PROJECT REPORT

FOR

Empowering Villages Center and Agricultural Training Facility

IN

Rubagabaga Village, Rwanda

FOR

Journeyman International

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June 5th, 2019

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ABSTRACT

By partnering with non-profit organizations such as Journeyman International and Empowering Villages, undergraduate students can engage in senior projects that have far reaching humanitarian impacts. Journeyman International is well known for creating powerful teams of students who tackle design challenges in developing countries. This paper details the work of two architectural engineering students from California Polytechnic State University, San Luis Obispo on a design for the Empowering Villages Center (EVC) and Agricultural Training Facility (ATF) in Rubagabaga Village, Rwanda. The EVC and ATF project was proposed by Empowering Villages, an organization that aims to bring electricity and socioeconomic growth to rural communities in East Africa. The students collaborated on an interdisciplinary team for nine months to produce structural calculations and drawings for the project. In addition to the structural calculations and drawings, this report includes a project overview, challenges, the final impact, team dynamics, and personal reflections.

INTRODUCTION

JOURNEYMAN INTERNATIONAL

Journeyman International (JI) is a non-profit organization founded in 2009 with the mission statement to "Build What Matters Most". By partnering undergraduate students from the Architecture, Architectural Engineering, and Construction Management disciplines at Cal Poly, JI creates interdisciplinary teams to design humanitarian projects around the world. Student volunteers serve as the project designers in order to make JI a low cost option for building in developing and underprivileged areas.

EMPOWERING VILLAGES

JI partners with other nonprofit organizations to provide quality and meaningful design work for a variety of sectors. For this project, JI partnered with Empowering Villages, a rural community development model that helps bring socio-economic sustainability to developing areas. Empowering Villages is funded by East African Power who construct hydropower plants in developing villages throughout East Africa. These hydropower plants bring electricity to villages that may otherwise not have access to power and allows them to develop their small villages effectively and efficiently. Empowering Villages reached out to JI to design the Empowering Villages Center (EVC) and Agricultural Training Facility (ATF) in Rubagabaga Village, Rwanda.

RWANDA: THE HISTORY

From the 1300s to late 1800s, the Hutu and Tutsi were harmonious under a centralized monarchy with Tutsi kings. However, leadership was passed around under colonial rule—the Germans in 1899 and the Belgians in 1919. These sudden leadership changes were followed by the hostile Rwandan leadership of President Gregoire Kayibanda and President Juvenal Habyarimana. Discrimination against Tutsi was institutionalized, thus beginning one of the most extensive genocides the world has seen. The Tutsi were targeted from 1959 onwards—leading to hundreds of thousands of deaths and nearly two million exiles.

In 1979, the Rwandese Alliance for National Unity (RANU) was created to support Rwanda refugees in exile and mobilize against aggressive political actions and genocide ideology. The RANU was renamed the Rwandese Patriotic Front (RPF) in 1987, followed by the launch of an armed liberation struggle in 1990. The dictatorship was removed in 1994, ending the genocide of over one million Tutsi.

PROJECT DESCRIPTION

PURPOSE

The Empowering Villages Center was proposed to provide space for assembly, social programs, skills trainings, and recreation. Most importantly, the EVC will serve as a gathering place for the people of Rubagabaga Village and the surrounding areas. The creation of a centralized space where local people can congregate allows villagers to take ownership of their community.

The Agricultural Training Facility was proposed to allow local farmers to adopt innovative strategies that can make their land more profitable. As seen in *Figure 2*, the project site is located near steep mountainside slopes that local farmers currently struggle to stabilize. The goal is to provide local farmers with the tools to maximize crop yields and income while also emphasizing environmental sustainability.

Figure 1: Kaseke Village,
Down the river from Rubagabaga Village

Figure 2: Project site,
Located on the plateau

The overarching goal of this project was to promote a healthy community dynamic and a sense of place for the people in Rubagabaga Village. East African Power recently completed a hydropower plant adjacent to the project site, proving their ability to employ local people, through construction and development, helping bring financial stability to the villagers. The goal of the design team for the EVC and ATF was to create a building that could be constructed by villagers to continue monetary flow into Rubagabaga Village.

DESIGN TEAM

The project design team consisted of architecture student Mackenzie Dias, construction management student Jake Stom, and architectural engineering students Jenna Williams and Julia De Hart. While this project fulfilled the student's senior thesis projects for Cal Poly, they each joined the project to help the people of Rubagabaga Village. The team worked together for nine months to generate a final design product.

DESIGN OVERVIEW

It was decided by the design team that the best way to incorporate the goals of both the EVC and ATF was to bring them together as one building with two wings. As shown in beige in *Figure 3*, the ATF would be set up as a classroom with adjacent administration offices and storage rooms. A crops testing area is located outside the ATF for farmers to practice the techniques they learn about during their training. The EVC, as seen in red below, serves as the second wing of the combined-use building. The open floor plan offers flexibility so the people of Rubagabaga Village can utilize the space as needed. Large sliding doors serve as entrances to the ATF from either side of the building while a sliding door between program spaces offers separation during class time. An auxiliary building at the back of the site serve as bathrooms. A steel canopy is also located in front of the structure to provide covered outdoor seating.

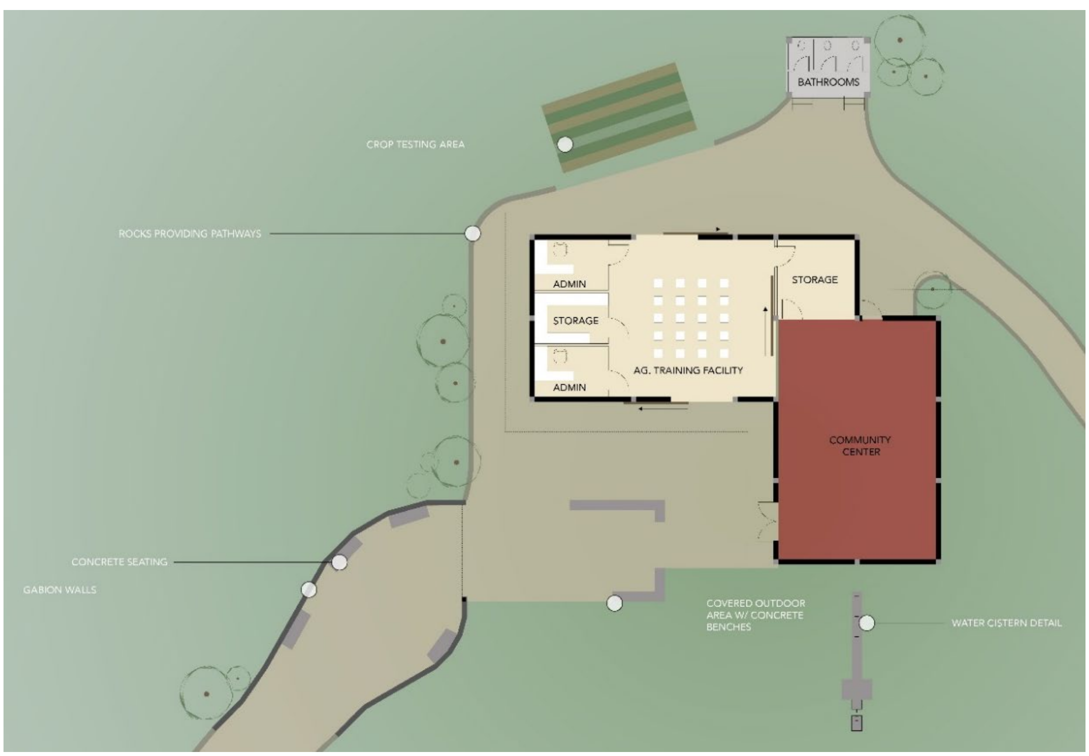

Figure 3: Floor Plan

The structural system of the building was chosen based on material availability and on-site constructability. The gravity system consists of a steel decking roof and milled eucalyptus trusses. The trusses over the EVC are monosloped while those over the ATF are in a butterfly configuration as illustrated in *Figures 4 and 5*, respectively. Both systems allow natural sunlight and fresh air to enter and circulate throughout the building. Steel rod-braces serve as the roof diaphragm and the main lateral force resisting system consists of confined masonry walls with concrete tie beams and columns. The entire structure sits on a concrete slab on grade with robust concrete foundation walls.

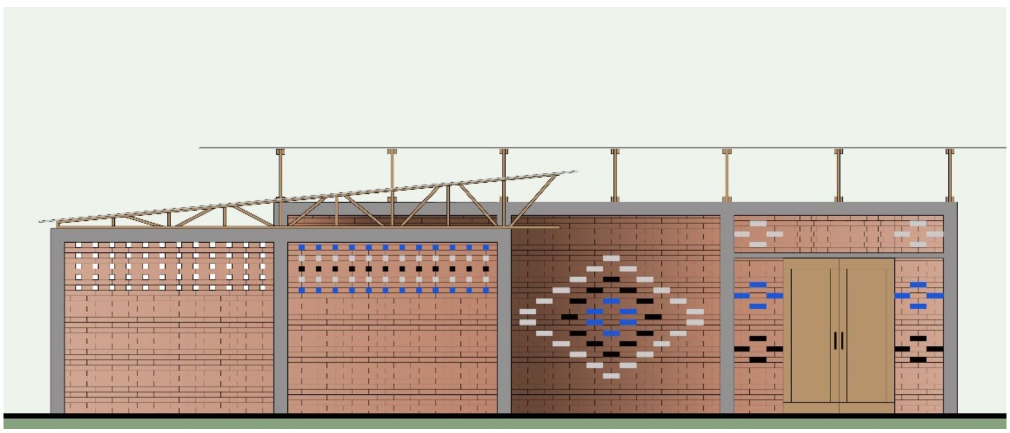

Figure 4: North Elevation

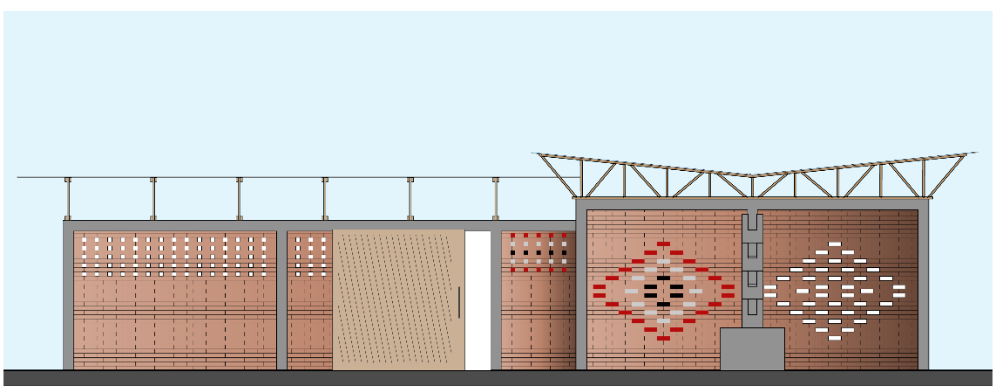

Figure 5: South Elevation

DELIVERABLES

The deliverables required of the architectural engineering students were structural calculations (Appendix A) and structural drawings (Appendix B) for the project.

CALCULATIONS

The gravity calculations for this project began with estimating member sizes to find a building weight. Load take-offs were produced separately for the EVC and ATF since the buildings had separate roof systems and different wall heights. Next, a corrugated, concealed fix decking was chosen from a Rwandan manufacturer, Safintra, to prevent water leakage and to define a water runoff direction. A purlin spacing was chosen based on the decking specifications. Truss demands were determined in RISA-3D modeling. The students did not have sufficient information on the design properties of Rwandan eucalyptus for the purlins and trusses. The design values for Douglas Fir Larch Grade 2 were used instead, as they were determined to be conservative for the eucalyptus member design. All timber members and truss connections were designed using the 2015 National Design Specification (NDS) by the American Wood Council (AWC). Due to the variability of eucalyptus in a wet region like Rwanda, temperature and moisture content factors were taken into consideration. The final truss member sizes were taken to be the same for both program areas for constructability ease. The slab on grade design was chosen from a typical U.S. standard design for 1-2 story buildings, a 5” thick slab with #3 bars at 18” on center each way.

The lateral calculations considered both wind and seismic forces to determine the governing load case. A wind speed for the region near Rubagabaga Village was difficult to find, so the design team proceeded with a conservative wind speed of 110 mph. This is the lowest wind pressure found on maps for the U.S., but still highly conservative for Rwanda. Seismic values were easier to find, and the final values used are from a conference paper, Seismic Design Considerations for East Africa [2]. In accordance with ASCE 7-16 procedures, it was determined that the seismic loads governed for the project site.

Lateral load calculations were completed to determine the diaphragm design. Rod braces were designed to be placed between the purlins around the perimeter of the EVC and the ATF to serve as the load resisting system for governing seismic forces at the roof. Rod braces were also added in elevation, perpendicular to the trusses at midspan in the EVC and ATF to provide out of plane bracing to the bottom chord of both sets of trusses.

Confined masonry walls were designed in accordance with the manual created by EERI and IAEE, Seismic Design Guide for Low-Rise Confined Masonry Buildings [3]. The walls were designed for a lateral wall density based on seismic hazard, number of stories, brick type, and soil type. The walls were also designed for a gravity wall density based on the gravity load, brick strength, and mortar strength. The walls consist of two wythes made from custom size clay bricks that can be made by local people. The concrete tie-columns and tie-beams were sized and reinforced by the prescriptive design recommended by the Seismic Design Guide.

The wall foundations were designed to resist forces obtained from a lateral seismic load distribution. A conservative allowable soil bearing pressure was obtained from the 2015 International Building Code (IBC) since students were unable to obtain a geotechnical report for the site. The footing sizes and flexural reinforcement were determined using the American Concrete Institute (ACI) 318-14. The governing allowable stress design load combination was used to determine a sufficient footing size and the governing strength design combination was used to determine the flexural reinforcement, both transverse and longitudinal.

The restroom was dimensionally set to be the same plan size as one of the storage rooms in the ATF in order to minimize design calculations and provide uniformity throughout the design to make construction easier. The restroom gravity system was designed to mimic the ATF design, as the trusses were of the same size and spacing. The lateral system was designed with the same procedure used for the EVC and ATF.

Finally, a steel canopy area was designed using hollow structural steel sections for the beam, girder, and column members. The Safintra corrugated steel decking previously described for the EVC and ATF is also used for the canopy roofing and spans between beams.

DRAWINGS

The structural drawings consist of a foundation plan, roof framing plan, wall elevations, truss elevations, and supplementary details. The structural details included in the construction documents outline roof connections, truss connections, wall connections, and foundations. General notes are provided to specify materials and construction practices for this project. The structural drawings were coordinated with architectural drawings provided by the architecture student and were completed in metric units for ease of use in Rwanda.

CHALLENGES

Throughout this project, the students were met with different roadblocks that arise from considering international design aspects and working within an interdisciplinary team.

MATERIALS

One challenge was the availability and quality of materials available in Rwanda. The students were in contact with Rwandan engineers and JI staff members to determine the best design values for unfamiliar materials in the U.S., like eucalyptus. Eucalyptus in Rwanda also varies across the country, so it was established that controlling the species of eucalyptus that would be used for the project was impossible. Extensive research was conducted to attempt to find the compressive and bending values for Rwandan eucalyptus before it was decided to assume a conservative value that could account for discrepancies in wood quality, moisture content, and temperature effects.

CONFINED MASONRY DESIGN

Students were required to self-educate themselves on the design of confined masonry for this project. It was the chosen construction technique because of its success in previous earthquakes, unlike masonry infill. Confined masonry engages the masonry with concrete tie beams and tie columns, as shown in *Figure 6*. Using the Seismic Design Guide from EERI, the students were able to follow prescriptive design practices used for similar low-rise, confined masonry buildings.

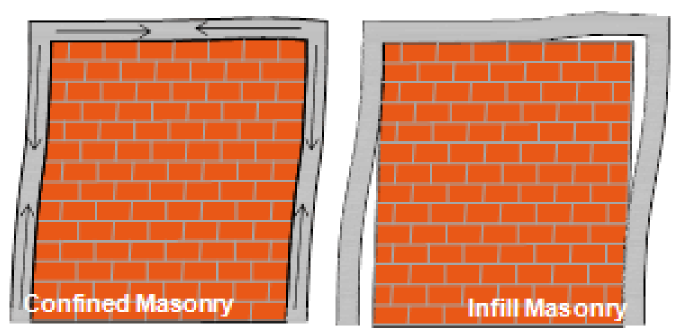

Figure 6: Confined Masonry versus Infill masonry

INTERDISCIPLINARY TEAMWORK

The third challenge experienced by the students was working with an interdisciplinary team. Coordinating ideas with students from different disciplines required each student to present and communicate their ideas effectively so that other team members could understand the design intention. At times, the architecture student would move forward with an idea without consulting the other disciplines, and this required compromise from all students to come to an agreement on the final design.

THE FINAL IMPACT

Perhaps the most exciting part of this project is that construction of the EVC and ATF will begin in the summer of 2019. The hydropower plant has been completed since team members visited the site in December 2018 and it won an award at the annual Infrastructure Industry Conference in Cape Town, South Africa. The most rewarding part of completing a Journeyman International project is reflecting on the international scale of the project and all the people that the design will benefit. There were numerous considerations for the global, cultural, social, environmental, economic, and constructability impact that this project would have in Rwanda and around the world.

GLOBAL CONSIDERATIONS

Designing a building for Rwanda, a country located half-way around the world from the design team, produces inherent far-reaching impacts. The team designed an agricultural training facility and community center for a village that otherwise would remain fairly underdeveloped and underprivileged. The local people will also have electricity from the hydropower plant located around the river bend from the team's project. The Rubagabaga Village community will have access to new technology and resources that will allow them to become more integrated with the larger Rwandan as well as global society.

CULTURAL CONSIDERATIONS

Rwanda underwent a loss of identity followed by the birth of a new identity in a very short time period. Julia had the opportunity to experience Rwandan culture firsthand, and see the residual effects of the Rwandan genocide. Building in a small, somewhat remote village meant that we could be dealing with a community that has not yet recovered. By incorporating traditional practices into the building design, like the Rwandan paintings on the brick walls, we are able to establish a known identity that the local people can connect with.

SOCIAL CONSIDERATIONS

The building of the EVC and ATF will greatly impact the lives of the people in Rubagabaga Village. Farmers have the opportunity to become educated in high yield crops and environmentally friendly farming techniques. The community center will provide local people with a place to gather and discuss community concerns as well as organize local events. The entangled cultural and social value that this project brings to the local people will foster an engaged, tight-knit community.

ENVIRONMENTAL CONSIDERATIONS

Rubagabaga Village is located on the Rubagabaga River, 25 kilometers south of the city of Musanze. There are vehicle accessible roads that land on the opposite side of the river, facing the site. This posed the challenge for our site to be built with materials that could be transported across the river. All materials were restricted in length and weight to ensure they were manageable to be hauled across the river. The proximity to the river also required the team to direct any site runoff away from the river to avoid pollution. Another environmental concern that the team took into consideration was providing a roof water collection system for rainfall. Using a water cistern, rainfall will go pass through different natural filters to produce clean, potable water.

ECONOMIC CONSIDERATIONS

All designs of this building were created so that local people could contribute to the construction. The villagers are paid for their labor contributions, establishing an economic flow throughout the village and surrounding areas. Labor is extremely inexpensive in Rwanda. For example, a laborer will be paid $2.00 a day to break rocks into gravel. This is much more cost effective and much better for the local laborers and their families than it would be to bring a concrete truck in from a third party for pouring. Not only will the construction of this project provide money for villagers, but the agricultural training facility will teach farmers how to produce more abundant crops—leading to an even more prosperous outcome for Rubagabaga Village.

CONSTRUCTABILITY CONSIDERATIONS

Each piece of the design was carried out with the intention that the Rubagabaga community could contribute to its construction. All buildings will have bamboo woven mat ceilings and brick walls painted with traditional Rwandan designs, both of which can be fabricated by local people. Given proper instruction and tools, locals can mill eucalyptus trees from the area to form the trusses, make handmade clay bricks for the walls, and mix the concrete for the site.

TRAVEL EXPERIENCE

Cal Poly Students in Rwanda

In December 2018, project team member Julia De Hart travelled to Rwanda with six other students also partnering with JI. We landed in the country's capital, Kigali, and were met by Carly Althoff, a Cal Poly architecture alumni who now lives in Rwanda as a full-time JI staff member, as well as other JI and Empowering Villages staff. The main purpose of the trip was to visit each JI team's site while taking in as much culture and history along the way.

Hydropower plant adjacent to project site

First, the site at Rubagabaga Village was visited, located about 30km south of Musanze, the nearest city of notable size. We travelled through villages and banana plantations on dirt roads before finally crossing a river in our car to arrive at our destination. The hydropower plant commissioned by the country of Rwanda with East African Power, was under construction while we were there. It was eye-opening to see how something as large-scale as a hydropower plant is constructed in a developing country. They compensate the lack of heavy machinery with sheer manpower. Huge groups of people line up to carry rocks uphill, dig trenches with shovels, and break rocks on site with a hammer and chisel to make aggregate.

Students engaging with local children

The best part of the entire experience was interacting with the people, especially the kids, whom our project will impact. When we hiked through villages and country sides, kids would gather and follow us for miles, helping us take the right path and use the right footholds after laughing at us when we took the wrong ones. The native Rwandans travelling with us would tell elder members of the communities why we were there and their faces would light up and come over to shake our hands. Barriers of language and culture have no substance when compared to laughter and humanity.

TEAM EVALUATIONS

TEAM DYNAMICS

Unlike the architecture student or the construction management student, who work independently on their own tasks, the architectural engineering students on the team had a unique opportunity to work together on their deliverables. The students gravitated towards the parts of the project that best fit their skill sets. Jenna had previously completed a research project for a class on confined masonry, so she was more comfortable taking on this task. Julia had held a drafting internship for the past two years, so she was more efficient in creating the drawings for the project. The students usually worked at the same time, setting up work days so that they could bring any questions or concerns to each other easily. The students had already created a solid team dynamic foundation last quarter working on the Cal Poly EERI Seismic Design Competition Team, so they were quick to understand how each other communicated and worked best.

PERSONAL REFLECTION - JULIA DE HART

I am so grateful to be a part of a Journeyman project and the greater Journeyman team. I heard JI founder, Daniel Wiens, speak at a SEAOC student chapter meeting as an underclassman and was immediately convinced that I wanted to partner with them for my senior project. This project forced me to find solutions for things that I would not normally be faced with when designing in the United States. My design labs at Cal Poly prepared me to design a project of this scale. I had experience in all of the materials, but I had to adapt to the construction means and methods that are typical for a developing country like Rwanda.

Understanding the global scale of the project helped put everything into perspective. The enormous amount of pride I have for the impact our design will have on the Rwandan people makes every ounce of work worth the effort. I was fortunate enough to travel to Rwanda and interact with the people first hand. Being able to embrace their culture, learn about their history, and eat their food are all life-changing experiences that have earned a special place in my heart forever. I plan to return so that I can witness my first completed project as a structural engineer.

PERSONAL REFLECTION - JENNA WILLIAMS

Completing this humanitarian project taught me numerous technical and life lessons. From working on an interdisciplinary team to realizing the impact that this project will have in Rwanda, I have learned the importance of recognizing and embracing the big picture.

The international aspect of this project required me to engage in self-education. Even though we had learned how to assemble a calculations and drawings packet from design lab, this project required more research into Rwanda. Challenges with material availability and confined masonry design were new topics that I had to invest time learning about. In addition to learning on my own, I had to evaluate when it was best to contact our on-ground contacts at JI and Empowering Villages when I had a bigger question. This project began my regular use of “engineering judgement” to inform my decisions.

Working on an interdisciplinary team allowed me to learn the needs of everyone on a project: architect, engineer, contractor, and most importantly, the client. When a challenge was present, it was always most beneficial to consider how the project served the client. Journeyman International provided me the opportunity to develop my interpersonal skills for the workplace and for life.

Oddly enough, I never felt as if this was a “requirement”, but instead it was something that I was truly passionate about. I began working on humanitarian projects with Cal Poly Structural Engineering Students for Humanity (SESH) in 2018, and since then I’ve caught the “humanitarian bug”. My ambition to help others and spread safe engineering practices around the world has been met through designing for Rubagabaga Village. Having the opportunity to work with Journeyman International and continue my growth as a member of the structural engineering industry who gives back was extremely rewarding. I plan to continue my involvement in humanitarian work after I complete my graduate degree in June 2020.

APPENDIX A: CALCULATIONS

STRUCTURAL CALCULATIONS

FOR

Empowering Village Center and Agricultural Training Facility

IN

RUBAGABAGA VILLAGE, RWANDA

Prepared For:

Journeyman International

Prepared By:

Jenna Williams and Julia De Hart

Prepared At:

California Polytechnic State University, San Luis Obispo

Prepared On:

June 5th, 2019

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DESIGN CRITERIA

Design Codes: IBC 2015
ASCE 7-16
ACI 318-14
AISC 360-16
NDS-15

Risk Category: II

Seismic:

Seismic Coefficients:

S_{DS} = 0.608 g

S_{D1} = 0.152 g

Importance Factor:

I_e = 1.0

Site Class: D

Wind:

Wind Exposure: Partially Enclosed

Wind Speed: 110 mph

Material

Concrete: f'c = 3000 psi (20.7 MPa)

Steel Reinforcement: fy = 40 ksi (275 MPa)

Masonry: f'm = 3000 psi (20.7 MPa)

Timber: Eucalyptus (Design Values taken from DF #2)

Geotechnical Report: Not Available
Use IBC Chapter 18 Soil Pressure Values

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations

EVC LOAD TAKE OFF

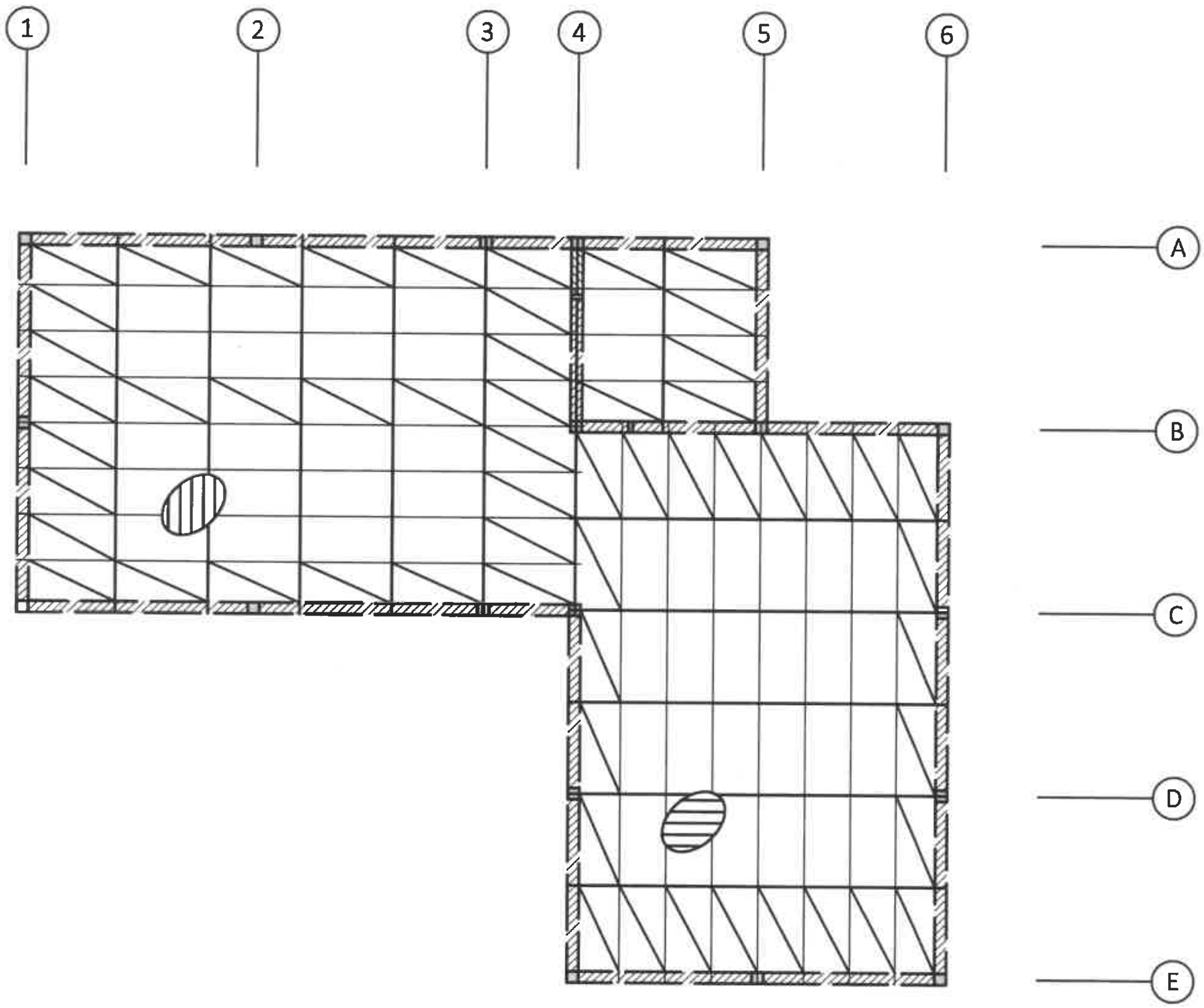
DEAD LOAD	WEIGHT (PSF)	WEIGHT(kg/m^2)
METAL DECKING	0.50	2.44
BAMBOO WEAVE CEILING	0.50	2.44
MISC.	2.00	9.76
TOTAL TO PURLINS:	3.00	14.65
PURLINS	2.08	10.16
TOTAL TO TRUSSES:	5.08	24.81
WOOD TRUSSES	11.96	58.41
TOTAL TO COLUMNS AND WALLS:	17.04	83.22
CONCRETE COLUMNS	8.79	42.91
MASONRY WALLS	210.97	1029.76
TOTAL TO FOUNDATION:	236.81	1156.19

LIVE LOAD	WEIGHT (PSF)	WEIGHT(kg/m^2)
ROOF	20.00	97.65

TOTAL AREA 112 m^2

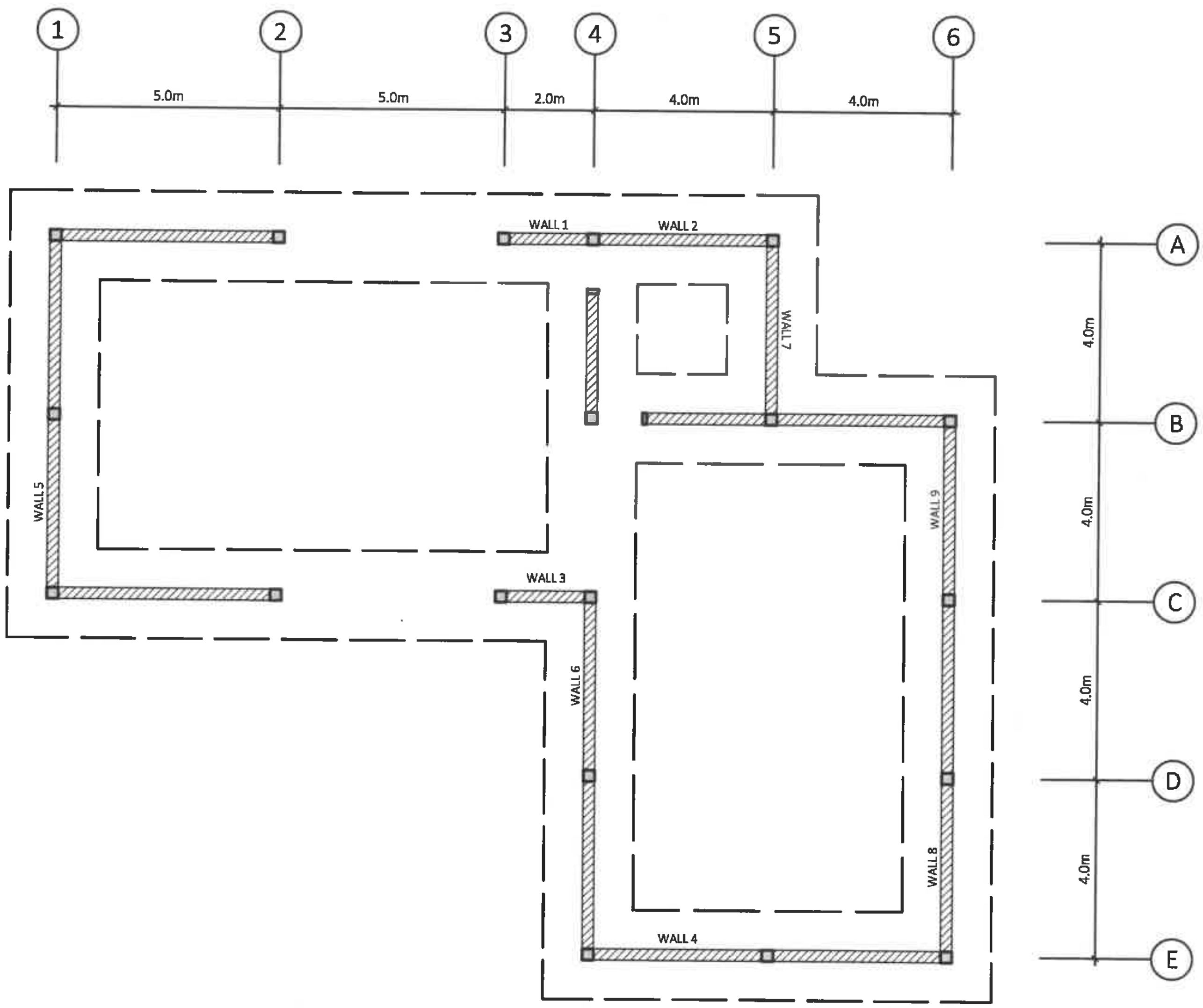
Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations		
	ATF LOAD TAKE OFF		
		WEIGHT (PSF)	WEIGHT(kg/m^2)
	DEAD LOAD		
	METAL DECKING	0.50	2.44
	BAMBOO WEAVE CEILING	0.50	2.44
	MISC.	2.00	9.76
	TOTAL TO PURLINS:	3.00	14.65
	PURLINS	2.08	10.16
	TOTAL TO TRUSSES:	5.08	24.81
	WOOD TRUSSES	11.18	54.60
	TOTAL TO COLUMNS AND WALLS:	16.26	79.41
	CONCRETE COLUMNS	14.10	68.83
	MASONRY WALLS	164.09	800.92
	TOTAL TO FOUNDATION:	194.45	949.38
		WEIGHT (PSF)	WEIGHT(kg/m^2)
	LIVE LOAD		
	ROOF	20.00	97.65
	TOTAL AREA 96 m^2		



ROOF FRAMING KEY PLAN

N.T.S.



FOUNDATION KEY PLAN

N.T.S.

References	Calculations
	DECKING DESIGN
	Purlin Spacing: 1 m
	Load: 2.44 kg/m^2 *self weight of decking*
See Appendix Page 99-100	Choose SAFLOK 700 concealed fix roofing Aluminum-Zinc, 0.5mm gauge
	Allowable Spacing: 1.4 m > 1m ***GOOD***
	Allowable Load: 153 kg/m^2 > 2.44 kg/m^2 ***GOOD***
	USE SAFLOK 700 ALUMINUM-ZINC 0.5mm GAUGE DECKING

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations

PURLIN DESIGN

References				
	w_D =	3 lb/ft	0.25 lb/in	
	w_L =	20 lb/ft	1.67 lb/in	
	L =	2 m	78.74 in	
NDS T4.3.1	F_b' =	$F_b(C_D*C_M*C_t*C_L*C_F*C_{fu}*C_i*C_r)$		
		F_b =	525 psi	*use DF#2 design values, conservative
		C_D =	1.0	
		C_M =	1.0	
		C_t =	1.0	
		C_L =	1.0	
		C_F =	1.5	
		C_{fu} =	1.0	
		C_i =	1.0	
		C_r =	1.0	
	F_b' =	787.5 psi		
	f_b =	M/S		
		M =	1485.4 lb-in	
		S_{req} =	1.89 in^3	30910 mm^3

Use 50mm x 100mm purlins @ 1m o.c. (S= 83,333 mm^3)

Use 2x4 purlins @ 40" o.c.

