California Polytechnic University prides itself on its “Learn by Doing” teaching procedures. The “Learn by Doing” atmosphere is ingrained in every student that attends the university. It is necessary for students especially in the ARCE field to obtain real life experience before entering the professional world. Ensuring that ARCE students have a means to practice and create new knowledge in the field of reinforced concrete shear wall testing is necessary to maintain Cal Poly’s education progression. Creating a reinforced concrete shear wall that can be built year after year for ARCE students to test on has been asked for by the ARCE department. The concrete reinforced shear wall focuses on testing wall types constructed in the 1970’s. These shear walls are common throughout California where earthquakes are prevalent. With the goal of the wall to be broken in shear and then patched using an FRP wrap, this demonstrates real life utilization of FRP wrap to structurally fix a building. With previous failures of delivery of a project of this type, a compressive construction plan has never been more necessary.

**Key Words:** Concrete, Shear, Earthquake, FRP, Construction

**Introduction**

Throughout the state of California, many buildings are out of code. Testing and research are necessary to provide solutions for patching and retrofitting buildings in the event of an earthquake. Earthquakes cause buildings to be “subjected to random motion of the ground at its base which induces inertia forces in the building that in turn cause stresses” (Murty et al. 1). Although earthquakes are prevalent in California and are a problem that will never go away, their effects on buildings can be mitigated. With the, “current practice to improve the response of these walls is to increase cross sectional area by epoxying rebar into existing walls and spraying a layer of shotcrete, or adding new concrete shear walls to the building plan” (Ostrom 6) has proven to be extremely costly and time consuming. This project aims to demonstrate the effectiveness of Fiber Reinforced Panel (FRP) wrap and other reinforcement procedures in the future. FRP wraps are a cost effective and effective means of retrofitting concrete walls that have been subjected to shear force. *Structure Magazine* explains that, “FRP composite materials are comprised of high strength continuous fibers, such as glass, carbon, or steel wires, embedded in a polymer matrix”. FRP is an extremely effective fiber solution to solving structural issues. Ensuring the quality and effectiveness of these materials is necessary for their widespread use and implementation in the field.

In order to test FRP and similar retrofits, Cal Poly San Luis Obispo (SLO) has setup a testing bay. They have tested a number of wall types in recent years and this project will focus on the concrete...
shear wall. The project scope of the concrete-reinforced shear wall includes the fundraising and construction of a 5’ wide 12’-8” tall 5” thick wall. The project will be poured on the existing foundation where, after curing, it will be subjected to shear force by hydraulic jacks. Utilizing shear force to emulate the effects of an earthquake will break the wall. Once broken, the wall will be reinforced with FRP wrap and then subjected to force again. The goal is to test the strength and effectiveness of structural retrofit solutions.

This project was performed by a group of students consisting of, “two Graduate Architectural Engineering students, one Senior Construction Management/Architectural Engineering student, one Senior Construction Management student and two helpers for the construction: One second year Mechanical Engineering student and one third year Construction Management student” (Espitia 1) last year and after the test the ARCE department deemed this project one that they want to continue year after year. After significant issues with the construction quality, it was determined that a comprehensive building plan is necessary to make this a sustainable project.

**Project Scope**

This project focuses on delivering a reinforced concrete shear wall that can reconstructed year after year by the ARCE department. The goal of this report is to present a seamless construction manual so issues and discrepancies in the construction process can be avoided. The project scope includes the construction of the concrete wall not limited to placement of concrete, rebar and wall stripping. The procedure to deliver this wall is discussed in the complete project installation manual.

**Deliverables**

This project provided the deliverable of the Construction Installation Manual. This manual is broken down into the main sections of General Information, Construction Installation, Safety and Quality Assurance (QA) and Quality Control (QC). This report will discuss the contents and findings in these sections. Defined in this section is the project information that is necessary to safely deliver a quality project. Figure 1, demonstrates all deliverables that are included in the project which can be referenced in Appendix A.
General Information

The general information section of this manual details the necessary measures that need to be taken to begin construction. This section aims to define the knowledge and information that must be known at a minimum before the project begins. This section provides background, lessons learned from the past project, specifications, materials, necessary tools, drawings, schedule, concrete delivery method and placing method. This information must be understood for the user to understand how to deliver the wall. All information discussed above can be referenced in Appendix A Section 1.
Construction Installation

The construction installation guide explains in detail how to install and complete the physical product in a step by step process. This is a guide that, with the exact procedures, needs to be followed to deliver the wall to project specifications and quality standard. The section is divided into two parts, form work and concrete. The form work section specifies the procedures necessary to construct the concrete formwork. One thing that is important to note is that the previous year’s foundation will be reused so there will be no form work that pertains to foundation construction. The concrete section explains the concrete placement method. Placement is discussed in the general information section, but this section gives specific installation instruction. The construction installation instruction includes all aspects and information that is necessary to construct the wall on a jobsite. Figure 2. Is an example of what can be found in the project installation instructions. Information pertaining to the construction installation can be found in Appendix 1 Section 2.

Figure 2. Project Instructions

<table>
<thead>
<tr>
<th>Meeting:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meetings will be specified by the ARCE department but will be held at a minimum of once a week. Meetings are essential to ensuring that the goals of the ARCE department are clearly defined. Sufficient communication is necessary to ensure the delivery of this project.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Construction:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordination with the ARCE department’s High Bay is necessary for the delivery of this project. Once the schedule has been finalized and the High Bay is available, construction can begin.</td>
</tr>
</tbody>
</table>

| Formwork: |
| 1. Materials must be delivered to site. When materials are delivered, verify material quantities are correct and material types are correct. |
| 2. Begin wall framing: The wall panels will be framed on the floor of the High Bay. This ensures that the panels are level and true as this is the smoothest and flattest surface available in the area. |
| 3. The foundation will be reused. It is located outside of the High Bay. The High Bay crane will be necessary to place the foundation in place. |
| 4. Foundation is to be drilled and specified dowels are to be inserted. |
| 5. Once wall panels have been completely constructed, they will be set into place using the High Bay crane. |
| 6. Place 3 wall panels in place, pin them to the ground and utilize steel HSS tubing to shore the top of wall. |
| 7. Insert and construct internal rebar cage following specified rebar. |
| 8. Coat all forms with specified form oil or bond breaker. |
| 9. Once rebar is inserted, lift final wall into place and close wall up. |
| 10. Place working platform into place. It will be necessary to construct a new one as last year’s is not to a safe standard. This platform must rest on the steel beams of the surrounding structure and span the wide side of the wall. |
| 11. Now that all walls are in place, begin log cabin to hold panels together. |
| 12. Insert and secure all required snap ties. |
| 13. Ensure that walls are plumb and true, and all specifications and plans have been followed. |
| 14. Wall is now ready for concrete. |

| Concrete: |
| 1. Inspect and verify that wall is structurally sound and that all performance specifications have been met. |
| 2. Area must be prepped for concrete delivery. Affected areas will be covered with plastic and taped to ensure nothing is damaged by concrete. |
| 3. Concrete delivery method will vary depending on funding and donations, but we are recommending three separate concrete mobilizations to ensure the upmost mix quality. |
| 4. Concrete trucks will enter on Cuesta Ave and turn onto college Ave where they are to back into the site. One traffic controller is necessary to ensure the safety of pedestrians. More information on this can be found in the Site Logistics Section. |

Figure 2. Project Instructions
Safety

The safety section is one of the most important sections in this manual. This section outlines the necessary measures and precautions that need to be taken to ensure worker safety. This section includes a Covid-19 statement, public safety regulations, construction personnel regulation, PPE regulations, jobsite safety instruction, and toolbox talks and JHA form. In these sections the necessary information of safety regulations and procedures are explained. If followed, the toolbox talks and JHA forms that are provided will ensure site safety. Figure 3 is an example of the type of information that can be found in the site safety section. These are to be utilized using the provided instructions. All information in the safety section can be found in Appendix A Section 3.

