the space. The team is left thinking about the many different versions of the structure that were never thought of, and a temporary structure for the winter (as simple as I-bolts glued into the walls with a small movable structure to hold it all up). The pandemic changed priorities for a lot of people, and no one was excluded, it became apparent that the roof was not going to be able to be built and that definitely took some wind from the sails. The team would have loved to build it but unfortunately did not get the opportunity this semester.

Prepping/Deconstruction of the site

Before building anything, the site must be cleared of existing structures. There were two small roofs that were in place. The small living roof still stands which protects the cob oven. It is suggested this roof is removed to optimize new roof space. A temporary roof that had stood well past its useful life was removed now leaving the cob oven partially exposed. The temporary roof

was a small wobbly roof and structure that didn't meet the needs of the CCAT. It was dismantled and CCAT members were able to repurpose the structure for other productive projects.

Repurposing materials is always encouraged. Many trips to the CCAT site were taken to measure, mark, and understand the constraints of the building project. With these many trips there is great confidence in the prototypes designed. On the site, there were several meetings held with CCAT to better understand their desires and needs. This space is used as a work area almost every week and it is used as a kitchen monthly. Understanding its use and layout was very beneficial to the design of the structure.

Suggested Construction

This semester, Under One Roof planned to design and build a structure roof intended to shelter an outside classroom at CCAT. The design process was long and iterative, during which the team worked through many different versions of the structure. It was started with an elaborate building and was pared down to a simple permanent roof. The construction portion of the project was derailed just days before it was scheduled to start, because of the global pandemic in March of 2020. So, in short, the roof was never built.

The space that CCAT wants to cover has a few challenges that should be taken into consideration in the future. The goal was to cover a rocket-mass heated bench and cob oven cooking area, the open concrete slab near it was meant to be incorporated to make an outside covered classroom. The cooking area and cob oven was an extra concern because they gas off black smoke that stains the ceiling. The site is also quite large with an irregular shape. The plan was simply to make a timber frame structure that holds up a conventional roof. To construct this roof the following steps are suggested for construction.

How to Build a Roof Based on the Design

- Start by figuring out the area you need to cover.
- Then decide how tall you would like it and how you want it to look.
- When it is time to break ground, you will need to dig a hole for every post to plant them in the ground.
- There are plenty of ways to attach a post for longevity. It is suggested to put metal footings in cement and attach the poles to that.
- When the poles are being put up it is necessary to use temporary braces to hold them in place during construction.
- Leave the braces on until you put in the middle support beams, those will tie everything together and start to make it rigid.
- After the middle support is up get the big beams up on top.
- Getting these big beams up high is hard work so scaffolding and teamwork may be necessary.

- The next step is putting the rafters up on the beams and blocking them out, putting pieces of wood that keep them from moving or falling flat under the weight of the roof.
- On top of the rafter's thin pieces of wood running perpendicular to the rafters will need to be laid down, parallel to the beams. This helps distribute the surface pressure if someone walks on the roof. They also keep the sheet metal ridged.
- Finally put the metal on and secure it into place
- Add some trip and flashing,
- Roof Completed

It can also be planned to build off the back-retaining wall. The bottom slope of the roof would be set on the existing wall and the top slope would be held up by 2 6x6 freestanding posts. The freestanding posts are anchored into the ground with concrete and steel mounts.

Additions

- Add storage in the ceiling, integrating the middle supports.
- Add lights for night class and cooking
- Add a solar array to power the lights

Photo Examples

Below are photographs of design elements to help visualize construction methods



Image 3: How rafters will sit on stem wall



Image 4: Joints that hold the roof



Image 5: Footings to anchor structure

Concerns / Potential issues

This roof is intended to have a blend of functionality and the CCAT sustainable and practical style. The roof that is proposed will be topped with corrugated metal and will be strong enough to hold people that need to walk on top of it. It will be held together with large Lag bolts and heavy grade deck screws to ensure stability. Some of the big concerns in building this were the forces that might be applied, Arcata is in an earthquake prone area therefore the roof needs to be able to move and be strong enough to withstand an earthquake. Safety and stability are the top priorities in constructing this roof and other similar projects.

Next Steps

It is anticipated that, with this guide, taking the next step of constructing a roof for CCAT will now be provided with guidance and direction to make the construction process safe and easy to follow.

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