Construction of the SLO Botanical Gardens Foot Bridge - Interdisciplinary Project

Connor Layman
California Polytechnic State University
San Luis Obispo, California

In the Winter quarter of 2020, a project based senior project was sought out by a Cal Poly Construction Management student, and he was connected with the San Luis Obispo Botanical Gardens (SLO BG). SLO BG is a non-profit organization located on 150 acres in the El Chorro Regional Park. After meeting with the SLO BG staff and exploring their many needed projects, the student and the staff mutually concluded that he would build a bridge and accompanying stairs which resided on a well-traveled trail on the property. He successfully developed the project schedule, budget, recruited an architect for design assistance, and secured funding for the project. However, many delays were faced due to the COVID-19 pandemic and government bureaucracy. The scope of the project was subsequently changed to become a purely preconstruction and prefabrication project. Throughout the duration of work, the materials were acquired, prefabricated, plans were created and revised many times, the permitting process was started, and the site was prepared for the installation of the bridge. The project was brought to the point where the permitting process needed to be completed, and the bridge and stairs need only be installed on site.

Key Words: SLO, Botanical Gardens, Bridge, Prefabrication, Permitting

Introduction

The San Luis Obispo Botanical Gardens is a non-profit organization that leases 150 acres of the El Chorro Regional Park property from the SLO County Parks Department. Located halfway between San Luis Obispo and Morro Bay on Highway One, the SLO BG hosts hundreds of annual community Garden events. Currently, SLO BG achievements include installation of a 2-acre Present Garden, 2-acre Children's Garden, construction of a sustainable office building and rental facility, propagation of thousands of drought-tolerant plants each year, installation of a ¾ mile hiking trail, hosting hundreds of annual tours, installation of a 1-acre Fire Safe Demonstration Garden, and planting the largest Chilean wine palm grove outside of Chile. When the SLO BG master plan is complete, it will be the only garden of its kind in the United States exclusively devoted to the ecosystems and plants of the five Mediterranean climate regions in the world. Other components of the master plan include the addition of miles of hiking trails, hosting a wider variety of demonstrations, and building more sustainable buildings for education and research.

With such rapid expansion, SLO BG has a huge demand for donations and volunteers. This makes them a perfect client for Construction Management students looking to build their senior projects. The construction management student building the bridge and the SLO BG staff met, and compiled a list of all current projects they were ready to start construction on. After careful consideration, SLO BG and the builder mutually decided that the bridge project was of the most necessity and urgency to the Garden. The bridge project consisted of the cleanup of the trail surrounding the bridge, construction of the bridge over a creek that flowed through the middle of the trail, and the installation of stairs after the bridge to help visitors climb up a steep part of the trail. The bridge project was necessary because annual rains would cause the creek to fill up with water and turn the steep slope into mud,

necessitating both the bridge and stairs. Reference Figure 1 for a picture of the SLO Botanical Gardens.

Figure 1 - SLO Botanical Gardens

Interdisciplinary Teamwork

To aid in bringing a more professional design of the bridge together, the builder recruited fifth year architect major Cutler Patierno. Cutler was experienced working with construction management students, as he was a part of the 2019 Design-Build construction team, and participated in the Reno competition. There, he designed plans for a Moxy Hotel, and presented on his work. The builder heard good things about Cutler, and with a light coursework load, Cutler was more than happy to help design the bridge. Cutler and the builder both met with Lindsey Morgan, Chenda Lor, and Craig Blett to address preliminary design concerns. Lindsey and Chenda were both paid employees of the SLO BG, and Craig was a retired engineer who volunteers at SLO BG. Lindsey and Chenda set the requirements for the bridge and stairs, and Craig provided design and structural advice. The builder proceeded to hand draw an initial bridge design, which was then sent to Cutler to put into CAD. Cutler then provided both section and plan drawings of the bridge. See Figures 2 and 3.