Site Safety

Safety Statement: “Ensuring that all workers return home uninjured and safe is the number one priority on this project. All OSHA standards and guidelines will be referenced and followed for the duration of this project.”

Safety is the most important part of this project. Ensuring that all interacting with this project directly or indirectly is necessary. This project being on the Cal Poly campus during the school year presents its own problems. Not only must the safety of the workers be taken in consideration the safety of the students also needs to be taken into consideration.

Covid-19 Statement: With the recent development of the Covid-19 pandemic its necessary to take precautions to ensure to stop the spread of Covid-19. This site will require all individual working on site to wear a face covering. Social distancing will be enforced on site and all members will work 6ft appart. If individuals are feeling unwell, they will be asked to stay home or will be sent home. Preventing the spread of Covid-19 and ensuring worker health and safety is of the upmost importance.

Public: As stated in the site logistics plan, the safety of the public must be considered at all times. Utilizing flaggers and traffic control is necessary to protect the public during deliveries. It is also necessary to ensure that unauthorized personnel do not enter the construction site. Students must remember this is an active construction project so there are real dangers present. Ensuring that the public is safe is necessary to the success of this project.

Construction Personnel: All construction personnel are to be subjected to Cal OSHA laws and regulations. These standards must be met during all times and all phases of the project.

PPE Regulations:

Listed below are the necessary jobsite PPE items.

- Vest
- Hard Hat
- Gloves
- Safety Glasses
- Construction Boots
- Pants and Long sleeves

Jobsite Safety Instructions: Listed below are the daily safety procedures needed to be taken by all personnel on the jobsite.

1. Only authorized personnel are to enter the site.
2. Those on site must wear specified PPE.
3. Before beginning work, workers must engage in a stretch and flex.
4. A toolbox talk will be chosen for that day that correlates to work to be performed. This will be read before work begins.

Figure 3. Site Safety
**QAQC**

The QAQC section provides a quality checklist and defines the necessary steps to execute the project to the necessary quality. Last year’s project’s major flaw was its failure to ensure quality, so this section is extremely important. Users of this must follow the specified information to ensure a quality product is delivered to the client. All information discussed in this section can be found in Appendix A Section 4.

**Lessons Learned from the Past Project**

This project was first performed by a group of students in 2018-2019. This project was a joint project between CM students and ARCE students. The goal was to provide a concrete shear wall that emulated a wall utilized in Los Angeles hospital construction. With California continually experiencing earthquakes, the structural integrity of these walls has been called into question. One solution to fix damage from shear force is to use FRP wrap. Last year’s project used specifications and design that was common in the 1970s and was able to deliver a testable wall for the ARCE department. A wall was delivered but there were many quality issues with the final project. Pictures are unavailable of these quality failures as they are not noted in the previous reports. One major issue was that the wall bulged a total of 8” about 1 foot from the bottom of the wall. It is hard to accurately conclude the effects of FRP wrap if the wall has bulged a total of 4” making its actual thickness 13” at one spot when it was specified to be 5”. Ensuring the wall is completed to the project specifications is necessary to conclude the effects of FRP wrap.

After discussion, Terry Roy of McClone Construction, the owner of the plans for this wall, concluded that the sources of failure in last year’s project was failure to follow the plans and project specifications. The first major mistake was the failure to use snap ties. Snap ties are a construction form system that holds two forms together and resist them from separating. Snap ties are necessary to prevent bulging and breakage in concrete form work. If snap ties were utilized in this project, it would have largely prevented the bulging of the form work.

Another failure in last year’s project was the failure to recognize that the plans call for a 4ft liquid limit per hour. What this means is that the form work is engineered to be poured at a rate of 4ft per hour. This ensures that the concrete has time to set up. Without letting the concrete set up, too much stress is put on the form work, causing the forms to bow. It is necessary that the form work specifications are followed to ensure that the final product is to a high-quality standard.

The final issue that has been determined is that the plywood used did not follow the specified plywood on the drawings. Last year’s project did not use the called out ¼” MDO or plyform or SIM. This is a major mistake as they used OSB instead. Oriented Strand Board is strong in a non-form application. OSB being fused by compression and glue does not fare well in liquid applications. Utilizing OSB as the form plywood caused the form work to bow and warp. Water in the mix caused the OSB strands to separate which lead to a further decrease in the structural integrity of the form work.

In future projects, it is necessary that the form drawings are followed to exactly what is specified on the drawing. These plans are engineered for a reason, and it is necessary to follow them to ensure the
upmost project quality. Quality issues in last year’s project can be directly attributed to negligence in the construction process, not engineering error.

**Conclusion**

Making sure the concrete-reinforced shear wall is easy to construct and deliver is necessary for the continuation of the project. This project is essential to the continued learning and testing done by the ARCE department and needs to be made sustainable. This project installation guide provides the proper instructions and guidance to make this a sustainable project. It is necessary for this guide to be followed throughout the construction process. Ensuring quality needs to be of the upmost concern and in the previous year, the quality issues were caused by human error and not engineering error. This guide easily lays out the proper steps that need to be followed. Cal Poly, a university that prides themselves on their “Learn by Doing” culture, needs projects like this to continue their legacy. This project provides students with the opportunity to test real world structural applications. Making sure this is an easy-to-perform project year after year is necessary to ensure the longevity of the project.