References	Calculations

ATF TRUSS DESIGN (TRUSS A&B)

References						
See Appendix Page 102-108	Max Chord Force =	2086	kg	4598.8	lb	
	Max Web Force =	490	kg	1080.3	lb	
	Max Diagonal Force =	1525	kg	3362.0	lb	

NDS T4.3.1

$F_c' = F_b(C_D*C_M*C_t*C_L*C_F*C_{fu}*C_i*C_r)$

F_c =	775	psi	*use DF#2 design values, conservative
C_D =	1.0		
C_M =	0.8		
C_t =	1.0		
C_F =	1.15		
C_i =	1.0		

F_c' = 713.0 psi

NDS T4.3.1

$F_t' = F_b(C_D*C_M*C_t*C_L*C_F*C_{fu}*C_i*C_r)$

F_t =	325	psi	*use DF#2 design values, conservative
C_D =	1.0		
C_M =	1.0		
C_t =	1.0		
C_F =	1.50		
C_i =	1.0		

F_t' = 487.5 psi

CHORD

f_c =	P/A				
	A_{req} =	6.45	in^2	3.22	in^2 per chord
				2080.64	mm^2 per chord
f_t =	P/A				
	A_{req} =	9.43	in^2	4.72	in^2 per chord
				3043.07	mm^2 per chord

Use double 50mm x 100mm chord members (A= 5000mm^2)

Use double 2x4 chord members (A= 5.25in^2)

Julia De Hart
Jenna Williams

References	Calculations

ATF TRUSS DESIGN (TRUSS A&B)

WEB

f_c = P/A
A_{req} = 1.52 in^2 977.48 mm^2

f_t = P/A
A_{req} = 2.22 in^2 1429.63 mm^2

Use 50mm x 100mm vertical members (A=5000mm^2)
Use double 2x4 vertical members (A= 5.25in^2)

DIAGONAL

f_c = P/A
A_{req} = 4.72 in^2 3042.16 mm^2

f_t = P/A
A_{req} = 6.90 in^2 4449.35 mm^2

Use 50mm x 100mm diagonal members (A=5000mm^2)
Use double 2x4 diagonal members (A= 5.25in^2)

Use 50mm x 150mm diagonal members (A= 7500mm^2)
for all Truss B and C members

(double 2x6 diagonal members equivalent)

Journeyman International	Julia De Hart
Rubagabaga Village EVC and ATF	Jenna Williams

References	Calculations

ATF TRUSS DESIGN (TRUSS A&B)

ATF TRUSS CONNECTIONS

WEB MEMBER TO CHORD

Width of main member =	5.5 in	150 mm
Width of side member =	5.5 in	150 mm
Thickness of main member =	1.5 in	50 mm
Thickness of side member =	1.5 in	50 mm
G =	0.55	0.55
Bolt diameter =	0.5 in	12.7 mm

DEMAND =

Truss A	1107 kg	2440.5 lb
Truss B	462 kg	1018.5 lb

CAPACITY

NDS TA 12F $Z_{||}' = Z_{||}(C_D*C_M*C_t*C_g*C_\Delta)$

$Z_{||}$ = 1150 lb

C_D = 1.25

C_M = 1

C_t = 1

C_g = 0.99

C_Δ = 1

$Z_{||}'$ = 1423.1 lb per bolt

Truss A # $bolts_{req}$ = 1.71

Truss B # $bolts_{req}$ = 0.72

TRUSS A	Use 2-12.7mm ø bolts (2-1/2" ø bolts)
TRUSS B	Use 1-12.7mm ø bolt (1/2" ø bolt)

References	Calculations

EVC TRUSS DESIGN (TRUSS C)

See Appendix Page 109-113

Max Chord Force =	3495	kg	7705.2	lb
Max Web Force =	1232	kg	2716.1	lb
Max Diagonal Force =	1827	kg	4027.8	lb

NDS T4.3.1

$F_c' = F_b(C_D*C_M*C_t*C_L*C_F*C_{fu}*C_i*C_r)$

F_c =	775 psi	*use DF#2 design values, conservative
C_D =	1.0	
C_M =	0.8	
C_t =	1.0	
C_F =	1.15	
C_i =	1.0	

F_c' = 713.0 psi

NDS T4.3.1

$F_t' = F_b(C_D*C_M*C_t*C_L*C_F*C_{fu}*C_i*C_r)$

F_t =	325 psi	*use DF#2 design values, conservative
C_D =	1.0	
C_M =	1.0	
C_t =	1.0	
C_F =	1.50	
C_i =	1.0	

F_t' = 487.5 psi

CHORD

f_c =	P/A		
	A_{req} =	10.81 in^2	5.40 in^2 per chord
			3486.02 mm^2 per chord
f_t =	P/A		
	A_{req} =	15.81 in^2	7.90 in^2 per chord
			5098.52 mm^2 per chord

Use double 50mm x 150mm chord members (A= 7500mm^2)

Use double 2x6 chord members (A= 8.25in^2)

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References	Calculations

EVC TRUSS DESIGN (TRUSS C)

WEB

f_c =	P/A		
	A_{req} =	3.81 in^2	2457.67 mm^2
f_t =	P/A		
	A_{req} =	5.57 in^2	3594.49 mm^2

Use 50mm x 100mm vertical members (A= 5000mm^2)

Use double 2x4 vertical members (A= 5.25in^2)

DIAGONAL

f_c =	P/A		
	A_{req} =	5.65 in^2	3644.61 mm^2
f_t =	P/A		
	A_{req} =	8.26 in^2	5330.47 mm^2

Use 50mm x 150mm diagonal members (A= 7500mm^2)

Use double 2x6 diagonal members (A= 8.25in^2)

**Use 50mm x 150mm members (A= 7500mm^2)
for all Truss A members**

(double 2x6 diagonal members equivalent)

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References	Calculations

EVC TRUSS DESIGN (TRUSS C)

EVC TRUSS CONNECTIONS

WEB MEMBER TO CHORD

Width of main member =	5.5 in	150 mm
Width of side member =	5.5 in	150 mm
Thickness of main member =	1.5 in	50 mm
Thickness of side member =	1.5 in	50 mm
G =	0.55	0.55
Bolt diameter =	0.5 in	12.7 mm

DEMAND : 1200 kg   2645.5 lb

CAPACITY

NDS TA 12F $Z_{||}' = Z_{||}(C_D * C_M * C_t * C_g * C_\Delta)$

$Z_{||}$ =	1150 lb
C_D =	1.25
C_M =	1
C_t =	1
C_g =	0.99
C_Δ =	1

$Z_{||}'$ = 1423.1 lb

$bolts_{req}$ = 1.86

SPACING

Minimum end distance

4D =	2 in	50.8 mm

Minimum spacing of bolts in a row

4D =	2 in	50.8 mm

Minimum edge distance

1.5D =	0.75 in	19.05 mm

Use 2-12.7mm ø bolts (2-1/2" ø bolts)

Check Bolt Spacing on Chord Member

50.8	mm end clear
50.8	mm spacing
19.05	mm edge clear
120.65	mm min. chord member

150mm deep chord necessary for chord members

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References	Calculations

TRUSS DESIGN SUMMARY

TRUSS A	Metric	U.S. Equivalent
Chords	50x150mm	2x6
Web	50x100mm	2x4
Diagonals	50x100mm	2x4
Bolts	2-12.7mm ø bolts	2-1/2" ø
TRUSS B		
Chords	50x150mm	2x6
Web	50x100mm	2x4
Diagonals	50x100mm	2x4
Bolts	1-12.7mm ø bolts	1-1/2" ø
TRUSS C		
Chords	50x150mm	2x6
Vertical	50x150mm	2x6
Diagonal	50x100mm	2x4
Bolts	2-12.7mm ø bolts	2-1/2" ø

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Jenna Williams

References	Calculations

SLAB ON GRADE DESIGN - EVC AND ATF

Slab on grade to be constructed by
typical slab on grade construction and minimum reinforcing:

Imperial Equivalent:
5" thick slab with #3 @18" o/c each way

SI Equivalent:

USE 125mm THICK SLAB w/ 10mm REINFORCING BARS @ 0.4m EACH WAY

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References	Calculations

SEISMIC LOAD CALCULATIONS - EVC AND ATF

ASCE 7-16 — **SEISMIC INPUT VALUES**

S_S = 0.76 g *See Appendix Page 113*

S_1 = 0.19 g

T12.2-1 — R = 1 (Ordinary Reinforced Masonry Shear Wall)

I_e = 1.0 (Risk Category II Building)

Site Class: E (Soft Clay)

11.4-1 — S_{MS} = F_aS_s = 0.912 g

11.4-2 — S_{M1} = F_vS_1 = 0.228 g

F_a = 1.2

F_v = 1.2

11.4-3 — S_{DS} = $2S_{MS}/3$ = 0.608 g

11.4-4 — S_{D1} = $2S_{M1}/3$ = 0.152 g

SEISMIC WEIGHT

ITEM	psf	kg/m^2	ECV trib	kg	ATF trib	kg
Ceiling	3.0	14.6	96	1406	112	1640
Purlins	2.08	10.2	96	975	112	1137
EVC Truss	12.0	58.4	96	5606		
ATF Truss	11.2	54.6			112	6114
Walls (10")	125	610.3	72	43942	88	53707
			Σ	51929	Σ	62598

W_{EVC} = 51929 kg 114.5 kips

W_{ATF} = 62598 kg 138.0 kips

W_{total} = 114527 kg 252.5 kips

BASE SHEAR

V = CsW

Cs = $S_{DS}/(R/I_e)$ = 0.608

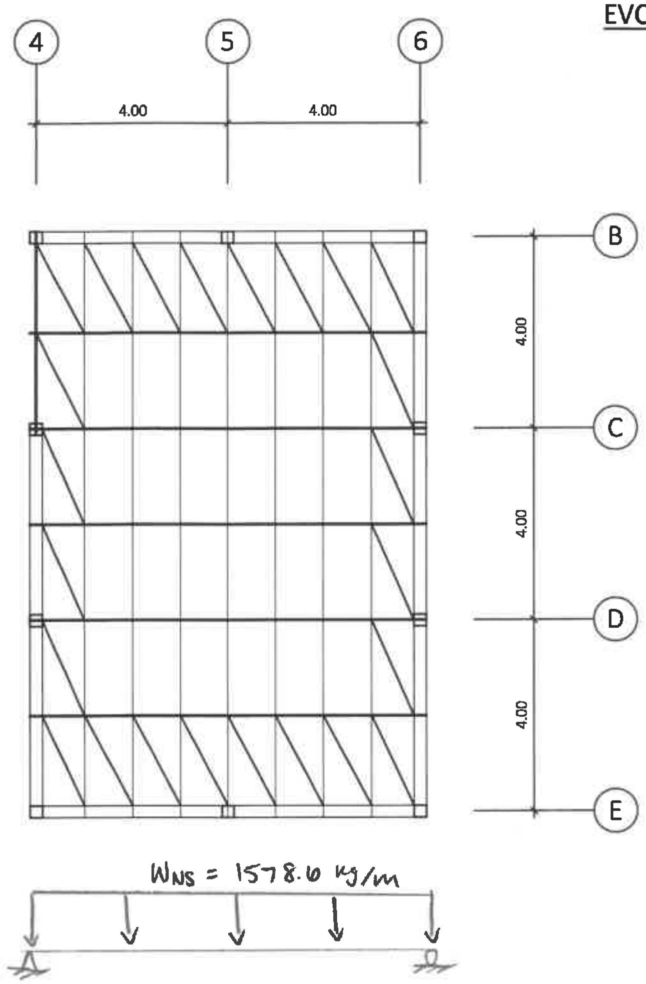
Cs min = $0.044S_{DS}I_e$ 0.027

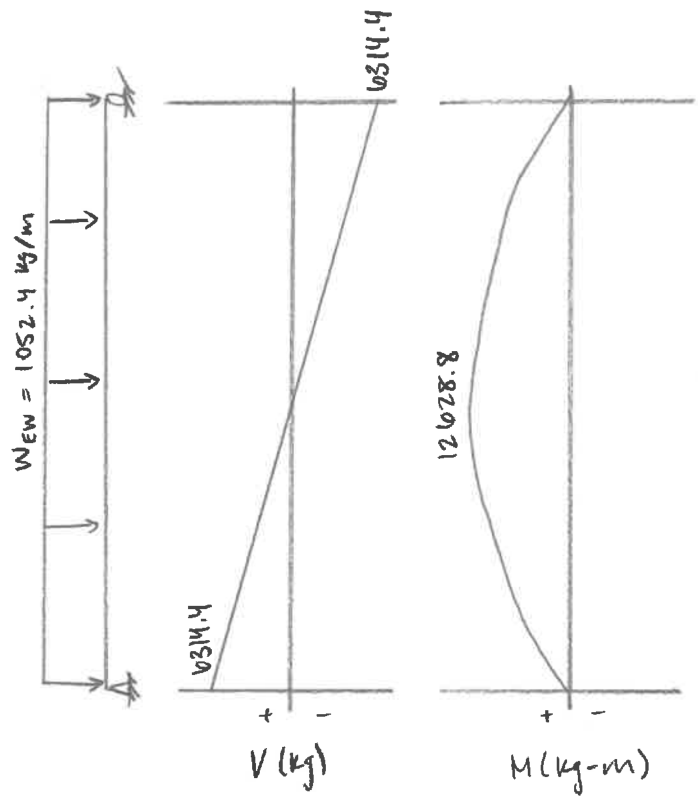
Cs max = $S_{D1}/T(R/I_e)$ 1.852

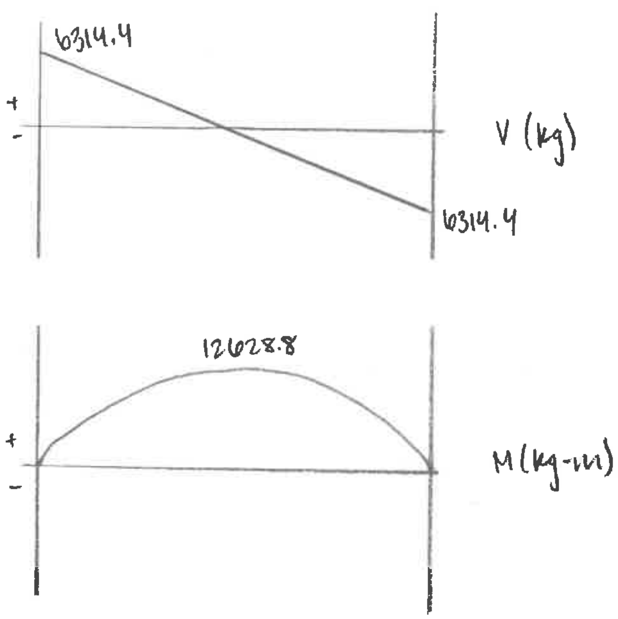
T = C_th_n^x = 0.082

V = 69632 kg 153.5 kips

References	Calculations
	WIND LOAD CALCULATIONS
ASCE 7-16	
	WIND SPEED VALUES
	$V =$ 110 mph 49.17 m/s
T26.6-1	$K_d =$ 0.85
26.7	Exposure: B
F26.8-1	$K_{zt} =$ 1.0
T26.9-1	$K_e =$ 1.0
26.11	$G =$ 0.85
26.12	Enclosure: Partially Enclosed
T26.13-1	$GC_{pi} =$ -0.55
T26.10-1	$K_z =$ 0.7
26.10-1	$q_z =$ 0.613*(Kz*Kzt*Kd*Ke*V^2) =
	18.43 psf
F27.3-1	$C_p =$ 0.8
27.3-1	p = qz*(GCp-Gcpi) =
	22.67 psf 110.68 kg/m^2
	General Building Parameters:
	height = 4.5 m (tallest wall)
	length = 20 m (longest wall length)
	DETERMINE GOVERNING CASE
	WIND LOADING
	Vw = p*h*l =
	9962 kg
	SEISMIC LOADING
	Vs = 69632 kg
	SEISMIC LOADING GOVERNS


4
5
6
4.00
4.00
B
C
D
E
4.00
4.00
4.00
WNS = 1578.6 kg/m


WEW = 1052.4 kg/m
6314.4
6314.4
+
-
V (kg)
12628.8
+
-
M (kg-m)


6314.4
+
-
V (kg)
6314.4
12628.8
+
-
M (kg-m)

References	Calculations

ASCE 7-16

EVC DIAPHRAGM DESIGN

DIAPHRAGM FORCES

W_{EVC} =	51929 kg		
Fp = Vs =	31573 kg		
Fp_{min} =	$0.2*S_{DS}*Ie*W_{px}$ =	6315 kg	
Fp_{max} =	$0.4*S_{DS}*Ie*W_{px}$ =	12629 kg	
Fp_{EVC} =	12629 kg	27.8 kips	

N/S		E/W	
Fline =	6314.5 kg	Fline =	6314.5 kg
# rods =	6	# rods =	8
Frod =	1052.4 kg/rod	Frod =	789.3 kg/rod
component =	0.9	component =	0.4
Faxial =	941.3 kg/rod	Faxial =	353.0 kg/rod

DIAGONAL ROD DESIGN

N/S

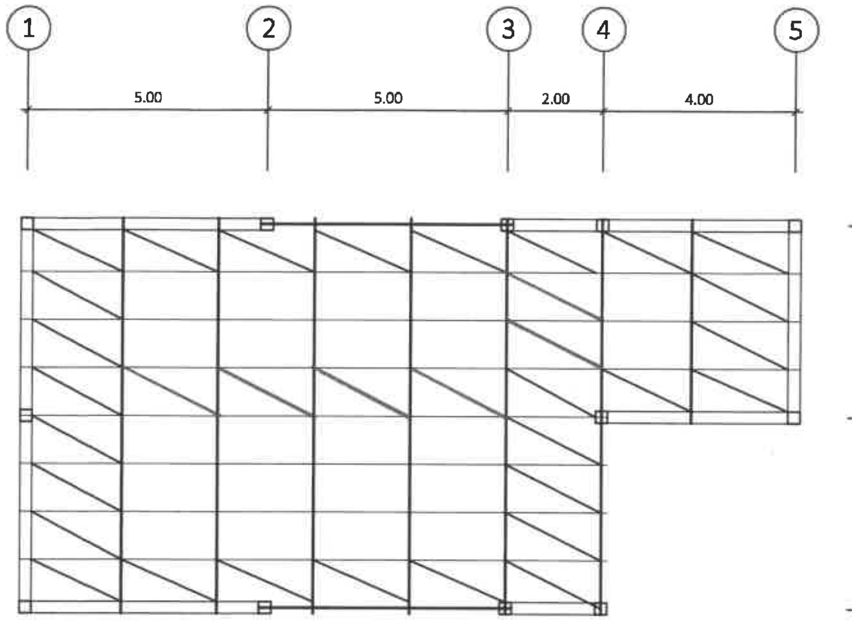
Pu =	941.3 kg	2.08 k	
ϕPn =	ϕFyAg =	2.08	
	ϕ =	0.9	
	Fy =	50 ksi	
	Ag req =	0.046 in^2	
ϕPn - Pu =	0.00		
	diam req =	0.24 in =	6.15 mm

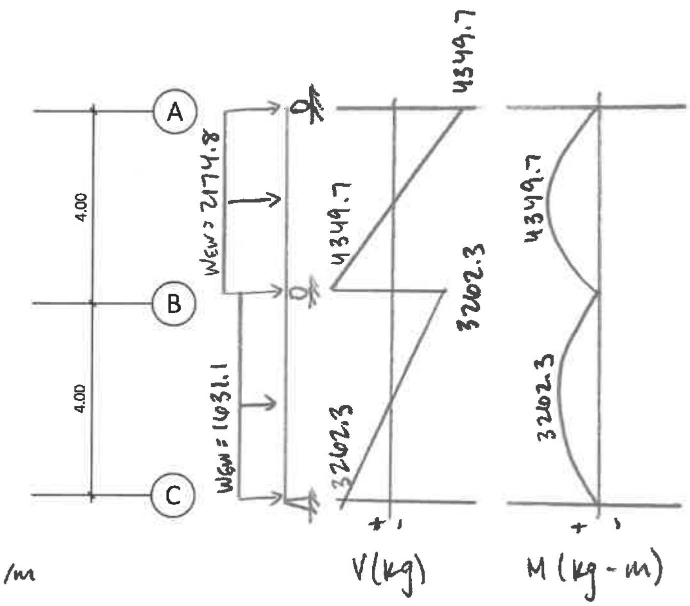
6.35mm diameter rod adequate for EVC in N/S direction (.25" Ø)

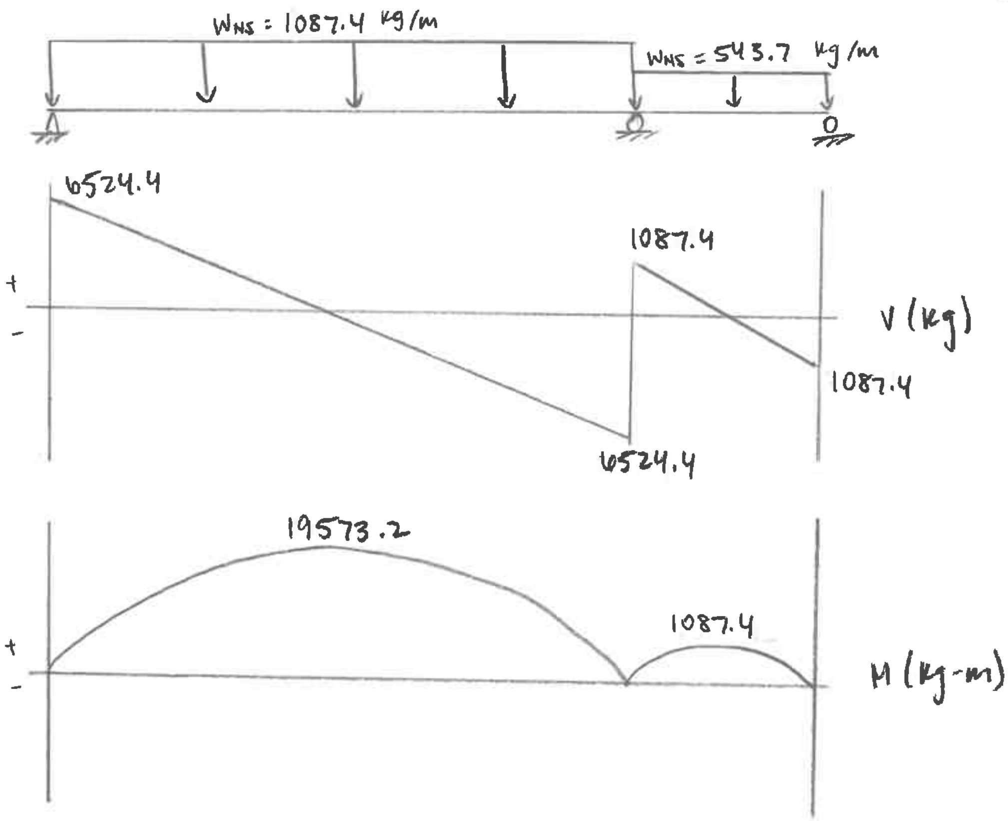
E/W

Pu =	353.0 kg	0.78 k	
ϕPn =	ϕFyAg =	0.78	
	ϕ =	0.9	
	Fy =	50 ksi	
	Ag req =	0.017 in^2	
ϕPn - Pu =	0.00		
	diam req =	0.15 in =	3.77 mm

6.35mm diameter rod adequate for EVC in N/S direction (.25" Ø)


1
2
3
4
5
5.00
5.00
2.00
4.00


A
B
C
4.00
4.00
WEW = 2174.8
WEW = 1631.1
4349.7
4349.7
3262.3
3262.3
V(kg)
4349.7
3262.3
M (kg-m)


WNS = 1087.4 kg/m
WNS = 543.7 kg/m
6524.4
1087.4
1087.4
6524.4
V (kg)
19573.2
1087.4
M (kg-m)

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References	Calculations
ASCE 7-16	ATF DIPHRAGM DESIGN

DIAPHRAGM FORCES

W_{ATF} = 62598 kg
Fp = Vs = 38060 kg
Fp_{min} = $0.2*S_{DS}*Ie*W_{px}$ = 7612 kg
Fp_{max} = $0.4*S_{DS}*Ie*W_{px}$ = 15224 kg

Fp_{ATF}= 15224 kg 33.6 kips

N/S	line 1-4	line 4-5		E/W	line A-B	line B-C	
Area =	96	16		Area =	48	64	
Fline =	6524.5	1087.4	kg	Fline =	3262.3	4349.7	kg
# rods =	8	4		# rods =	6	8	
Frod =	815.6	271.9	kg/rod	Frod =	543.7	543.7	kg/rod
component =	0.4	0.4		component =	0.9	0.9	
Faxial =	364.7	121.6	kg/rod	Faxial =	486.3	486.3	kg/rod

DIAGONAL ROD DESIGN

N/S

Pu = 364.7 kg 0.80 k
ϕPn = ϕFyAg = 0.80
ϕ = 0.9
Fy = 50 ksi
Ag req = 0.018 in^2
ϕPn - Pu = 0.00
diam req = 0.15 in = 3.83 mm

6.35mm diameter rod adequate for ATF in N/S direction (.25" Ø)

E/W

Pu = 486.3 kg 1.07 k
ϕPn = ϕFyAg = 1.07
ϕ = 0.9
Fy = 50 ksi
Ag req = 0.024 in^2
ϕPn - Pu = 0.00
diam req = 0.17 in = 4.42 mm

6.35mm diameter rod adequate for ATF in N/S direction (.25" Ø)

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References	Calculations
Confined Masonry Design Guide	

CONFINED MASONRY WALL DESIGN - EVC AND ATF

Performance Objective: Life Safety

Lateral Wall Density

Required Wall Density = 1.0% for following conditions:

Low Seismic Hazard	PGA = 0.06g ≤ 0.08g
n = 1	1 story building
Solid Clay Bricks	handmade, Mortar Type III conservatively
Soil Type C	Soft clay soil

N/S Direction

Assume 2 wythes of 120mm brick

Floor area	Ap =	192.00 m^2		
Wall area	Aw =	5.00 m^2		
Wall density	d = Aw / Ap =	2.60 %	> 1.0 %	***GOOD***

E/W Direction

Assume 2 wythes of 120mm brick

Floor area	Ap =	192.00 m^2		
Wall area	Aw =	3.00 m^2		
Wall density	d = Aw / Ap =	1.56 %	> 1.0 %	***GOOD***

Gravity Wall Density

Strength Reduction Factor	Fr =	0.6
Gravity Load Factor	Fc =	1.4
Safety Factor	Fs = Fc / Fr =	2.33

Compressive Strength, σR

Eccentricty/Slenderness Factor	Fe =	0.7	for interior walls
Masonry Comp Strength	f'm =	15 kg/cm^2	

σR = Fe (f'm + 4) = 13.3 kg/cm^2

References	Calculations
Confined Masonry Design Guide	

CONFINED MASONRY WALL DESIGN - EVC AND ATF

Wall Density Index, Σd ≥ Fc (n*w) / σR

Weight	w =	83.22	kg/m^2		
Stories	n =	1			
For both directions:					
	Fc (n*w) / σR =	0.876	%		
	Σd = ΣAw/Ap =	4.17	%	> 0.876 %	***GOOD***
For one direction:					
	Fc (n*w) / σR =	0.438	%		
	Σd = ΣAw/Ap =	1.56	%	> 0.438 %	***GOOD***

Wall Distance/Thickness Ratio, B/t ≤ σR/(Fs*D*w)

Distance	B =	4	m		
Thickness	t =	0.250	m		
	B/t =	16.0			
	D =	1.0			
	σR/(Fs*D*w) =	684.93		> 16.7	***GOOD***

Conclusion

Provided confined masonry walls are sufficient

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References	Calculations
Confined Masonry Design Guide	**CONFINED MASONRY WALL DESIGN - EVC AND ATF** **TIE-COLUMN DESIGN** Spacing Maximum spacing of tie-columns shall not exceed 6m Smax = 5 m < 6m ***GOOD*** Minimum Dimensions Minimum depth x width of a tie-column 150mm x t t = 250 mm Tie-Columns shall be 250mm x 250mm > 150mm x 250mm ***GOOD*** Reinforcing Longitudinal Minimum 4 deformed reinforcing bars of minimum 10-mm diameter Reinforcing shall be (4) 13-mm diameter bars ***GOOD*** Tie Sizing and Spacing Minimum 6-mm diameter bars with 135° hooked ends Tie spacing cannot exceed 200mm with minimum 20mm cover Ties shall be 10-mm diameter transverse stirrups, spaced at 200m, with 50mm cover ***GOOD***

References	Calculations
Confined Masonry Design Guide	**CONFINED MASONRY WALL DESIGN - EVC AND ATF** **TIE-BEAM DESIGN** Spacing Tie-beams shall be provided at the top of each wall, and above and below each window opening — ***GOOD*** Minimum Dimensions Minimum depth x width of a tie-beam 150mm x t t = 250 mm Tie-Beams shall be 250mm x 250mm > 150mm x 250mm — ***GOOD*** Reinforcing Longitudinal Minimum 4 deformed reinforcing bars of minimum 10-mm diameter To ensure the effectiveness of tie-beams in resisting earthquake loads longitudinal bars should have a 90° hooked anchorage at intersections Reinforcing shall be (4) 13-mm diameter bar, with 90° hooked anchorage at intersections — ***GOOD*** Tie Sizing and Spacing Minimum 6-mm diameter bars with 135° hooked ends Tie spacing cannot exceed 200mm with minimum 20mm cover Ties shall be 10-mm diameter transverse stirrups, spaced at 200m, with 50mm cover — ***GOOD***

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Jenna Williams

References	Calculations

SEISMIC LOAD DISTRIBUTION - EVC AND ATF

WALL	DIRECTION	L (m)	H/L	Rc	origin dist.	d(m)	Rd	Rd^2
1	X	2	2.00	0.263	16	6.62	1.74	11.53
2	X	4	1.00	1.429	16	6.62	9.46	62.63
3	X	2	2.00	0.263	8	-1.38	-0.36	0.50
4	X	4	1.00	1.429	0	-9.38	-13.40	125.73
5	Y	4	1.00	1.429	0	-11.23	-16.05	180.22
6	Y	4	1.00	1.429	12	0.77	1.10	0.85
7	Y	4	1.00	1.429	16	4.77	6.82	32.51
8	Y	4	1.00	1.429	20	8.77	12.53	109.91
9	Y	4	1.00	1.429	20	8.77	12.53	109.91
							Σ	633.78

Xcm = 11.23 m Xcr = 13.60 m
Ycm = 9.38 m Ycr = 8.62 m

EAST/WEST (X)

ex = 0.05*16m = 0.80 m
e = (Xcm-Xcr) + ex = -1.57 m
Vbase = 70988 kg-m
Mtor = -111451 kg-m

	DIRECT SHEAR	TORSION SHEAR	WALL FORCE
V1 =	5517	-306	5211 kg
V2 =	29977	-1664	28313 kg
V3 =	5517	64	5581 kg
V4 =	29977	2357	32334 kg

Largest East/West Force: 32334 kg

NORTH/SOUTH (Y)

ey = 0.05*20m = 1.00 m
e = (Ycm-Ycr) + ey = 1.76 m
Vbase = 70988 kg-m
Mtor = 124815 kg-m

	DIRECT SHEAR	TORSION SHEAR	WALL FORCE
V5 =	14198	-3160	11037 kg
V6 =	14198	217	14414 kg
V7 =	14198	1342	15540 kg
V8 =	14198	2468	16666 kg
V9 =	14198	2468	16666 kg

Largest North/South Force: 16666 kg

References	Calculations
	WALL LINE A EAST/WEST FOUNDATION DESIGN
	Loads:
	P_{DL} = 73996 kg
	P_{LL} = 6249 kg
	V_E = 33524 kg *Based on Wall 1 and 2 results*
	Sds = 0.608
ASCE 7-16 12.13.4	$M_{ot} = 0.75*0.70*V_E*H_{wall}$ = 70401 kg-m
	Allowable Soil Bearing Pressure:
IBC TA 1806.2	f_{IBC} = 7324 kg/m^2
	$f_{allow} = 1.33*F_{IBC}$ = 9740 kg/m^2
	Try Footing Size:
	Length = 18 m
	Width = 2 m
	Depth = 1 m
	Wall length = 16 m
	$P_{footing}$ = 86501 kg
	P_{dead} = 73996 kg
	ΣP = 160497 kg
	USE 18m LONG x 2m WIDE x 1m DEEP FTG.

References	Calculations
	WALL LINE A EAST/WEST FOUNDATION DESIGN
	Allowable Stress Design Combinations
ASCE 7-16 2.4.5	Load Case 8: (1.0 + 0.14Sds)D + 0.7E
	ΣP_{LC8} = 197626 kg
	$M_R = \Sigma P * L/2$ = 1778632 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 8.6 m
	$l = 3x$ = 25.9 m
	$f_{bearing} = 2*\Sigma P / l*w$ 6189 kg/m^2 < 9740 kg/m^2 ***GOOD***
ASCE 7-16 2.4.5	Load Case 9: (1.0 + 0.105Sds)D + 0.525E + 0.75L
	ΣP_{LC9} = 193031 kg
	$M_R = \Sigma P * L/2$ = 1737277 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 8.6 m
	$l = 3x$ = 25.9 m
	$f_{bearing} = 2*\Sigma P / l*w$ 7451 kg/m^2 < 9740 kg/m^2 ***GOVERNS, GOOD***
ASCE 7-16 2.4.5	Load Case 10: (1.0 - 0.14Sds)D + 0.7E
	ΣP_{LC10} = 170303 kg
	$M_R = \Sigma P * L/2$ = 1532725 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 8.6 m
	$l = 3x$ = 25.8 m
	$f_{bearing} = 2*\Sigma P / l*w$ 6611 kg/m^2 < 9740 kg/m^2 ***GOOD***
	Strength Design Combinations
ASCE 7-16 2.3.6	Load Case 6: (1.2 + 0.2Sds)D + E + L
	ΣP_{LC6} = 96933 kg ***GOVERNS***
ASCE 7-16 2.3.6	Load Case7: (0.9-0.2Sds)D + E
	ΣP_{LC7} = 67190 kg

Julia De Hart
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References	Calculations

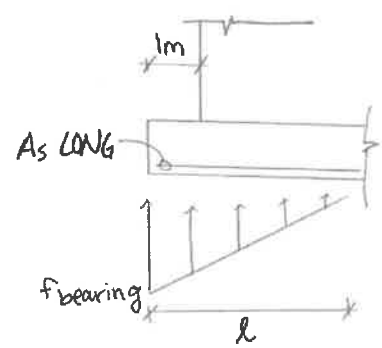
WALL LINE A EAST/WEST FOUNDATION DESIGN

Check Footing Shear

$V_{u,LC6} \leq$	96933	kg		
Φ =	0.75			
α =	2			
f'c =	3000	psi		
Acv = D*W =	3100	in^2		
ΦVc = Φα(f'c^.5)Acv =	254691	lbs		
	115526	kg	> 96933 kg	***GOOD***

Check for Longitudinal Flexural Reinforcement (Bottom)

x =	8.6	m
l = 3x =	25.9	m
$f_{bearing}$ =	7451	kg/m^2
$P_{triangle}$ =	193031	kg
x_{arm} =	0.36	m
Mu = P*x =	70401	kg-m



Try (6) #5 bars

# of bars =	12	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	3.72	in^2
Fy =	60	ksi
T = AsFy =	223.2	k
a = T / 0.85*f'c*b =	1.11	in
c = a / β =	1.31	in
d =	35.19	in
εt = 0.003(d-c/c) =	0.0777	>>> 0.005 ***STRAIN PASSES***
Φ =	0.9	

Journeyman International	Julia De Hart
Rubagabaga Village EVC and ATF	Jenna Williams

References	Calculations
ACI 318-14	WALL LINE A EAST/WEST FOUNDATION DESIGN

ΦMn = ΦAsFy(d-a/2) = 6957.2 k-in
80154 kg-m > 70401 kg-m ***GOOD***

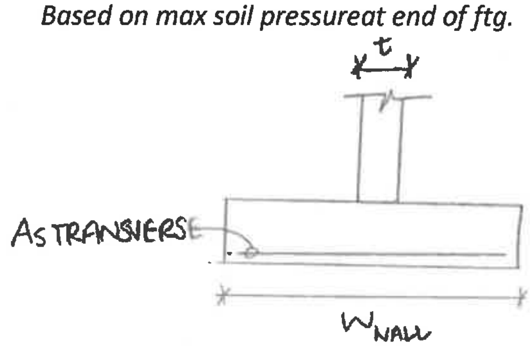
Imperial Equivalent: (6) #5 BARS

SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (B)

Check for Transverse Flexural Reinforcement (Bottom)

wu = 10985 kg/m^2 *Based on max soil pressureat end of ftg.*
l = W / t = 0.875 m
Mu = 4205 kg-m



Try #5 bars @ 12" o/c

# of bars =	1	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	0.31	in^2
Fy =	60	ksi
T = AsFy =	18.6	k
a = T / 0.85*f'c*b =	0.61	in
c = a / β =	0.72	in
d =	35.44	in

εt = 0.003(d-c/c) = 0.1457 >>> 0.005 ***STRAIN PASSES***
Φ = 0.9

ΦMn = ΦAsFy(d-a/2) = 588.2 k-in
6777 kg-m > 4205 kg-m ***GOOD***

Imperial Equivalent:

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (B)

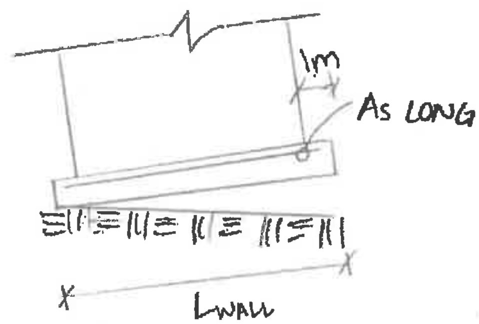
Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations
ACI 318-14	WALL LINE A EAST/WEST FOUNDATION DESIGN

Check for Longitudinal Flexural Reinforcement (Top)

wu = 732 kg/m^2
l = 9 m
Mu = 14831 kg-m

Based on ftg. rotating around toe



Try (6) #5 bars

# of bars =	6	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	1.86	in^2
Fy =	60	ksi
T = AsFy =	111.6	k
a = T / 0.85*f'c*b =	0.56	in
c = a / β =	0.65	in
d =	35.47	in
εt = 0.003(d-c/c) =	0.1597	>>> 0.005 **STRAIN PASSES**
Φ =	0.9	
ΦMn = ΦAsFy(d-a/2) =	3534.4	k-in
	40720	kg-m > 14831 kg-m **GOOD**

Imperial Equivalent: (6) #5 BARS

SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (T)

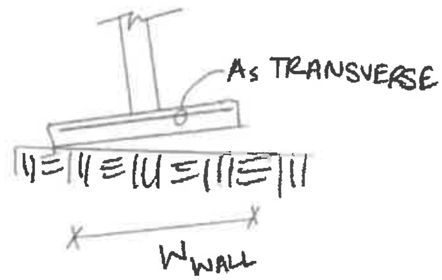
References	Calculations

ACI 318-14

WALL LINE A EAST/WEST FOUNDATION DESIGN

Check for Transverse Flexural Reinforcement (Top)

wu =	732	kg/m^2	
l =	0.875	m	
Mu =	280	kg-m	*Based on ftg. rotating around toe*



Try #5 bars @ 12" o/c

# of bars =	1	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	0.31	in^2
Fy =	60	ksi
T = AsFy =	18.6	k
a = T / 0.85*f'c*b =	0.61	in
c = a / β =	0.72	in
d =	35.44	in

εt = 0.003(d-c/c) =	0.1457	>>> 0.005	***STRAIN PASSES***
Φ =	0.9		
ΦMn = ΦAsFy(d-a/2) =	588.2 k-in		
	6777 kg-m	> 280 kg-m	***GOOD***

Imperial Equivalent: #5 BARS @ 12" O/C

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (T)

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations
	WALL LINE B EAST/WEST FOUNDATION DESIGN
	Loads:
	P_{DL} = 36998 kg
	P_{LL} = 3125 kg
	V_E = 0 kg *No EQ Loads to Line B*
	Sds = 0.608
ASCE 7-16 12.13.4	$M_{ot} = 0.75*0.70*V_E*H_{wall}$ = 0 kg-m
	Allowable Soil Bearing Pressure:
IBC TA 1806.2	f_{IBC} = 7324 kg/m^2 $f_{allow} = 1.33*F_{IBC}$ = 9740 kg/m^2
	Try Footing Size:
	Length = 10 m
	Width = 2 m
	Depth = 1 m
	Wall length = 8 m
	$P_{footing}$ = 48056 kg
	P_{dead} = 36998 kg
	ΣP = 85054 kg
	USE 10m LONG x 2m WIDE x 1m DEEP FTG.