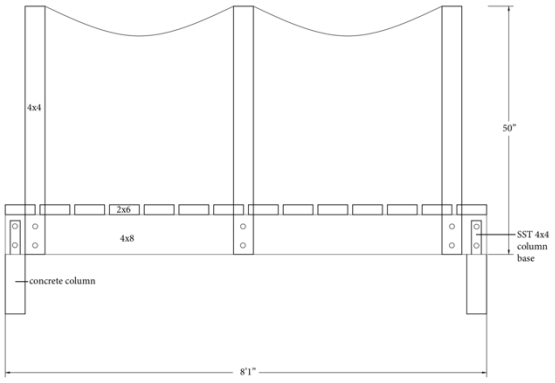

Figure 3 - Original Plans, Side View

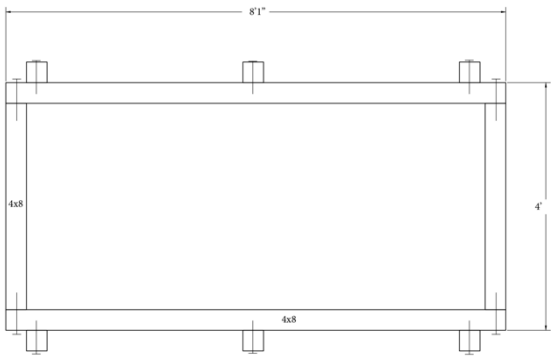

Figure 2 - Original Plans, Top View

Funding

Securing funding was the first portion of the project that caused a time delay. The builder applied for two senior project grants. The first was the Hasslein Fund sponsored by The Foundation for Interdisciplinary Studies (FIS). This grant offered a total of $20,000 to students doing interdisciplinary projects during this academic year. The second one was the Construction Management Council Senior Project Grant. The builder's project was awarded $1,500 from the Hasslein Fund, and he accepted this sum for his project. Later, the builder was also awarded the Construction Management Council Senior Project Grant, however since he had already won the first grant he graciously declined this second offer. About 5 weeks went by between submitting the application for the Hasslein Grant, and receiving notice that the builder had been offered the sum he applied for. A week went by waiting for the FIS to get the check in order with their organization. Cutler and the builder then both sent signatures stating that they agreed to the terms of the grant. Ten days after this, the builder was notified that the physical check would be mailed that day. Five days after this, the builder was notified that the check was actually sent that day. Eight days after the check was sent, the builder finally received it in the mail. Overall, the time delay from the day the grant application was due, to receiving the grant was over two months. Within this time, the entirety of the project could have been easily completed if there were no major delays.

Schedule

The original schedule for the SLO BG Bridge Project was a very reasonable one, however multiple issues related to funding, permitting, and COVID-19 caused considerable delays and even changed the scope of the project in its entirety. The original schedule estimated the architectural plans to be completed by 2/29/20, which was the only milestone to be met on time. Breaking ground was estimated to be started on 4/3/20, however the first day of construction on site was started on 5/16/20, almost a month and a half after the estimated date. This date was delayed considerably due to an underestimation of how long it would take funds to be received by the builder, and delays due to COVID-19. Funds from the Hasslein Grant were received on 4/28, and this length of time was not estimated properly. The builder only estimated about 9 days between the application due date and breaking ground. If the funds had been received a week after the application was submitted, the schedule could have stayed on track, however a severe underestimation of the time it would take the Foundation for Interdisciplinary Studies to decide on Grant recipients caused the first major setback. Additionally, delays from the COVID-19 pandemic included an increased time the builder needed to spend in his hometown of Davis, CA for spring break before coming back to complete the project in San Luis Obispo, and the closing of the SLO permit office. The builder went to the permit office to find out if he needed a permit the day after they closed because of COVID-19, and it was a matter of weeks before the Planning and Building department concluded that he should apply for a permit just to be safe.

After breaking ground, the next major milestone was considered to be the trail completion which included grading, a potential small retaining wall, and some trimming of the brush around the trail. This was estimated to be completed after the first day of construction on 4/4/20, but was completed on the second day of construction, 5/16/20 which was due to previously mentioned delays, and trouble finding volunteers, as well as restrictions by the SLO BG on how many people were allowed on site during quarantine. The time it took to finish the trail renovation was 9 man hours, solely completed by the individual builder, but would have been done in the estimate time under normal conditions. Total project completion was estimated to be finished on 4/12/20. Major delays due to permitting stopped the builder from being allowed to complete the project in its entirety, even though it was just two

working days from total completion. Without a permit, the SLO BG instructed the builder to halt construction. With just two weeks left in before the builder would leave the area, receiving a response from the permit office in a timely manner would be impossible, and therefore completion of construction was not feasible within the given time limit. The last day of construction on site was 5/21. A total of 18 man hours was put into the construction of the project at the end of this builder's involvement.