Sevilla, Rory De. “Feasibility of a Fiber Reinforced Polymer Retrofit for Non-Ductile Concrete Walls.” *California Polytechnic State University San Luis Obispo*, Digital Commons @ Cal Poly, 2019, pp. 1–8.
Appendix A

Construction Installation Guide Concrete Reinforced Shear Wall Cal Poly ARCE Department

Giovanni Dal Canto
California Polytechnic State University
San Luis Obispo, California
# Table of Contents

## General Information: Section 1
- Background ................................................................................................. 5
- Lessons Learned from the Past Project .......................................................... 6
- Specifications .................................................................................................. 7
  - Foundation .................................................................................................... 7
  - Formwork .................................................................................................... 7
  - Concrete ....................................................................................................... 7
  - Rebar ........................................................................................................... 7
- Materials ......................................................................................................... 8
- Necessary Tools .............................................................................................. 9
- Drawings ........................................................................................................ 10
- Schedule ........................................................................................................ 13
- Site logistics .................................................................................................. 14
- Concrete Delivery Method ............................................................................. 16
  - 3 Mobilizations ........................................................................................... 16
  - Mobile Batch Plant Truck ........................................................................... 16
  - Mixer Delivery Trailer ............................................................................... 16
  - Mix At Concrete Lab ................................................................................... 17
- Placing Method .............................................................................................. 18

## Construction Installation: Section 2
- Project Installation .......................................................................................... 20
  - Meetings ..................................................................................................... 20
  - Construction ............................................................................................... 20
  - Formwork .................................................................................................. 20
  - Concrete ..................................................................................................... 20

## Safety: Section 3
- Site Safety ..................................................................................................... 23
  - Safety Statement ......................................................................................... 23
  - Covid-19 Statement ..................................................................................... 23
  - Public .......................................................................................................... 23
  - Construction Personnel ............................................................................. 23
  - PPE Regulations ......................................................................................... 23
  - Jobsite Safety Instructions .......................................................................... 23
  - Tool box Talk and JHA form ...................................................................... 24

## QAQC: Section 4
- Quality Control and Quality Assurance ......................................................... 37
  - QAQC Checklist ......................................................................................... 37
- Project Images ............................................................................................... 39
- Citations ......................................................................................................... 41
Mission Statement

“To provide a sustainable project for students to practice “Learn by Doing” philosophies while ensuring quality and safety”

This manual is intended to provide the necessary details and information to perform this project year after year. This manual should be followed to ensure the safety and quality of this project.
General Information: Section 1
Background

Throughout the state of California, many buildings are out of code. Testing and research are necessary to provide solutions for patching and retrofitting buildings in the event of an earthquake. Earthquakes cause buildings to be “subjected to random motion of the ground at its base which induces inertia forces in the building that in turn cause stresses” (Murty et al. 1). Although earthquakes are prevalent in California and are a problem that will never go away, their effects on buildings can be mitigated. With the, “current practice to improve the response of these walls is to increase cross sectional area by epoxying rebar into existing walls and spraying a layer of shotcrete, or adding new concrete shear walls to the building plan” (Ostrom 6) has proven to be extremely costly and time consuming. This project aims to demonstrate the effectiveness of Fiber Reinforced Panel (FRP) wrap and other reinforcement procedures in the future. FRP wraps are a cost effective and effective means of retrofitting concrete walls that have been subjected to shear force. Structure Magazine explains that, “FRP composite materials are comprised of high strength continuous fibers, such as glass, carbon, or steel wires, embedded in a polymer matrix”. FRP is an extremely effective fiber solution to solving structural issues. Ensuring the quality and effectiveness of these materials is necessary for their widespread use and implementation in the field.

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In future projects, it is necessary that the form drawings are followed to exactly what is specified on the drawing. These plans are engineered for a reason, and it is necessary to follow them to ensure the upmost project quality. Quality issues in last year’s project can be directly attributed to negligence in the construction process, not engineering error.
Specifications

Foundation:
1. The foundation will be reused year to year.
2. Foundations is poured and will be moved into place.
3. If new foundation is needed follow drawing W-1.

Formwork:
1. Forms are not designed for full liquid head. Limit concrete pour rate to 4 vertical feet per hour.
2. All lumber studs in panels are designed as 2X4 DF #2 or better.
3. All plywood in ¾” MDO polyform or SIM.
4. For further information reference plan W-2.

Concrete:
1. Total Concrete need for this project is a little less than 1cy
2. Mix design will vary year to year. Consult ARCE department for mix design specifications.

Rebar
1. Mix design will vary year to year. Consult ARCE department for rebar specifications.

Further information pertaining wall size can be found in the Drawing Section
Materials

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form Oil/Bond Breaker</td>
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</tr>
<tr>
<td>Dowel Epoxy</td>
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</tr>
<tr>
<td>Tie Wire</td>
<td>3 Rolls</td>
</tr>
<tr>
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<tr>
<td>Vertical</td>
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Form Work

<table>
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<td>2&quot;x4&quot;x14'</td>
<td>16 Sticks</td>
</tr>
<tr>
<td>2&quot;x4&quot;x8' &quot;Plates/Walers&quot;</td>
<td>28 Sticks</td>
</tr>
<tr>
<td>2&quot;x4&quot;x10' &quot;Bracing&quot;</td>
<td>3 Sticks</td>
</tr>
<tr>
<td>2&quot;x4&quot;x10' &quot;Waler 2'-6&quot; Brac</td>
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</tr>
<tr>
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</tr>
<tr>
<td>Nails 10d Duplex</td>
<td>1 Box</td>
</tr>
<tr>
<td>Nails 8d</td>
<td>1 Box</td>
</tr>
</tbody>
</table>

Material Listed are general qualities. This should be used for reference not actual amounts. Materials will changed based on mix design and rebar specifications. Perform take off prior to construction.
Necessary Tools

Listed below are the tools needed to perform this project:

1. Framing Hammer (1 per worker)
2. Tape measure (1 per worker)
3. Construction Square (1 per worker)
4. Chalk line (1 per worker)
5. Torpedo level (1 per worker)
6. Cat’s Paw (1 per worker)
7. Linesman pliers (1 per worker)
8. 4ft level (1 shared on site)
9. 8ft level (1 shared on site)
10. 4ft ladder (1 shared on site)
11. 8ft ladder (1 shared on site)
12. 12ft ladder (1 shared on site)
13. Chop saw (1 shared on site)
14. Circular Saw (2 shared on site)
15. Plumb bob (1 shared on site)
16. Large Prybar (1 shared on site)
17. Mixture Sledge (1 shared on site)
18. Rebar Bender Cutter (1 shared on site)
19. Grinder (1 shared on site)
20. Concrete Vibrator (1 shared on site)
21. Rotor Hammer (1 shared on site)
22. Hilt Epoxy Gun (1 shared on site)

Note: Many of the tools listed above can be sourced from SST and the High Bay. Other tools will be needed to be purchased with project funds.
Drawings

On the following page are the engineered plans for the project:
GENERAL NOTES:
1. FORMS ARE NOT DESIGNED FOR FULL LIQUID HEAD. LIMIT CONCRETE POUR RATE TO 4 VERTICAL FEET PER HOUR.
2. ALL LUMBER STUDS IN PANELS ARE DESIRED AS 2X4 DF #2 OR BETTER
3. ALL PLYWOOD IS 7/8" MDO PLYFORM OR SIM.
1. **WALL PLAN VIEW**