References	Calculations
	WALL LINE B EAST/WEST FOUNDATION DESIGN
	Allowable Stress Design Combinations
ASCE 7-16 2.4.5	Load Case 8: (1.0 + 0.14Sds)D + 0.7E
	ΣP_{LC8} = 92294 kg
	$M_R = \Sigma P * L/2$ = 461470.3 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 5.0 m
	l = 3x = 15.0 m
	$f_{bearing} = 2*\Sigma P / l*w$ 5670 kg/m^2 < 9740 kg/m^2 ***GOOD***
ASCE 7-16 2.4.5	Load Case 9: (1.0 + 0.105Sds)D + 0.525E + 0.75L
	ΣP_{LC9} = 92828 kg
	$M_R = \Sigma P * L/2$ = 464138 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 5.0 m
	l = 3x = 15.0 m
	$f_{bearing} = 2*\Sigma P / l*w$ 6189 kg/m^2 < 9740 kg/m^2 ***GOVERNS, GOOD***
ASCE 7-16 2.4.5	Load Case 10: (1.0 - 0.14Sds)D + 0.7E
	ΣP_{LC10} = 77814 kg
	$M_R = \Sigma P * L/2$ = 389072.1 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 5.0 m
	l = 3x = 15.0 m
	$f_{bearing} = 2*\Sigma P / l*w$ 5188 kg/m^2 < 9740 kg/m^2 ***GOOD***
	Strength Design Combinations
ASCE 7-16 2.3.6	Load Case 6: (1.2 + 0.2Sds)D + E + L
	ΣP_{LC6} = 34880 kg ***GOVERNS***
ASCE 7-16 2.3.6	Load Case7: (0.9-0.2Sds)D + E
	ΣP_{LC7} = 18703 kg

Journeyman International	Julia De Hart
Rubagabaga Village EVC and ATF	Jenna Williams

References | Calculations

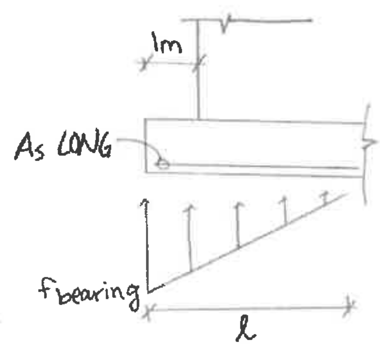
WALL LINE B EAST/WEST FOUNDATION DESIGN

Check Footing Shear

$V_{u,LC6} \leq$	34880	kg
Φ =	0.75	
α =	2	
f'c =	3000	psi
Acv = D*W =	3100	in^2
ΦVc = Φα(f'c^.5)Acv =	254691	lbs
	115526	kg > 34880 kg ***GOOD***

Check for Longitudinal Flexural Reinforcement (Bottom)

x =	5.0	m
l = 3x =	15.0	m
$f_{bearing}$ =	6189	kg/m^2
$P_{triangle}$ =	92828	kg
x_{arm} =	0.00	m
Mu = P*x =	0	kg-m



Try (6) #5 bars

# of bars =	12	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	3.72	in^2
Fy =	60	ksi
T = AsFy =	223.2	k
a = T / 0.85*f'c*b =	1.11	in
c = a / β =	1.31	in
d =	35.19	in
εt = 0.003(d-c/c) =	0.0777	>>> 0.005 ***STRAIN PASSES***
Φ =	0.9	

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams
References	**Calculations**

ACI 318-14

WALL LINE B EAST/WEST FOUNDATION DESIGN

ΦMn = ΦAsFy(d-a/2) = 6957.2 k-in
80154 kg-m > 0 kg-m ***GOOD***

Imperial Equivalent: (6) #5 BARS

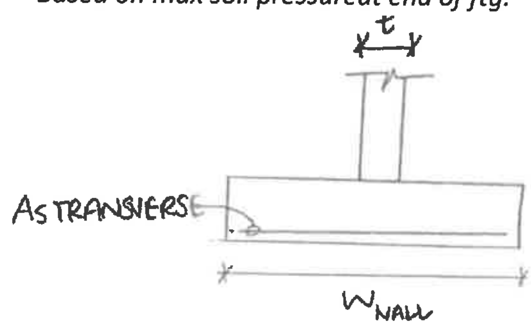
SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (B)

Check for Transverse Flexural Reinforcement (Bottom)

wu =	10985	kg/m^2
l = W / t =	0.875	m
Mu =	4205	kg-m

Based on max soil pressureat end of ftg.



Try #5 bars @ 12" o/c

# of bars =	1	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	0.31	in^2
Fy =	60	ksi
T = AsFy =	18.6	k
a = T / 0.85*f'c*b =	0.61	in
c = a / β =	0.72	in
d =	35.44	in

εt = 0.003(d-c/c) = 0.1457 >>> 0.005 ***STRAIN PASSES***
Φ = 0.9

ΦMn = ΦAsFy(d-a/2) = 588.2 k-in
6777 kg-m > 4205 kg-m ***GOOD***

Imperial Equivalent:

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (B)

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations

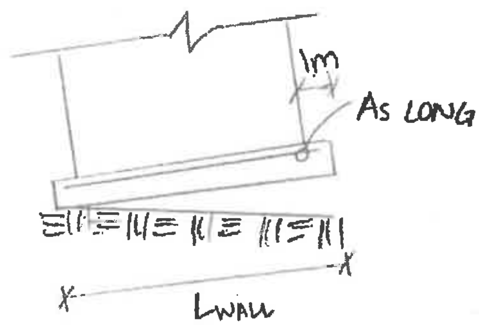
ACI 318-14

WALL LINE B EAST/WEST FOUNDATION DESIGN

Check for Longitudinal Flexural Reinforcement (Top)

wu =	732	kg/m^2
l =	5	m
Mu =	4578	kg-m

Based on ftg. rotating around toe



Try (6) #5 bars

# of bars =	6	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	1.86	in^2
Fy =	60	ksi
T = AsFy =	111.6	k
a = T / 0.85*f'c*b =	0.56	in
c = a / β =	0.65	in
d =	35.47	in
εt = 0.003(d-c/c) =	0.1597	>>> 0.005 ***STRAIN PASSES***
Φ =	0.9	
ΦMn = ΦAsFy(d-a/2) =	3534.4	k-in
	40720	kg-m > 14831 kg-m ***GOOD***

Imperial Equivalent: (6) #5 BARS

SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (T)

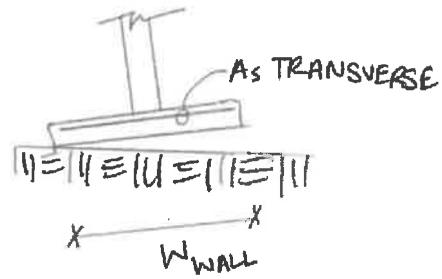
Journeyman International | Julia De Hart
Rubagabaga Village EVC and ATF | Jenna Williams

References	Calculations
ACI 318-14	WALL LINE B EAST/WEST FOUNDATION DESIGN

Check for Transverse Flexural Reinforcement (Top)

wu =	732	kg/m^2
l =	0.875	m
Mu =	280	kg-m

Based on ftg. rotating around toe



Try #5 bars @ 12" o/c

# of bars =	1			
bar diameter =	0.625	in		
bar area =	0.31	in^2		
cover =	3.00	in		
As =	0.31	in^2		
Fy =	60	ksi		
T = AsFy =	18.6	k		
a = T / 0.85*f'c*b =	0.61	in		
c = a / β =	0.72	in		
d =	35.44	in		
εt = 0.003(d-c/c) =	0.1457	>>> 0.005		***STRAIN PASSES***
Φ =	0.9			
ΦMn = ΦAsFy(d-a/2) =	588.2	k-in		
	6777	kg-m	> 280 kg-m	***GOOD***

Imperial Equivalent: #5 BARS @ 12" O/C

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (T)

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations
	WALL LINE C EAST/WEST FOUNDATION DESIGN
	Loads:
	P_{DL} = 55497 kg
	P_{LL} = 4687 kg
	V_E = 5581 kg *Based on Wall 3 results*
	Sds = 0.608
ASCE 7-16 12.13.4	$M_{ot} = 0.75*0.70*V_E*H_{wall}$ = 11720 kg-m
	Allowable Soil Bearing Pressure:
IBC TA 1806.2	f_{IBC} = 7324 kg/m^2
	$f_{allow} = 1.33*F_{IBC}$ = 9740 kg/m^2
	Try Footing Size:
	Length = 14 m
	Width = 2 m
	Depth = 1 m
	Wall length = 12 m
	$P_{footing}$ = 67278 kg
	P_{dead} = 55497 kg
	ΣP = 122776 kg
	USE 14m LONG x 2m WIDE x 1m DEEP FTG.

References	Calculations

WALL LINE C EAST/WEST FOUNDATION DESIGN

Allowable Stress Design Combinations

ASCE 7-16 2.4.5

Load Case 8: (1.0 + 0.14Sds)D + 0.7E

ΣP_{LC8} =	137133 kg		
$M_R = \Sigma P * L/2$ =	959931.5 kg		
$x = (M_R - M_{OT}) / \Sigma P$ =	6.9 m		
$l = 3x$ =	20.7 m		
$f_{bearing} = 2*\Sigma P / l*w$	5919 kg/m^2	< 9740 kg/m^2	***GOOD***

ASCE 7-16 2.4.5

Load Case 9: (1.0 + 0.105Sds)D + 0.525E + 0.75L

ΣP_{LC9} =	137059 kg		
$M_R = \Sigma P * L/2$ =	959413 kg		
$x = (M_R - M_{OT}) / \Sigma P$ =	6.9 m		
$l = 3x$ =	20.7 m		
$f_{bearing} = 2*\Sigma P / l*w$	6607 kg/m^2	< 9740 kg/m^2	***GOVERNS, GOOD***

ASCE 7-16 2.4.5

Load Case 10: (1.0 - 0.14Sds)D + 0.7E

ΣP_{LC10} =	116232 kg		
$M_R = \Sigma P * L/2$ =	813622.1 kg		
$x = (M_R - M_{OT}) / \Sigma P$ =	6.9 m		
$l = 3x$ =	20.7 m		
$f_{bearing} = 2*\Sigma P / l*w$	5616 kg/m^2	< 9740 kg/m^2	***GOOD***

Strength Design Combinations

ASCE 7-16 2.3.6

Load Case 6: (1.2 + 0.2Sds)D + E + L

ΣP_{LC6} = 54726 kg ***GOVERNS***

ASCE 7-16 2.3.6

Load Case7: (0.9-0.2Sds)D + E

ΣP_{LC7} = 31766 kg

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations

WALL LINE C EAST/WEST FOUNDATION DESIGN

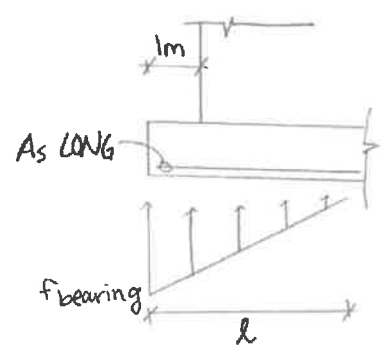
Check Footing Shear

$V_{u,LC6} \le$	54726	kg
Φ =	0.75	
α =	2	
f'c =	3000	psi
Acv = D*W =	3100	in^2
ΦVc = Φα(f'c^.5)Acv =	254691	lbs
	115526	kg

> 34880 kg ***GOOD***

Check for Longitudinal Flexural Reinforcement (Bottom)

x =	6.9	m
l = 3x =	20.7	m
$f_{bearing}$ =	6607	kg/m^2
$P_{triangle}$ =	137059	kg
x_{arm} =	0.09	m
Mu = P*x =	11720	kg-m



Try (6) #5 bars

# of bars =	12	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	3.72	in^2
Fy =	60	ksi
T = AsFy =	223.2	k
a = T / 0.85*f'c*b =	1.11	in
c = a / β =	1.31	in
d =	35.19	in
εt = 0.003(d-c/c) =	0.0777	>>> 0.005
Φ =	0.9	

STRAIN PASSES

Journeyman International	Julia De Hart
Rubagabaga Village EVC and ATF	Jenna Williams

References	Calculations
ACI 318-14	WALL LINE C EAST/WEST FOUNDATION DESIGN

ΦMn = ΦAsFy(d-a/2) = 6957.2 k-in
80154 kg-m > 11720 kg-m ***GOOD***

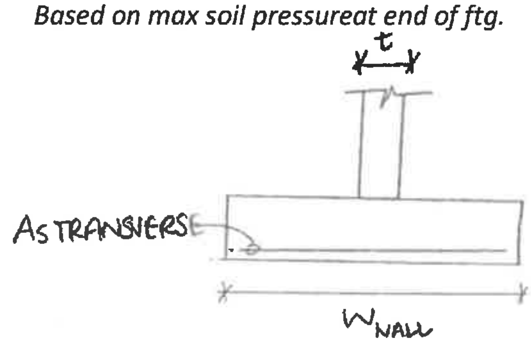
Imperial Equivalent: (6) #5 BARS

SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (B)

Check for Transverse Flexural Reinforcement (Bottom)

wu =	10985	kg/m^2	*Based on max soil pressureat end of ftg.*
l = W / t =	0.875	m	
Mu =	4205	kg-m	



Try #5 bars @ 12" o/c

# of bars =	1	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	0.31	in^2
Fy =	60	ksi
T = AsFy =	18.6	k
a = T / 0.85*f'c*b =	0.61	in
c = a / β =	0.72	in
d =	35.44	in
εt = 0.003(d-c/c) =	0.1457	>>> 0.005 ***STRAIN PASSES***
Φ =	0.9	

ΦMn = ΦAsFy(d-a/2) = 588.2 k-in
6777 kg-m > 4205 kg-m ***GOOD***

Imperial Equivalent:

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (B)

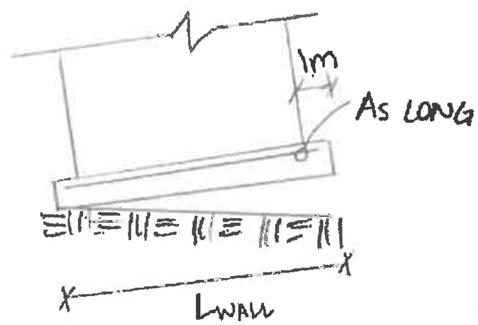
Journeyman International | Julia De Hart
Rubagabaga Village EVC and ATF | Jenna Williams

References	Calculations
ACI 318-14	

WALL LINE C EAST/WEST FOUNDATION DESIGN

Check for Longitudinal Flexural Reinforcement (Top)

wu = 732 kg/m^2
l = 7 m
Mu = 8972 kg-m   *Based on ftg. rotating around toe*



Try (6) #5 bars

# of bars =	6	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	1.86	in^2
Fy =	60	ksi
T = AsFy =	111.6	k
a = T / 0.85*f'c*b =	0.56	in
c = a / β =	0.65	in
d =	35.47	in
εt = 0.003(d-c/c) =	0.1597	>>> 0.005 ***STRAIN PASSES***
Φ =	0.9	
ΦMn = ΦAsFy(d-a/2) =	3534.4	k-in
	40720	kg-m > 14831 kg-m ***GOOD***

Imperial Equivalent: (6) #5 BARS

SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (T)

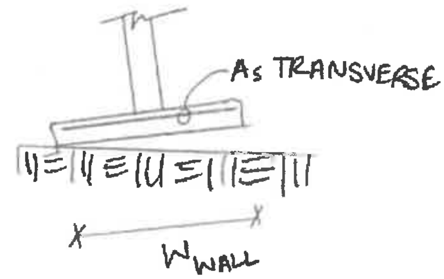
Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations
ACI 318-14	

WALL LINE C EAST/WEST FOUNDATION DESIGN

Check for Transverse Flexural Reinforcement (Top)

wu = 732 kg/m^2
l = 0.875 m
Mu = 280 kg-m *Based on ftg. rotating around toe*



Try #5 bars @ 12" o/c

# of bars =	1	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	0.31	in^2
Fy =	60	ksi
T = AsFy =	18.6	k
a = T / 0.85*f'c*b =	0.61	in
c = a / β =	0.72	in
d =	35.44	in
εt = 0.003(d-c/c) =	0.1457	>>> 0.005 ***STRAIN PASSES***
Φ =	0.9	
ΦMn = ΦAsFy(d-a/2) =	588.2	k-in
	6777	kg-m > 280 kg-m ***GOOD***

Imperial Equivalent: #5 BARS @ 12" O/C

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (T)

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations

WALL LINE E EAST/WEST FOUNDATION DESIGN

Loads:

P_{DL} =	9250 kg	
P_{LL} =	781 kg	
V_E =	32334 kg	*Based on Wall 4 results*
Sds =	0.608	

ASCE 7-16 12.13.4 — $M_{ot} = 0.75*0.70*V_E*H_{wall}$ = 67901 kg-m

Allowable Soil Bearing Pressure:

IBC TA 1806.2

f_{IBC} =	7324 kg/m^2
$f_{allow} = 1.33*F_{IBC}$ =	9740 kg/m^2

Try Footing Size:

Length =	10 m
Width =	2 m
Depth =	1 m
Wall length =	8 m

$P_{footing}$ =	48056 kg
P_{dead} =	9250 kg
ΣP =	57306 kg

USE 10m LONG x 2m WIDE x 1m DEEP FTG.

Journeyman International	Julia De Hart
Rubagabaga Village EVC and ATF	Jenna Williams

References	Calculations
	WALL LINE E EAST/WEST FOUNDATION DESIGN
	Allowable Stress Design Combinations
ASCE 7-16 2.4.5	Load Case 8: (1.0 + 0.14Sds)D + 0.7E
	ΣP_{LC8} = 84817 kg
	$M_R = \Sigma P$ * L/2 = 424086.2 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 4.2 m
	l = 3x = 12.6 m
	$f_{bearing} = 2*\Sigma P / l*w$ 4549 kg/m^2 < 9740 kg/m^2 ***GOOD***
ASCE 7-16 2.4.5	Load Case 9: (1.0 + 0.105Sds)D + 0.525E + 0.75L
	ΣP_{LC9} = 78525 kg
	$M_R = \Sigma P$ * L/2 = 392626 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 4.1 m
	l = 3x = 12.4 m
	$f_{bearing} = 2*\Sigma P / l*w$ 6330 kg/m^2 < 9740 kg/m^2 ***GOVERNS, GOOD***
ASCE 7-16 2.4.5	Load Case 10: (1.0 - 0.14Sds)D + 0.7E
	ΣP_{LC10} = 75062 kg
	$M_R = \Sigma P$ * L/2 = 375307.7 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 4.1 m
	l = 3x = 12.3 m
	$f_{bearing} = 2*\Sigma P / l*w$ 6109 kg/m^2 < 9740 kg/m^2 ***GOOD***
	Strength Design Combinations
ASCE 7-16 2.3.6	Load Case 6: (1.2 + 0.2Sds)D + E + L
	ΣP_{LC6} = 64871 kg ***GOVERNS***
ASCE 7-16 2.3.6	Load Case7: (0.9-0.2Sds)D + E
	ΣP_{LC7} = 51037 kg

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations

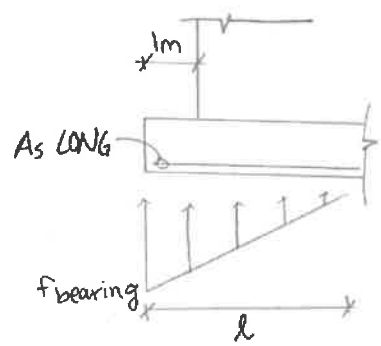
WALL LINE E EAST/WEST FOUNDATION DESIGN

Check Footing Shear

$V_{u,LC6} \leq$	64871 kg			
Φ =	0.75			
α =	2			
f'c =	3000 psi			
Acv = D*W =	3100 in^2			
ΦVc = Φα(f'c^.5)Acv =	254691 lbs			
	115526 kg	> 64871 kg	***GOOD***	

Check for Longitudinal Flexural Reinforcement (Bottom)

x =	4.1 m
l = 3x =	12.4 m
$f_{bearing}$ =	6330 kg/m^2
$P_{triangle}$ =	78525 kg
x_{arm} =	0.86 m
Mu = P*x =	67901 kg-m



Try (6) #5 bars

# of bars =	12		
bar diameter =	0.625 in		
bar area =	0.31 in^2		
cover =	3.00 in		
As =	3.72 in^2		
Fy =	60 ksi		
T = AsFy =	223.2 k		
a = T / 0.85*f'c*b =	1.11 in		
c = a / β =	1.31 in		
d =	35.19 in		
εt = 0.003(d-c/c) =	0.0777	>>> 0.005	***STRAIN PASSES***
Φ =	0.9		

References	Calculations

ACI 318-14

WALL LINE E EAST/WEST FOUNDATION DESIGN

ΦMn = ΦAsFy(d-a/2) =	6957.2	k-in		
	80154	kg-m	> 67901 kg-m	***GOOD***

Imperial Equivalent: (6) #5 BARS

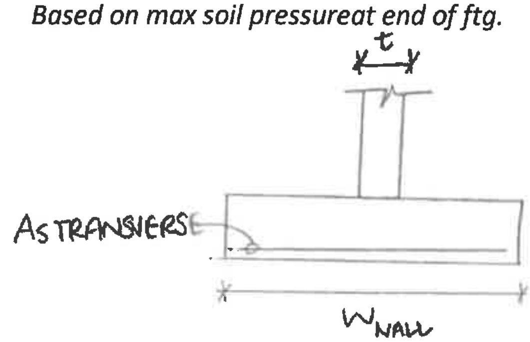
SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (B)

Check for Transverse Flexural Reinforcement (Bottom)

wu =	10985	kg/m^2
l = W / t =	0.875	m
Mu =	4205	kg-m

Based on max soil pressureat end of ftg.



Try #5 bars @ 12" o/c

# of bars =	1	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	0.31	in^2
Fy =	60	ksi
T = AsFy =	18.6	k
a = T / 0.85*f'c*b =	0.61	in
c = a / β =	0.72	in
d =	35.44	in

εt = 0.003(d-c/c) =	0.1457	>>> 0.005	***STRAIN PASSES***
Φ =	0.9		

ΦMn = ΦAsFy(d-a/2) =	588.2	k-in		
	6777	kg-m	> 4205 kg-m	***GOOD***

Imperial Equivalent:

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (B)

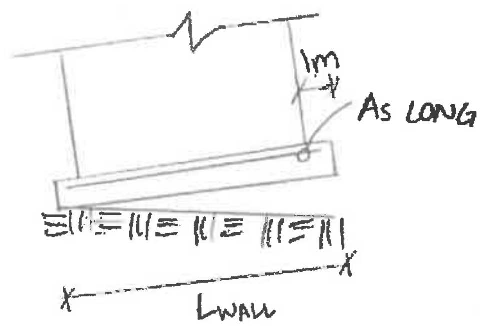
References	Calculations
ACI 318-14	WALL LINE E EAST/WEST FOUNDATION DESIGN

WALL LINE E EAST/WEST FOUNDATION DESIGN

Check for Longitudinal Flexural Reinforcement (Top)

wu =	732	kg/m^2
l =	5	m
Mu =	4578	kg-m

Based on ftg. rotating around toe



Try (6) #5 bars

# of bars =	6			
bar diameter =	0.625	in		
bar area =	0.31	in^2		
cover =	3.00	in		
As =	1.86	in^2		
Fy =	60	ksi		
T = AsFy =	111.6	k		
a = T / 0.85*f'c*b =	0.56	in		
c = a / β =	0.65	in		
d =	35.47	in		
εt = 0.003(d-c/c) =	0.1597	>>> 0.005		***STRAIN PASSES***
Φ =	0.9			
ΦMn = ΦAsFy(d-a/2) =	3534.4	k-in		
	40720	kg-m	> 4578 kg-m	***GOOD***

Imperial Equivalent: (6) #5 BARS

SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (T)

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations

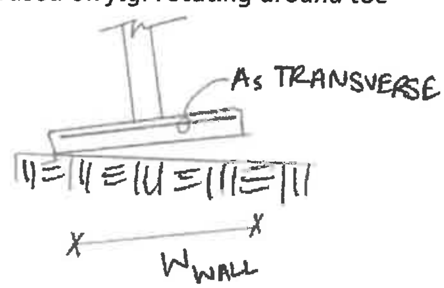
ACI 318-14

WALL LINE E EAST/WEST FOUNDATION DESIGN

Check for Transverse Flexural Reinforcement (Top)

wu =	732	kg/m^2
l =	0.875	m
Mu =	280	kg-m

Based on ftg. rotating around toe



Try #5 bars @ 12" o/c

# of bars =	1	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	0.31	in^2
Fy =	60	ksi
T = AsFy =	18.6	k
a = T / 0.85*f'c*b =	0.61	in
c = a / β =	0.72	in
d =	35.44	in
εt = 0.003(d-c/c) =	0.1457	>>> 0.005
Φ =	0.9	

STRAIN PASSES

ΦMn = ΦAsFy(d-a/2) =	588.2	k-in	
	6777	kg-m	> 280 kg-m

GOOD

Imperial Equivalent: #5 BARS @ 12" O/C

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (T)

References	Calculations
	WALL LINE 1 NORTH/SOUTH FOUNDATION DESIGN
	Loads:
	P_{DL} = 9250 kg
	P_{LL} = 781 kg
	V_E = 11037 kg *Based on Wall 5 results*
	Sds = 0.608
ASCE 7-16 12.13.4	$M_{ot} = 0.75*0.70*V_E*H_{wall}$ = 23178 kg-m
	Allowable Soil Bearing Pressure:
IBC TA 1806.2	f_{IBC} = 7324 kg/m^2
	$f_{allow} = 1.33*F_{IBC}$ = 9740 kg/m^2
	Try Footing Size:
	Length = 10 m
	Width = 2 m
	Depth = 1 m
	Wall length = 8 m
	$P_{footing}$ = 48056 kg
	P_{dead} = 9250 kg
	ΣP = 57306 kg
	USE 10m LONG x 2m WIDE x 1m DEEP FTG.

Journeyman International	Julia De Hart
Rubagabaga Village EVC and ATF	Jenna Williams

References	Calculations
	WALL LINE 1 NORTH/SOUTH FOUNDATION DESIGN
	Allowable Stress Design Combinations
ASCE 7-16 2.4.5	Load Case 8: (1.0 + 0.14Sds)D + 0.7E
	ΣP_{LC8} = 69909 kg
	$M_R = \Sigma P * L/2$ = 349547.2 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 4.7 m
	l = 3x = 14.0 m
	$f_{bearing} = 2*\Sigma P / l*w$ 4092 kg/m^2 < 9740 kg/m^2 ***GOOD***
ASCE 7-16 2.4.5	Load Case 9: (1.0 + 0.105Sds)D + 0.525E + 0.75L
	ΣP_{LC9} = 67344 kg
	$M_R = \Sigma P * L/2$ = 336722 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 4.7 m
	l = 3x = 14.0 m
	$f_{bearing} = 2*\Sigma P / l*w$ 4822 kg/m^2 < 9740 kg/m^2 ***GOVERNS, GOOD***
ASCE 7-16 2.4.5	Load Case 10: (1.0 - 0.14Sds)D + 0.7E
	ΣP_{LC10} = 60154 kg
	$M_R = \Sigma P * L/2$ = 300768.7 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 4.6 m
	l = 3x = 13.8 m
	$f_{bearing} = 2*\Sigma P / l*w$ 4345 kg/m^2 < 9740 kg/m^2 ***GOOD***
	Strength Design Combinations
ASCE 7-16 2.3.6	Load Case 6: (1.2 + 0.2Sds)D + E + L
	ΣP_{LC6} = 43574 kg ***GOVERNS***
ASCE 7-16 2.3.6	Load Case7: (0.9-0.2Sds)D + E
	ΣP_{LC7} = 29741 kg

Journeyman International	Julia De Hart
Rubagabaga Village EVC and ATF	Jenna Williams

References	Calculations

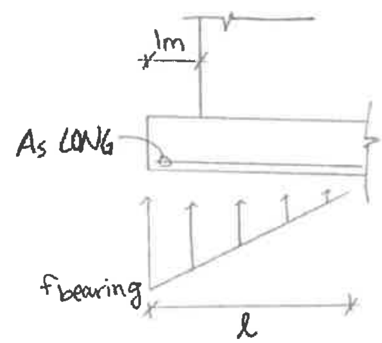
WALL LINE 1 NORTH/SOUTH FOUNDATION DESIGN

Check Footing Shear

$V_{u,LC6}$ ≤	43574	kg
Φ =	0.75	
α =	2	
f'c =	3000	psi
Acv = D*W =	3100	in^2
ΦVc = Φα(f'c^.5)Acv =	254691	lbs
	115526	kg > 43574 kg ***GOOD***

Check for Longitudinal Flexural Reinforcement (Bottom)

x =	4.7	m
l = 3x =	14.0	m
$f_{bearing}$ =	4822	kg/m^2
$P_{triangle}$ =	67344	kg
x_{arm} =	0.34	m
Mu = P*x =	23178	kg-m



Try (6) #5 bars

# of bars =	12	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	3.72	in^2
Fy =	60	ksi
T = AsFy =	223.2	k
a = T / 0.85*f'c*b =	1.11	in
c = a / β =	1.31	in
d =	35.19	in
εt = 0.003(d-c/c) =	0.0777	>>> 0.005 ***STRAIN PASSES***
Φ =	0.9	

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References	Calculations

ACI 318-14

WALL LINE 1 NORTH/SOUTH FOUNDATION DESIGN

$\Phi M_n = \Phi A_s F_y (d - a/2) =$ 6957.2 k-in
80154 kg-m > 23178 kg-m ***GOOD***

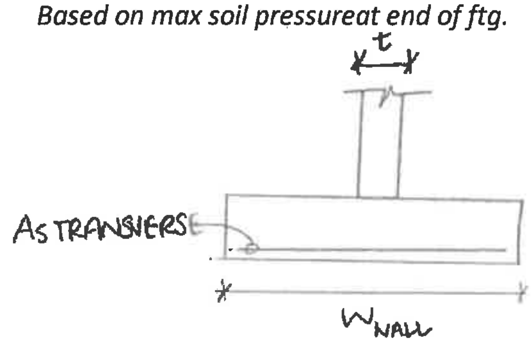
Imperial Equivalent: (6) #5 BARS

SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (B)

Check for Transverse Flexural Reinforcement (Bottom)

wu =	10985	kg/m^2	*Based on max soil pressureat end of ftg.*
l = W / t =	0.875	m	
Mu =	4205	kg-m	



Try #5 bars @ 12" o/c

# of bars =	1	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	0.31	in^2
Fy =	60	ksi
T = AsFy =	18.6	k
a = T / 0.85*f'c*b =	0.61	in
c = a / β =	0.72	in
d =	35.44	in

εt = 0.003(d-c/c) = 0.1457 >>> 0.005 ***STRAIN PASSES***
Φ = 0.9

$\Phi M_n = \Phi A_s F_y (d - a/2) =$ 588.2 k-in
6777 kg-m > 4205 kg-m ***GOOD***

Imperial Equivalent:

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (B)

Journeyman International	Julia De Hart
Rubagabaga Village EVC and ATF	Jenna Williams

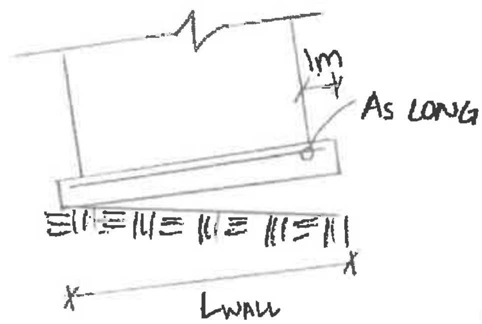
References	Calculations

ACI 318-14

WALL LINE 1 NORTH/SOUTH FOUNDATION DESIGN

Check for Longitudinal Flexural Reinforcement (Top)

wu =	732	kg/m^2	
l =	5	m	
Mu =	4578	kg-m	*Based on ftg. rotating around toe*



Try (6) #5 bars

# of bars =	6			
bar diameter =	0.625	in		
bar area =	0.31	in^2		
cover =	3.00	in		
As =	1.86	in^2		
Fy =	60	ksi		
T = AsFy =	111.6	k		
a = T / 0.85*f'c*b =	0.56	in		
c = a / β =	0.65	in		
d =	35.47	in		
εt = 0.003(d-c/c) =	0.1597	>>> 0.005		***STRAIN PASSES***
Φ =	0.9			
ΦMn = ΦAsFy(d-a/2) =	3534.4	k-in		
	40720	kg-m	> 4578 kg-m	***GOOD***

Imperial Equivalent: (6) #5 BARS

SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (T)

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations

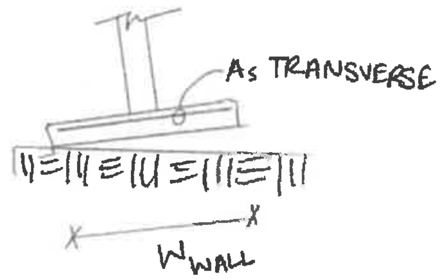
ACI 318-14

WALL LINE 1 NORTH/SOUTH FOUNDATION DESIGN

Check for Transverse Flexural Reinforcement (Top)

wu = 732 kg/m^2
l = 0.875 m
Mu = 280 kg-m

Based on ftg. rotating around toe



Try #5 bars @ 12" o/c

# of bars =	1	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	0.31	in^2
Fy =	60	ksi
T = AsFy =	18.6	k
a = T / 0.85*f'c*b =	0.61	in
c = a / β =	0.72	in
d =	35.44	in
εt = 0.003(d-c/c) =	0.1457	>>> 0.005 — ***STRAIN PASSES***
Φ =	0.9	
ΦMn = ΦAsFy(d-a/2) =	588.2	k-in
	6777	kg-m > 280 kg-m — ***GOOD***

Imperial Equivalent: #5 BARS @ 12" O/C

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (T)

References	Calculations
	WALL LINE 4 NORTH/SOUTH FOUNDATION DESIGN
	Loads:
	P_{DL} = 36998 kg
	P_{LL} = 3125 kg
	V_E = 14414 kg *Based on Wall 6 results*
	Sds = 0.608
ASCE 7-16 12.13.4	Mot = 0.75*0.70*V_E*H_{wall} = 30270 kg-m
	Allowable Soil Bearing Pressure:
IBC TA 1806.2	f_{IBC} = 7324 kg/m^2
	f_{allow} = 1.33*F_{IBC} = 9740 kg/m^2
	Try Footing Size:
	Length = 10 m
	Width = 2 m
	Depth = 1 m
	Wall length = 8 m
	$P_{footing}$ = 48056 kg
	P_{dead} = 36998 kg
	ΣP = 85054 kg
	USE 10m LONG x 2m WIDE x 1m DEEP FTG.