Deliverables

Originally, the main scope of the project included trail grading and cleanup, installation of the bridge, and installation of the stairs. After delays and revisions, the scope of the builder's work still included trail grading and cleanup, but excluded installation of the bridge and stairs. However, with such a large amount of work planned in the first place, the revised scope was still acceptable under the standards of a Cal Poly Construction Management senior project.

Plans

Developing plans was the first step in completing this senior project. After the builder and architect met with the SLO BG staff, the expectations were set and the builder began drawing plans. The plans conceived included a 4' wide by 8' long rectangular bridge with 4"x8" pressure treated lumber used for the beams and 2"x6" boards used for the decking. After consulting with the engineer Craig Blett, 2' deep concrete columns with an inset metal SST column brace were called out for the column system. The 4"x8" beams would sit in the column braces and 8" lag bolts would be used to screw to bolt everything together. The original plans called for 4"x4" pieces of lumber to be used for the handrail, however, this was revised and deleted from the plans as the bridge did not sit high enough off the ground to necessitate handrails. Because the bridge was also located in a hiking trail, it was assumed that the bridge would not need to be ADA compliant as a disabled person would not be able to reach the bridge in the first place. If the SLO Planning and Building committee decides the bridge does need to be ADA compliant, these handrails can be easily and cheaply added to the bridge. Modifications can be made to the stairs as well, but this was not in the original plans. After the architect put the plans into CAD, he left to travel abroad and was no longer available to assist in project completion. When revisions to the bridge plans needed to be made, the builder did these on his own in Bluebeam, as well as creating new plans for the stairs. Revisions were only made to satisfy the needs of the permit office, they were not needed to complete the project. See Figures 4 and 5.