2. **WALL ELEVATION VIEW**

3. **WALL PANEL FABRICATION**

**GENERAL NOTES:**

1. FORMS ARE NOT DESIGNED FOR FULL LIQUID HEAD. LIMIT CONCRETE POUR RATE TO 4 VERTICAL FEET PER HOUR.
2. ALL LUMBER STUDS IN PANELS ARE DESIGNED AS 2X4 DF #2 OR BETTER
3. ALL PLYWOOD IS 7/16 MDO PLYFORM OR SIM.
The construction schedule inserted above is a conceptual construction schedule. This schedule is only used to show sequencing not actual duration. Durations in this schedule are estimated, not actual. The schedule will be created every year in coordination with the ARCE department. It is necessary that the schedule is precise and accurate in order to successfully deliver the project.
Site Logistics

Concrete Reinforced Shear Wall
- Yellow: Area of Work
- Red: Concrete Wash Out
- Green: Dumpsters
- Arrow: Haul Route
- Orange: Laydown Area
- Blue: Pumping Area
- Slash: Site Entrance
The concrete shear wall will be constructed in the ARCE High Bay which is highlighted in yellow. The lay-down area is located under the High Bay area because the other side must be kept open for trucks and concrete pumping reasons. This project will utilize the concrete laboratory wash out and dumpsters. Concrete and delivery trucks will be utilizing the highlighted delivery route. Trucks will enter on College Ave, where they will cross Perimeter Ave and then reach the site. Trucks will make the turn on College Ave toward the business building and then back into the site. Trucks will exit the site entrance and continue following College Ave out of the campus. This is a live campus so student safety must be kept in mind at all times.
Concrete Delivery Method

Listed below are the available concrete delivery methods from most effective to least effective:

1. **3 Mobilizations:** After discussions with Terry Roy of McClone construction, we determined that having 3 concrete deliveries of half a yard will be the best way to deliver concrete to this project. The current form work calls for a liquid head limit of 4ft per hour. This means that the form work is engineered to only handle four vertical feet of concrete per hour. This means that three separate concrete deliveries are necessary to meet this requirement as the wall is 12’-8” high. Three separate deliveries is the best method as it ensures that all pours are of the highest quality and mixed design is exact.

**Pros:**
- Mix is consistent
- High quality concrete
- Ensures that 4ft liquid head per hours is met

**Cons:**
- Expensive
- Lots of waste
- More deliveries means more coordination

2. **Mobile Batch Plant Truck:** A mobile batch plant truck is the second best option for this project. A mobile batch plant truck is a concrete truck that can mix concrete on site. This ensures that all concrete is to the specified mix design. This is a great option, but we are worried it might be hard to procure. In addition to this, it is hard to justify the amount of time is needed to deliver such a small amount of concrete.

**Pros:**
- Mix is consistent
- High quality concrete
- Ensures that 4ft liquid head per hours is met

**Cons:**
- Expensive
- Hard to procure
- Has to be on site for entire pour

3. **Mixer Delivery Trailer:** The third option is utilizing concrete trailer delivery. Concrete will be picked up and delivered by the customer. This allows for small batches to be easily delivered. The major concern with this delivery method is that the concrete will separate and begin to cure during transport.

**Pros:**
- Cheap
- Easy to deliver
- Small batch

**Cons:**
- Low quality concrete
- Significant aggregate separation
• Decreased working time

4. **Mix At Concrete Lab**: The fourth option is to mix the concrete at the concrete lab located on campus by utilizing the small mixer there. This would allow for small batches to be created. One major issue is the concrete quality. It is extremely hard to ensure the concrete is to the quality and mix design necessary for this project.

**Pros:**

• Cheap
• Easy to deliver
• Small batch

**Cons:**

• Low quality concrete
• Significant aggregate separation
• Decreased working time
Placing Method

The previous project utilized a trailer concrete pump to move the concrete to the top of the wall. Future projects will not utilize this method as the previous project violated the 4ft liquid head per hour pour rate. With having to pour at a rate of 4ft per hour in a wall that holds less than a yard of concrete, it makes no sense to utilize a concrete pump. Pouring at this rate will waste lots of concrete in the line and makes it hard to control the pour rate even using a small hose.

It has been determined that the best placement method is to utilize a bucket pulley system. Concrete will be unloaded from the delivery method and placed into a bucket. Workers on the scaffold will lift the bucket to the top of the wall and dump concrete into the wall. This system will allow for the pour rate to be easily met. This method is more labor intensive, but it is the best way to ensure that the pour rate of 4ft per hour is met.

One concern with this pouring method is the drop height. Dropping concrete from the 12’-8” can be bad as the aggregates will separate and cause the mix to become inconsistent. Options such as inserting a small PVC tremie have been looked at, but the wall’s width is too small. The wall thickness is 5” and with rebar in the center this allows for less than 2 ½” of space. This being said there is no reasonable way to utilize a tremie in this situation.

Another option that has been evaluated is a pour window in the form. This would allow the concrete drop height to be reduced. Adding a window to the form adds its own sets of complications. This require lots more framing and reinforcement, overall complicating the process. Because of this complication, this method has been deemed unnecessary. With proper vibration of the concrete it has been determined that dropping the concrete from the full height will still provide a quality and desired finished product.
Construction Installation: Section 2
Project Instructions

Meetings:
Meetings will be specified by the ARCE department but will be held at a minimum of once a week. Meetings are essential to ensuring that the goals of the ARCE department are clearly defined. Sufficient communication is necessary to ensure the delivery of this project.

Construction:
Coordination with the ARCE department’s High Bay is necessary for the delivery of this project. Once the schedule has been finalized and the High Bay is available, construction can begin.

Formwork:
1. Materials must be delivered to site. When materials are delivered, verify material quantities are correct and material types are correct.
2. Begin wall framing: The wall panels will be framed on the floor of the High Bay. This ensures that the panels are level and true as this is the smoothest and flattest surface available in the area.
3. The foundation will be reused. It is located outside of the High Bay. The High Bay crane will be necessary to place the foundation in place.
4. Foundation is to be drilled and specified dowels are to be inserted.
5. Once wall panels have been completely constructed, they will be set into place using the High Bay crane.
6. Place 3 wall panels in place, pin them to the ground and utilize steel HSS tubing to shore the top of wall.
7. Insert and construct internal rebar cage following specified rebar.
8. Coat all forms with specified form oil or bond breaker.
9. Once rebar is inserted, lift final wall into place and close wall up.
10. Place working platform into place. It will be necessary to construct a new one as last year’s is not to a safe standard. This platform must rest on the steel beams of the surrounding structure and span the wide side of the wall.
11. Now that all walls are in place, begin log cabin to hold panels together.
12. Insert and secure all required snap ties.
13. Ensure that walls are plumb and true, and all specifications and plans have been followed.
14. Wall is now ready for concrete.

Concrete:
1. Inspect and verify that wall is structurally sound and that all performance specifications have been met.
2. Area must be prepped for concrete delivery. Affected areas will be covered with plastic and taped to ensure nothing is damaged by concrete.
3. Concrete delivery method will vary depending on funding and donations, but we are recommending three separate concrete mobilizations to ensure the upmost mix quality. For more information reference concrete Placing Method.
4. Concrete trucks will enter on Cuesta Ave and turn onto college Ave where they are to back into the site. One traffic controller is necessary to ensure the safety of pedestrians. More information on this can be found in the Site Logistics Section.
5. Once truck has entered into the site, a slump test must be performed to ensure the concrete is to the specified mix design. Concrete cylinders will be taken for strength testing. Concrete truck ticket must be kept and documented in Procore.

