Students at California Polytechnic University have created an unsafe dirt trail down a hillside west of the Cerro Vista Apartment Complex on the university’s campus. This heavily traveled trail is a shortcut to an existing pedestrian pathway which connects Village Drive to Poly Canyon Village, as well as the R-3 and R-4 parking structures. The use of this trail raises alarm for potential safety concerns for students using it, especially during winter months when the hillside becomes very slippery. This paper outlines the design and preconstruction plan for the West Cerro Vista Stair Project, which proposes replacing the current trail with two independent concrete stairways. The scope of the preconstruction plan includes the preliminary design of the stairway, estimate of cost to construct, construction schedule, project cost forecast, site logistics plan, traffic control plan, risk hazard analysis, as well as a land acquisition and permitting plan. The purpose of this paper is to bring awareness of the safety concern with the existing trail, as well as provide a potential solution that may be continued into a final design phase and constructed in the proposed location.

**Keywords:** Preconstruction, Estimate, Design, Logistics, Plan

**Introduction**

The Cerro Vista Apartment Complex is an on-campus housing facility on the campus of California Polytechnic State University, San Luis Obispo. The complex houses a wide variety of students from first-year students, to continuing education and graduate students. These students often have to travel back and forth from the Poly Canyon Village Housing Complex, R-3 and R-4 parking structures, among many other locations north-west of the Cerro Vista Apartment Complex. The current path that students are supposed to travel takes them very far out of the way in the opposite direction, and as a result, the students often decide to traverse the hillside down an unsafe foot trail. The trail goes directly down the hillside west of the Cerro Vista Apartments, across Poly Canyon Road, and eventually connects to an existing pedestrian path. The trail is a safety hazard to the students, especially in the winter time when it becomes muddy and very slippery.

The objective of this paper is to bring awareness to the safety concern with the existing trail, as well as to initiate the mitigation of the issue through a preconstruction plan including the design of a potential solution to the problem. With the tools provided in this senior project, Cal Poly Facilities will be able to determine the demand for such a project, the cost of construction, potential risks, and duration of construction. The goal after completion of this senior project if for Cal Poly Facilities to initiate a final design process, and construction phase of the proposed stairway.
General Project Background

Having lived in the Cerro Vista Apartment Complex myself, I have traversed the student created trail many times and have experienced both its convenience and potential hazards. The convenience of this trail in unparalleled in comparison to the existing route that students are supposed to follow. The existing route doubled both the distance and time it took me to reach Poly Canyon Village, which was a common destination for myself along with many other residents of the Cerro Vista Apartment Complex. This is because Poly Canyon Village is home to many essential resources for residents of Cerro Vista including the post office where packages arrive, closest food and dining options, as well as the parking structures where we had to park our vehicles. As a result, most Cerro Vista residents, myself included, heavily traveled along this trail. I have also however seen the potential hazards to students that the trail poses. The trail is largely composed of loose soil and rock, with very steep slopes in some sections, as well as occasional tree roots sticking up. The combination of such hazards makes the trail a significant risk for trips, slips and falls, especially if one considers that many students walk up this trail with their hands full of groceries. I have personally witnessed and experienced my fair share of slips, trips, and falls on this trail which is why I decided to choose it as my senior project, as I hope to initiate the solution which will allow students the means to safely traverse up and down the hillside.

Important Project Design Considerations

Cal Poly 2035 Master Plan
California Polytechnic State University, San Luis Obispo, has already initiated a plan for how the campus is going to grow over the next 20 years from the plan’s initial creation in 2015. This plan outlines what types of projects the school plans to construct, as well as their locations. This was an important document to investigate in order to determine whether or not the school was planning to use the land for any future expansion projects, as well as to see if they had already thought of a solution to this issue. Additionally, it was important to consider how the growth of the campus would affect the potential foot traffic of the project. According to the 2019 revision of the master plan, there are no proposed projects in the stairway’s location. Furthermore, it is apparent that the school is planning on constructing more buildings directly west of the Cerro Vista Apartment Complex, which will result in even further foot traffic along the current trail. This means that the demand for the project will significantly increase over time.