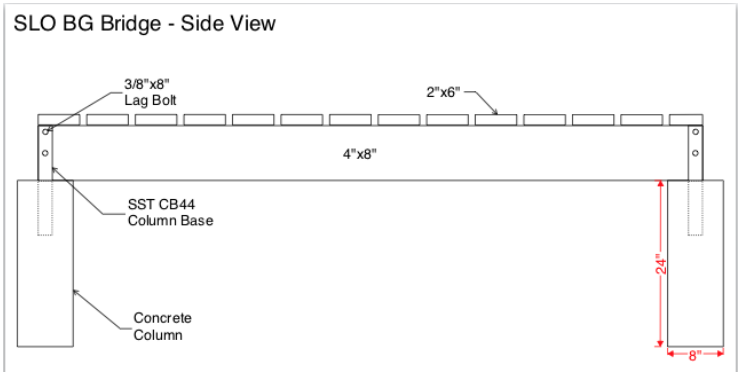

Figure 4 - Revised Plan, Bridge

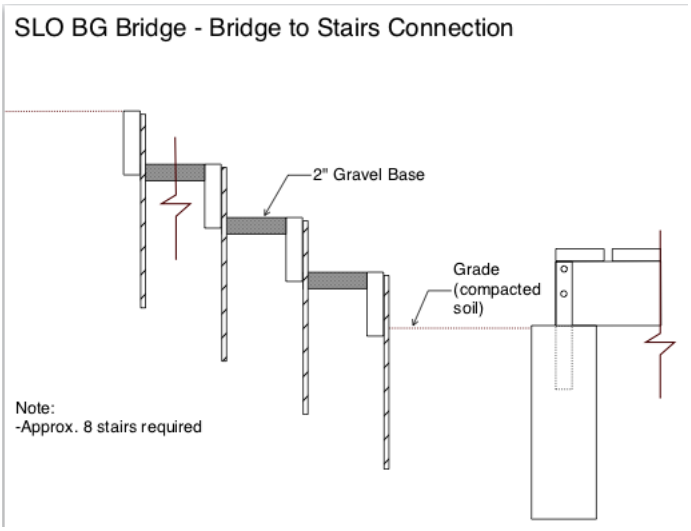

Figure 5 - Revised Plans, Stairs

Budget

One positive aspect of this project was that it was built substantially under the initial budget. During application for the Hasslein Grant, the plans were in the very basic design phase, and specific number could not be reached. The builder, along with opinions from a few other Construction Management Students estimated that the bridge would cost around $1,000, and with most construction projects tending to go over budget, the builder added $500 to the initial amount, and applied for $1,500 in grant money. This amount was also estimated to take care of the cost of the stairs, and any tool or food costs. After finalizing a more specific bridge design, the builder made an estimate pulling from the Home Depot and calling Hayward Lumber for prices. The estimate for the bridge was about $700, not including the stairs, tools, or food for volunteers. Unexpectedly, SLO BG got a very generous discount from Hayward Lumber so the cost was cut dramatically. The real cost of materials for the bridge from Hayward Lumber was only $356 after the discount for SLO BG. Material costs for the stairs are Cost of materials for from Home Depot were $128. Tool costs for the project totaled $168. Cost of food for the volunteers totaled $59. This brings the total for the project at its current state to $711. During the writing of this senior project report, the project is not fully installed on site, however, all of the estimated materials have been paid for and minimal extra costs are expected. When the next student takes responsibility for the completion of the project, funds will be transferred to their ownership, or the builder will reimburse the new student for their expenses, then make a donation to SLO BG for the remaining amount. See Figure 6 for cost breakdown.

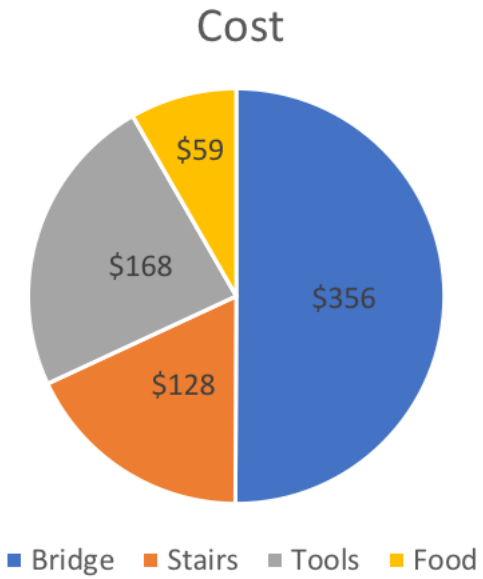

Figure 6 – Project Cost

Prefabrication and Construction

Prefabrication of all the materials was seen as the most logical way to build this project. First, the builder purchased the materials, and transported them to the yard at his house. The builder then cut all the members to size with a skill saw and fit them together to ensure they fit properly (See Figures 7 and 8). He made one mistake while cutting the decking which was cutting the decking to 4' each, which did not take into account the real size of the 4"x8" beams that were supporting the decking. The builder had to cut another inch off all the 2"x6" decking lumber which resulted in a better fit. He then fit the column base on the beams and marked the holes for inserting the lag bolts. The pilot holes were drilled and the beams were marked for which sides were the top and bottom. This marked the completion of the bridge prefabrication. See Figure 9.

After prefabrication was complete, site preparation was started at the SLO BG. First, the builder decided exactly what angel he wanted the bridge to be set at, and then he started digging into the side of the hill and leveling the trail. Originally the trail led downhill and diagonally across the stream. After the builder was done, the trail walked parallel to the stream at a slight upward slope. The side of the hill near the old trail was dug out, and the excess dirt was used to level the trail and make it more prominent. The builder wanted to save money by buying as little tools as possible, but this backfired because it caused him to spend more time laboring on site. Harbor Freight Tools, a local store, had a small selection of landscaping tools so the builder bought a rake and a drain spade shovel, which was useless in the hard dirt. Luckily, an employee was on site and lent the builder a better shovel and a digging bar. On the second day of construction the builder brought with him a better shovel and a post hole digger. On that day the builder dug the four column holes and continued to grade the trail. To ensure the holes were square, the builder took the diagonals of the holes and made small adjustments in the holes until the lengths between the diagonal holes were exactly the same. On the last day of the builder's involvement on site, the builder and two volunteers continued to level out the landing of the bridge. Chenda from SLO BG requested that there be a three foot wide path at the end of the bridge to