Julia De Hart
Jenna Williams

References	Calculations
	WALL LINE 4 NORTH/SOUTH FOUNDATION DESIGN
	Allowable Stress Design Combinations
ASCE 7-16 2.4.5	Load Case 8: (1.0 + 0.14Sds)D + 0.7E
	ΣP_{LC8} = 102384 kg
	$M_R = \Sigma P * L/2$ = 511920.3 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 4.7 m
	$l = 3x$ = 14.1 m
	$f_{bearing} = 2*\Sigma P / l*w$ 6027 kg/m^2 < 9740 kg/m^2 ***GOOD***
ASCE 7-16 2.4.5	Load Case 9: (1.0 + 0.105Sds)D + 0.525E + 0.75L
	ΣP_{LC9} = 100395 kg
	$M_R = \Sigma P * L/2$ = 501976 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 4.7 m
	$l = 3x$ = 14.1 m
	$f_{bearing} = 2*\Sigma P / l*w$ 7123 kg/m^2 < 9740 kg/m^2 ***GOVERNS, GOOD***
ASCE 7-16 2.4.5	Load Case 10: (1.0 - 0.14Sds)D + 0.7E
	ΣP_{LC10} = 87904 kg
	$M_R = \Sigma P * L/2$ = 439522.1 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 4.7 m
	$l = 3x$ = 14.0 m
	$f_{bearing} = 2*\Sigma P / l*w$ 6294 kg/m^2 < 9740 kg/m^2 ***GOOD***
	Strength Design Combinations
ASCE 7-16 2.3.6	Load Case 6: (1.2 + 0.2Sds)D + E + L
	ΣP_{LC6} = 49294 kg ***GOVERNS***
ASCE 7-16 2.3.6	Load Case7: (0.9-0.2Sds)D + E
	ΣP_{LC7} = 33118 kg

Journeyman International | Julia De Hart
Rubagabaga Village EVC and ATF | Jenna Williams

References	Calculations
ACI 318-14	

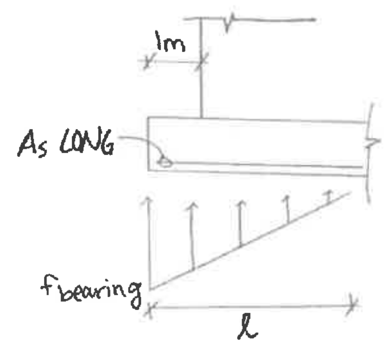
WALL LINE 4 NORTH/SOUTH FOUNDATION DESIGN

Check Footing Shear

$V_{u,LC6} \leq$	49294 kg			
Φ =	0.75			
α =	2			
f'c =	3000 psi			
Acv = D*W =	3100 in^2			
ΦVc = Φα(f'c^.5)Acv =	254691 lbs			
	115526 kg	> 49294 kg		***GOOD***

Check for Longitudinal Flexural Reinforcement (Bottom)

x =	4.7 m
l = 3x =	14.1 m
$f_{bearing}$ =	7123 kg/m^2
$P_{triangle}$ =	100395 kg
x_{arm} =	0.30 m
Mu = P*x =	30270 kg-m



Try (6) #5 bars

# of bars =	12		
bar diameter =	0.625 in		
bar area =	0.31 in^2		
cover =	3.00 in		
As =	3.72 in^2		
Fy =	60 ksi		
T = AsFy =	223.2 k		
a = T / 0.85*f'c*b =	1.11 in		
c = a / β =	1.31 in		
d =	35.19 in		
εt = 0.003(d-c/c) =	0.0777	>>> 0.005	***STRAIN PASSES***
Φ =	0.9		

References	Calculations

ACI 318-14

WALL LINE 4 NORTH/SOUTH FOUNDATION DESIGN

ΦMn = ΦAsFy(d-a/2) =	6957.2	k-in		
	80154	kg-m	> 30270 kg-m	***GOOD***

Imperial Equivalent: (6) #5 BARS

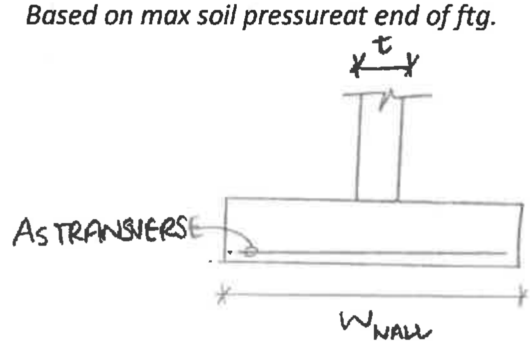
SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (B)

Check for Transverse Flexural Reinforcement (Bottom)

wu =	10985	kg/m^2	*Based on max soil pressureat end of ftg.*
l = W / t =	0.875	m	
Mu =	4205	kg-m	

Try #5 bars @ 12" o/c



# of bars =	1	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	0.31	in^2
Fy =	60	ksi
T = AsFy =	18.6	k
a = T / 0.85*f'c*b =	0.61	in
c = a / β =	0.72	in
d =	35.44	in
εt = 0.003(d-c/c) =	0.1457	>>> 0.005 ***STRAIN PASSES***
Φ =	0.9	

ΦMn = ΦAsFy(d-a/2) =	588.2	k-in		
	6777	kg-m	> 4205 kg-m	***GOOD***

Imperial Equivalent:

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (B)

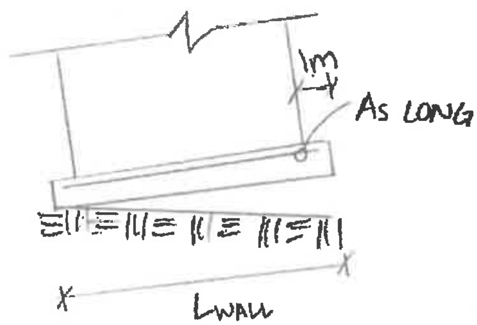
Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations
ACI 318-14	WALL LINE 4 NORTH/SOUTH FOUNDATION DESIGN

Check for Longitudinal Flexural Reinforcement (Top)

wu = 732 kg/m^2
l = 5 m
Mu = 4578 kg-m

Based on ftg. rotating around toe



Try (6) #5 bars

# of bars =	6	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	1.86	in^2
Fy =	60	ksi
T = AsFy =	111.6	k
a = T / 0.85*f'c*b =	0.56	in
c = a / β =	0.65	in
d =	35.47	in
εt = 0.003(d-c/c) =	0.1597	>>> 0.005 ***STRAIN PASSES***
Φ =	0.9	
ΦMn = ΦAsFy(d-a/2) =	3534.4	k-in
	40720	kg-m > 4578 kg-m ***GOOD***

Imperial Equivalent: (6) #5 BARS

SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (T)

Journeyman International	Julia De Hart
Rubagabaga Village EVC and ATF	Jenna Williams

References | **Calculations**

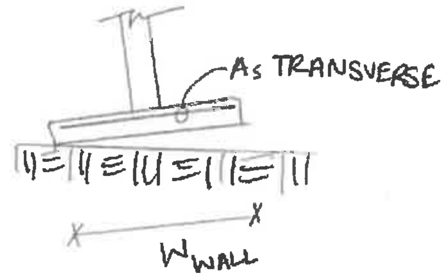
ACI 318-14

WALL LINE 4 NORTH/SOUTH FOUNDATION DESIGN

Check for Transverse Flexural Reinforcement (Top)

wu =	732	kg/m^2
l =	0.875	m
Mu =	280	kg-m

Based on ftg. rotating around toe



Try #5 bars @ 12" o/c

# of bars =	1	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	0.31	in^2
Fy =	60	ksi
T = AsFy =	18.6	k
a = T / 0.85*f'c*b =	0.61	in
c = a / β =	0.72	in
d =	35.44	in
εt = 0.003(d-c/c) =	0.1457	>>> 0.005	***STRAIN PASSES***
Φ =	0.9	
ΦMn = ΦAsFy(d-a/2) =	588.2	k-in
	6777	kg-m	> 280 kg-m	***GOOD***

Imperial Equivalent: #5 BARS @ 12" O/C

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (T)

Julia De Hart
Jenna Williams

References	Calculations
	WALL LINE 6 NORTH/SOUTH FOUNDATION DESIGN
	Loads:
	P_{DL} = 36998 kg
	P_{LL} = 3125 kg
	V_E = 15540 kg *Based on Wall 7 results*
	Sds = 0.608
ASCE 7-16 12.13.4	$M_{ot} = 0.75*0.70*V_E*H_{wall}$ = 32634 kg-m
	Allowable Soil Bearing Pressure:
IBC TA 1806.2	f_{IBC} = 7324 kg/m^2
	$f_{allow} = 1.33*F_{IBC}$ = 9740 kg/m^2
	Try Footing Size:
	Length = 6 m
	Width = 2 m
	Depth = 1 m
	Wall length = 4 m
	$P_{footing}$ = 28834 kg
	P_{dead} = 36998 kg
	ΣP = 65832 kg
	USE 6m LONG x 2m WIDE x 1m DEEP FTG.

References	Calculations

WALL LINE 6 NORTH/SOUTH FOUNDATION DESIGN

Allowable Stress Design Combinations

ASCE 7-16 2.4.5

Load Case 8: (1.0 + 0.14Sds)D + 0.7E

ΣP_{LC8} =	82313	kg
$M_R = \Sigma P * L/2$ =	246940.3	kg
$x = (M_R - M_{OT}) / \Sigma P$ =	2.6	m
$l = 3x$ =	7.8	m

$f_{bearing} = 2*\Sigma P / l*w$ 8429 kg/m^2 < 9740 kg/m^2 ***GOOD***

ASCE 7-16 2.4.5

Load Case 9: (1.0 + 0.105Sds)D + 0.525E + 0.75L

ΣP_{LC9} =	80537	kg
$M_R = \Sigma P * L/2$ =	241610	kg
$x = (M_R - M_{OT}) / \Sigma P$ =	2.6	m
$l = 3x$ =	7.8	m

$f_{bearing} = 2*\Sigma P / l*w$ 10346 kg/m^2 < 9740 kg/m^2 ***GOVERNS, GOOD***

ASCE 7-16 2.4.5

Load Case 10: (1.0 - 0.14Sds)D + 0.7E

ΣP_{LC10} =	71106	kg
$M_R = \Sigma P * L/2$ =	213318.7	kg
$x = (M_R - M_{OT}) / \Sigma P$ =	2.5	m
$l = 3x$ =	7.6	m

$f_{bearing} = 2*\Sigma P / l*w$ 9328 kg/m^2 < 9740 kg/m^2 ***GOOD***

Strength Design Combinations

ASCE 7-16 2.3.6

Load Case 6: (1.2 + 0.2Sds)D + E + L

ΣP_{LC6} = 37718 kg ***GOVERNS***

ASCE 7-16 2.3.6

Load Case7: (0.9-0.2Sds)D + E

ΣP_{LC7} = 26762 kg

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations

ACI 318-14

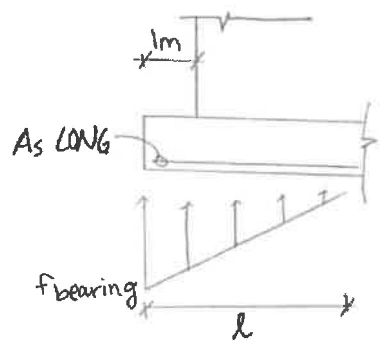
WALL LINE 6 NORTH/SOUTH FOUNDATION DESIGN

Check Footing Shear

$V_{u,LC6} \leq$	37718 kg			
Φ =	0.75			
α =	2			
f'c =	3000 psi			
Acv = D*W =	3100 in^2			
ΦVc = $\Phi\alpha$(f'c^.5)Acv =	254691 lbs			
	115526 kg	> 37718 kg		***GOOD***

Check for Longitudinal Flexural Reinforcement (Bottom)

x =	2.6 m
l = 3x =	7.8 m
$f_{bearing}$ =	10346 kg/m^2
$P_{triangle}$ =	80537 kg
x_{arm} =	0.41 m
Mu = P*x =	32634 kg-m



Try (6) #5 bars

# of bars =	12		
bar diameter =	0.625 in		
bar area =	0.31 in^2		
cover =	3.00 in		
As =	3.72 in^2		
Fy =	60 ksi		
T = AsFy =	223.2 k		
a = T / 0.85*f'c*b =	1.11 in		
c = a / β =	1.31 in		
d =	35.19 in		
ε_t = 0.003(d-c/c) =	0.0777	>>> 0.005	***STRAIN PASSES***
Φ =	0.9		

Journeyman International	Julia De Hart
Rubagabaga Village EVC and ATF	Jenna Williams

References	Calculations
ACI 318-14	

WALL LINE 6 NORTH/SOUTH FOUNDATION DESIGN

ΦMn = ΦAsFy(d-a/2) = 6957.2 k-in
80154 kg-m > 32634 kg-m ***GOOD***

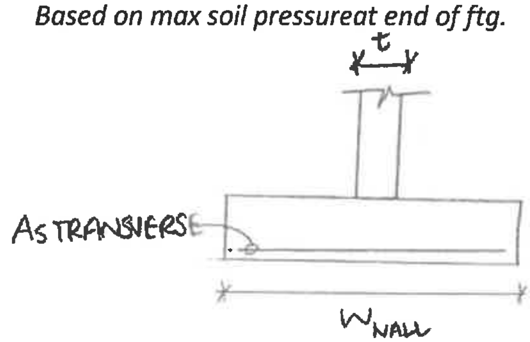
Imperial Equivalent: (6) #5 BARS

SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (B)

Check for Transverse Flexural Reinforcement (Bottom)

wu =	10985	kg/m^2	*Based on max soil pressureat end of ftg.*
l = W / t =	0.875	m	
Mu =	4205	kg-m	



Try #5 bars @ 12" o/c

# of bars =	1	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	0.31	in^2
Fy =	60	ksi
T = AsFy =	18.6	k
a = T / 0.85*f'c*b =	0.61	in
c = a / β =	0.72	in
d =	35.44	in

εt = 0.003(d-c/c) = 0.1457 >>> 0.005 ***STRAIN PASSES***
Φ = 0.9

ΦMn = ΦAsFy(d-a/2) = 588.2 k-in
6777 kg-m > 4205 kg-m ***GOOD***

Imperial Equivalent: #5 BARS @12" O/C

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (B)

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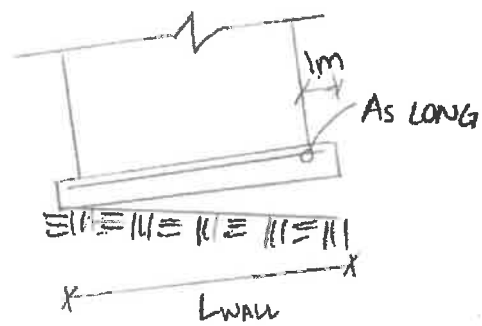
References	Calculations
ACI 318-14	WALL LINE 6 NORTH/SOUTH FOUNDATION DESIGN

Check for Longitudinal Flexural Reinforcement (Top)

wu =	732	kg/m^2	
l =	3	m	
Mu =	1648	kg-m	*Based on ftg. rotating around toe*



Try (6) #5 bars

# of bars =	6	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	1.86	in^2
Fy =	60	ksi
T = AsFy =	111.6	k
a = T / 0.85*f'c*b =	0.56	in
c = a / β =	0.65	in
d =	35.47	in

εt = 0.003(d-c/c) =	0.1597 >>> 0.005		***STRAIN PASSES***
Φ =	0.9		
ΦMn = ΦAsFy(d-a/2) =	3534.4 k-in		
	40720 kg-m	> 1648 kg-m	***GOOD***

Imperial Equivalent: (6) #5 BARS

SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (T)

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations

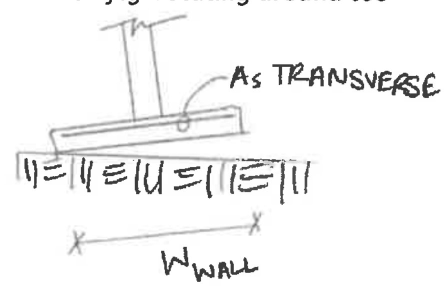
ACI 318-14

WALL LINE 6 NORTH/SOUTH FOUNDATION DESIGN

Check for Transverse Flexural Reinforcement (Top)

wu = 732 kg/m^2
l = 0.875 m
Mu = 280 kg-m

Based on ftg. rotating around toe



Try #5 bars @ 12" o/c

# of bars =	1	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	0.31	in^2
Fy =	60	ksi
T = AsFy =	18.6	k
a = T / 0.85*f'c*b =	0.61	in
c = a / β =	0.72	in
d =	35.44	in
εt = 0.003(d-c/c) =	0.1457	>>> 0.005 — ***STRAIN PASSES***
Φ =	0.9	
ΦMn = ΦAsFy(d-a/2) =	588.2	k-in
	6777	kg-m > 280 kg-m — ***GOOD***

Imperial Equivalent: #5 BARS @ 12" O/C

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (T)

References	Calculations
	WALL LINE 7 NORTH/SOUTH FOUNDATION DESIGN
	Loads:
	P_{DL} = 55497 kg
	P_{LL} = 4687 kg
	V_E = 33331 kg — *Based on Wall 8 and Wall 9 results*
	Sds = 0.608
ASCE 7-16 12.13.4	$M_{ot} = 0.75*0.70*V_E*H_{wall}$ = 69996 kg-m
	Allowable Soil Bearing Pressure:
IBC TA 1806.2	f_{IBC} = 7324 kg/m^2
	$f_{allow} = 1.33*F_{IBC}$ = 9740 kg/m^2
	Try Footing Size:
	Length = 14 m
	Width = 2 m
	Depth = 1 m
	Wall length = 12 m
	$P_{footing}$ = 67278 kg
	P_{dead} = 55497 kg
	ΣP = 122776 kg
	USE 14m LONG x 2m WIDE x 1m DEEP FTG.

Julia De Hart
Jenna Williams

References	Calculations
	WALL LINE 7 NORTH/SOUTH FOUNDATION DESIGN
	Allowable Stress Design Combinations
ASCE 7-16 2.4.5	Load Case 8: (1.0 + 0.14Sds)D + 0.7E
	ΣP_{LC8} = 156558 kg
	$M_R = \Sigma P * L/2$ = 1095909 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 6.6 m
	l = 3x = 19.7 m
	$f_{bearing} = 2*\Sigma P / l*w$ 6245 kg/m^2 < 9740 kg/m^2 ***GOOD***
ASCE 7-16 2.4.5	Load Case 9: (1.0 + 0.105Sds)D + 0.525E + 0.75L
	ΣP_{LC9} = 151628 kg
	$M_R = \Sigma P * L/2$ = 1061396 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 6.5 m
	l = 3x = 19.6 m
	$f_{bearing} = 2*\Sigma P / l*w$ 7730 kg/m^2 < 9740 kg/m^2 ***GOVERNS, GOOD***
ASCE 7-16 2.4.5	Load Case 10: (1.0 - 0.14Sds)D + 0.7E
	ΣP_{LC10} = 135657 kg
	$M_R = \Sigma P * L/2$ = 949599.4 kg
	$x = (M_R - M_{OT}) / \Sigma P$ = 6.5 m
	l = 3x = 19.5 m
	$f_{bearing} = 2*\Sigma P / l*w$ 6974 kg/m^2 < 9740 kg/m^2 ***GOOD***
	Strength Design Combinations
ASCE 7-16 2.3.6	Load Case 6: (1.2 + 0.2Sds)D + E + L
	ΣP_{LC6} = 82476 kg ***GOVERNS***
ASCE 7-16 2.3.6	Load Case7: (0.9-0.2Sds)D + E
	ΣP_{LC7} = 59516 kg

Journeyman International
Rubagabaga Village EVC and ATF
Julia De Hart
Jenna Williams

References	Calculations

ACI 318-14

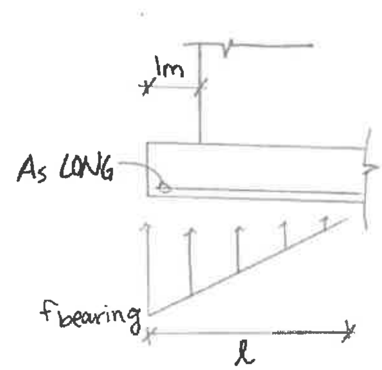
WALL LINE 7 NORTH/SOUTH FOUNDATION DESIGN

Check Footing Shear

$V_{u,LC6} \leq$	82476 kg		
Φ =	0.75		
α =	2		
f'c =	3000 psi		
Acv = D*W =	3100 in^2		
ΦVc = Φα(f'c^.5)Acv =	254691 lbs		
	115526 kg	> 82476 kg	***GOOD***

Check for Longitudinal Flexural Reinforcement (Bottom)

x =	6.5 m
l = 3x =	19.6 m
$f_{bearing}$ =	7730 kg/m^2
$P_{triangle}$ =	151628 kg
x_{arm} =	0.46 m
Mu = P*x =	69996 kg-m



Try (6) #5 bars

# of bars =	12		
bar diameter =	0.625 in		
bar area =	0.31 in^2		
cover =	3.00 in		
As =	3.72 in^2		
Fy =	60 ksi		
T = AsFy =	223.2 k		
a = T / 0.85*f'c*b =	1.11 in		
c = a / β =	1.31 in		
d =	35.19 in		
εt = 0.003(d-c/c) =	0.0777	>>> 0.005	***STRAIN PASSES***
Φ =	0.9		

References	Calculations
ACI 318-14	WALL LINE 7 NORTH/SOUTH FOUNDATION DESIGN

ΦMn = ΦAsFy(d-a/2) =	6957.2	k-in		
	80154	kg-m	> 69996 kg-m	***GOOD***

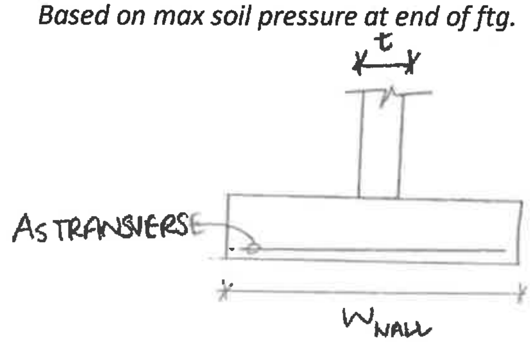
Imperial Equivalent: (6) #5 BARS

SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (B)

Check for Transverse Flexural Reinforcement (Bottom)

wu =	10985	kg/m^2	*Based on max soil pressure at end of ftg.*
l = W / t =	0.875	m	
Mu =	4205	kg-m	



Try #5 bars @ 12" o/c

# of bars =	1	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	0.31	in^2
Fy =	60	ksi
T = AsFy =	18.6	k
a = T / 0.85*f'c*b =	0.61	in
c = a / β =	0.72	in
d =	35.44	in

εt = 0.003(d-c/c) =	0.1457	>>> 0.005	***STRAIN PASSES***
Φ =	0.9		

ΦMn = ΦAsFy(d-a/2) =	588.2	k-in		
	6777	kg-m	> 4205 kg-m	***GOOD***

Imperial Equivalent: #5 BARS @12" O/C

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (B)

References | Calculations

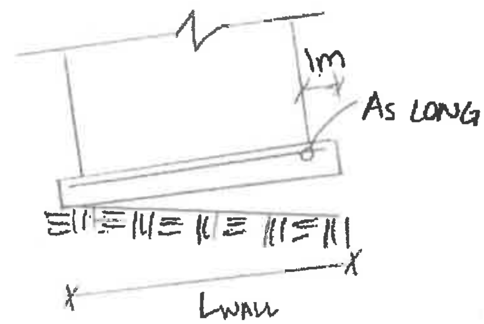
ACI 318-14

WALL LINE 7 NORTH/SOUTH FOUNDATION DESIGN

Check for Longitudinal Flexural Reinforcement (Top)

wu = 732 kg/m^2
l = 7 m
Mu = 8972 kg-m

Based on ftg. rotating around toe



Try (6) #5 bars

# of bars = 6
bar diameter = 0.625 in
bar area = 0.31 in^2
cover = 3.00 in

As = 1.86 in^2
Fy = 60 ksi
T = AsFy = 111.6 k

a = T / 0.85*f'c*b = 0.56 in
c = a / β = 0.65 in
d = 35.47 in

εt = 0.003(d-c/c) = 0.1597 >>> 0.005 ***STRAIN PASSES***
Φ = 0.9

ΦMn = ΦAsFy(d-a/2) = 3534.4 k-in
40720 kg-m > 8972 kg-m ***GOOD***

Imperial Equivalent: (6) #5 BARS

SI Equivalent:

USE (6) 16mm BARS LONGITUDINAL (T)

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

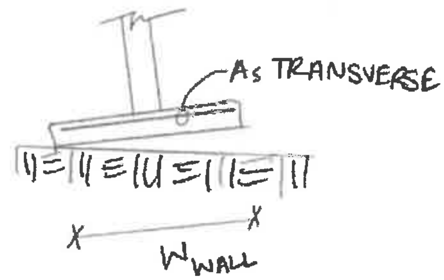
References	Calculations

ACI 318-14

WALL LINE 7 NORTH/SOUTH FOUNDATION DESIGN

Check for Transverse Flexural Reinforcement (Top)

wu =	732	kg/m^2	
l =	0.875	m	
Mu =	280	kg-m	*Based on ftg. rotating around toe*



Try #5 bars @ 12" o/c

# of bars =	1			
bar diameter =	0.625	in		
bar area =	0.31	in^2		
cover =	3.00	in		
As =	0.31	in^2		
Fy =	60	ksi		
T = AsFy =	18.6	k		
a = T / 0.85*f'c*b =	0.61	in		
c = a / β =	0.72	in		
d =	35.44	in		
εt = 0.003(d-c/c) =	0.1457	>>> 0.005		***STRAIN PASSES***
Φ =	0.9			
ΦMn = ΦAsFy(d-a/2) =	588.2	k-in		
	6777	kg-m	> 280 kg-m	***GOOD***

Imperial Equivalent: #5 BARS @ 12" O/C

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (T)

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

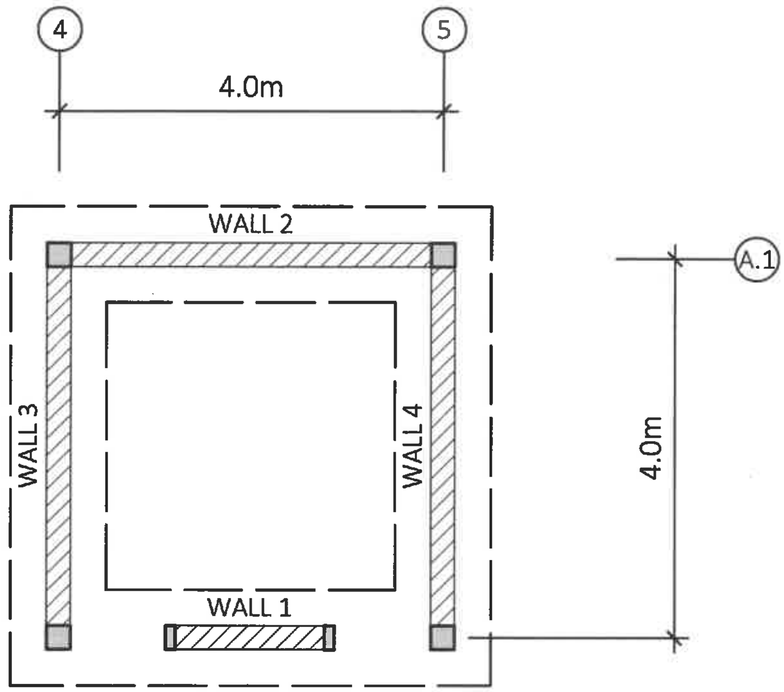
References | **Calculations**

RESTROOM LOAD TAKE OFF

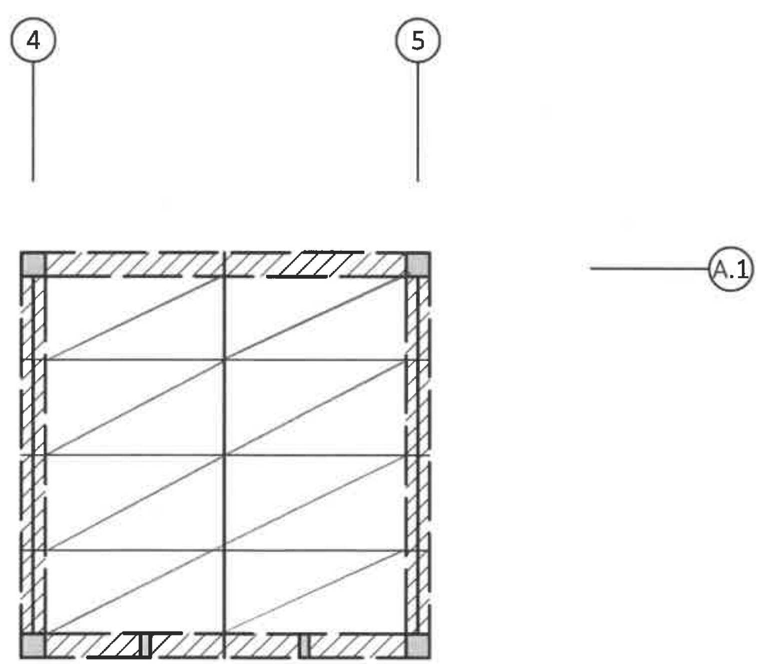
		WEIGHT (PSF)	WEIGHT(kg/m^2)
DEAD LOAD			
METAL DECKING		0.50	2.44
BAMBOO WEAVE CEILING		0.50	2.44
MISC.		2.00	9.76
	TOTAL TO PURLINS:	3.00	14.65
PURLINS		2.08	10.16
	TOTAL TO TRUSSES:	5.08	24.81
WOOD TRUSSES		11.18	54.60
	TOTAL TO COLUMNS AND WALLS:	16.26	79.41
CONCRETE COLUMNS		3.85	18.77
MASONRY WALLS		246.16	1201.50
	TOTAL TO FOUNDATION:	266.26	1300.00

	WEIGHT (PSF)	WEIGHT(kg/m^2)
LIVE LOAD		
ROOF	20.00	97.65

TOTAL AREA 96 m^2



RESTROOM FOUNDATION KEY PLAN
N.T.S.



RESTROOM FRAMING KEY PLAN
N.T.S.

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations

RESTROOM DECKING DESIGN

DECKING TO MATCH DECKING IN EVC AND ATF

Loads to decking in Restroom are equal to the loads to decking in ATF

USE EVC AND ATF DECKING DESIGN

RESTROOM PURLIN DESIGN

PURLINS TO MATCH PURLINS IN EVC AND ATF

Loads to purlins in Restroom are equal to the loads to purlins in ATF

USE EVC AND ATF PURLIN DESIGN

RESTROOM TRUSS DESIGN

TRUSS TO MATCH TRUSS B FROM ATF

Loads to truss in Restroom are equal to the loads to truss in ATF

USE ATF TRUSS B DESIGN

References	Calculations
	SLAB ON GRADE DESIGN - RESTROOM Slab on grade to be constructed by typical slab on grade construction and minimum reinforcing: Imperial Equivalent: 5" thick slab with #3 @18" o/c each way SI Equivalent: USE 125mm THICK SLAB w/ 10mm REINFORCING BARS @ 0.4m EACH WAY

Journeyman International | Julia De Hart
Rubagabaga Village EVC and ATF | Jenna Williams

References | Calculations

ASCE 7-16

SEISMIC LOAD CALCULATIONS - RESTROOMS

SEISMIC INPUT VALUES

S_{DS} = 0.608 g

R = 1

SEISMIC WEIGHT - RESTROOMS

ITEM	psf	kg/m^2	Trib Area (m)		kg
Ceiling	3.0	14.6	16		234.4
Purlins	2.1	10.2	16		162.5
Truss B	11.2	54.6	4	4	873.4
Walls (10")	125	610.3	16	2	19529.7
				TOTAL	20800 kg

W = 20800 kg 45.86 kips

BASE SHEAR

V = CsW

Cs = 0.608

V = 12646 kg 27.88 kips

References	Calculations

RESTROOM DIAPHRAGM DESIGN

DIAPHRAGM TO MATCH DIAPHRAGM IN EVC AND ATF

Lateral loads to EVC and ATF are larger than lateral loads to the Restroom

USE EVC AND ATF DIAPHRAGM DESIGN *conservative*

Journeyman International
Rubagabaga Village EVC and ATF
Julia De Hart
Jenna Williams

References	Calculations
Confined Masonry Design Guide	

CONFINED MASONRY WALL DESIGN - RESTROOM

Performance Objective: Life Safety

Lateral Wall Density

Required Wall Density = 1.0% for following conditions:

Low Seismic Hazard	PGA = 0.06g ≤ 0.08g
n = 1	1 story building
Solid Clay Bricks	handmade, Mortar Type III conservatively
Soil Type C	Soft clay soil

N/S Direction

Assume 2 wythes of 120mm brick

Floor area	Ap =	16.00 m^2		
Wall area	Aw =	2.00 m^2		
Wall density	d = Aw / Ap =	12.50 %	> 1.0 %	***GOOD***

E/W Direction

Assume 2 wythes of 120mm brick

Floor area	Ap =	16.00 m^2		
Wall area	Aw =	1.00 m^2		
Wall density	d = Aw / Ap =	6.25 %	> 1.0 %	***GOOD***

Gravity Wall Density

Strength Reduction Factor	Fr =	0.6
Gravity Load Factor	Fc =	1.4
Safety Factor	Fs = Fc / Fr =	2.33

Compressive Strength, σR

Eccentricty/Slenderness Factor	Fe =	0.7	for interior walls
Masonry Comp Strength	f'm =	15 kg/cm^2	

σR = Fe (f'm + 4) = 13.3 kg/cm^2

Julia De Hart
Jenna Williams

References	Calculations
Confined Masonry Design Guide	

CONFINED MASONRY WALL DESIGN - RESTROOM

Wall Density Index, Σd ≥ Fc (n*w) / σR

Weight	w =	83.22 kg/m^2		
Stories	n =	1		
For both directions:				
	Fc (n*w) / σR =	0.876 %		
	Σd = ΣAw/Ap =	18.75 %	> 0.876 %	***GOOD***
For one direction:				
	Fc (n*w) / σR =	0.438 %		
	Σd = ΣAw/Ap =	6.25 %	> 0.438 %	***GOOD***

Wall Distance/Thickness Ratio, B/t ≤ σR/(Fs*D*w)

Distance	B =	4 m		
Thickness	t =	0.250 m		
	B/t =	16.0		
	D =	1.0		
	σR/(Fs*D*w) =	684.93	> 16.7	***GOOD***

Conclusion

Provided confined masonry walls are sufficient

References	Calculations
Confined Masonry Design Guide	

CONFINED MASONRY WALL DESIGN - RESTROOM

TIE-COLUMN DESIGN

Spacing

Maximum spacing of tie-columns shall not exceed 6m

Smax = 4 m < 6m ***GOOD***

Minimum Dimensions

Minimum depth x width of a tie-column 150mm x t

t = 250 mm

Tie-Columns shall be 250mm x 250mm > 150mm x 250mm ***GOOD***

Reinforcing

Longitudinal

Minimum 4 deformed reinforcing bars of minimum 10-mm diameter

Reinforcing shall be (4) 13-mm diameter bars ***GOOD***

Tie Sizing and Spacing

Minimum 6-mm diameter bars with 135° hooked ends

Tie spacing cannot exceed 200mm with minimum 20mm cover

Ties shall be 10-mm diameter transverse stirrups, spaced at 200m, with 50mm cover ***GOOD***

Julia De Hart
Jenna Williams

References	Calculations
Confined Masonry Design Guide	**CONFINED MASONRY WALL DESIGN - RESTROOM**

CONFINED MASONRY WALL DESIGN - RESTROOM

TIE-BEAM DESIGN

Spacing

Tie-beams shall be provided at the top of each wall, and above and below each window opening — ***GOOD***

Minimum Dimensions

Minimum depth x width of a tie-beam 150mm x t

t = 250 mm

Tie-Beams shall be 250mm x 250mm > 150mm x 250mm — ***GOOD***

Reinforcing

Longitudinal

Minimum 4 deformed reinforcing bars of minimum 10-mm diameter

To ensure the effectiveness of tie-beams in resisting earthquake loads longitudinal bars should have a 90° hooked anchorage at intersections

Reinforcing shall be (4) 13-mm diameter bar, with 90° hooked anchorage at intersections — ***GOOD***

Tie Sizing and Spacing

Minimum 6-mm diameter bars with 135° hooked ends

Tie spacing cannot exceed 200mm with minimum 20mm cover

Ties shall be 10-mm diameter transverse stirrups, spaced at 200m, with 50mm cover — ***GOOD***

Journeyman International
Rubagabaga Village EVC and ATF
Julia De Hart
Jenna Williams

References	Calculations

SEISMIC LOAD DISTRIBUTION - RESTROOM

WALL	DIRECTION	L (m)	H/L	Rc	origin dist.	d(m)	Rd	Rd^2
1	X	2	2.00	0.263	0	-9.38	-2.47	23.14
2	X	4	1.00	1.429	4	-5.38	-7.69	41.36
3	Y	4	1.00	1.429	0	-9.38	-13.40	125.73
4	Y	4	1.00	1.429	4	-5.38	-7.69	41.36
							Σ	231.59

Xcm =	2 m	Xcr =	2.00 m
Ycm =	2 m	Ycr =	3.38 m

EAST/WEST (X)

			DIRECT SHEAR	TORSION SHEAR	WALL FORCE
ex = 0.05*16m =	0.20 m				
e = (Xcm-Xcr) + ex =	0.20 m				
Vbase =	12646 kg	V1 =	983	-27	956 kg
Mtor =	2529 kg-m	V2 =	29977	-84	29893 kg

Largest East/West Force: 29893 kg

NORTH/SOUTH (Y)

			DIRECT SHEAR	TORSION SHEAR	WALL FORCE
ey = 0.05*20m =	0.20 m				
e = (Ycm-Ycr) + ey =	-1.18 m				
Vbase =	12646 kg-m	V3 =	5340	862	6203 kg
Mtor =	-14900 kg-m	V4 =	29977	495	30472 kg

Largest North/South Force: 30472 kg

Journeyman International	Julia De Hart
Rubagabaga Village EVC and ATF	Jenna Williams

References	Calculations
	RESTROOM WALL FOUNDATION DESIGN
	Loads:
	P_{DL} = 9250 kg
	P_{LL} = 781 kg
	V_E = 30472 kg — *Based on Largest Wall Force, Wall 4*
	Sds = 0.608
ASCE 7-16 12.13.4	$M_{ot} = 0.75*0.70*V_E*H_{wall}$ = 63990 kg-m
	Allowable Soil Bearing Pressure:
IBC TA 1806.2	f_{IBC} = 7324 kg/m^2
	$f_{allow} = 1.33*F_{IBC}$ = 9740 kg/m^2
	Try Footing Size:
	Length = 6 m
	Width = 1 m
	Depth = 1 m
	Wall length = 4 m
	$P_{footing}$ = 14417 kg
	P_{dead} = 9250 kg
	ΣP = 23666 kg
	USE 6m LONG x 2m WIDE x 1m DEEP FTG.