6. The concrete truck will dump into wheelbarrow and wheeled to the formwork. A bucket pulley system will be utilized to lift the concrete to the working platform. This pulley system still needs to be designed and finalized but it has been deemed to be the best option to lift concrete. When placing, care must be taken to not move or shift formwork.

7. After much discussion it has been determined after discussion with Terry Roy from McClone Construction that there is no need for windows in the form to be created to reduce concrete drop height. The wall is all too small to utilize any type of tremie as the wall thickness is 5”.

8. Concrete is to be poured at a rate of 4ft liquid head per hour. Being staged in 3 pours the first pour will pour 4’-8” liquid head per hour because the total wall height is 12’-8”. The 1st pour will violate the liquid head limit by 8” but this violation has been deemed structurally viable and will not affect the form strength. The next two pours will be poured at 4ft liquid head per hour.

9. Verify form structural integrity and plumpness throughout the entire placement process.

10. Concrete will be vibrated utilizing the High Bay’s concrete vibrator. Concrete will be vibrated to specified amount.

11. Once all pours have been completed, the top will be screeded and finished with a trowel.

12. Thoroughly clean area after pour.

13. Let wall cure for 28 days.

14. Wall striping date will be determined by the concrete mix design.

15. Strip Concrete wall.
Safety: Section 3
Site Safety

Safety Statement: “Ensuring that all workers return home uninjured and safe is the number one priority on this project. All OSHA standards and guidelines will be referenced and followed for the duration of this project.”

Safety is the most important part of this project. Ensuring that all interacting with this project directly or indirectly is necessary. This project being on the Cal Poly campus during the school year presents its own problems. Not only must the safety of the workers be taken in consideration the safety of the students also needs to be taken into consideration.

Covid-19 Statement: With the recent development of the Covid-19 pandemic its necessary to take precautions to ensure to stop the spread of Covid-19. This site will require all individual working on site to wear a face covering. Social distancing will be enforced on site and all members will work 6ft apparat. If individuals are feeling unwell, they will be asked to stay home or will be sent home. Preventing the spread of Covid-19 and ensuring worker health and safety is of the upmost importance.

Public: As stated in the site logistics plan, the safety of the public must be considered at all times. Utilizing flaggers and traffic control is necessary to protect the public during deliveries. It is also necessary to ensure that unauthorized personnel do not enter the construction site. Students must remember this is an active construction project so there are real dangers present. Ensuring that the public is safe is necessary to the success of this project.

Construction Personnel: All construction personnel are to be subjected to Cal OSHA laws and regulations. These standards must be met during all times and all phases of the project.

PPE Regulations:

Listed below are the necessary jobsite PPE items.

- Vest
- Hard Hat
- Gloves
- Safety Glasses
- Construction Boots
- Pants and Long sleeves

Jobsite Safety Instructions: Listed below are the daily safety procedures needed to be taken by all personnel on the jobsite.

1. Only authorized personnel are to enter the site.
2. Those on site must wear specified PPE.
3. Before beginning work, workers must engage in a stretch and flex.
4. A toolbox talk will be chosen for that day that correlates to work to be performed. This will be read before work begins.
5. All members will be briefed on the day's goals and task before beginning work for the day.
6. Before performing a task, a JHA form must be filled out. JHA forms will be filled out anytime a new task is to be performed.

**Toolbox Talks and JHA form:** Being funded by Swinnerton Construction will utilize Swinerton constructions toolbox talks and JHA to ensure the jobsite is safe. View Attached forms for toolbox talks and JHA form.

**On the following page are the tool box talks and JHA form:**
Crystalline Silica is an important industrial material found abundantly in the earth’s crust. Quartz, the most common people are exposed to silica with 90% of those people working in construction.

Cal/OSHA §1532.3 Occupational Exposures to Respirable Crystalline Silica: This standard applies to all occupational micrograms per cubic meter of air (25 µg/m³) as an 8-hour time-weighted average (TWA) under any foreseeable exposure to respirable crystalline silica in construction work, except where employee exposure will remain below 25 condition.

Workplace tasks that may result in exposure include but are not limited to: sawing, grinding drilling, coring, sanding, chipping, dry mixing, sweeping, air blowing, and blasting.

1. Health Effects
   a. Inhaled silica dust scars lungs
   b. Silicosis, a lung disease, is caused by breathing dust containing respirable silica - THERE IS NO CURE!
   c. The dust causes fibrosis and reduces the lung’s ability to absorb oxygen,
      i. Early stages go unnoticed
      ii. Continued Exposure may result in shortness of breath
      iii. Prolonged high exposure can lead to extreme shortness of breath, chest pain, respiratory failure, and death.

2. Available Control Methods
   a. Exposure Control Plans
      i. Each subcontractor where silica is present must prepare and implement a written Silica Exposure Control Plan
   b. Engineering Controls
      i. Specific tools designed to reduce exposure such as dust collection devices and wet methods should be utilized where feasibility allows
   c. Work Practice
      i. Avoid dry sweeping and compressed air to clean areas
      ii. Restrict work areas where there is potential to exposure to other workers
   d. Administrative Controls
      i. Work where exposure levels will be limited to short durations; rotate worker job tasks to limit exposures
   e. Respiratory Protection
      i. Where engineering controls, work practice and administrative controls are unable to reduce or eliminate exposure, a respiratory protection program in accordance with §5144 must be in place.
      ii. Training, fit testing, medical clearance/surveillance, and appropriate equipment will be provided to all employees subject to exposures in excess of the Action Level of 25 µg/m³

3. Employee Right to Know/Hazard Communication
   a. The Silica standard is available for review by all employees upon request
   b. Safety Data Sheets are maintained for materials where silica exposure may be present.
   c. Where sampling occurs, exposure results will be kept and maintained in accordance with §3204.

4. Competent Person
   a. Contractors where crystalline silica is anticipated with assign a Competent Person to implement and evaluate the Exposure Control Plan.

5. Medical Surveillance
   a. Medical exams, including chest x-rays and lung function tests will be provided every 3 years to workers who are required to wear respirators more than 30 days a year.
SLIPS, TRIPS AND FALLS
“WORKER AWARENESS”
(SAFETY GUIDANCE DOCUMENT)

According to the Department of Labor, “Slips, trips, and falls constitute the majority of general industry accidents. They cause 15% of all accidental deaths, and are second only to motor vehicles as a cause of fatalities.

There are many situations that may cause slips, trips, and falls, such as ice, wet spots, grease, polished floors, loose flooring or carpeting, uneven walking surfaces, clutter, electrical cords, open desk drawers and filing cabinets and damaged ladder steps. The controls needed to prevent these hazards are usually obvious, but too often ignored, such as keeping walkways and stairs clear of scrap and debris; coiling up extension cords, lines, and hoses when not in use; keeping electrical and other wires out of the way; wearing lug soles in icy weather; clearing parking lots, stairs, and walkways in snowy weather; and using salt/sand as needed.