connect it to the start of the stairs. Construction on site stopped there because the next step was to pour the concrete columns with the inlaid SST column brace, which would have been a tripping/stabbing hazard because the bridge was not allowed to be permanently installed. See Figure 10 and 11 for site conditions before and after completion of the project.

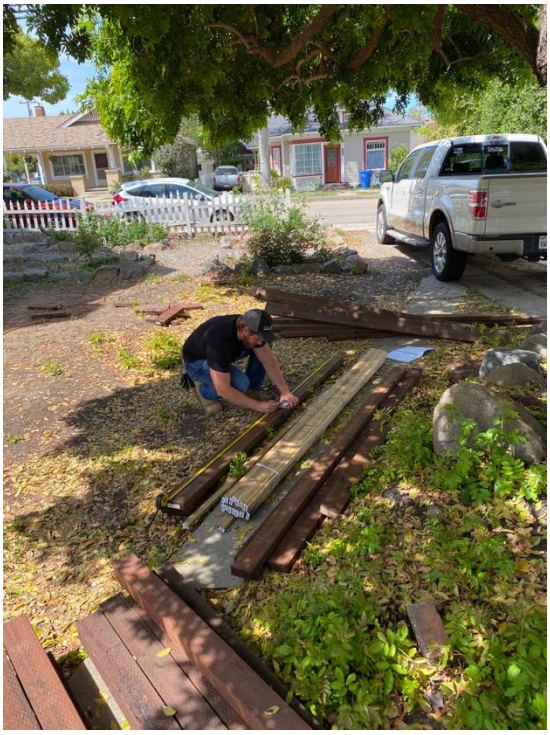

Figure 9 – Sizing Material

Figure 8 – Cutting Material

Figure 7 – Completed Bridge

Figure 11 - Site Before Earthwork (looking in)

Figure 10 - Site After Earthwork (looking out)

Permitting

The permitting process is the reason the bridge was not fully completed, and the reason the scope of the project was diminished to the preconstruction and prefabrication aspects. Getting a hold of someone with the authority to decide whether or not a permit was needed was quite a long process. In typical government fashion, the SLO Planning and Building department was slow and vague with their responses. After many emails and phone calls, the builder finally received a call that said he will probably need one because the project rests on public land. In essence, to find out if the bridge required a permit, the builder would have to gather all the information needed and apply for a permit. The application was a 9 page document, with most of the question and information required being completely irrelevant for a project of this size and scope. The application asked things such as how many linear feet of walls there will be, what type of MEP systems will be used, and how many bathrooms there would be. The application was clearly meant for a complete building, but the builder was reassured this was the application he needed to fill out. It was surprising to everyone involved in the project that an 8' long bridge on a hiking trail would require a permit, and Chenda was especially frustrated that this project was taking as much time to permit as the other much larger projects on her plate. The builder proceeded to gather as much information as he could to get the permit. The builder put together many documents required by the permit before coming to the realization that there was not enough time for them to review a permit before the end of school. The documents acquired included plans of the bridge and stairs, location of project as compare to the property lines, location of project on a topographical map with the flow of water shown, and locations of nearby structures, wells, leach fields, nearby water treatment facilities, parking, and septic tanks. The rest of the permit was information that would be required by SLO BG to find.