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations

RESTROOM WALLS FOUNDATION DESIGN

Allowable Stress Design Combinations

ASCE 7-16 2.4.5

Load Case 8: (1.0 + 0.14Sds)D + 0.7E

ΣP_{LC8} =	47011	kg		
$M_R = \Sigma P * L/2$ =	141032.7	kg		
$x = (M_R - M_{OT}) / \Sigma P$ =	1.6	m		
l = 3x =	4.9	m		
$f_{bearing} = 2*\Sigma P / l*w$	9627	kg/m^2	< 9740 kg/m^2	***GOOD***

ASCE 7-16 2.4.5

Load Case 9: (1.0 + 0.105Sds)D + 0.525E + 0.75L

ΣP_{LC9} =	41761	kg		
$M_R = \Sigma P * L/2$ =	125282	kg		
$x = (M_R - M_{OT}) / \Sigma P$ =	1.5	m		
l = 3x =	4.4	m		
$f_{bearing} = 2*\Sigma P / l*w$	18969	kg/m^2	< 9740 kg/m^2	***GOVERNS, GOOD***

ASCE 7-16 2.4.5

Load Case 10: (1.0 - 0.14Sds)D + 0.7E

ΣP_{LC10} =	42982	kg		
$M_R = \Sigma P * L/2$ =	128945.9	kg		
$x = (M_R - M_{OT}) / \Sigma P$ =	1.5	m		
l = 3x =	4.5	m		
$f_{bearing} = 2*\Sigma P / l*w$	18961	kg/m^2	< 9740 kg/m^2	***GOOD***

Strength Design Combinations

ASCE 7-16 2.3.6

Load Case 6: (1.2 + 0.2Sds)D + E + L

ΣP_{LC6} = 40779 kg ***GOVERNS***

ASCE 7-16 2.3.6

Load Case7: (0.9-0.2Sds)D + E

ΣP_{LC7} = 36083 kg

References	Calculations
ACI 318-14	

RESTROOM WALLS FOUNDATION DESIGN

Check Footing Shear

$V_{u,LC6} \le$ 40779 kg

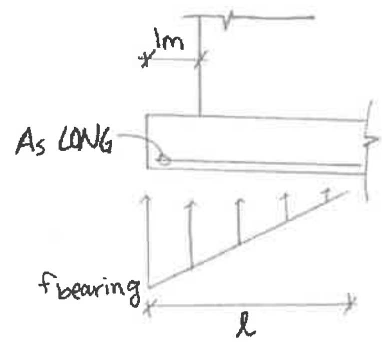
Φ = 0.75
α = 2
f'c = 3000 psi
Acv = D*W = 1550 in^2

ΦVc = Φα(f'c^.5)Acv = 127345 lbs
57763 kg > 40779 kg ***GOOD***

Check for Longitudinal Flexural Reinforcement (Bottom)

x = 1.5 m
l = 3x = 4.4 m
$f_{bearing}$ = 18969 kg/m^2

$P_{triangle}$ = 41761 kg
x_{arm} = 1.53 m
Mu = P*x = 63990 kg-m



Try (6) #5 bars

\# of bars = 12
bar diameter = 0.625 in
bar area = 0.31 in^2
cover = 3.00 in

As = 3.72 in^2
Fy = 60 ksi
T = AsFy = 223.2 k

a = T / 0.85*f'c*b = 2.22 in
c = a / β = 2.62 in
d = 34.63 in

εt = 0.003(d-c/c) = 0.0367 >>> 0.005 ***STRAIN PASSES***
Φ = 0.9

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References	Calculations

ACI 318-14

RESTROOM WALLS FOUNDATION DESIGN

ΦMn = ΦAsFy(d-a/2) = 6733.9 k-in
77581 kg-m > 63990 kg-m ***GOOD***

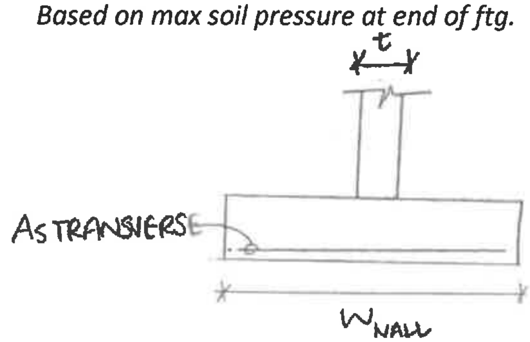
Imperial Equivalent: (4) #5 BARS

SI Equivalent:

USE (4) 16mm BARS LONGITUDINAL (B)

Check for Transverse Flexural Reinforcement (Bottom)

wu = 10985 kg/m^2 *Based on max soil pressure at end of ftg.*
l = W / t = 0.375 m
Mu = 772 kg-m



Try #5 bars @ 12" o/c

# of bars =	1	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	0.31	in^2
Fy =	60	ksi
T = AsFy =	18.6	k
a = T / 0.85*f'c*b =	0.61	in
c = a / β =	0.72	in
d =	35.44	in

εt = 0.003(d-c/c) = 0.1457 >>> 0.005 ***STRAIN PASSES***
Φ = 0.9

ΦMn = ΦAsFy(d-a/2) = 588.2 k-in
6777 kg-m > 772 kg-m ***GOOD***

Imperial Equivalent: #5 BARS @ 12" O/C

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (B)

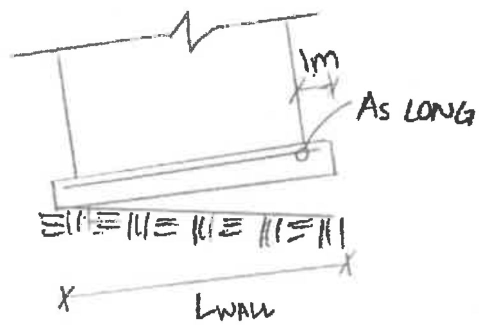
Journeyman International	Julia De Hart
Rubagabaga Village EVC and ATF	Jenna Williams

References	Calculations
ACI 318-14	

RESTROOM WALLS FOUNDATION DESIGN

Check for Longitudinal Flexural Reinforcement (Top)

wu = 732 kg/m^2
l = 3 m
Mu = 3296 kg-m — *Based on ftg. rotating around toe*



Try (6) #5 bars

# of bars =	6	
bar diameter =	0.625	in
bar area =	0.31	in^2
cover =	3.00	in
As =	1.86	in^2
Fy =	60	ksi
T = AsFy =	111.6	k
a = T / 0.85*f'c*b =	1.11	in
c = a / β =	1.31	in
d =	35.19	in
εt = 0.003(d-c/c) =	0.0777	>>> 0.005 — ***STRAIN PASSES***
Φ =	0.9	
ΦMn = ΦAsFy(d-a/2) =	3478.6	k-in
	40077	kg-m > 3296 kg-m — ***GOOD***

Imperial Equivalent: (4) #5 BARS

SI Equivalent:

USE (4) 16mm BARS LONGITUDINAL (T)

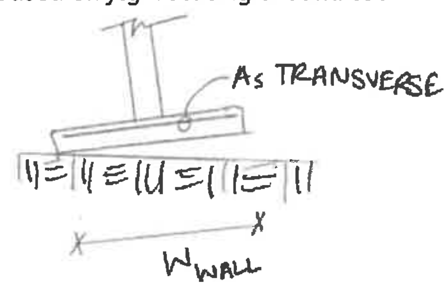
Journeyman International	Julia De Hart
Rubagabaga Village EVC and ATF	Jenna Williams

References	Calculations
ACI 318-14	RESTROOM WALLS FOUNDATION DESIGN

Check for Transverse Flexural Reinforcement (Top)

wu =	732	kg/m^2
l =	0.375	m
Mu =	51	kg-m

Based on ftg. rotating around toe



Try #5 bars @ 12" o/c

# of bars =	1			
bar diameter =	0.625	in		
bar area =	0.31	in^2		
cover =	3.00	in		
As =	0.31	in^2		
Fy =	60	ksi		
T = AsFy =	18.6	k		
a = T / 0.85*f'c*b =	0.61	in		
c = a / β =	0.72	in		
d =	35.44	in		
εt = 0.003(d-c/c) =	0.1457	>>> 0.005		***STRAIN PASSES***
Φ =	0.9			
ΦMn = ΦAsFy(d-a/2) =	588.2	k-in		
	6777	kg-m	> 51 kg-m	***GOOD***

Imperial Equivalent: #5 BARS @ 12" O/C

SI Equivalent:

USE 16mm BARS @ 0.3m O/C TRANSVERSE (T)

Journeyman International	Julia De Hart
Rubagabaga Village EVC and ATF	Jenna Williams

References	Calculations

TRUSS TO WALL CONNECTION

Design for out-of-plane wall loads

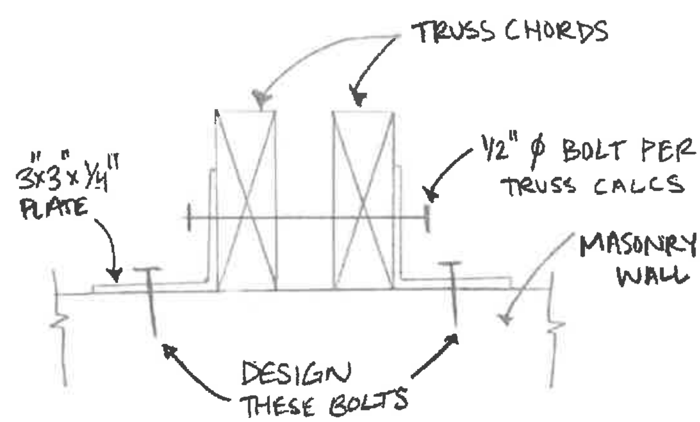
$F_p = 0.8*S_{ds}*I_e*W_p$

S_{ds} = 0.608 g
I_e = 1
$W_p = W_{pcf}*t_{wall}*S_{truss}*h_{wall}$

Wall thickness,	t_{wall} =	250	mm
Truss spacing,	S_{truss} =	2	m
Wall height,	h_{wall} =	4	m

W_p = 2403 kg

F_p = 1169 kg



Bolt Design

Try (2) 1/2" diameter A307 bolts

References					
AISC 360 TA 7-1	$V = \Phi r_n$ =	8.29 k			
	$V_{2\ bolts}$ =	16.58 k			
		7521 kg	> 1169 kg	***GOOD***	

USE EQUIVALENT OF (2) 1/2" DIAMETER A307 BOLTS

Journeyman International
Rubagabaga Village EVC and ATF

Julia De Hart
Jenna Williams

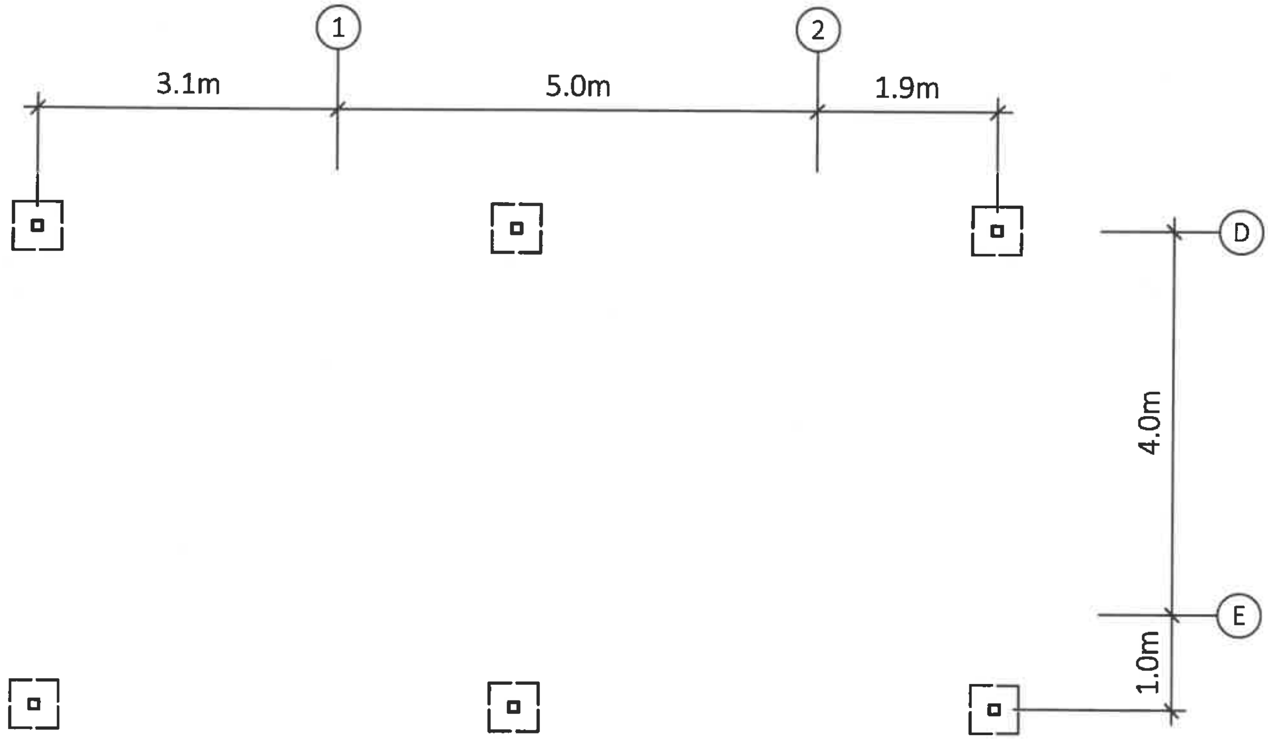
References | Calculations

STEEL CANOPY LOAD TAKE OFF

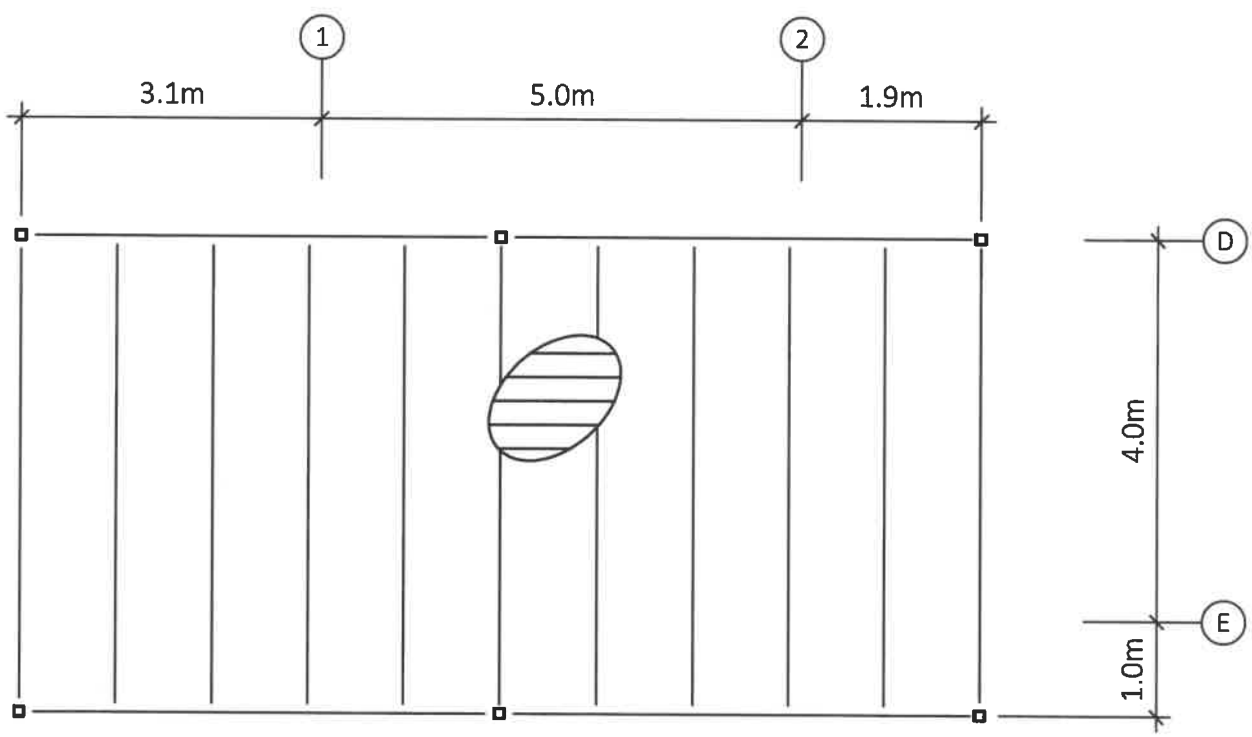
	WEIGHT (PSF)	WEIGHT(kg/m^2)
DEAD LOAD		
METAL DECKING	0.50	2.44
MISC.	1.00	4.88
TOTAL TO HSS BEAMS:	1.50	7.32
HSS BEAMS	1.65	8.05
TOTAL TO HSS GIRDERS:	3.15	15.37
HSS GIRDERS	3.52	17.21
TOTAL TO COLUMNS:	6.67	32.58
HSS COLUMNS	0.98	4.77
TOTAL TO FOUNDATION:	7.65	37.35

	WEIGHT (PSF)	WEIGHT(kg/m^2)
LIVE LOAD		
ROOF	20.00	97.65

TOTAL AREA 16 m^2



STEEL CANOPY FOUNDATION KEY PLAN
N.T.S.



STEEL CANOPY FRAMING KEY PLAN
N.T.S.

Journeyman International Rubagabaga Village EVC and ATF	Julia De Hart Jenna Williams

References	Calculations

STEEL CANOPY FRAMING - HSS BEAM DESIGN

L = 5 m

	psf	trib (ft)
Dead	1.50	3.28
Live	20.00	3.28

D = 4.9 lb/ft
L = 65.6 lb/ft

Load Combinations

1.4D = 6.9 lb/ft
1.2D+1.6L = 110.9 lb/ft ***governs***

AISC 360 — Bending

Mu = 3.7 k-ft

F2-1 — ϕMn = ϕFyZx

ϕ = 0.9
Fy = 50 ksi
Z_{xreq} = 0.082891 in^3

ϕMn-Mu = 0

HSS2x2x1/8" adequate (Zx = .584 in^3)

Shear Check

Vu = 0.91 kips

G4-1 — ϕVn = $0.6F_yA_wC_{v2}$

kv = 5.34
E = 29000 ksi
C_{v2} = 1.0 since h/tw < 1.1√(kvE/Fy) 1503.5
h/t_w 16 √(k_vE/Fy) =
h = 2.0 in
t_w = 0.125 in
Aw = 0.5 in^2

ϕVn = 15 kips

ϕVn > Vu **OKAY**

Deflection Check

T3-23 — Δ = 5wl^4/384EI

I = 0.486 in^4

Δ = 0.01 in

IBC T1604.3 — Δallow= L/180 = 0.09 in

Δallow > Δ **OKAY**

use HSS 2x2x1/8" beams for steel canopy

Journeyman International
Rubagabaga Village EVC and ATF

Julia De Hart
Jenna Williams

References	Calculations

STEEL CANOPY FRAMING - HSS GIRDER DESIGN

L = 5 m

	psf	trib (ft)
Dead	3.15	8.20
Live	20.00	8.20

D = 25.8 lb/ft
L = 164.0 lb/ft

Load Combinations

1.4D = 36.2 lb/ft
1.2D+1.6L = 293.5 lb/ft ***governs***

AISC 360

Bending

F2-1 Mu = 9.9 k-ft

ϕMn = ϕFyZx

ϕ = 0.9

Fy = 50 ksi

Zx_{req} = 0.21936 in^3

ϕMn-Mu = 0

HSS2x2x1/8" adequate (Zx = .584 in^3)

Shear Check

Vu = 2.41 kips

G4-1 ϕVn = $0.6F_yA_wC_{v2}$

kv = 5.34

E = 29000 ksi

C_{v2} = 1.0 since h/tw < 1.1√(kvE/Fy)

h/t_w 16 $\sqrt{(k_vE/Fy)}$ = 61.2

h = 2.0 in

t_w = 0.125 in

Aw = 0.5 in^2

ϕVn = 15 kips

ϕVn > Vu **OKAY**

Deflection Check

T3-23 Δ = 5wl^4/384EI

I = 0.486 in^4

Δ = 0.02 in

IBC T1604.3 Δallow= L/180 = 0.09 in

Δallow > Δ **OKAY**

use HSS 2x2x1/8" girders for steel canopy

Journeyman International
Rubagabaga Village EVC and ATF
Julia De Hart
Jenna Williams

References	Calculations

STEEL CANOPY FRAMING - HSS COLUMN DESIGN

L = 3 m

	psf	trib (ft^2)
Dead	6.67	41.01
Live	20.00	41.01

D = 273.7 lb
L = 820.2 lb

Load Combinations

1.4D = 383.1 lb
1.2D+1.6L = 1640.7 lb ***governs***

AISC 360

Compression

E3-1 — Pu = 1.6 kips

ϕPn = ϕFcrAg

ϕ = 0.9

check HSS2x2x1/8"

l_u = 9.84 ft

T4-4

ϕPn = 7.63 kips

ϕPn > Pu **OKAY**

use HSS2x2x1/8" columns for steel canopy

References	Calculations

STEEL CANOPY PAD FOOTING DESIGN

	psf	trib (ft^2)
Dead	7.65	41.01
Live	20.00	41.01

D = 313.7 lb
L = 820.2 lb

Load Combinations

1.4D = 439.2 lb
1.2D+1.6L = 1688.8 lb ***governs***

P_u = 1688.8 lb
$f_{bearing}$ = 1500 psf

A_{req} = 0.89 ft^2
b_{req} = 0.94 ft 0.29 m

use 0.3x0.3x0.5m footing

SAFINTRA
world class roofing systems

SAFLOK 700
■ concealed fix roofing ■

PRODUCT DESCRIPTION & FEATURES

Concealed-fixing, also referred to as secret fix, is designed for very low pitched roofs. Because clips under the sheet hold it down, the sheet is not punctured with fasteners, and remains completely watertight even at a very low slope. The securing clips are pre-fixed into the purlins and the sheet is mechanically snapped onto the clip. As a concealed fix sheet can also expand and contract over the clips as the temperature changes, this system is ideal for long spans on industrial, commercial and retail buildings.

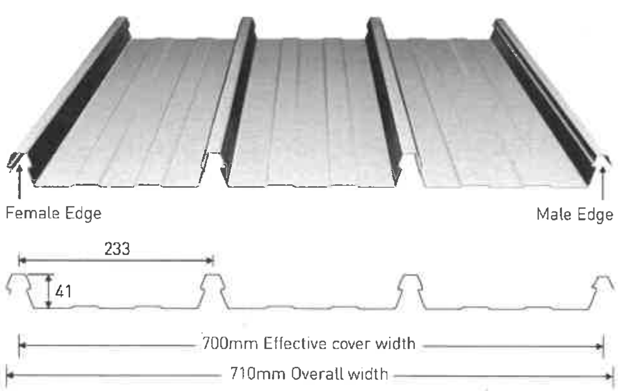
SAFLOK 700 is a concealed fix sheet profile with an effective cover width of 700mm. It is an angular interlocking standing seam trapezoidal rib profile, and is usually roll formed on mobile mills on the building site.

CLIPPING SYSTEM

The SAFLOK 700 clip incorporates a dual action component to positively hold down the male-female joint on every third rib, and an anchor to clasp the two inner ribs. Every rib is therefore secured, making it fully interlocking. It is essential that the male rib is directly engaged to the underside of the clip.

Clips for Aluminium Material:

- An Aluminium clip is a necessity when using Aluminium Material.
- When using Aluminium material on galvanized steel purlins it is recommended to make use of an isolation tape to prevent the bridging of the two dissimilar materials. The recommended tape is a "Denso LDP 300" or similar. Should the two metals have direct contact it will ultimately result in the manifestation of galvanic corrosion. The service life of the Aluminium will be compromised.



MATERIAL OPTIONS

Aluminium - Zinc	**Gauge (mm)**	
AZ150 G550 Unpainted	0.50	0.55
AZ150 G550 Painted	0.50	0.55
Aluminium	**Gauge (mm)**	
Aluminium Mill Finish	0.70	0.80
Aluminium G4 Colortech	0.70	0.80

Other gauges are available on special request.

SAMPLE SPECIFICATION

Safintra 0,50mm thick SAFLOK 700 Colorplus® AZ150 interlocking roof sheeting fixed to steel internal purlins at 2000mm, and ridge/eaves purlins at 1700mm centres using SAFLOK 700 clips which must be screw fixed to steel purlins with class 3 wafer head self-tapping screws, all in accordance with manufacturer's recommendations.

The sheeting will be a double interlocking concealed fix "SAFLOK 700" profile as manufactured by Safintra Roofng, roll formed in continuous lengths from certified G550 steel or aluminium 3004 H14.

The profile shall be roll formed with 4 ribs and centres not exceeding 233mm and a cover width not exceeding 700mm. The male rib is to include spurs to ensure a double interlocking action with adjacent sheets. The minimum sheet depth will be 41mm. Two stiffening ribs are incorporated in each pan.

We do not recommend using Saflok on a roof pitch exceeding 5 degrees due to the possibility of oil canning.

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SAFLOK 700
■ concealed fix roofing ■

PURLIN SPACINGS

Note:
It is important to reduce purlin spacings by 20% when spring curving a roof

Span tables are for SAFLOK 700 with light foot traffic only. Span tables are based on 1.5kPa downward pressure, 1.6kPa upward pressure and 0.75kPa for the side cladding, inward or outward. The span tables are maximum recommended spans based on buildings up to 10m high in Region B, Terrain Category 3. For further clarity on terrain categories, and wind speeds, please refer to the Safintra Design and Installation Manual (specifically pages 5,6 and 10,11)

GAUGE	0.5mm	0.55mm	0.8mm
MATERIAL	ALUMINIUM-ZINC	ALUMINIUM-ZINC	ALUMINIUM
ROOFS	mm	mm	mm
Single Span	1 400	1 700	1 400
End Span	1 700	2 100	1 500
Internal/Double Span	2 000	2 300	2 000
Cantilever (Unstiffened)	150	260	180
Cantilever (Stiffened)	350	400	380
SIDE CLADDING			
Single Span	2 100	2 300	1 600
End Span	2 400	2 600	2 200
Internal Span	2 600	2 700	2 400
Cantilever	300	400	300
Approximate Mass/m²	5.2kg	6.2kg	2.9kg

Saflok 700 clips are calculated at 330g per clip - require approximately 1.5 clips per m².

WIND SPEED TABLE	
Wind Zone	Purlin spacing for sheeting
Low (32 m/s) 115km/h	As per the profile span tables
Medium (37 m/s) 133km/h	As per the profile span tables - 5%
High (44 m/s) 158km/h	As per the profile span tables - 25%, all roof perimeters secured
Severe (50 m/s) 179km/h	As per the profile span tables - 25%. Consult your local Safintra branch

LENGTHS & ROOF PITCH

SAFLOK 700 can be ordered in any practical length as per customer requirements. On site rolling is recommended for lengths in excess of 13 metres. The minimum roof pitch when using SAFLOK 700 is 2° on steel and 3° on wood.

DRAINAGE TABLE

DRAINAGE TABLE	ROOF SLOPE				
RAINFALL INTENSITY MM/HOUR	2°	3°	5°	8°	10°
250	75	90			
300	65	75	95		
400	50	55	70	80	90
500	40	45	55	65	70

Maximum roof run for roof slopes and rainfall intensities shown.