Please remember to always discuss the following in your morning Safety THA Meetings and Pre-Activity Plans:

- Wearing the proper foot attire is necessary when climbing and working on wet / slippery surfaces.
- Taking the “long way around” will sometimes eliminate your exposure to an unsafe area / location.
- When walking on wet / slippery surfaces always hold on to nearby railings and equipment.
- Always have an emergency rescue plan and discuss who will follow what procedures.
- Complete a daily Task Hazard Analysis (THA) for each operation.
- Inspect and document findings for all areas of work prior to commencement.
- Address any revisions or deviations from the plan with management.
- Maintain three point contact when ascending and descending from ladders.
- Always seek approval or assistance should there be any unforeseen conditions.
- Never take a shortcut of any kind that deviates from the original plan and procedures approved.

Example of areas where walking / working surfaces are difficult to access and manage proper footing.
Personal Protective Equipment (P.P.E.) Review

Personal Protective Equipment (PPE) is designed to keep you from being seriously injured or killed on the job. PPE is any clothing or equipment that you may wear to help minimize the exposure to an identified hazard.

- Always remember to wear your PPE appropriately – If you do not wear your PPE correctly, you do not get the desired level or protection.
- The minimum required PPE on all jobsites is: Hard Hats, Safety Glasses and High Visibility Vests. Some PPE may be different based on the work you are performing and the hazards identified with that work. Refer to your Pre-Task Plan.
- Hard Hats are designed and tested to be worn with the bill facing forward. You should never modify any PPE – this includes adjusting the suspension system in your hard hat to wear it backwards.
- When using a face shield, be sure to install the frame correctly to your hard hat and wear the shield appropriately. Note – safety glasses are also required in most situations.
- Safety glasses must be ANSI Z87.1 approved. This code will typically be stamped on the frame of the glasses. If you wear prescription glasses, Over The Glasses (OTG) safety glasses are available. Prescription glasses with side shields are not acceptable as they do not provide the necessary protection.

Employers are responsible to:

1) Identify existing and predictable hazards in the work environment prior to work beginning. This is typically done through our Pre-Task Plan or Job Hazard Analysis process.
2) Determine the appropriate methods of controlling exposure to the identified hazards. Remember that PPE is always the last level of control.
3) Provide and pay for most PPE that is required to do the work – (there are some exceptions to what PPE must be paid for by the employer, including items such as work boots and prescription eye wear. If you have any questions, please contact your supervisor or safety manager.)
4) Provide training on the proper selection, use and care of PPE.

Employees are expected to:

1) Participate in all training provided.
2) Use and care for the PPE as indicated by your supervisor and manufacturers’ instructions.
3) Inspect PPE prior to use and replace PPE as necessary. See your supervisor for procedures for replacing your PPE on your jobsite.

REMEMBER: P.P.E. is always your last line of defense against any hazards!

Rev. 04/2018
TOOLBOX TALK
HAND TOOL SAFETY

INTRODUCTION
Even non-powered hand tools can be dangerous if used improperly. When we first use a particular tool often times our awareness is high as we figure out the best way to utilize it. However, as we become more skilled and gain experience, day can be underestimated, and sometimes this lack of caution is what leads to accidents. Observing all of the following safe work practices will help keep us from damaging the tool, the materials, and ourselves.

TYPES OF TOOLS
- Cutting, gripping, or pinching tools – saws, pliers, utility knives, and cutters are examples of tools with sharp edges, blades, or pinch points that can catch our individual fingers or parts of the hand.
- Striking tools – hammers and other striking tools are mainly used to hit other tools or materials with high force.
- Driving tools – screwdrivers, wrenches, and nut drivers are used to drive and remove fasteners in material.
- Struck or hammered tools – punches, chisels, and nail sets are held at a specific point of the material and then struck by the appropriate striking tool.

SAFE WORK PRACTICES
- Plan ahead to make sure you have the right tool for the job.
- Keep tools in good condition by only using them for their intended purpose.
- Wear necessary personal protective equipment.
- Inspect your tools! Look for cracked or bent pieces, loose or missing parts, and rust or corrosion.
- Make sure that handles are not loose, cracked, or splintered.
- If the tool has blades or cutting edges make sure they not dull and are also protected when not in use.
- Make sure impact tools such as chisels, wedges, or drift pins do not have mushroomed heads.
- If a tool is defective or damaged in any way, do not use it!
- Always keep tools in a safe place, such as a tool belt. Elevated work areas and ladder platforms are not appropriate storage areas.
- Never modify or attempt a makeshift repair on a tool.
- Consider the use of tool lanyards when working at heights to protect workers below.
- Always be aware of your hand and body positioning to stay out of the line of fire just in case the tool slips.

CONCLUSION
The greatest hazards posed by hand tools result from misuse and improper maintenance. Even though there is a high exposure to potential injury using hand tools because of how often we use them, we can keep the level of risk low by following the safe work practices mentioned.

DISCUSSION QUESTIONS – ASK YOUR CREW:
- How often do we need to inspect the hand tools we use every day?
- What are some examples of defects that we should be looking for when inspecting our hand tools?
- Other than inspection, what are some safe work practices that we can follow to make sure we are protecting ourselves or the people around us?
SWINERTON
Fall Protection Training Series (1 of 4)

Fall Protection Basics
When we talk about Fall Protection in construction, we primarily think about wearing a body harness and using a lifeline (lanyard or retractable — "yo-yo"). In reality, "Fall Protection" includes many different systems that are on our projects constantly. These systems include:
1) Personal Fall Arrest Systems – designed to stop you AFTER you fall;
2) Personal Fall Restraint Systems – designed to PREVENT you from falling;
3) Barriers and Guardrails – designed to eliminate the fall hazard in the work environment; hole covers and floor opening covers;

SOME NUMBERS TO KNOW
- **6 Feet** – Any employee that may be exposed to a fall 6 feet or greater must be protected by an approved fall protection system;
- **18 ½ Feet** – This is the total minimum distance required from your anchor point to the ground below when using a 6' lanyard;
- **5,000 Pounds** – The amount of impact your anchorage point must be capable of supporting;

PERSONAL FALL ARREST SYSTEM BASICS
A Full Body Harness, when worn correctly, is designed to distribute the impact and pressure of a fall across your body. Failing to wear your harness correctly increases your chance of serious bodily injury in a fall. To be able to use any fall protection systems you must first be trained. This training will include topics such as: use, inspection, care and limitations of the equipment.
- Always review manufacturer's instructions prior to using any fall protection devices and inspect your equipment prior to each use.
- The "D" Ring shall be worn between your shoulder blades;
- Your anchor needs to be attached to something structural that is capable of supporting 5,000 pounds of force;
- Know your fall distance – plan for free fall, arresting distance, stretch of your lanyard, etc. when calculating your fall distance. Make sure you have enough to avoid coming into contact with a lower level;