Lessons Learned

There were many, many lessons learned during the completion of this project that are applicable to how processes run in the construction industry and the world. The first important lesson learned was that items out of your control can take much longer than expected. The schedule for this project was created before receiving funds and without research into the permitting process or how long it usually takes. Both of these delayed the project from the intended schedule. When dealing with a bureaucracy such as the government, expect to have to go through red tape and seemingly unnecessary procedures. Often times, the procedures are not tailored to your needs, so it will seem as though you are completing unnecessary work. People you are working with will not always respond quickly, or at all, or keep their word to you. You must learn to be flexible and to find another way of making progress when you hit a roadblock. Additionally, think about every step in the process of building. For this project, the prefabrication process was not added as a milestone, and would have added some more time to the original schedule. Lastly, make sure you have all the tools needed to succeed. While it may seem like an unnecessary cost in the beginning, it will be a worthwhile investment. These problems, while relatively small because of the limited scope of the project, mimic problems found in most construction projects. By using this project as a case study, we can get an understanding for construction after finishing school.

Future Project

With the change in scope due to permitting issues, there is now room for another senior project to finish the installation of the bridge. All the preconstruction and prefabrication was finished with exception to some parts of the stairs. At the end of this half of the project there are still a few things to

do. Earthwork for the stairs needs to be complete, and the stairs need to be cut to size and installed on site. The permit process needs to be seen through until completion. Some more information may need to be gathered, and submitted to the SLO Planning and Building committee. When this is complete, the concrete columns need to be poured and the column braces need to be set in the concrete. After this, beams need to be bolted into the column braces and the decking needs to be screwed on. The trail where new, loose dirt was laid needs to be tamped down to increase the durability of the walkway, and this will complete the installation of the bridge. See Figure 12 for project location in SLO.

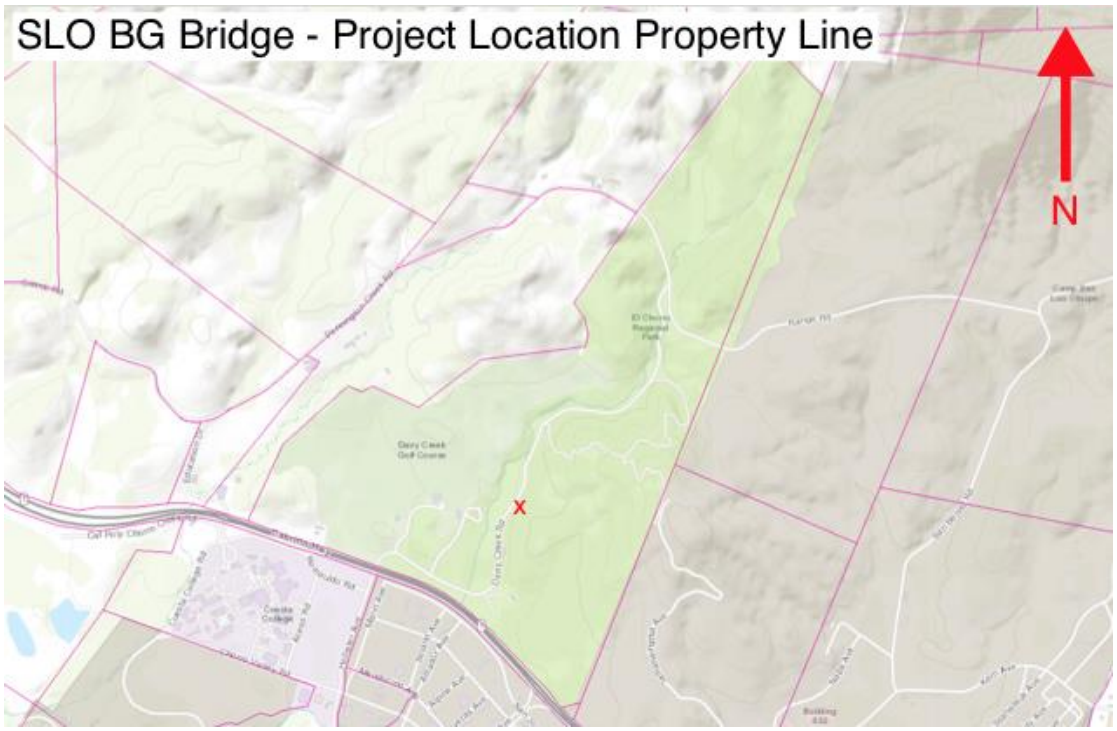

Figure 12 - Project Location