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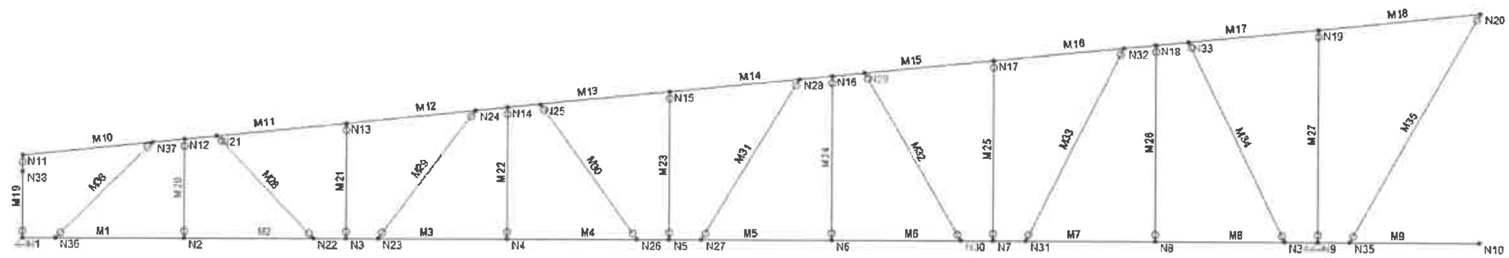
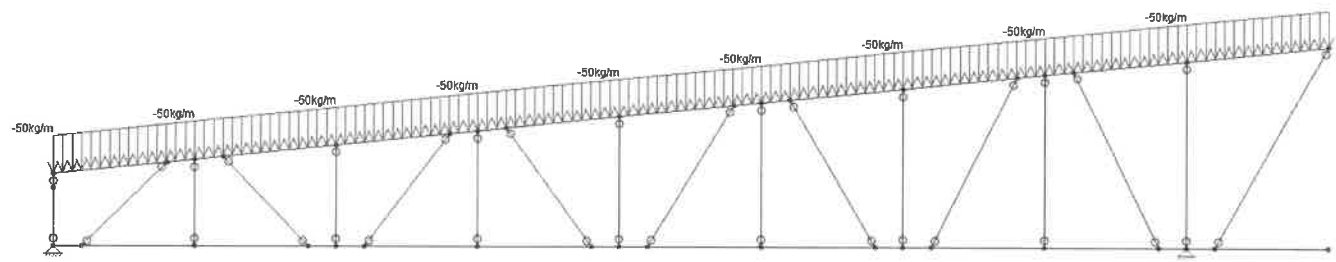
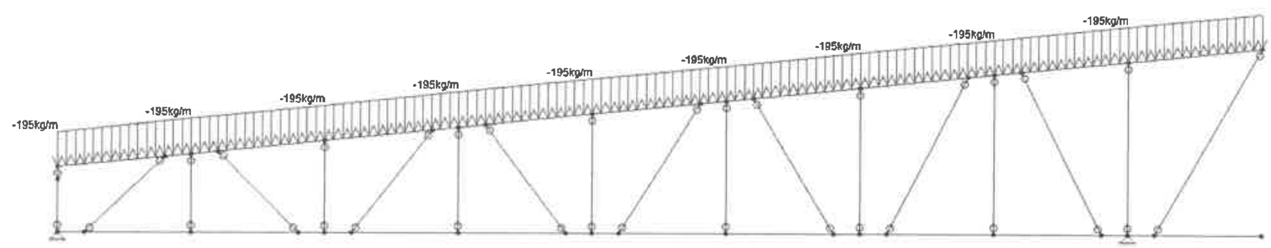
TRUSS A



DEAD LOAD



LIVE LOAD



Joint Coordinates and Temperatures

	Label	X [m]	Y [m]	Temp [F]
1	N1	0	-.4	0
2	N2	1	-.4	0
3	N3	2	-.4	0
4	N4	3	-.4	0
5	N5	4	-.4	0
6	N6	5	-.4	0
7	N7	6	-.4	0
8	N8	7	-.4	0
9	N9	8	-.4	0
10	N10	9	-.4	0
11	N11	0	.1	0
12	N12	1	.2	0
13	N13	2	.3	0
14	N14	3	.4	0
15	N15	4	.5	0
16	N16	5	.6	0
17	N17	6	.7	0
18	N18	7	.8	0
19	N19	8	.9	0
20	N20	9	1	0
21	N21	1.2	.22	0
22	N22	1.8	-.4	0
23	N23	2.2	-.4	0
24	N24	2.8	.38	0
25	N25	3.2	.42	0
26	N26	3.8	-.4	0
27	N27	4.2	-.4	0
28	N28	4.8	.58	0
29	N29	5.2	.62	0
30	N30	5.8	-.4	0
31	N31	6.2	-.4	0
32	N32	6.8	.78	0
33	N33	7.2	.82	0
34	N34	7.8	-.4	0
35	N35	8.2	-.4	0
36	N36	.2	-.4	0
37	N37	.8	.18	0
38	N38	0	0	0

Member Distributed Loads (BLC 1 : Dead)

	Member Label	Direction	Start Magnitude[kg/...	End Magnitude[kg/m,...	Start Location[m,%]	End Location[m,%]
1	M10	Y	-50	-50	0	0
2	M11	Y	-50	-50	0	0
3	M12	Y	-50	-50	0	0
4	M13	Y	-50	-50	0	0
5	M14	Y	-50	-50	0	0
6	M15	Y	-50	-50	0	0
7	M16	Y	-50	-50	0	0
8	M17	Y	-50	-50	0	0
9	M18	Y	-50	-50	0	0

Member Distributed Loads (BLC 2 : Live)

	Member Label	Direction	Start Magnitude[kg/...	End Magnitude[kg/m,...	Start Location[m,%]	End Location[m,%]
1	M10	Y	-195	-195	0	0

Member Distributed Loads (BLC 2 : Live) (Continued)

	Member Label	Direction	Start Magnitude[kg/...	End Magnitude[kg/m....	Start Location[m,%]	End Location[m,%]
2	M11	Y	-195	-195	0	0
3	M12	Y	-195	-195	0	0
4	M13	Y	-195	-195	0	0
5	M14	Y	-195	-195	0	0
6	M15	Y	-195	-195	0	0
7	M16	Y	-195	-195	0	0
8	M17	Y	-195	-195	0	0
9	M18	Y	-195	-195	0	0

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	Dead	DL	1	1			9
2	Live	LL	1	1			9

Load Combinations

	Descripti...	Solve	PDelta	SRSS	BLC	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...
1	D+L	Yes			DL	1	LL	1																

Maximum Member Section Forces

	LC	Member Label		Axial[kg]	Loc[m]	Shear[kg]	Loc[m]	Moment[kg-m]	Loc[m]
1	1	M1	max	1317.728	.198	985.762	.198	35.545	1
2			min	-4.426	.208	-292.266	.208	-195.024	.198
3	1	M2	max	2.727	.792	571.977	1	50.828	.792
4			min	-563.997	.802	-20.808	0	-63.343	1
5	1	M3	max	-561.165	.198	85.798	.198	29.864	1
6			min	-733.917	.208	-139.353	.208	-80.249	.198
7	1	M4	max	-579.26	1	129.286	.792	29.864	0
8			min	-729.391	0	-66.097	.802	-72.237	.802
9	1	M5	max	-248.217	1	26.243	1	42.077	.208
10			min	-577.551	0	-507.881	0	-59.229	0
11	1	M6	max	254.018	1	239.16	.792	22.492	0
12			min	-246.318	0	-598.85	.802	-166.398	.802
13	1	M7	max	843.51	1	175.843	1	145.19	.208
14			min	256.107	0	-973.282	0	-47.95	0
15	1	M8	max	1523.819	1	255.899	.792	25.002	1
16			min	845.789	0	-1107.169	.802	-194.225	.792
17	1	M9	max	72.501	.198	131.458	.198	25.002	0
18			min	-3.007	.208	-3.007	.208	-1.19	.208
19	1	M10	max	1423.052	.806	870.479	.806	139.185	.806
20			min	-23.009	.796	-270.005	.796	-29.202	1.005
21	1	M11	max	1898.375	.209	557.701	0	45.881	1.005
22			min	1389.656	.199	-323.406	1.005	-135.375	.199
23	1	M12	max	2114.457	.806	180.078	.806	45.881	0
24			min	1916.237	.796	-27.631	.796	-39.418	1.005
25	1	M13	max	2086.117	0	35.955	.209	37.966	1.005
26			min	1943.857	1.005	-173.997	.199	-39.418	0
27	1	M14	max	1989.932	0	288.274	0	37.966	0
28			min	1597.697	1.005	-444.702	1.005	-115.307	.796
29	1	M15	max	1579.077	0	187.012	.209	102.455	.199
30			min	1152.988	1.005	-697.794	.199	-31.583	0
31	1	M16	max	1192.815	0	373.031	0	29.634	0
32			min	483.322	1.005	-945.62	1.005	-191.073	.796

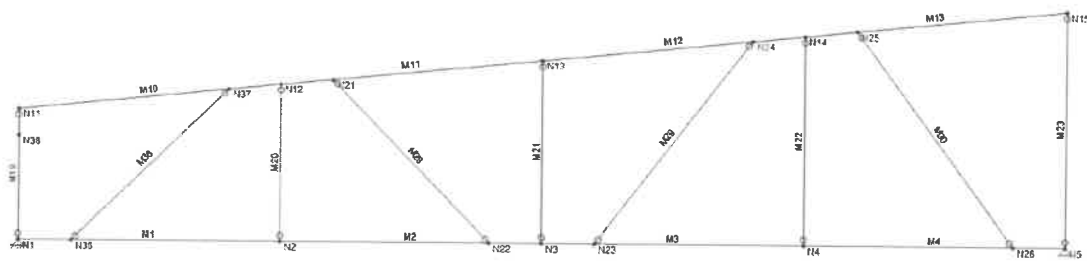
RISA A NEMETSCHEK COMPANY
Company :
Designer :
Job Number :
Model Name :

Apr 23, 2019
11:55 AM
Checked By:_____

Maximum Member Section Forces (Continued)

	LC	Member Label		Axial[kg]	Loc[m]	Shear[kg]	Loc[m]	Moment[kg-m]	Loc[m]
33	1	M17	max	478.376	0	359.746	.209	199.859	.199
34			min	-71.546	1.005	-1065.793	.199	-11.068	1.005
35	1	M18	max	-74.937	0	109.778	0	0	1.005
36			min	-95.259	1.005	-131.804	1.005	-36.133	.461
37	1	M19	max	-79.05	.5	.949	0	0	0
38			min	-80.949	0	-.949	.5	-.119	.25
39	1	M20	max	-266.172	.6	1.139	0	0	0
40			min	-268.451	0	-1.139	.6	-.171	.3
41	1	M21	max	489.589	.7	1.329	0	0	0
42			min	486.931	0	-1.329	.7	-.233	.35
43	1	M22	max	-259.586	.8	1.519	0	0	0
44			min	-262.625	0	-1.519	.8	-.304	.4
45	1	M23	max	445.954	.9	1.709	0	0	0
46			min	442.536	0	-1.709	.9	-.385	.45
47	1	M24	max	-206.112	1	1.899	0	0	0
48			min	-209.91	0	-1.899	1	-.475	.5
49	1	M25	max	379.362	1.1	2.089	0	0	0
50			min	375.184	0	-2.089	1.1	-.574	.55
51	1	M26	max	-72.492	1.2	2.279	0	0	0
52			min	-77.05	0	-2.279	1.2	-.684	.6
53	1	M27	max	-58.762	1.3	2.469	0	0	0
54			min	-63.699	0	-2.469	1.3	-.802	.65
55	1	M28	max	-817.311	0	2.317	.863	.5	.431
56			min	-817.387	.863	-2.317	0	0	0
57	1	M29	max	289.085	.984	.342	0	0	0
58			min	283.844	0	-.342	.984	-.084	.492
59	1	M30	max	244.958	0	2.697	1.016	.685	.508
60			min	244.123	1.016	-2.697	0	0	0
61	1	M31	max	-616.268	1.149	.722	0	0	0
62			min	-622.269	0	-.722	1.149	-.207	.575
63	1	M32	max	975.693	0	3.076	1.183	.91	.592
64			min	974.098	1.183	-3.076	0	0	0
65	1	M33	max	-1278.684	1.324	1.101	0	0	0
66			min	-1285.445	0	-1.101	1.324	-.365	.662
67	1	M34	max	1523.091	0	3.456	1.36	1.175	.68
68			min	1520.736	1.36	-3.456	0	0	0
69	1	M35	max	162.62	1.612	1.139	0	0	0
70			min	154.265	0	-1.139	1.612	-.459	.806
71	1	M36	max	1843.408	.835	.038	.835	.008	.417
72			min	1838.926	0	-.038	0	0	0

TRUSS B



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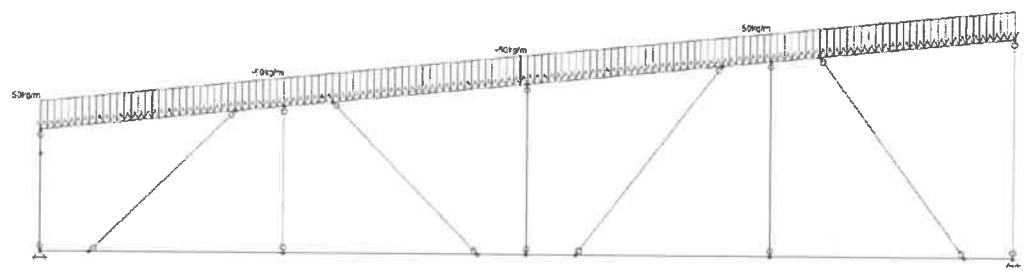
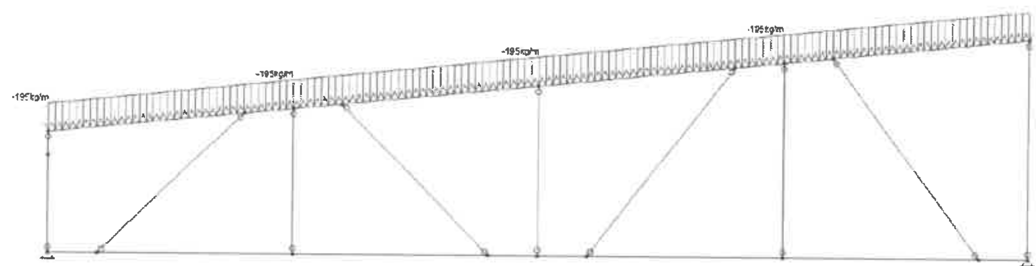


LIVE LOAD



Joint Coordinates and Temperatures

	Label	X [m]	Y [m]	Temp [F]
1	N1	0	-.4	0
2	N2	1	-.4	0
3	N3	2	-.4	0
4	N4	3	-.4	0
5	N5	4	-.4	0
6	N11	0	.1	0
7	N12	1	.2	0
8	N13	2	.3	0
9	N14	3	.4	0
10	N15	4	.5	0
11	N21	1.2	.22	0
12	N22	1.8	-.4	0
13	N23	2.2	-.4	0
14	N24	2.8	.38	0
15	N25	3.2	.42	0
16	N26	3.8	-.4	0
17	N36	.2	-.4	0
18	N37	.8	.18	0
19	N38	0	0	0

Member Distributed Loads (BLC 1 : Dead)

	Member Label	Direction	Start Magnitude[kg/...	End Magnitude[kg/m,...	Start Location[m,%]	End Location[m,%]
1	M10	Y	-50	-50	0	0
2	M11	Y	-50	-50	0	0
3	M12	Y	-50	-50	0	0
4	M13	Y	-50	-50	0	0

Member Distributed Loads (BLC 2 : Live)

	Member Label	Direction	Start Magnitude[kg/...	End Magnitude[kg/m,...	Start Location[m,%]	End Location[m,%]
1	M10	Y	-195	-195	0	0
2	M11	Y	-195	-195	0	0
3	M12	Y	-195	-195	0	0
4	M13	Y	-195	-195	0	0

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	Dead	DL	1	1			4
2	Live	LL	1	1			4

Load Combinations

	Descripti...	Solve	PDelta	SRSS	BLC	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...
1	D+L	Yes			DL	1	LL	1																

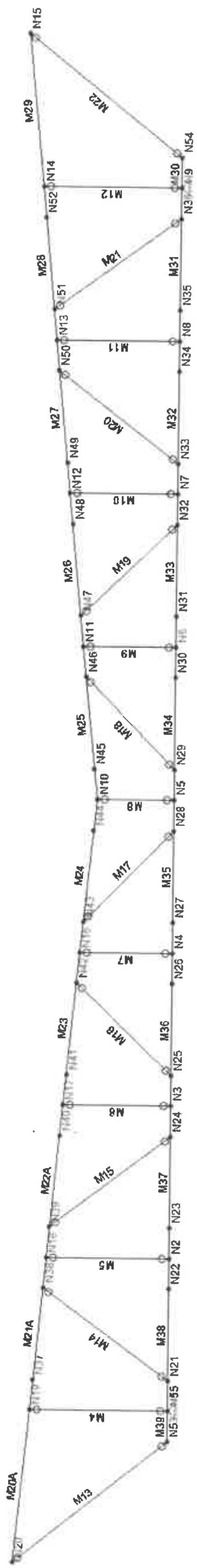
Maximum Member Section Forces

	LC	Member Label		Axial[kg]	Loc[m]	Shear[kg]	Loc[m]	Moment[kg-m]	Loc[m]
1	1	M1	max	443.696	.198	418.846	.198	24.112	1
2			min	-130.593	.208	-136.246	.208	-82.822	.198
3	1	M2	max	-123.44	.792	121.341	1	24.112	0
4			min	-173.331	.802	62.617	0	-51.389	1

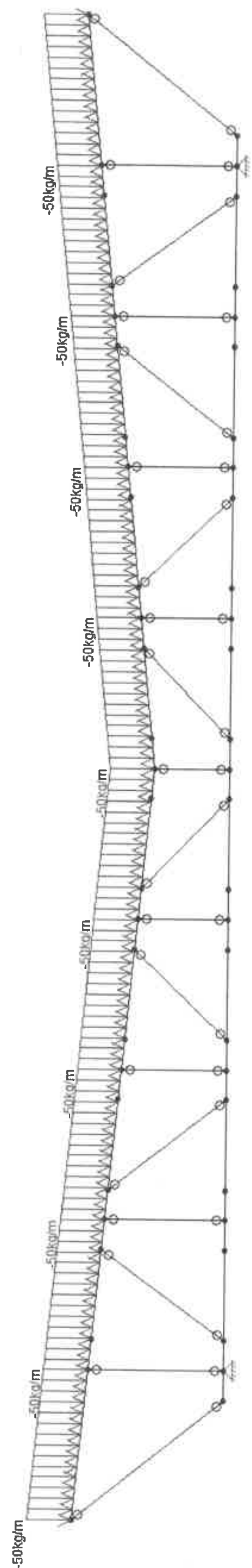
Maximum Member Section Forces (Continued)

	LC	Member Label		Axial[kg]	Loc[m]	Shear[kg]	Loc[m]	Moment[kg-m]	Loc[m]
5	1	M3	max	51.608	1	-8.422	1	15.775	1
6			min	-171.25	0	-296.437	0	-51.389	0
7	1	M4	max	498.08	1	136.552	.792	15.775	0
8			min	53.127	0	-461.754	.802	-91.314	.802
9	1	M10	max	619.157	.806	347.479	.806	42.247	.806
10			min	-10.816	.796	-148.072	.796	-22.113	1.005
11	1	M11	max	640.577	.209	106.936	0	37.387	1.005
12			min	592.985	.199	-191.333	1.005	-38.759	.209
13	1	M12	max	667.646	0	226.884	0	37.387	0
14			min	405.161	1.005	-272.36	1.005	-67.043	.796
15	1	M13	max	392.848	0	181.648	.209	69.009	.199
16			min	-2.678	1.005	-458.563	.199	-17.445	0
17	1	M19	max	43.491	.5	.949	0	0	0
18			min	41.592	0	-.949	.5	-.119	.25
19	1	M20	max	-193.577	.6	1.139	0	0	0
20			min	-195.856	0	-1.139	.6	-.171	.3
21	1	M21	max	420.437	.7	1.329	0	0	0
22			min	417.778	0	-1.329	.7	-.233	.35
23	1	M22	max	-138.928	.8	1.519	0	0	0
24			min	-141.966	0	-1.519	.8	-.304	.4
25	1	M23	max	9.823	.9	1.709	0	0	0
26			min	6.405	0	-1.709	.9	-.385	.45
27	1	M28	max	-74.117	0	2.317	.863	.5	.431
28			min	-74.193	.863	-2.317	0	0	0
29	1	M29	max	-353.6	.984	.342	0	0	0
30			min	-358.841	0	-.342	.984	-.084	.492
31	1	M30	max	744.224	0	2.697	1.016	.685	.508
32			min	743.389	1.016	-2.697	0	0	0
33	1	M36	max	803.245	.835	.038	.835	.008	.417
34			min	798.764	0	-.038	0	0	0

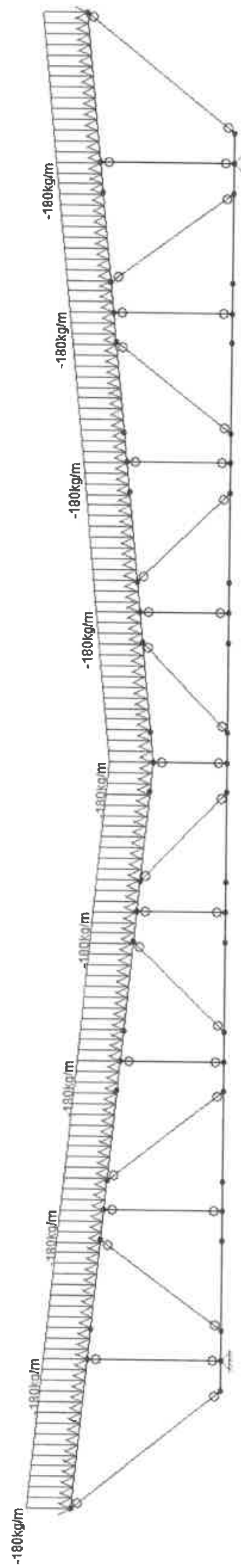
TRUSS C



DEAD LOAD



LIVE LOAD



Joint Coordinates and Temperatures

	Label	X [m]	Y [m]	Temp [F]
1	N1	-0.	0	0
2	N2	1	0	0
3	N3	2	0	0
4	N4	3	0	0
5	N5	4	0	0
6	N6	5	0	0
7	N7	6	0	0
8	N8	7	0	0
9	N9	8	0	0
10	N10	4	.5	0
11	N11	5	.6	0
12	N12	6	.7	0
13	N13	7	.8	0
14	N14	8	.9	0
15	N15	9	1	0
16	N16	3	.6	0
17	N17	2	.7	0
18	N18	1	.8	0
19	N19	0	.9	0
20	N20	-1	1	0
21	N21	.2	0	0
22	N22	.8	0	0
23	N23	1.2	0	0
24	N24	1.8	0	0
25	N25	2.2	0	0
26	N26	2.8	0	0
27	N27	3.2	0	0
28	N28	3.8	0	0
29	N29	4.2	0	0
30	N30	4.8	0	0
31	N31	5.2	0	0
32	N32	5.8	0	0
33	N33	6.2	0	0
34	N34	6.8	0	0
35	N35	7.2	0	0
36	N36	7.8	0	0
37	N37	.2	.88	0
38	N38	.8	.82	0
39	N39	1.2	.78	0
40	N40	1.8	.72	0
41	N41	2.2	.68	0
42	N42	2.8	.62	0
43	N43	3.2	.58	0
44	N44	3.8	.52	0
45	N45	4.2	.52	0
46	N46	4.8	.58	0
47	N47	5.2	.62	0
48	N48	5.8	.68	0
49	N49	6.2	.72	0
50	N50	6.8	.78	0
51	N51	7.2	.82	0
52	N52	7.8	.88	0
53	N53	-.2	0	0
54	N54	8.2	0	0
55	N55	0	0	0

Member Distributed Loads (BLC 1 : Dead)

	Member Label	Direction	Start Magnitude[kg/...	End Magnitude[kg/m,...	Start Location[m,%]	End Location[m,%]
1	M4	Y	0	0	0	0
2	M40	Y	-50	-50	0	0
3	M41	Y	-50	-50	0	0
4	M42	Y	-50	-50	0	0
5	M23	Y	-50	-50	0	0
6	M24	Y	-50	-50	0	0
7	M26	Y	-50	-50	0	0
8	M25	Y	-50	-50	0	0
9	M27	Y	-50	-50	0	0
10	M28	Y	-50	-50	0	0
11	M29	Y	-50	-50	0	0

Member Distributed Loads (BLC 2 : Live)

	Member Label	Direction	Start Magnitude[kg/...	End Magnitude[kg/m,...	Start Location[m,%]	End Location[m,%]
1	M40	Y	-180	-180	0	0
2	M41	Y	-180	-180	0	0
3	M42	Y	-180	-180	0	0
4	M23	Y	-180	-180	0	0
5	M24	Y	-180	-180	0	0
6	M25	Y	-180	-180	0	0
7	M26	Y	-180	-180	0	0
8	M27	Y	-180	-180	0	0
9	M28	Y	-180	-180	0	0
10	M29	Y	-180	-180	0	0

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	Dead	DL		-1			11
2	Live	LL		-1			10

Load Combinations

	Descripti...	Solve	PDelta	SRSS	BLC	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...
1	D+L	Yes			DL	1	LL	1																

Maximum Member Section Forces

	LC	Member Label		Axial[kg]	Loc[m]	Shear[kg]	Loc[m]	Moment[kg-m]	Loc[m]
1	1	M4	max	-39.86	0	2.686	0	0	0
2			min	-45.231	.9	-2.686	.9	-.604	.45
3	1	M5	max	-98.764	0	2.387	0	0	0
4			min	-103.539	.8	-2.387	.8	-.477	.4
5	1	M6	max	337.634	0	2.089	0	0	0
6			min	333.456	.7	-2.089	.7	-.366	.35
7	1	M7	max	-398.985	0	1.79	0	0	0
8			min	-402.566	.6	-1.79	.6	-.269	.3
9	1	M8	max	1232.372	0	1.492	0	0	0
10			min	1229.388	.5	-1.492	.5	-.187	.25
11	1	M9	max	-398.785	0	1.79	0	0	0
12			min	-402.366	.6	-1.79	.6	-.269	.3
13	1	M10	max	336.818	0	2.089	0	0	0
14			min	332.64	.7	-2.089	.7	-.366	.35
15	1	M11	max	-101.052	0	2.387	0	0	0

Maximum Member Section Forces (Continued)

	LC	Member Label		Axial[kg]	Loc[m]	Shear[kg]	Loc[m]	Moment[kg-m]	Loc[m]
16			min	-105.826	.8	-2.387	.8	-.477	.4
17	1	M12	max	-46.843	0	2.686	0	0	0
18			min	-52.214	.9	-2.686	.9	-.604	.45
19	1	M13	max	166.948	0	.597	0	0	0
20			min	156.205	1.281	-.597	1.281	-.191	.64
21	1	M14	max	1777.261	0	4.237	0	0	0
22			min	1775.948	1.016	-4.237	1.016	-1.076	.508
23	1	M15	max	-1560.727	.984	.537	.984	.132	.492
24			min	-1568.963	0	-.537	0	0	0
25	1	M16	max	1389.067	0	3.641	0	0	0
26			min	1388.947	.863	-3.641	.863	-.785	.431
27	1	M17	max	-716.793	.835	.06	0	0	0
28			min	-723.836	0	-.06	.835	-.012	.417
29	1	M18	max	-777.014	.835	3.521	0	0	0
30			min	-777.133	0	-3.521	.835	-.735	.417
31	1	M19	max	1443.204	.863	.06	.863	.013	.431
32			min	1435.923	0	-.06	0	0	0
33	1	M20	max	-1607.324	0	4.118	0	0	0
34			min	-1608.398	.984	-4.118	.984	-1.013	.492
35	1	M21	max	1827.405	1.016	.656	1.016	.167	.508
36			min	1818.931	0	-.656	0	0	0
37	1	M22	max	164.607	0	5.371	0	0	0
38			min	163.414	1.281	-5.371	1.281	-1.72	.64
39	1	M40	max	-77.153	1.005	112.078	0	6.494	1.005
40			min	-108.807	0	-125.002	1.005	-26.622	.471
41	1	M41	max	866.223	1.005	1168.433	.806	216.762	.806
42			min	-69.98	0	-357.43	.796	-10.977	1.005
43	1	M42	max	1986.555	1.005	1018.723	0	2.404	1.005
44			min	878.901	0	-360.229	1.005	-209.535	.209
45	1	M23	max	2851.757	1.005	868.622	.806	99.52	.796
46			min	1955.453	0	-215.908	.796	-68.589	1.005
47	1	M24	max	3493.118	1.005	421.31	0	-12	1.005
48			min	2893.596	0	-264.618	1.005	-147.869	.209
49	1	M25	max	3495.361	0	272.054	0	-12	0
50			min	2871.997	1.005	-451.135	1.005	-153.29	.796
51	1	M26	max	2833.741	0	224.732	.209	106.002	.199
52			min	1926.926	1.005	-898.917	.199	-68.098	0
53	1	M27	max	1962.104	0	366.58	0	2.353	0
54			min	846.539	1.005	-1045.846	1.005	-214.142	.796
55	1	M28	max	838.384	0	366.753	.209	223.505	.199
56			min	-99.671	1.005	-1198.618	.199	-10.207	0
57	1	M29	max	-102.194	0	125.596	0	6.301	0
58			min	-118.114	1.005	-113.058	1.005	-26.91	.534
59	1	M30	max	98.635	0	133.466	.2	0	0
60			min	97.062	.2	131.892	0	-26.536	.2
61	1	M31	max	2125.538	0	279.327	1	211.616	.208
62			min	1038.04	1	-1202.924	0	-26.536	0
63	1	M32	max	1035.653	0	184.504	.792	65.036	1
64			min	44.519	1	-1086.907	.802	-150.653	.792
65	1	M33	max	42.43	0	296.384	1	213.029	.198
66			min	-969.115	1	-748.531	0	-20.004	1
67	1	M34	max	-970.905	0	-96.174	.792	185.983	1
68			min	-1539.97	1	-633.685	.802	-20.004	0
69	1	M35	max	-1027.693	.208	601.801	.198	185.983	0
70			min	-1543.019	.198	103.739	.208	-19.679	1
71	1	M36	max	-78.651	.802	719.567	1	207.522	.802
72			min	-1041.94	.792	-289.019	0	-19.679	0

Maximum Member Section Forces (Continued)

	LC	Member Label		Axial[kg]	Loc[m]	Shear[kg]	Loc[m]	Moment[kg-m]	Loc[m]
73	1	M37	max	867.231	.208	1058.758	.198	65.262	0
74			min	-83.854	.198	-178.557	.208	-144.847	.208
75	1	M38	max	1898.376	.802	1173.579	1	206.196	.792
76			min	852.387	.792	-271.094	0	-26.156	1
77	1	M39	max	106.331	0	-129.991	.2	0	.2
78			min	104.757	.2	-131.565	0	-26.156	0

Table 6 shows the spectral values at T=0 s (PGA), 0.2 s and 1 s for both RP=475 and 2475 yr., as well as the values provided by GSHAP. It is highlighted that the PGA values for RP=475 yr. derived in this study are generally larger than those provided by GHSAP with differences larger than three times in Mombasa, Dar Es Salaam, Dodoma and Lilongwe. It also shows the highest hazard is in Bujumbura and Djibouti, again substantially higher than the equivalent GSHAP values.

Table 6: PSHA results in terms of spectral acceleration at T=0 s (PGA), 0.2 s and 1 s for RP=475 and 2475 yr. The PGA values provided by GSHAP are also show for comparison.

		SA(ζ=5% - RP=475 yr.) (g)		SA(ζ=5% - RP=2475 yr.) (g)		
Country	**City**	**PGA**	**PGA GSHAP**	**PGA**	**SA (T=0.2s)**	**SA (T=1s)**
Ethiopia	Addis Ababa	0.13	0.11	0.29	0.71	0.17
South Sudan	Juba	0.18	0.13	0.36	0.89	0.20
Uganda	Kampala	0.09	0.09	0.18	0.45	0.13
Rwanda	Kigali	0.15	0.06	0.31	0.76	0.19
Burundi	Bujumbura	0.27	0.13	0.48	1.24	0.27
Kenya	Nairobi	0.09	0.06	0.21	0.54	0.14
Kenya	Mombasa	0.09	0.01	0.20	0.51	0.09
Tanzania	Dar Es Salaam	0.09	0.03	0.20	0.50	0.09
Tanzania	Dodoma	0.12	0.03	0.23	0.56	0.12
Tanzania	Arusha	0.12	0.16	0.23	0.56	0.11
Malawi	Lilongwe	0.20	0.05	0.37	0.94	0.15
Malawi	Blantyre	0.12	0.09	0.25	0.62	0.10
Djibouti	Djibouti	0.26	0.17	0.47	1.21	0.24

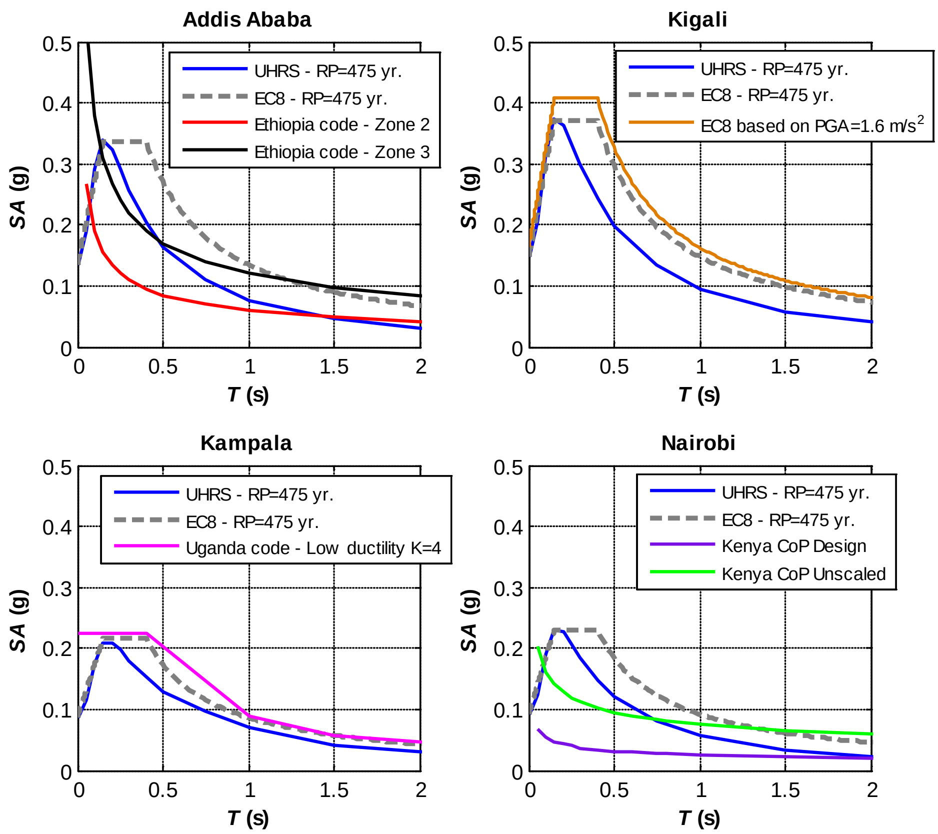


Figure 5: Uniform hazard spectra at Addis Ababa, Kigala, Kampala and Nairobi (blue curves) compared with the elastic acceleration spectra derived from EN 1998 based on the PGA for RP=475 yr. and country seismic code criteria.

APPENDIX B: DRAWINGS

GENERAL

1. APPLICABLE CODE: 2015 INTERNATIONAL BUILDING CODE (IBC)

DESIGN WIND SPEED (CBC SECTION 1609): 110MPH, EXPOSURE B
DESIGN BASED ON SIMILAR UNITED STATES CONDITIONS
DESIGN SEISMIC CRITERIA (SEISMIC DESIGN CONSIDERATIONS FOR EAST AFRICA):

SEISMIC IMPORTANCE FACTOR, IE:	1.0
SHORT PERIOD MCE ACCELERATION, SS:	0.76g
LONG PERIOD MCE ACCELERATION, S1:	0.19g
RESPONSE MODIFICATION COEFFICIENT, R:	1.0
SITE CLASS:	E (SOFT CLAY)
SITE COEFFICIENTS, FA & FV:	1.2

2. GOVERNING CODE AUTHORITY: COUNTRY OF RWANDA

3. THESE GENERAL NOTES SUPERSEDE THE REQUIREMENTS OF THE PROJECT SPECIFICATIONS. IN CASE OF CONFLICT BETWEEN THE PLANS AND SPECIFICATIONS, CONTACT THE OWNER'S REPRESENTATIVE.

4. CONTRACT DOCUMENTS INDICATE INFORMATION SUFFICIENT TO CONVEY DESIGN INTENT. REVIEW CONTRACT DOCUMENTS AND VERIFY FIELD AND EXISTING CONDITIONS. PROMPTLY NOTIFY STRUCTURAL ENGINEER PRIOR TO PROCEEDING WITH WORK IF DESIGN INTENT REQUIRES FURTHER CLARIFICATION.

5. REFERENCE TO CODES, RULES, REGULATIONS, STANDARDS, MANUFACTURER'S INSTRUCTIONS OR REQUIREMENTS OF REGULATORY AGENCIES IS TO THE LATEST PRINTED EDITION OF EACH IN EFFECT AT THE DATE OF SUBMISSION OF BID UNLESS THE DOCUMENT DATE IS SHOWN.

6. TYPICAL DETAILS AND GENERAL NOTES APPLY TO ALL PARTS OF THE WORK EXCEPT WHERE SPECIFICALLY DETAILED OR UNLESS NOTED OTHERWISE (U.N.O.)

7. THE STRUCTURAL DRAWINGS ILLUSTRATE THE NEW STRUCTURAL MEMBERS. REFER TO ARCHITECTURAL, MECHANICAL AND ELECTRICAL DRAWINGS FOR NON-STRUCTURAL ITEMS WHICH REQUIRE SPECIAL PROVISIONS DURING THE CONSTRUCTION OF THE STRUCTURAL MEMBERS.

8. REFER TO ARCHITECTURAL DRAWINGS FOR FLOOR DEPRESSIONS, EDGE OF SLAB, OPENINGS, SLOPES, DRAINS, CURBS, PADS, EMBEDDED ITEMS, NON-BEARING PARTITIONS, ETC. REFER TO MECHANICAL AND ELECTRICAL DRAWINGS FOR SLEEVES, OPENINGS, AND HANGERS FOR PIPES, DUCTS AND EQUIPMENT.

9. THE CONTRACTOR SHALL VERIFY AND BE RESPONSIBLE FOR COORDINATING THE WORK OF ALL TRADES AND SHALL VERIFY ALL DIMENSIONS AND CONDITIONS WHICH IMPACT THE WORK. FIELD VERIFY SIZES, ELEVATIONS, HOLE LOCATIONS, ETC. PRIOR TO FABRICATION.

10. DRAWING DIMENSIONS ARE TO FACE OF FINISH, JOINT CENTERLINE OR COLUMN GRID CENTERLINE UNLESS NOTED OTHERWISE. DO NOT SCALE THE DRAWINGS.

11. CONTRACTOR SHALL CAREFULLY REVIEW THE DRAWINGS TO IDENTIFY THE SCOPE OF WORK REQUIRED. VISIT THE SITE TO RELATE THE SCOPE OF WORK TO EXISTING CONDITIONS AND DETERMINE THE EXTENT TO WHICH THOSE CONDITIONS AND PHYSICAL SURROUNDINGS WILL IMPACT THE WORK.

12. EXISTING CONDITIONS AS SHOWN ON THESE PLANS ARE FOR REFERENCE ONLY. CONTRACTOR IS REQUIRED TO FIELD VERIFY ALL EXISTING CONDITIONS PRIOR TO CONSTRUCTION. CONTRACTOR SHALL REPORT CONDITIONS THAT CONFLICT WITH THE CONTRACT DOCUMENTS TO THE OWNER'S REPRESENTATIVE. DO NOT DEVIATE FROM THE CONTRACT DOCUMENTS WITHOUT WRITTEN DIRECTION FROM THE OWNER'S REPRESENTATIVE.

13. THE CONTRACTOR SHALL RESOLVE ANY CONFLICTS ON THE DRAWINGS OR IN THE SPECIFICATIONS WITH THE OWNER'S REPRESENTATIVE BEFORE PROCEEDING WITH THE WORK.

14. ANY DEVIATION, MODIFICATION & SUBSTITUTION FROM THE APPROVED SET OF STRUCTURAL DRAWINGS SHALL BE SUBMITTED TO THE OWNER'S REPRESENTATIVE FOR REVIEW/APPROVAL PRIOR TO ITS USE OR INCLUSION ON THE SHOP DRAWINGS & PRIOR TO PROCEEDING WITH THE WORK.

15. THE CONTRACTOR SHALL PROVIDE ALL NECESSARY SHORES, BRACES AND GUYS REQUIRED TO SUPPORT ALL LOADS TO WHICH THE BUILDING STRUCTURE AND COMPONENTS, SOILS, OTHER STRUCTURES AND UTILITIES MAY BE SUBJECTED DURING CONSTRUCTION. SHORING SYSTEMS SHALL BE DESIGNED AND STAMPED BY A CIVIL ENGINEER LICENSED IN THE STATE OF CALIFORNIA. VISITS TO THE SITE BY THE OWNER'S REPRESENTATIVE WILL NOT INCLUDE OBSERVATION OF THE ABOVE NOTED ITEMS.