BARRIERS AND GUARDRAILS
Fall protection can include properly installed guardrail systems. A proper guardrail system:
- Must have a top rail installed at 42 - 45 inches above the working surface and must withstand, at minimum 200 pounds of force;
- A mid-rail must be installed half way between the top rail and the working surface and be capable of withstanding at least 150 pounds of force;
- Toeboards are a required part of any properly installed guardrail system to prevent objects from being kicked off of the working surface to an area below;
- When using wire rope for guardrails, it must be tightened and clamped in accordance with OSHA regulations;

HOLE & FLOOR OPENING COVERS
- Any floor hole 2" in diameter or greater must be properly covered to prevent items from being kicked into them and falling to a lower level;
- Any floor opening 12" in diameter or greater must be protected by a properly installed, secured and marked cover; Markings must be reapplied as necessary;

NOTE: To use a Fall Arrest/ Fall Restraint system, each employee must complete hands on training. This module does not allow an employee to use a harness or other systems.
Fall Protection – Barriers & Guardrails

HIERARCHY OF CONTROLS:
When considering the various options for protecting workers from fall hazards, keep in mind the “hierarchy of controls”:
1) Engineering Controls (changing the working environment to eliminate the hazard);
2) Administrative Controls (making management decisions that limit exposure to hazards);
3) Personal Protective Equipment (guarding the employee while working in the hazardous condition) –
NOTE: PPE should be the last option utilized to protect workers;

GUARDRAILS
When any walking or working surface exposes anyone to a fall of **6 feet or greater**, fall protection is required. Following the above hierarchy of control, barriers and guardrails should be considered prior to using personal protective equipment as a properly installed guardrail system will eliminate the exposure to the fall. A properly installed guardrail system consists of:
1) A handrail/top rail installed between 39” and 45” (per OSHA) and between 42” and 45” (per Cal/OSHA) that will withstand at least 200 pounds of force in the outward and downward directions;
2) A midrail installed halfway between the top rail and the working surface that will withstand at least 150 pounds of force in the outward and downward directions;
3) A toeboard (at least 4” high) at the bottom to prevent objects from being kicked off of the walking/working surface;

When wood guardrails are built, they must be built out of select lumber, free of damage and the support members are not to be spaced more than 8’ to provide the maximum amount of support. **Do Not use duplex nails or screws to build your guardrail systems.**

When wire rope guardrails are used, they must be taught and the top rail cannot deflect more than 3”. Wire ropes must be properly clamped to avoid displacement of the rails. Forged stainless steel wire rope clips are required to properly secure the ends of wire rope guardrails. Always refer to the manufacturer for proper installation, number of clips based on diameter of wire rope and to review the warning information and limits.

BARRIERS
Other construction activities require additional options for fall protection. “Controlled Access Zones” (CAZ) are allowed by OSHA under very specific conditions. A CAZ allows people to work in an area where a fall hazard exists without fall protection as long as various requirements are met prior to work commencing. **NOTE: SWINERTON BUILDERS DOES NOT ALLOW CONTROLLED ACCESS ZONES ON OUR PROJECTS.** Contact your Safety Manager for additional information or questions regarding Controlled Access Zones.

A leading edge is a side of a walking or working surface that is constantly changing – formwork decking operations is a good example. When a leading edge is on site, a physical barrier – such as a 2x4” rail or stanchions should be utilized to restrict access to the decking operation. **Anyone on the working side of the barrier must have the necessary fall protection systems in place.** **NOTE: Danger or Caution tape are not acceptable barriers.**

LINKS FOR REFERENCE:

Cal/OSHA - Design and Construction of Guardrails
Crosby Clips - Warnings & Application Instructions
Fall Protection – Fall Restraint Systems
A Fall Restraint system is a fall protection system that prevents the user from reaching an unprotected point and a fixed length lifeline.

Positioning Device Systems
Positioning device systems are frequently used in reinforcing steel operations to allow workers to work “hands-free”. In addition to their positioning device, workers must utilize a personal fall arrest system and any exposed vertical rebar must be properly protected to avoid impalement hazards. Positioning Device Systems must:

- Be rigged so that an employee cannot free fall more than 2 feet;
- Be inspected prior to each use for wear, damage, and other deterioration;
  - Any devices that are suspected to be damaged shall be removed from service;
- Not be used with ‘non-locking’ snap hooks;

Anchor points for positioning device systems must be capable of supporting at least 3,000 pounds or twice the intended load, whichever is greater;

Personal Fall Restraint System
A full body harnesses shall be used for a personal fall restraint system and the anchor point must be capable of supporting 4 times the intended load;

A fall restraint system is designed to allow a worker to perform their work but will not allow them to go past the unprotected side or edge of the working surface.

An example of a fall restraint system is below. The system consists of a fixed lifeline (NOT a retractable/yo-yo) that limits the distance you can travel from the anchor point.

As with every fall protection system, proper hands on training is required prior to use and all equipment must be inspected by the user prior to each use.

![Fall Restraint Diagram]

Fixed length lanyard
Fall hazard
Anchor point
“Fall restraint”

LINKS FOR REFERENCE:
“SUPERVISORS ACCIDENT INVESTIGATION FORM” and “RCA FORM”:
HTTPS://SWINNET.SWINERTON.COM/SAFETY/PAGES/SAFETYFORMS.ASPX
Cal/OSHA Fall Arrest, Restraint and Positioning Device Regulation
OSHA Fact Sheet
OSHA

NOTE: To use a Fall Arrest/Fall Restraint system, each employee must complete hands on training. This module does not allow an employee to use a harness or other systems.
Fall Protection – Fall Arrest Systems

A Personal Fall Arrest System is an engineered system used to stop an employee from coming into contact with a lower level after a fall from an elevated working level. A typical system consists of an anchorage point, lifeline, and a full body harness. A personal fall arrest system, while common in construction, should be the last line of defense against a fall hazard. Always try to use barricades or barriers first. Note: The use of a body belt for fall arrest is prohibited.

A few things that you need to remember when working with a fall arrest system are:
1) All employees using a personal fall arrest system must have documented training every twelve months.
2) A written fall protection and fall rescue plan must be completed and onsite. The plan must be feasible and practical and all employees performing the work must be trained to the plan. The training must be documented.
3) These things must be completed prior to the commencement of work.

An approved personal fall arrest system must be worn by any employee whose work exposes them to fall greater than 6 feet. Conditions that commonly expose workers to falls that require use of a fall protection system include, but may not be limited to:
- Perimeter of a structure; Unprotected sides and edges of floors; Leading edges;
- Shaftways and openings; and Sloped roof surfaces;

Inspections

Personal fall arrest systems must be inspected by the user prior to each use. You need to inspect your equipment for wear, damage, and other deterioration. Any defective equipment shall be removed from service. If you are not sure or suspect that something is wrong with your equipment, DO NOT USE IT. Remove it from service and follow up with your supervisor immediately.

All personal fall arrest equipment is to be inspected by a competent person at least twice per year. These inspections must be documented and documentation maintained and available upon request. For additional information about these inspections, contact your safety manager.