Figure 2. Cal Poly 2035 Master Plan Map

Cal Poly Zoning

In addition to the 2035 Master Plan, the design for the project also had to consider the zoning requirements on California Polytechnic State University’s campus. According to zoning information provided by Cal Poly Facilities, the project is located in zone OS-1. This area is reserved for open space, passive recreational uses, and outdoor teaching and learning facilities or displays. It also notes that prior to installing any new facilities in the area, an analysis of soil compaction and suitability given the nature and size of the proposed project will be required. Therefore, prior to the start of any on site construction, the soil should be tested by a third-party geotechnical company. The proposed stairway is an open space design, similar to the existing stairway in this zone, so Cal Poly’s zone requirements should not be an issue for the project.
Procédure

Site Survey

Avant de commencer le design des escaliers, j’ai d’abord dû déterminer le grade existant de la colline. La première étape était de trouver les plans de construction du parcours existant, ce qui a été un peu de travail, du moment que le parcours faisait partie d’une change order du projet Poly Canyon Village et n’était pas initialement trouvé dans les plans. Toutefois, après avoir correspondu avec Cal Poly Facilities, j’ai pu les trouver. C’était crucial car il n’y avait pas de repères de niveau dans l’endroit, et j’ai pu utiliser l’élévation d’un escalier sur les plans existants des plans d’escalier comme mon point de départ. Puis j’ai pu emprunter l’intersection station de gestion des travaux pour mesurer graduellement les élévations du grade existant. Cela a été fait en trois parties le long de la ligne centrale de la piste de manière à déterminer le grade existant le long du chemin que mon design d’escaliers serait suivi. En utilisant les données de la mesure, j’ai pu déterminer le chemin d’escaliers, mais également modeller le grade existant au Revit.

Design

Après que la mise en place a été terminée, j’ai utilisé les données pour modéliser le grade existant du parcours, avec le reste du design d’escaliers au moyen de Autodesk Revit. Le modèle de grade existant a été très précieux car j’ai pu superposer le design d’escaliers avec le grade existant pour déterminer un design approprié qui respecte les codes d’État et de comté, ainsi que les standards de Cal Poly. Les escaliers ont une hauteur verticale universelle de 7 po et une longueur horizontale de 12 po, et toutes les plateformes ont au moins 4 pi de dimension dans la direction de la marche. La hauteur de la rambarde est de 36 po, et tous les rebords de rambarde s’étendent au moins 1 pi sur la plateforme, comme requis par les codes. De plus, le modèle a permis de maintenir le design le plus près possible du grade existant en minimisant le travail de nivellement nécessaire pendant la construction.

Pour le processus de design, je me suis décidé à diviser les escaliers en 3 sections principales: Escalier 1, Escalier 2 et Escalier 3. Escalier 1 est la section la plus petite de l’escalier et se connecte à l’escalier existant. Escalier 1 est...
approximately 70 foot 6 inches of horizontal run, rises approximately 12 feet in elevation, and has a total of 22 steps, and 8 landings. Stair 2 shares Stair 1’s top landing but takes a 51 degree turn towards Cerro Vista. Stair 2 has approximately 107 foot 6 inches of horizontal run, and rises approximately 23 feet in elevation over the course of 39 steps and 7 risers. The top landing of Stair 2 ends on the west edge of Poly Canyon Road and shares an equal elevation with the road. Stair 3 is not connected to stair 1 or 2. Stair 3’s bottom landing is offset 20 feet, 1 and 5/8 inches from the closest point to Stair 2’s top landing. Stair 3 takes a 12 degree turn south of stair 2 to ensure that its top landing arrives square to Cerro Vista Circle Road. Stair 3 has approximately 109 feet of horizontal run and rises approximately 30 feet in elevation through 52 steps and 10 risers.

The project was designed as a monolithic reinforced concrete stairway to not only resemble the similar stairs in the area, but to ensure that it is a permanent solution to the safety concern. Additionally, the handrails are designed to be 1 and ½ inch galvanized steel pipe, and the stair tread grips are anchored black anti-slip strips in order to fit in with similar staircases along the existing path. That way the staircase does not look out of place in its environment.
Quantity Takeoffs

Earthwork

After completion of the stairway plans, the quantity takeoff and estimate phase could begin. Because I was both the designer and estimator of the project, the quantity take-off phase was relatively smooth. I was able to overlay the final and existing grades in the model which made for fairly simple earthwork takeoff. There was a 6 inch layer of compacted crushed stone layer that accounted for the majority of the cut, and much of the excavated soil was able to be reused as fill in areas that required it. As a result, the site was relatively balanced and after all cut and fill calculations were completed, the project only required approximately 21 bank cubic yards of soil to be off hauled. The total amount of crushed stone to be imported is approximately 39 bank cubic yards. It is important to note that the earthwork quantities will need to be adjusted following a soils report, as their respective swell factors and compaction factors are unknown at this time.