Anchorage Points

All anchorage points must be capable of supporting at least 5,000 pounds per employee. These can consist of a beam clamp, beam strap or a vertical or horizontal lifeline that are properly installed. Remember to keep the steel connector ring on your anchor point as close to the structure as possible to help limit the total fall distance. If you are not sure what an adequate anchorage point is, contact your supervisor prior to doing your work.

NEVER use fall protection equipment for hoisting materials or equipment and NEVER use rigging equipment as fall protection. These are two different systems and are not compatible.

Horizontal and Vertical Lifelines

Vertical Lifelines are commonly used with suspended scaffold systems (swing-stages). They must be properly installed by a qualified person and limited to use by only one worker per line. Each line must be attached to an anchor point different from that used for the scaffold. A fall

NOTE: To use a Fall Arrest/ Fall Restraint system, each employee must complete hands on training. This module does not allow an employee to use a harness or other systems.

Rev. 02/2016
protection lifeline termination plate with proper carabiner should be used to attach the vertical lifeline.

Horizontal Lifelines are frequently installed between columns to allow for movement across large spans of a working surface while keeping the anchor point close to the worker. Remember that the total number of employees allowed on the lifeline at one time is dependent on the number of steel rings on the system.

Always remember to protect lifelines and other components of the system against being cut or damaged from sharp or rough edges. Using a ‘softener’ can help protect your equipment.

See your supervisor or safety manager for additional information on these systems.

**Full Body Harness**
A full body harness is required when using a personal fall arrest system. Ensure that you put the harness on correctly and that it fits you properly. If you need a medium harness, putting on an X-Large harness and “making it fit” puts you at risk of severe injury in the event of a fall.

When putting your harness on, be sure that:
- The chest strap is across your chest;
- The back D-ring is positioned between your shoulder blades;
- The leg straps of your harness are snug – you should be able to slide your hands between your legs and the strap of your harness but not be able to pull your hands away. If you can move your hands, your harness is not snug enough;
- The vertical straps are snug;
- The sub pelvic strap is underneath your rear end to provide a seat in the event that you do fall.

**If You Fall**
In the event that you fall while wearing a harness, it is important that you remember the following:
1) Your harness will stretch – this is why it is critical that you are wearing it correctly and have it fitted properly;
2) Pull the chest strap down and out of your throat so that you can breathe;
3) Put your legs together and raise your knees to your chest. This will cause the sub pelvic strap to slide underneath you and give you a seat. This will keep your blood flowing properly and put you in an ideal position to be rescued. Suspension trauma (when your blood pools in your legs due to having your circulation cut off) can start after 12-15 minutes of hanging in a harness. This is for people in ideal health and may be much less for many users.
4) When possible, self-rescue is preferred;
5) If you fall in a harness, it is important that you be seen by a doctor – regardless of how you feel.

Prior to using any fall protection equipment, you must receive training. This training is to be repeated at least every 12 months or more frequently if the job or conditions require. If you have any questions or concerns – you are required to speak to your supervisor immediately.

**NOTE:** To use a Fall Arrest/ Fall Restraint system, each employee must complete hands on training. This module does not allow an employee to use a harness or other systems.

Rev. 02/2016
TOOLBOX TALK
REBAR & IMPALEMENT HAZARDS

INTRODUCTION
Steel reinforcing bars, or rebar, are a common safety hazard on construction sites. These steel bars have the ability to hazard of impalement, Cal/OSHA and company policy require that rebar and other projections on a worksite must be guarded or covered whenever there are workers around or above them.

HAZARD
A majority of the time it is rebar on the jobsite that is the source of tripping/impalement hazards. However, other protrusions and vertical objects can also present the same type of danger. If it LOOKS like it can impale you if you fall on site, often times we do not identify unprotected impalement hazards even when they are right next to us! We must always consider the presence of these hazards whenever we are assessing our specific work areas.

- Rebar can protrude from concrete footing and foundation work
- Concrete formwork pins and stakes can protrude at low levels
- Small diameter vertical piping and conduits can also be an impalement hazard
- Rebar and other protrusions are also a tripping hazard, which further increases the risk of falling onto them if a person isn’t paying attention or loses their balance.

PROTECTION
All jobsite employees must be trained to recognize when an impalement hazard exists, and must take action whenever they identify one where they are working. If you are working at heights and there are impalement hazards at a lower level, fall protection system such as guardrails or fall arrest should be considered. If protrusions are at ground level, multiple protective guards and caps exist:

- Square caps must be at least 4 in. x 4 in.
- Round caps must have a minimum 4.5 in. diameter.
- Manufactured cover must withstand 250 lbs. dropped from height of 10 ft.
- Most are steel reinforced.
- Rebar can potentially push through the top of a low quality or cheap plastic cap if impacted with enough force.

- Mushroom caps are useful to cover up sharp edges of horizontal rebar.
- Can help prevent scratches and cuts.
- These are NOT rated to protect against impalement. The rebar, with the cap still on it, has the potential to push through a person if someone falls on it.

DISCUSSION QUESTIONS – ASK YOUR CREW:
- Are there any areas we are working on the jobsite where we need to verify that impalement hazards are properly protected?
- What are the acceptable methods of protecting rebar? Are there any dimensions or specific requirements?
- Are mushroom caps rated for impalement protection? Why or why not?
# Job Hazard Analysis Form

<table>
<thead>
<tr>
<th>Scope of Work:</th>
<th>Location:</th>
<th>Trades Involved:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Form Completed By:</th>
<th>Job Title:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Task to be Performed:</th>
<th>Job Hazards:</th>
<th>Hazard Mitigation Strategy:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>


QAQC: Section 4
Quality Control Quality Assurance

To ensure the delivery of the project is to a high quality, QAQC programs must be utilized. The major problem with the previous wall was the lack of quality. If the student last year took proper steps to ensure quality, there would have been issues with the wall’s performance.

It is expected that all individuals working on this project verify and check for quality. Inserted below is the QAQC form. This form is to be filled out and uploaded into Procore to ensure the quality standards are being met.

QAQC Checklist: Attached on the following page is the QAQC checklist that is to be utilized
<table>
<thead>
<tr>
<th>#</th>
<th>Inspection Item</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Completed to Specified Standard</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Safety Instruction Were Followed</td>
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<td></td>
</tr>
<tr>
<td>3</td>
<td>Formwork is According to Drawings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Concrete Mix Design is Correct</td>
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<td></td>
</tr>
<tr>
<td>5</td>
<td>Rebar Design is as Specified</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Snap Ties Are Installed</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>7</td>
<td>All Material is to Specified Standard</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Client is Satisfied</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Project Images

These pictures were taken of the work area and are here for reference for individuals to better understand the jobsite.

Foundation to be Reused
Current Scaffold needs to be rebuilt, Here for reference when building new one.
Citations


Sevilla, Rory De. “Feasibility of a Fiber Reinforced Polymer Retrofit for Non-Ductile Concrete Walls.” *California Polytechnic State University San Luis Obispo*, Digital Commons @ Cal Poly, 2019, pp. 1–8.