![Figure 6. Stair 3 Cut and Fill Quantity Takeoff](image)

Steel Reinforcement

The stairs all require #4 rebar reinforcement for longitudinal bar, traverse bar, and stair nosing bars. The longitudinal bar running lengthwise along the long span of the stairs have a top and bottom bar vertically offset 2 inches from one another. The longitudinal bar is to be offset 12 inches on center. Additionally, along the top longitudinal bar, there are traverse bars set 12 inches on center. Furthermore, each stair has a nose bar with a minimum 1 inch concrete cover. The project calls for approximately 8691 linear feet of #4 rebar after considering lap factor and estimated waste. Therefore approximately 2.91 tons of #4 rebar should be ordered. It is also recommended that the rebar be prefabricated in order to save time and labor costs during the construction process.
Concrete & Formwork

The concrete formwork for the project was estimated using *RSMeans Heavy Construction Cost Data 2013*. *RSMeans* specified that this take off was determined using the horizontal run and width of stairs to calculate square footage of stairs as per section 03 11 23. The concrete required for the project was very straightforward to takeoff by taking the surface area of the stair cut sections and multiplying it by the 7 foot 6 inch width of the stairs. Stair 1 requires approximately 13.07 cubic yards, Stair 2 requires approximately 20.41 cubic yards, and Stair 3 requires approximately 22.61 cubic yards, for a total of 56.09 cubic yards. All three stairs are scheduled to be poured in the same day utilizing a concrete pump and 6 incrementally timed concrete trucks.

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<tr>
<th>Description</th>
<th>CY Concrete</th>
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<tr>
<td>Stair 3 Concrete</td>
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Figure 7. Reinforcing Steel Typical

Figure 8. Concrete Quantity Takeoff
Estimates

Project cost estimates were determined using a combination of average industry crew output and activity costs from *RSMeans Heavy Construction Cost Data 2013*, local equipment rental quotes, as well as local material quotes. Labor crews, activity outputs, and costs were determined using *RSMeans*. Industry price quotes from manufacturers and rental companies were used to determine all equipment costs, crushed stone import and delivery cost, concrete material and delivery cost, trucking off haul rates, as well as stair tread grip cost. The remainder of material costs were pulled from *RSMeans*. Bare cost of the project came out to $105,545.55, with a total estimated project cost of $137,209.22 which includes both a conservative 10% contingency, and an estimated 20% for project overhead and profit.

![Figure 9. Project Cost Summary](image1)

![Figure 10. Project Cost Forecast](image2)

Results

At the end of this senior project, I was able to successfully translate skills that I have learned through my courses at Cal Poly to create a complete design and preconstruction plan for the proposed stairway. An engineering surveying course enabled me to successfully survey the existing grade to begin my design. Then I was able to successfully design the stairway on AutoCAD Revit through knowledge obtained in various BIM and structures courses. Nearly every construction management lab course covered how to execute quantity take offs and estimates of required materials and labor in order to complete the estimate. Additionally, I was able to accomplish the estimate using knowledge learned in those courses, as well as gained skills on Revu Bluebeam and *RSMeans* interpretation. Furthermore, the advanced scheduling course enabled me to create a cost loaded critical path schedule and project cost forecast using Primavera P6 scheduling software. Ultimately, I was able to combine...
the skills learned in the above courses, as well as the rest of the construction management curriculum to successfully produce my final deliverables which included: A preliminary design, equipment and material takeoff, labor estimate, critical path schedule, cost loaded schedule, site logistics plan, traffic control plan, risk hazard analysis, as well as a land acquisition and permitting plan.

Additional Resource

![Figure 11. Project Schedule](image)

Conclusion

This project aimed to propose a solution to an existing safety concern where students have created an unsafe foot path west of the Cerro Vista Apartment Complex. The objective of the paper is to bring awareness to the safety concern with the existing trail as well as to initiate the mitigation of the issue through a preconstruction plan which includes the design of a potential solution to the problem. This project was a successful first step in the process to create a permanent solution to the issue. The deliverables of the project will allow Cal Poly Facilities to determine that there is indeed a demand for such a project, as well as allow them to analyze the potential cost of construction, potential risks, and duration of the project. In order to ensure the goal of this project, which is for Cal Poly Facilities to pursue the construction of the proposed stairway, I will contact Cal Poly Facilities and provide them with all project deliverables.

References