16. THE CONTRACTOR SHALL PROVIDE MEANS, METHOD, TECHNIQUES, SEQUENCE AND PROCEDURE OF CONSTRUCTION AS REQUIRED. SITE VISITS PERFORMED BY THE OWNER'S REPRESENTATIVE DO NOT INCLUDE INSPECTIONS OF MEANS AND METHODS OF CONSTRUCTION PERFORMED BY CONTRACTOR.

17. THE CONTRACTOR SHALL PROTECT ALL WORK, MATERIALS AND EQUIPMENT FROM DAMAGE AND SHALL PROVIDE PROPER STORAGE FACILITIES FOR MATERIALS AND EQUIPMENT DURING CONSTRUCTION.

GENERAL (CONT.)

18. STRUCTURAL OBSERVATIONS PERFORMED BY ENGINEER DURING CONSTRUCTION ARE NOT THE CONTINUOUS AND SPECIAL INSPECTION SERVICES AND DO NOT WAIVE THE RESPONSIBILITY FOR THE INSPECTIONS REQUIRED OF THE BUILDING INSPECTOR OR THE DEPUTY INSPECTOR. OBSERVATIONS ALSO DO NOT GUARANTEE CONTRACTOR'S PERFORMANCE AND SHALL NOT BE CONSIDERED AS SUPERVISION OF CONSTRUCTION.

19. CONTRACTORS SHALL REVIEW SHOP DRAWINGS FOR COMPLETENESS AND COMPLIANCE WITH CONTRACT DOCUMENTS. CONTRACTOR SHALL STAMP SHOP DRAWINGS PRIOR TO SUBMISSION TO OWNER'S REPRESENTATIVE.

20. REVIEW OF THE SHOP DRAWINGS SHALL NOT BE CONSTRUED AS AN AUTHORIZATION TO DEVIATE FROM CONTRACT DOCUMENTS.

21. SHOP DRAWINGS WILL NOT BE PROCESSED DUE TO INCOMPLETENESS, LACK OF CO-ORDINATION WITH RELEVANT PORTION OF CONTRACT DOCUMENTS, LACK OF CALCULATIONS IF REQUIRED AND WHERE DEVIATIONS, MODIFICATIONS AND SUBSTITUTIONS ARE INDICATED WITHOUT PRIOR WRITTEN APPROVAL FROM OWNER'S REPRESENTATIVE.

CONCRETE

1. CONCRETE IS REINFORCED AND CAST-IN-PLACE UNLESS OTHERWISE NOTED. WHERE REINFORCING IS NOT SPECIFICALLY SHOWN OR WHERE DETAILS ARE NOT GIVEN, PROVIDE REINFORCING SIMILAR TO THAT SHOWN FOR SIMILAR CONDITIONS, SUBJECT TO REVIEW BY THE OWNER'S REPRESENTATIVE.

2. ALL STRUCTURAL CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH AT 28 DAYS AS FOLLOWS:

SLAB ON GRADE	4,000 PSI (2.75MPa)
ALL OTHER CONCRETE	4,000 PSI (2.75MPa)

3. ALL STRUCTURAL CONCRETE MIXES SHALL BE TYPE II CEMENT AND SHALL BE DESIGNED BY AN APPROVED LABORATORY.

4. NO MORE THAN ONE GRADE OF CONCRETE SHALL BE ON THE JOB SITE AT ANY ONE TIME.

5. THOROUGHLY CLEAN AND ROUGHEN ALL HARDENED CONCRETE AND MASONRY SURFACES TO RECEIVE NEW CONCRETE. INTERFACE SHALL BE ROUGHENED TO A FULL AMPLITUDE OF 1/4" (6mm) UNLESS NOTED OTHERWISE.

6. KEY AND DOWEL POUR JOINTS AS SHOWN ON THE PLANS. ANY DEVIATION FROM POUR JOINTS SHOWN ON THE PLANS MUST BE APPROVED BY THE OWNER'S REPRESENTATIVE.

7. DEFECTIVE CONCRETE (VOIDS, ROCK POCKETS, HONEYCOMBS, CRACKING, ETC.) SHALL BE REMOVED AND REPLACED AS DIRECTED BY THE OWNER'S REPRESENTATIVE.

REINFORCEMENT

1. REINFORCING TO CONFORM TO THE FOLLOWING, UNLESS OTHERWISE NOTED:

REINFORCING STEEL — ASTM A706, 60 KSI

2. REINFORCING BARS SHALL HAVE THE FOLLOWING MINIMUM COVERAGE. PLACE BARS AS NEAR TO THE CONCRETE SURFACE AS THESE MINIMUMS PERMIT WHEREVER POSSIBLE UNLESS NOTED OTHERWISE:

MIN. CONCRETE COVER:

SLAB ON GRADE	CENTER OF SLAB
CONCRETE POURED AGAINST EARTH	3" (76mm)
EXPOSED TO WEATHER	1" (25mm)

3. HORIZONTAL WALL SPLICES SHALL BE STAGGERED. VERTICAL BARS SHALL NOT BE SPLICED EXCEPT AT HORIZONTAL SUPPORT, SUCH AS FLOOR OR ROOF, UNLESS DETAILED OTHERWISE. ALL BARS ENDING AT THE FACE OF A WALL, COLUMN, OR BEAM SHALL EXTEND TO WITHIN 2" OF THE FAR FACE AND HAVE A 90 DEGREE HOOK UNLESS OTHERWISE SHOWN.

4. BARS SHALL BE FIRMLY SUPPORTED AND ACCURATELY PLACED USING TIE AND SUPPORT BARS IN ADDITION TO REINFORCEMENT SHOWN WHERE NECESSARY FOR FIRM AND ACCURATE PLACING. ALL DOWELS SHALL BE ACCURATELY SET IN PLACE BEFORE PLACING CONCRETE.

5. DRAWINGS SHOW TYPICAL REINFORCING CONDITIONS. CONTRACTOR SHALL PREPARE DETAILED PLACEMENT DRAWINGS OF ALL CONDITIONS SHOWING QUANTITY, SPACING, SIZE, CLEARANCES, LAPS, INTERSECTIONS AND COVERAGE REQUIRED BY STRUCTURAL DETAILS, APPLICABLE CODE AND TRADE STANDARDS. CONTRACTOR SHALL NOTIFY REINFORCING INSPECTOR OF ANY ADJUSTMENTS FROM TYPICAL CONDITIONS THAT ARE PROPOSED IN PLACEMENT DRAWINGS TO FACILITATE FIELD PLACEMENT OF REINFORCING STEEL AND CONCRETE.

6. NO WELDING OF REINFORCEMENT (INCLUDING TACK WELDING) SHALL BE DONE UNLESS SHOWN ON THE DRAWINGS. WHERE SHOWN ON THE DRAWINGS, WELDING OF REINFORCING STEEL SHALL BE PERFORMED BY WELDERS SPECIFICALLY CERTIFIED FOR REINFORCING STEEL. USE E90XX ELECTRODES.

FOUNDATIONS

1. THE DESIGN OF THE FOUNDATION SYSTEM IS BASED UPON THE CRITERIA AND RECOMMENDATIONS CONTAINED IN THE GEOTECHNICAL INVESTIGATION REPORT ENTITLED "ARCE 452 SOILS REPORT" BY QUICKSAND TECHNOLOGIES, DATED 1/7/19.

2. FOUNDATION DESIGN VALUES:

BEARING CAPACITY:	1,500 PSF
LATERAL BEARING PRESSURE:	300 PSF/FT
COEFFICIENT OF FRICTION:	0.3
SOIL PROFILE TYPE:	Sd

3. REMOVE LOOSE SOIL AND STANDING WATER FROM FOUNDATION EXCAVATIONS PRIOR TO PLACING CONCRETE. THE GEOTECHNICAL ENGINEER SHALL INSPECT AND APPROVE ALL EXCAVATIONS, SOIL COMPACTION WORK PRIOR TO PLACEMENT OF ANY REBAR OR CONCRETE, SHORING INSTALLATIONS, BACKFILL MATERIALS AND BACK FILLING PROCEDURES.

4. NOTIFY THE OWNER'S REPRESENTATIVE IF ANY BURIED STRUCTURES NOT INDICATED, SUCH AS CESSPOOLS, CISTERNS, FOUNDATIONS, ETC., ARE FOUND.

5. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR EXCAVATION PROCEDURES INCLUDING LAGGING, SHORING, UNDERPINNING AND PROTECTION OF EXISTING CONSTRUCTION.

6. FOOTINGS SHALL BE A MINIMUM OF 24" (0.6m) BELOW ADJACENT GRADE OR FINISH FLOOR, WHICHEVER IS LOWER.

7. PLACE BACKFILL BEHIND RETAINING WALLS AFTER CONCRETE OR MASONRY HAS ATTAINED FULL DESIGN STRENGTH. BRACE BUILDING AND PIT WALLS BELOW GRADE FROM LATERAL LOADS UNTIL ATTACHED FLOORS AND SLABS ON GRADE ARE COMPLETE AND HAVE ATTAINED FULL DESIGN STRENGTH.

FORMWORK

1. BEFORE STARTING CONSTRUCTION, THE CONTRACTOR SHALL DEVELOP A PROCEDURE AND SCHEDULE FOR REMOVAL OF CONCRETE FORMS AND SHORES. CONCRETE FORMS AND SHORES SHALL BE REMOVED IN SUCH A MANNER AS TO NOT IMPAIR THE SAFETY AND SERVICEABILITY OF THE STRUCTURE. IN ADDITION TO THE ABOVE REQUIREMENTS, REMOVAL OF FORMS SHALL BE NO SOONER THAN THE FOLLOWING:

LOCATION	REMOVE FORMS NO SOONER THAN
BOTTOM FORMS AND SHORES FOR MILDLY REINFORCED SLABS, BEAMS, AND GIRDERS	72 HOURS & f'c=3,500 PSI MIN. (2.5 MPa)
SIDE FORMS FOR BEAMS AND GIRDERS	72 HOURS
COLUMNS AND WALLS	72 HOURS
FOOTINGS, PILE CAPS, AND GRADE BEAMS	48 HOURS

2. PROVIDE CURING WHERE FORMS ARE REMOVED IN LESS THAN 7 DAYS, INCLUDING BUT NOT LIMITED TO WALLS, COLUMNS, AND UNDERSIDE OF ELEVATED SLABS.

STRUCTURAL OBSERVATION

1. CONTINUOUS SPECIAL INSPECTION IS REQUIRED PER IBC. CONTINUOUS SPECIAL INSPECTION IS REQUIRED FOR THE FOLLOWING WORK AS DESCRIBED IN IBC:

1.1 ALL CONCRETE WORK
1.2 BOLTS INSTALLED IN CONCRETE
1.3 REINFORCING STEEL
1.4 JUST PRIOR TO PLACING CONCRETE FOUNDATIONS TO ENSURE SUBGRADE IS SUITABLE, FREE FROM LOOSE SOIL, AND FOUNDATIONS ARE OF PROPER DIMENSIONS

REVISIONS: BY:

DRAWINGS TO BE REVIEWED BY IN COUNTRY ARCHITECT/ENGINEER

DRAWINGS NOT FOR CONSTRUCTION

CLIENT:

JOURNEYMAN INTERNATIONAL
3471 N. MAIN ST.
PRINEVILLE, OR 97754

PROJECT:

RUBAGABAGA AGRICULTURAL TRAINING FACILITY AND COMMUNITY CENTER
RWANDA

SHEET TITLE:

GENERAL NOTES

DATE: 2019 - 06 - 06
SCALE: AS NOTED
DRAWN: JRD, JMW
DESIGNED: JRD, JMW
CHECKED: JM

SHEET:

S1.0

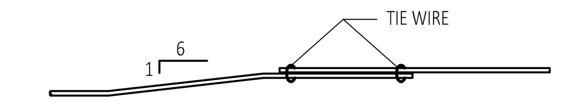
TENSION LAP SPLICE LENGTH (CLASS B)		
	4000 PSI (2.75 MPa)	
BAR SIZE	TOP	OTHER
#3 (10mm)	28" (72cm)	20 (50cm)
#4 (13mm)	34" (86cm)	25 (64cm)
#5 (16mm)	42" (1m)	31 (80cm)

NOTES: (#)
1. ALL SPLICES SHALL BE TENSION LAP SPLICES U.N.O.
2. LENGTHS SHOWN ARE FOR GRADE 60 UNCOATED BARS

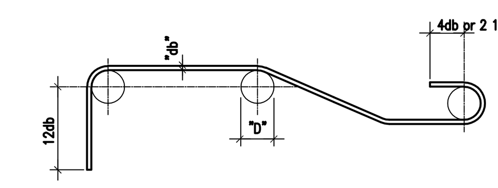
TENSION LAP SPLICES

N.T.S.

21



OFFSET & SPLICES

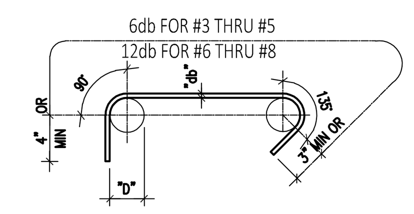


MIN BEND DIA. (PRINCIPAL REINF.)
D = 6db FOR #3 THRU #8 (10mm THRU 25mm)

N.T.S.

11

STANDARD HOOK DETAILS FOR PRINCIPAL REINFORCEMENT



MIN. BEND DIA. (STIRRUPS & TIES)

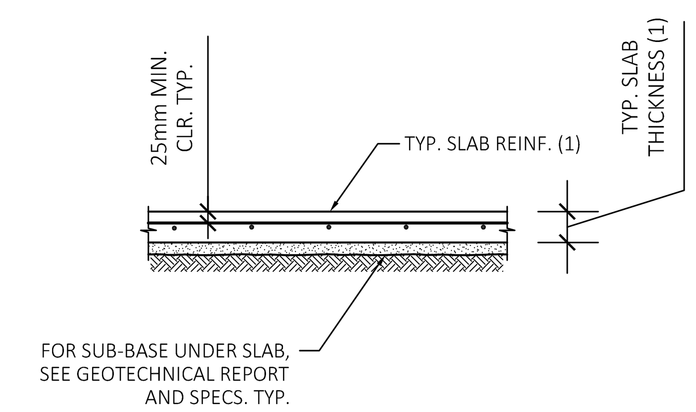
BAR	D
#3 (10mm)	1 1/2" (38mm)
#4 (13mm)	2" (50mm)
#5 (16mm)	2 1/2" (64mm)

STANDARD HOOK DETAILS FOR STIRRUPS & TIES

TYPICAL REINFORCEMENT

N.T.S.

12



NOTES: (#)
1. SEE FOUNDATION PLAN AND NOTES

SLAB ON GRADE

N.T.S.

13

REVISIONS: BY:

DRAWINGS TO BE REVIEWED BY IN COUNTRY ARCHITECT/ENGINEER

DRAWINGS NOT FOR CONSTRUCTION

CLIENT:

JOURNEYMAN INTERNATIONAL
3471 N. MAIN ST.
PRINEVILLE, OR 97754

PROJECT:

RUBAGABAGA AGRICULTURAL TRAINING FACILITY AND COMMUNITY CENTER
RWANDA

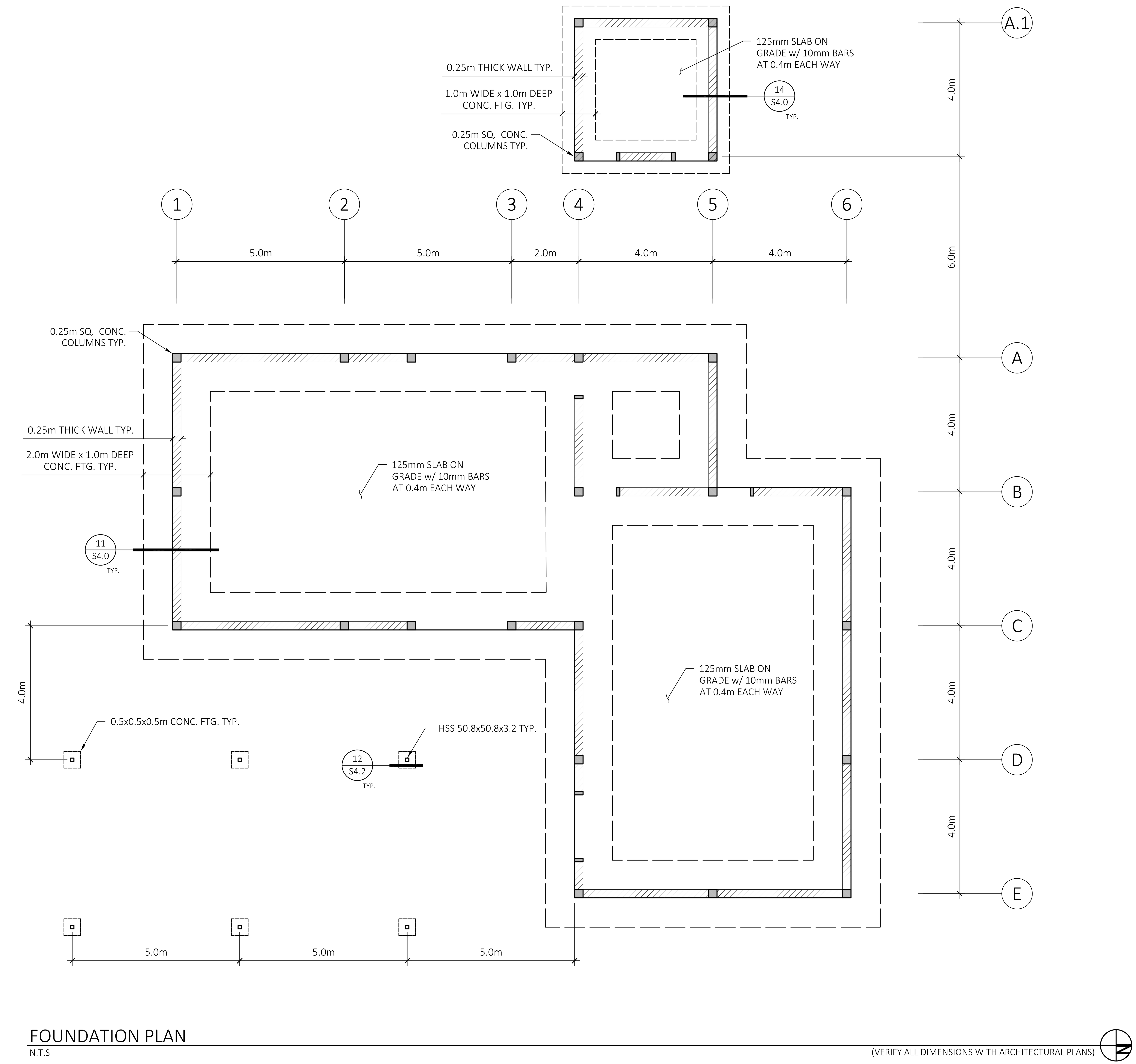
SHEET TITLE:

TYPICAL DETAILS

DATE: 2019 - 06 - 06
SCALE: AS NOTED
DRAWN: JRD, JMW
DESIGNED: JRD, JMW
CHECKED: JM

SHEET:

S1.1



FOUNDATION PLAN

N.T.S

(VERIFY ALL DIMENSIONS WITH ARCHITECTURAL PLANS)

REVISIONS: BY:

DRAWINGS TO BE REVIEWED BY IN COUNTRY ARCHITECT/ENGINEER

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RWANDA

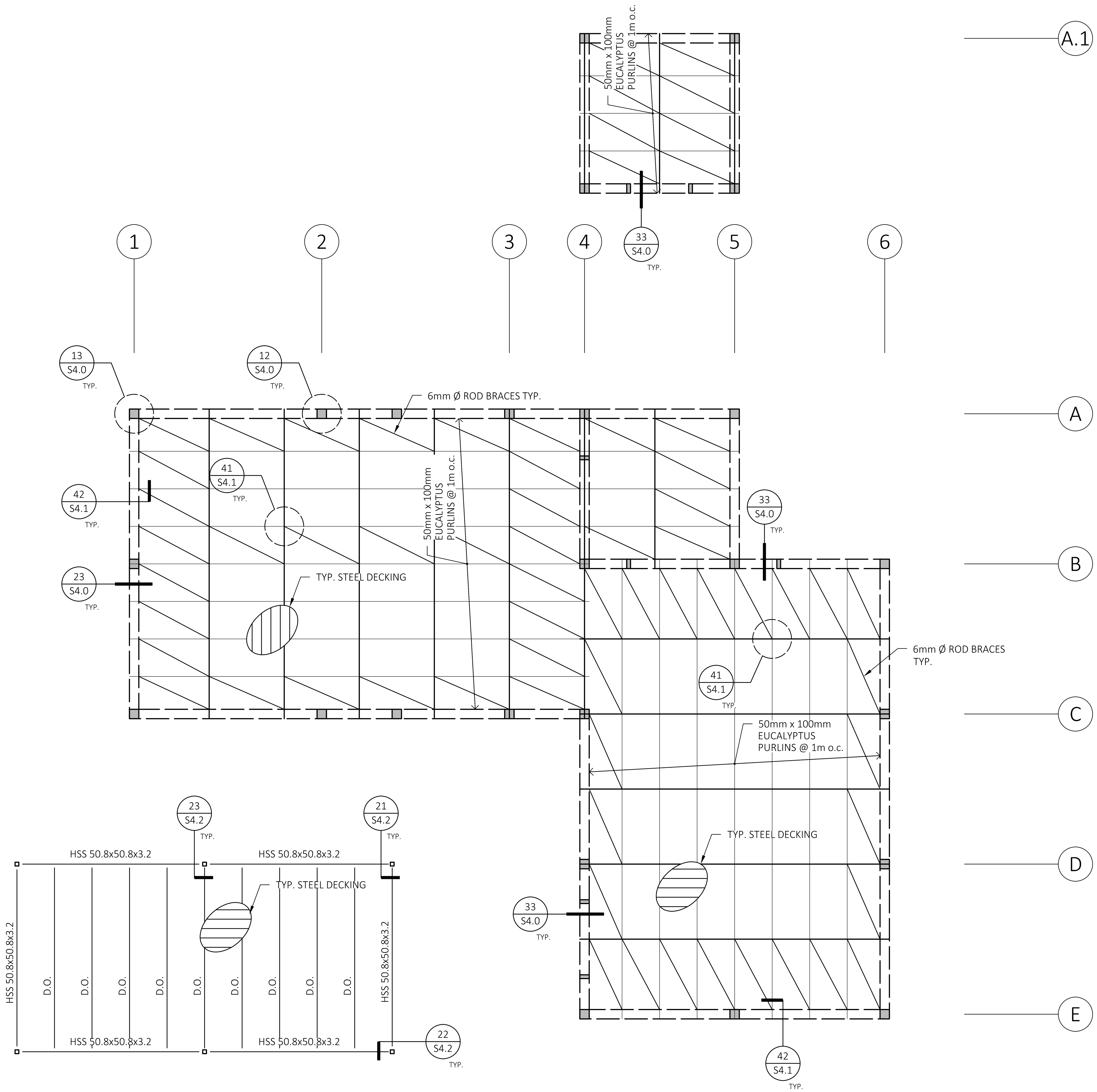
SHEET TITLE:

FOUNDATION PLAN

DATE: 2019 - 06 - 06
SCALE: AS NOTED
DRAWN: JRD, JMW
DESIGNED: JRD, JMW
CHECKED: JM

SHEET:

S2.0



ROOF FRAMING PLAN

N.T.S.

REVISIONS: BY:

DRAWINGS TO BE REVIEWED BY IN COUNTRY ARCHITECT/ENGINEER

DRAWINGS NOT FOR CONSTRUCTION

CLIENT:

JOURNEYMAN INTERNATIONAL
3471 N. MAIN ST.
PRINEVILLE, OR 97754

PROJECT:

RUBAGABAGA AGRICULTURAL TRAINING FACILITY AND COMMUNITY CENTER
RWANDA

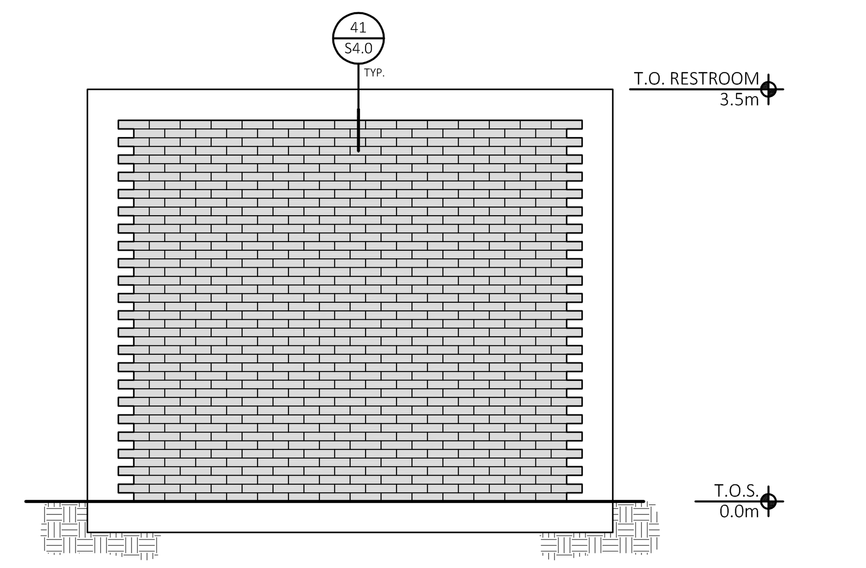
SHEET TITLE:

ROOF FRAMING PLAN

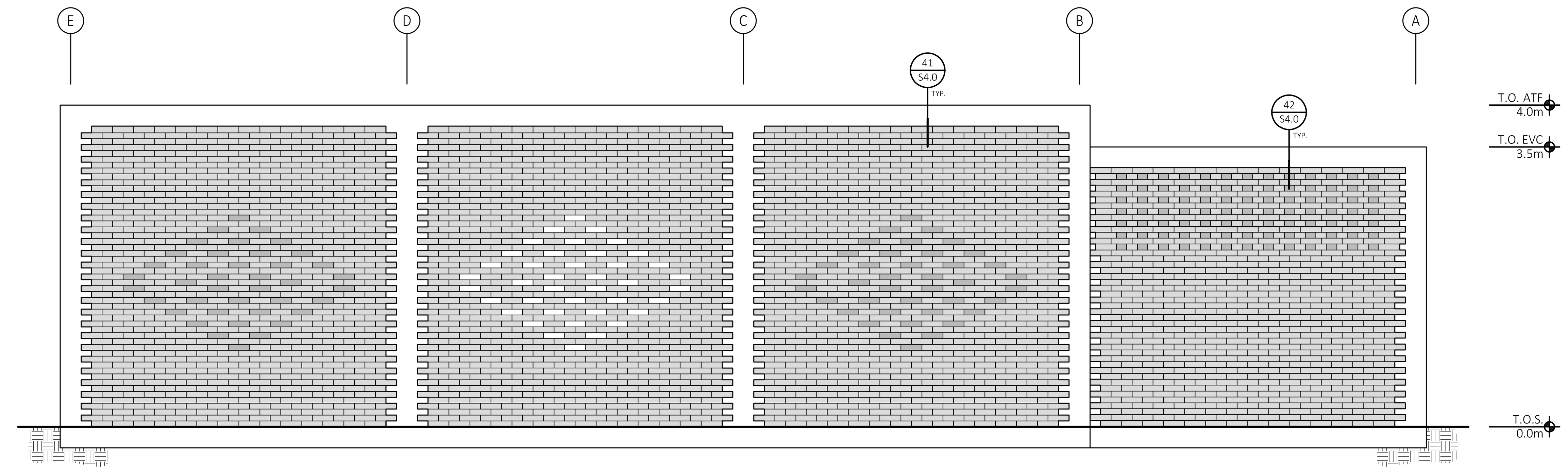
DATE: 2019 - 06 - 06
SCALE: AS NOTED
DRAWN: JRD, JMW
DESIGNED: JRD, JMW
CHECKED: JM

SHEET:

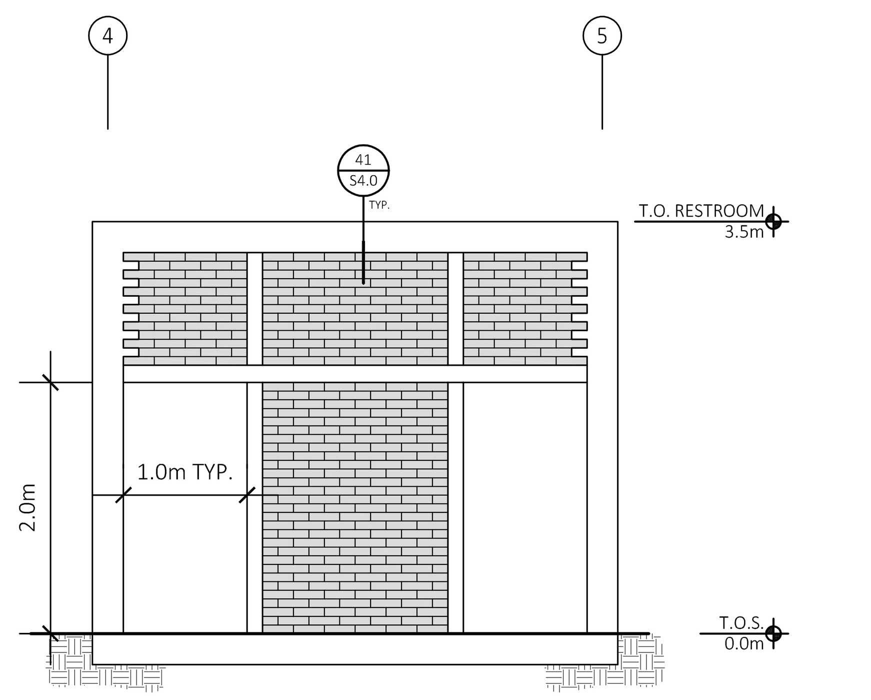
S2.1



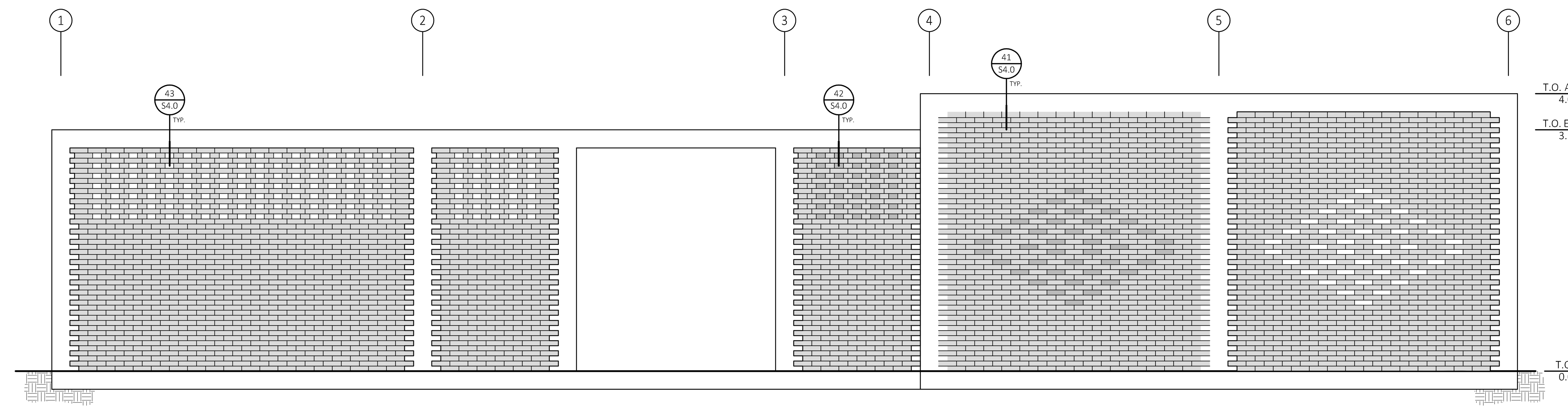
TYP. RESTROOM ELEVATION
N.T.S.
41



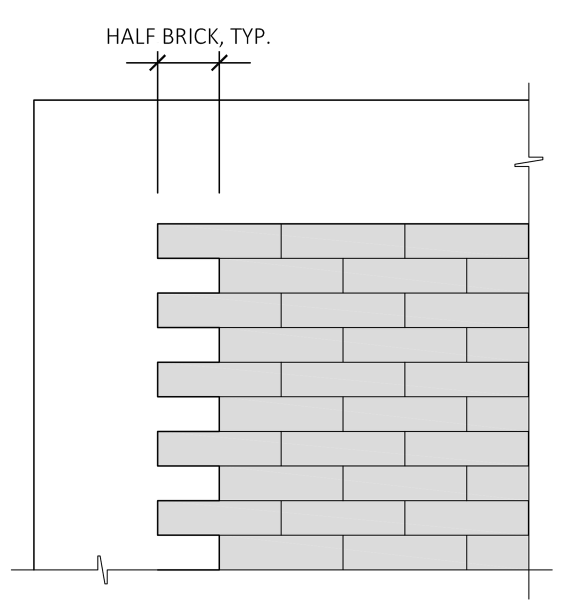
NORTH WALL ELEVATION
N.T.S.
11



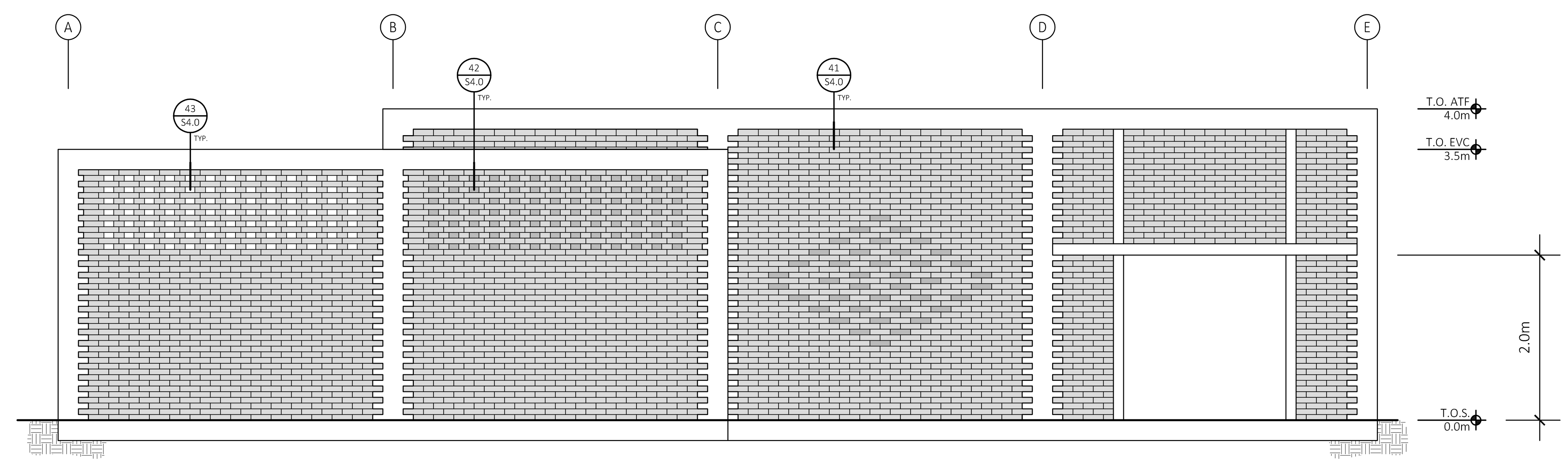
EAST RESTROOM ELEVATION
N.T.S.
42



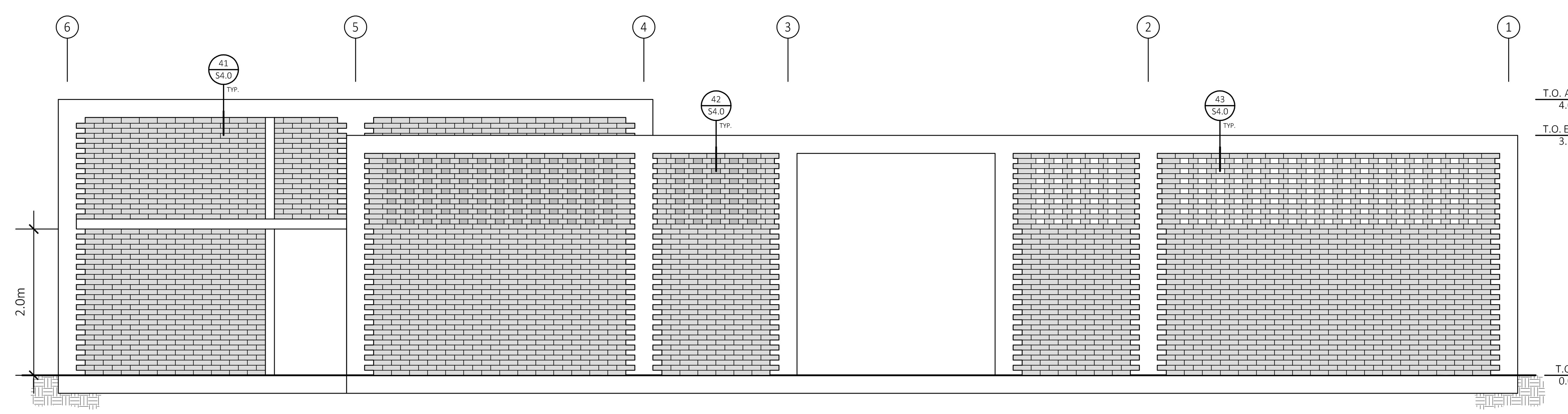
EAST WALL ELEVATION
N.T.S.
12



TYP. BRICK TEETHING
N.T.S.
43



SOUTH WALL ELEVATION
N.T.S.
13



WEST WALL ELEVATION
N.T.S.
14

REVISIONS: BY:

DRAWINGS TO BE REVIEWED BY IN COUNTRY ARCHITECT/ENGINEER

DRAWINGS NOT FOR CONSTRUCTION

CLIENT:

JOURNEYMAN INTERNATIONAL
3471 N. MAIN ST.
PRINEVILLE, OR 97754

PROJECT:

RUBAGABAGA AGRICULTURAL TRAINING FACILITY AND COMMUNITY CENTER
RWANDA

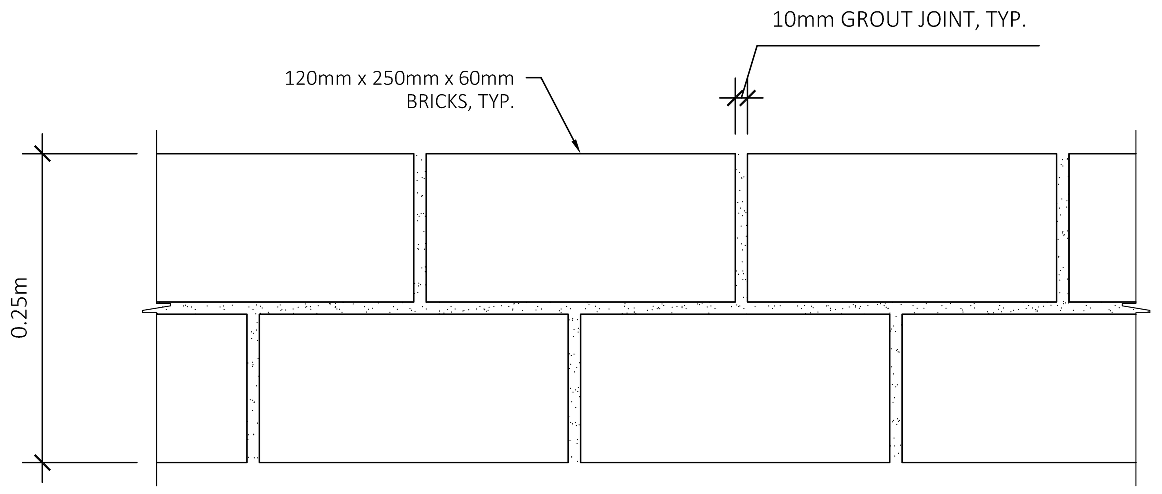
SHEET TITLE:

WALL ELEVATIONS

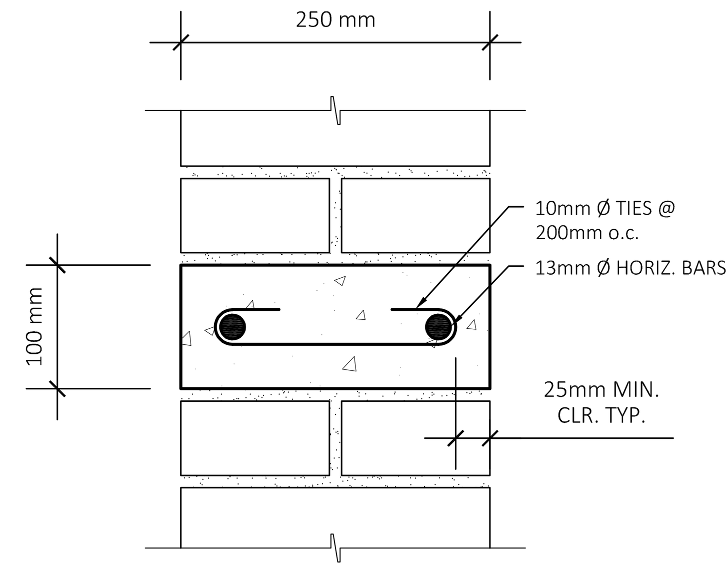
DATE: 2019 - 06 - 06
SCALE: AS NOTED
DRAWN: JRD, JMW
DESIGNED: JRD, JMW
CHECKED: JM

SHEET:

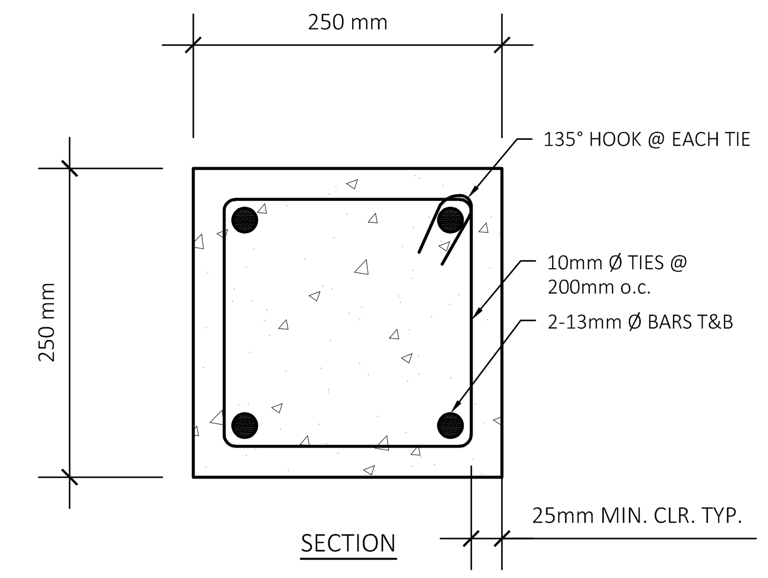
S3.0



TYPICAL WALL SECTION (41)
N.T.S.

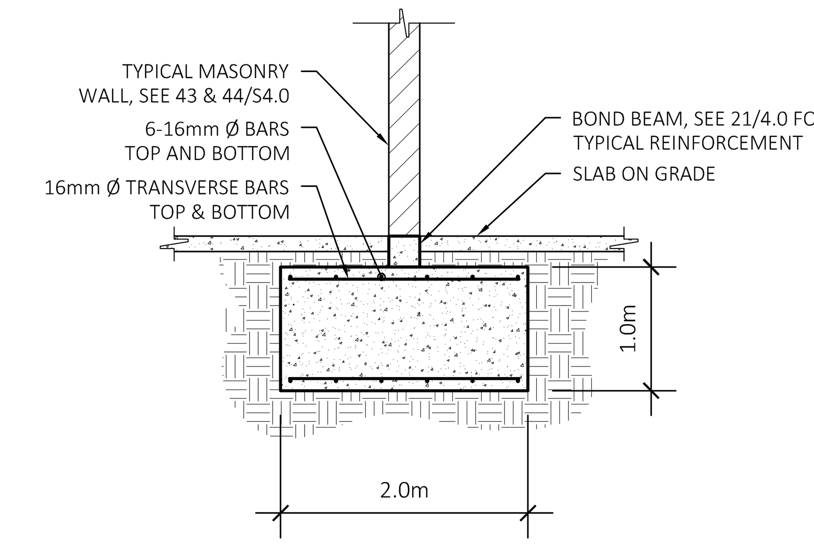


LINTEL/PLINTH REINF. (31)
N.T.S.

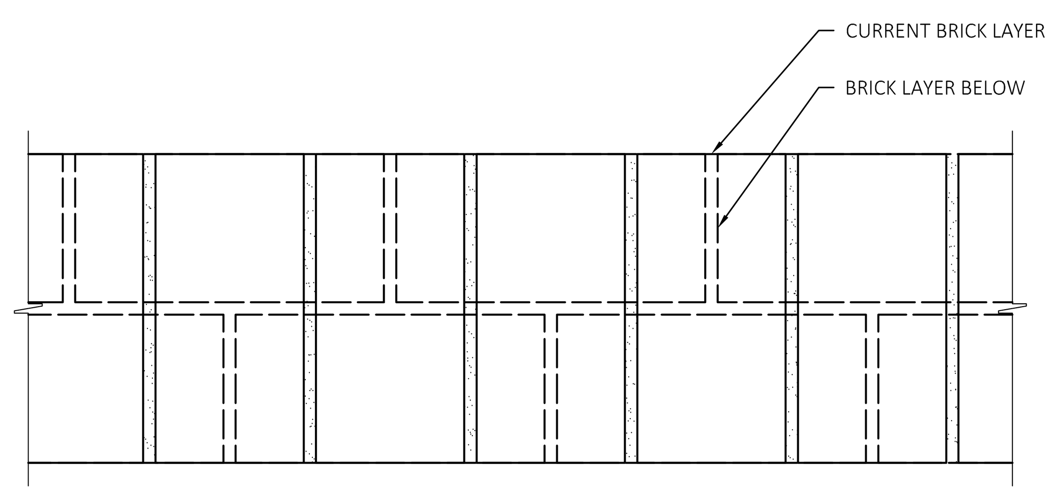


NOTES: (#)
1. TYPICAL TIE BEAM AND TIE COLUMN HAVE SAME REINFORCEMENT AS SEEN ABOVE.

TIE BEAM/COLUMN REINF. (21)
N.T.S.

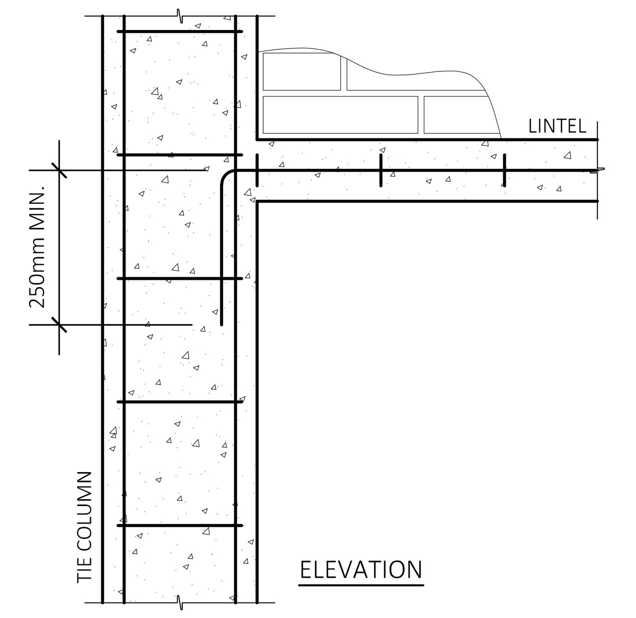


CONT. WALL FOOTING (11)
N.T.S.



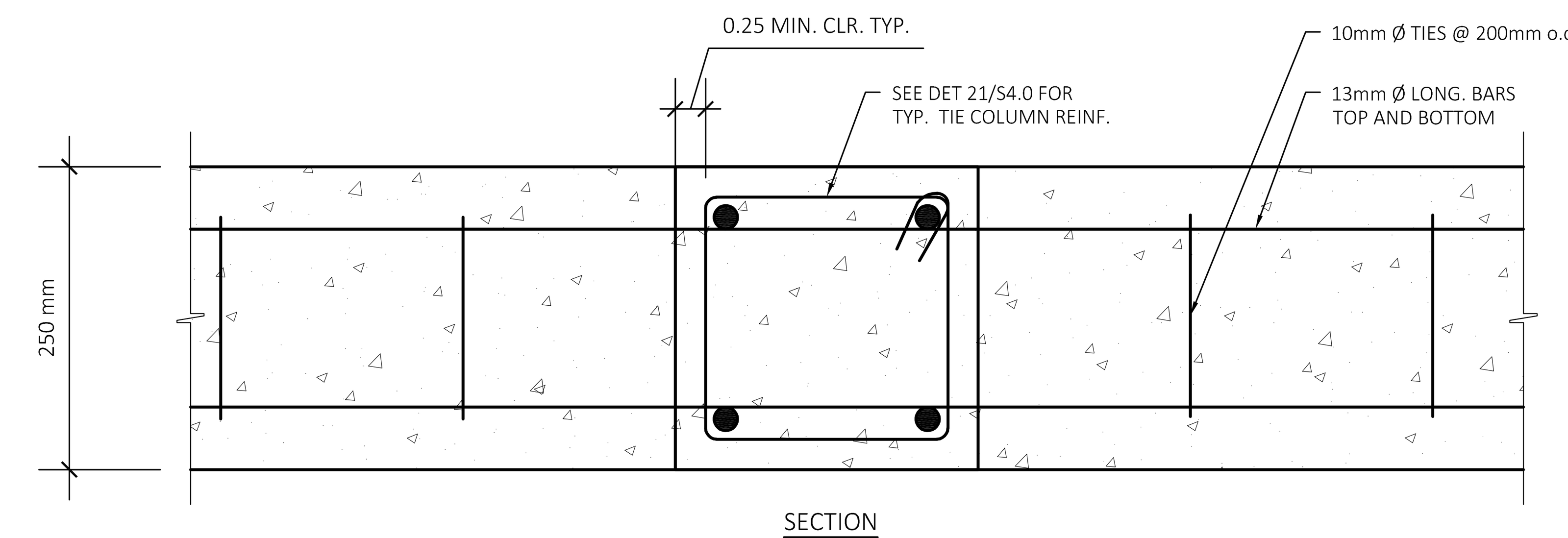
NOTES: (#)
1. SEE 41/S4.0 FOR TYPICAL BRICK SIZE

WALL SECTION w/ FLEMISH BOND (42)
N.T.S.

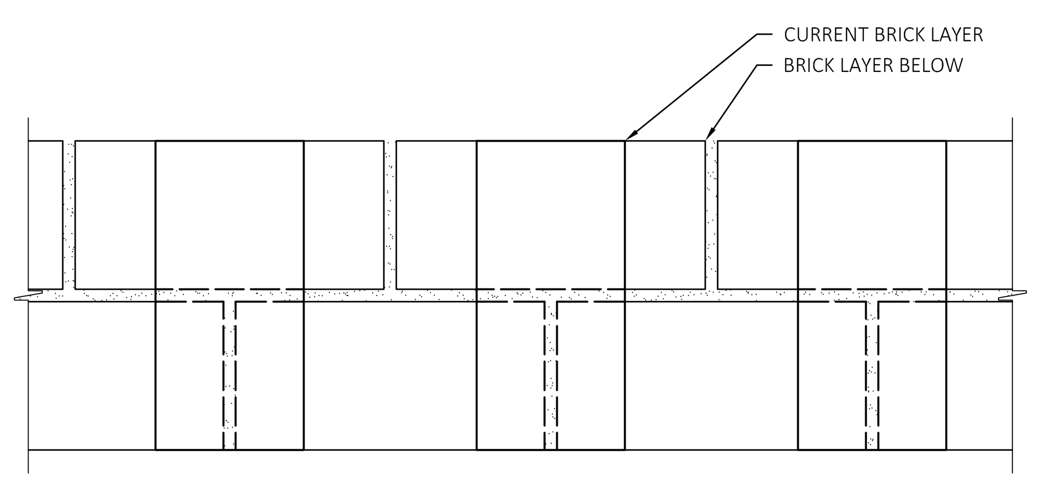


NOTES: (#)
1. SEE DET 21/S4.0 FOR TYPICAL TIE-COLUMN REINFORCEMENT
2. SEE DET 31/S4.0 FOR TYPICAL LINTEL REINFORCEMENT

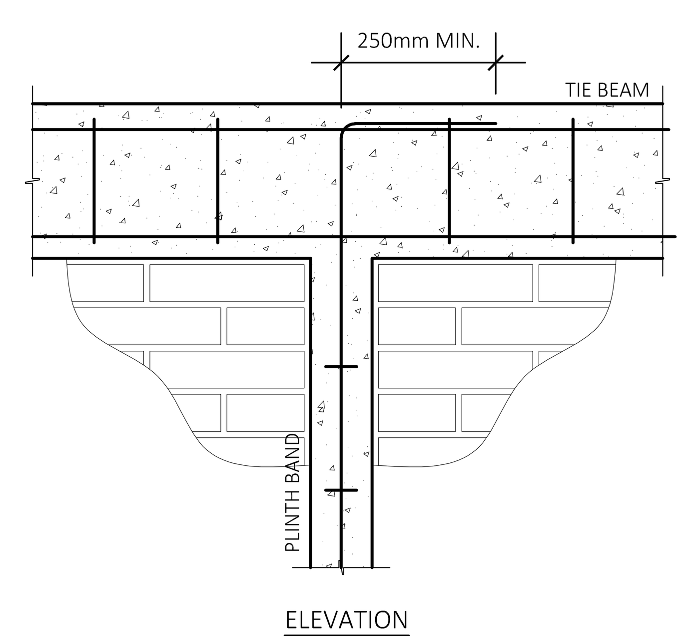
LINTEL TO TIE-COLUMN (32)
N.T.S.



CONT. TIE-BEAM REINFORCEMENT (12)
N.T.S.

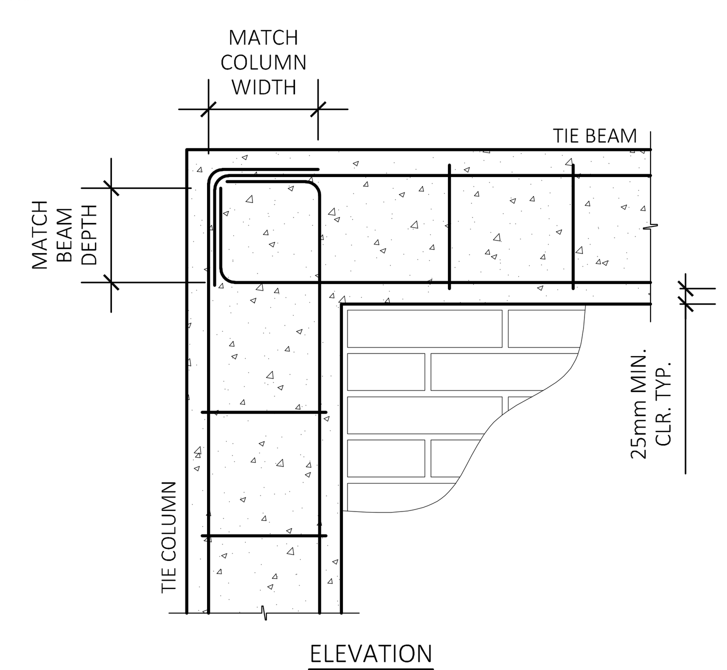


WALL SECTION w/ FLEMISH BOND MISSING BRICKS (43)
N.T.S.



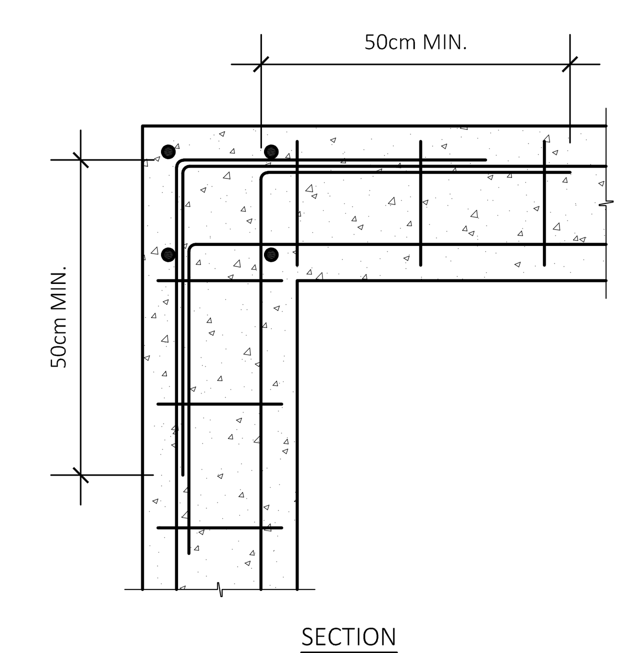
NOTES: (#)
1. SEE DET 21/S4.0 FOR TYPICAL TIE-BEAM REINFORCEMENT
2. SEE DET 31/S4.0 FOR TYPICAL PLINTH BAND REINFORCEMENT

PLINTH BAND TO TIE-BEAM (33)
N.T.S.



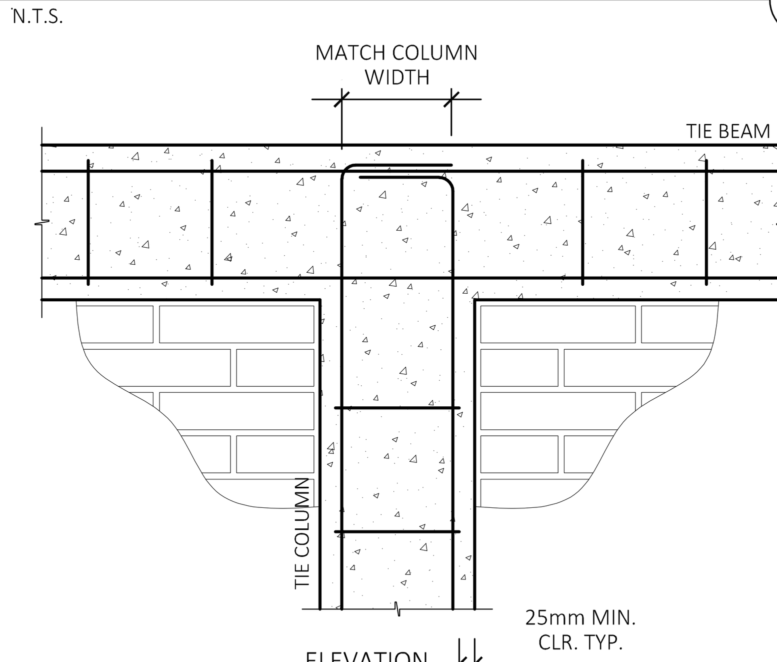
NOTES: (#)
1. SEE DET 21/S4.0 FOR TYPICAL TIE-BEAM AND TIE-COLUMN REINFORCEMENT

TIE-BEAM TO TIE-COLUMN (23)
N.T.S.



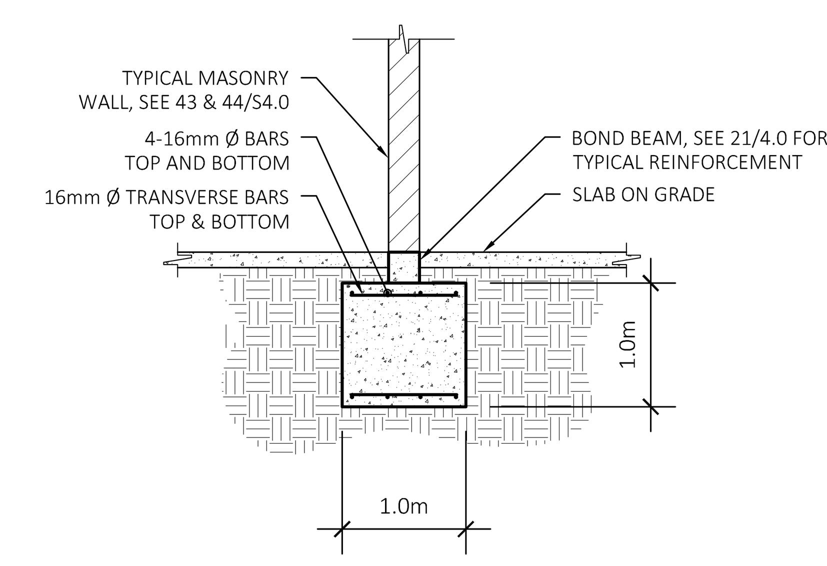
NOTES: (#)
1. SEE DET 21/S4.0 FOR TYPICAL TIE-BEAM AND TIE-COLUMN REINFORCEMENT

TIE BEAM CORNER REINF. (13)
N.T.S.



NOTES: (#)
1. SEE DET 21/S4.0 FOR TYPICAL TIE-BEAM AND TIE-COLUMN REINFORCEMENT

CONT. TIE-BEAM TO TIE-COL. (24)
N.T.S.



RESTROOM WALL FOOTING (14)
N.T.S.

REVISIONS: BY:

DRAWINGS TO BE REVIEWED BY IN COUNTRY ARCHITECT/ENGINEER

DRAWINGS NOT FOR CONSTRUCTION

CLIENT:

JOURNEYMAN INTERNATIONAL
3471 N. MAIN ST.
PRINEVILLE, OR 97754

PROJECT:

RUBAGABAGA AGRICULTURAL TRAINING FACILITY AND COMMUNITY CENTER
RWANDA

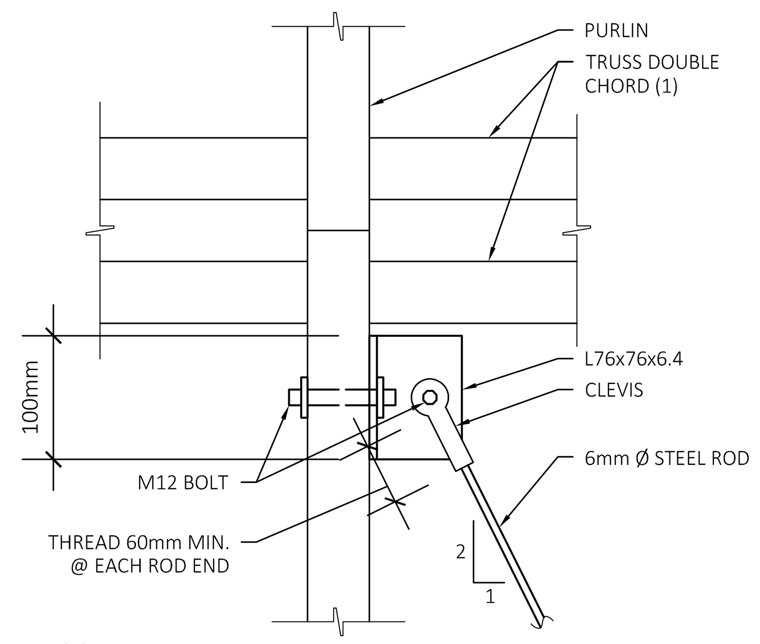
SHEET TITLE:

FOUNDATION AND WALL DETAILS

DATE: 2019 - 06 - 06
SCALE: AS NOTED
DRAWN: JRD, JMW
DESIGNED: JRD, JMW
CHECKED: JM

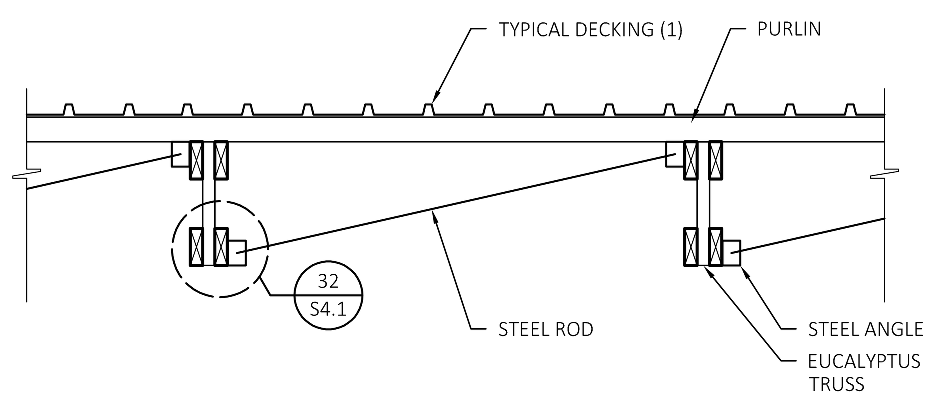
SHEET:

S4.0



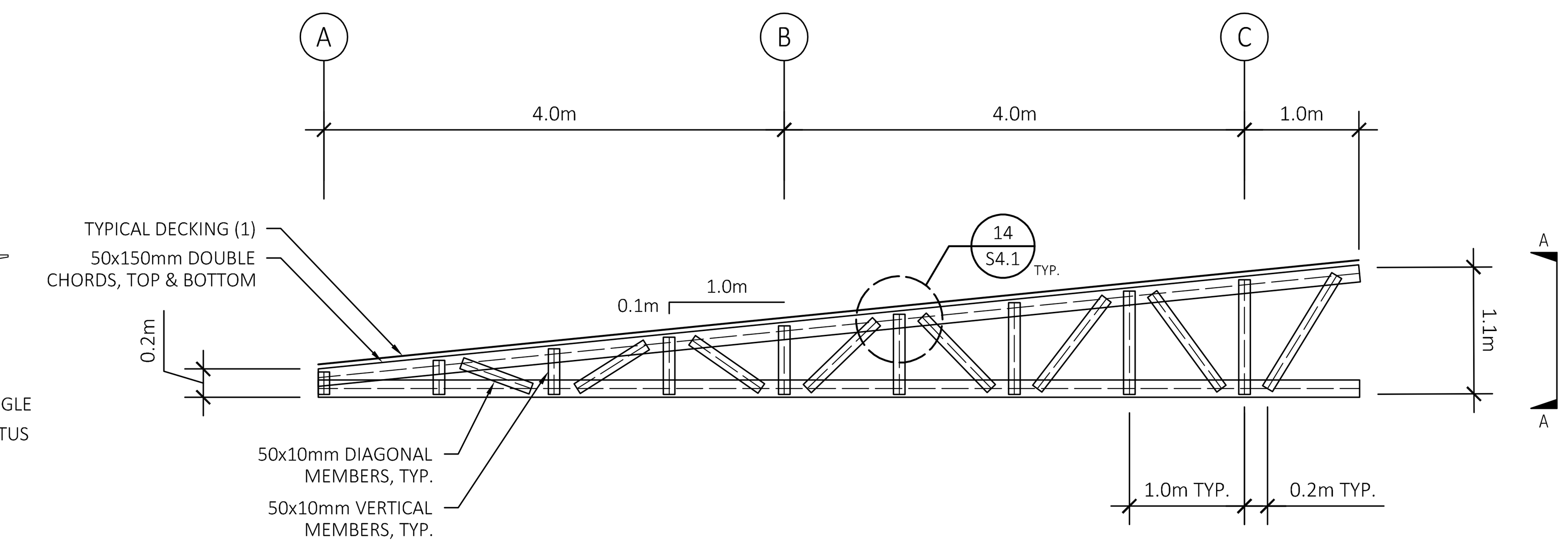
NOTES: (#)
1. SEE TRUSS ELEVATIONS FOR MEMBER SIZES ON DET 11, 12, 13/S4.1

ROD CONNECTION 41
N.T.S.



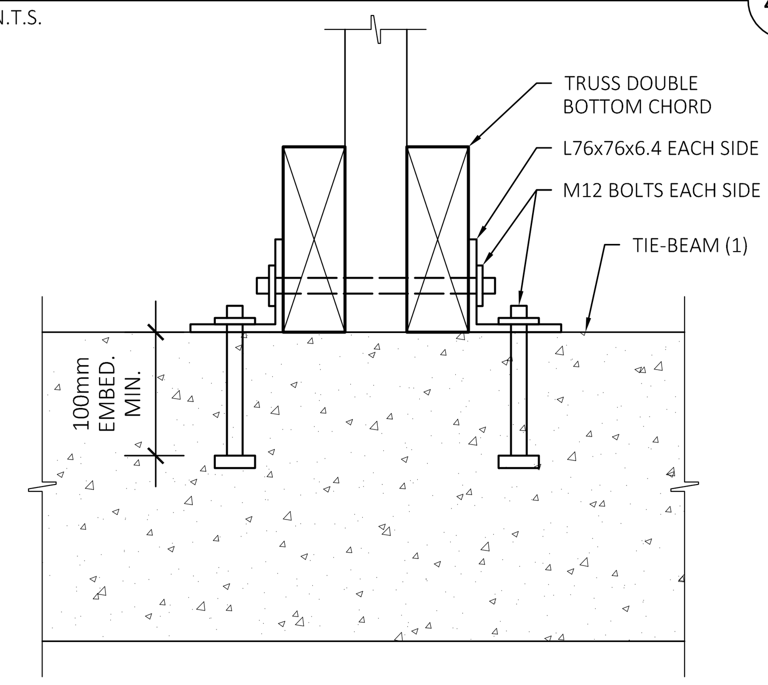
NOTES: (#)
1. SAFINTRA SAFLOK 700 DECKING w/ SL 700 CLIPS (AZ150 G550 PAINTED ALUMINUM-ZINC 0.5mm
2. OUT OF PLANE TRUSS BRACING OCCURS AT LINE 5 AND LINE B

MID-SPAN TRUSS SECTION 31
N.T.S.



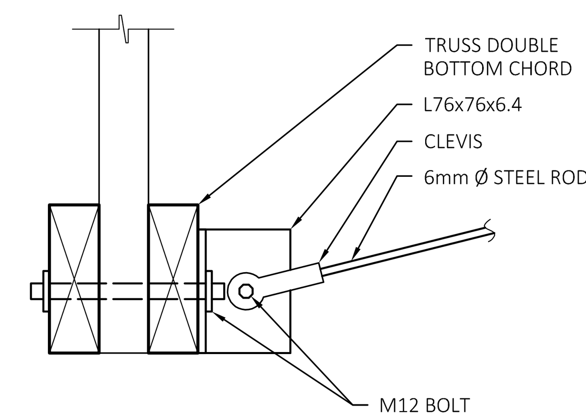
NOTES: (#)
1. SAFINTRA SAFLOK 700 DECKING w/ SL 700 CLIPS (AZ150 G550 PAINTED ALUMINUM-ZINC 0.5mm)

TRUSS A ELEVATION 11
N.T.S.

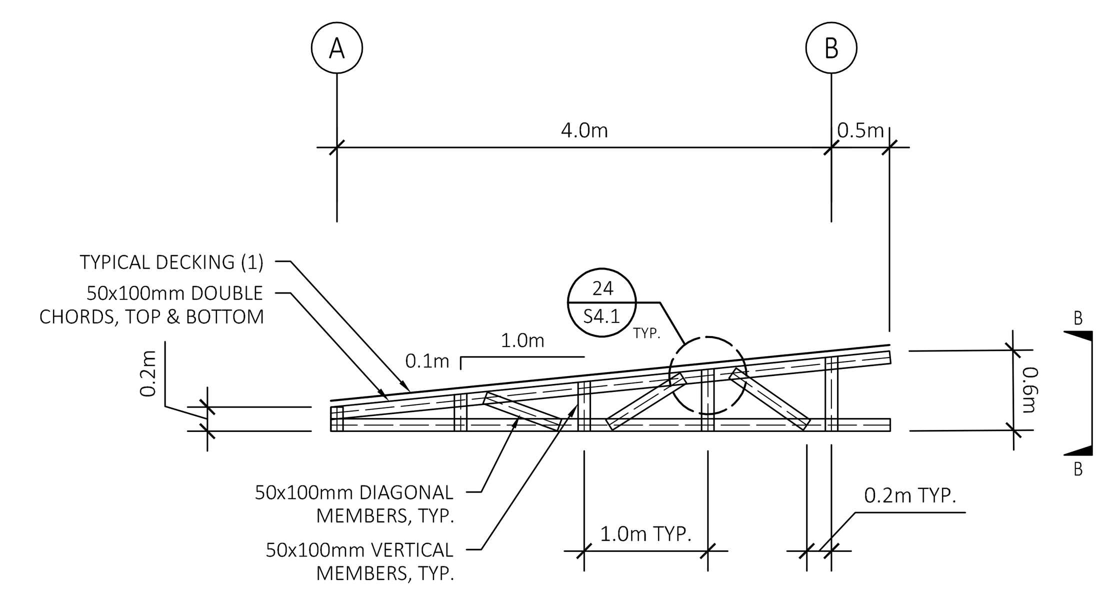


NOTES: (#)
1. TIE-BEAM REINFORCEMENT NOT SHOWN FOR CLARITY. SEE 21/S4.0 FOR TYPICAL REINFORCEMENT.

TRUSS TO WALL 42
N.T.S.

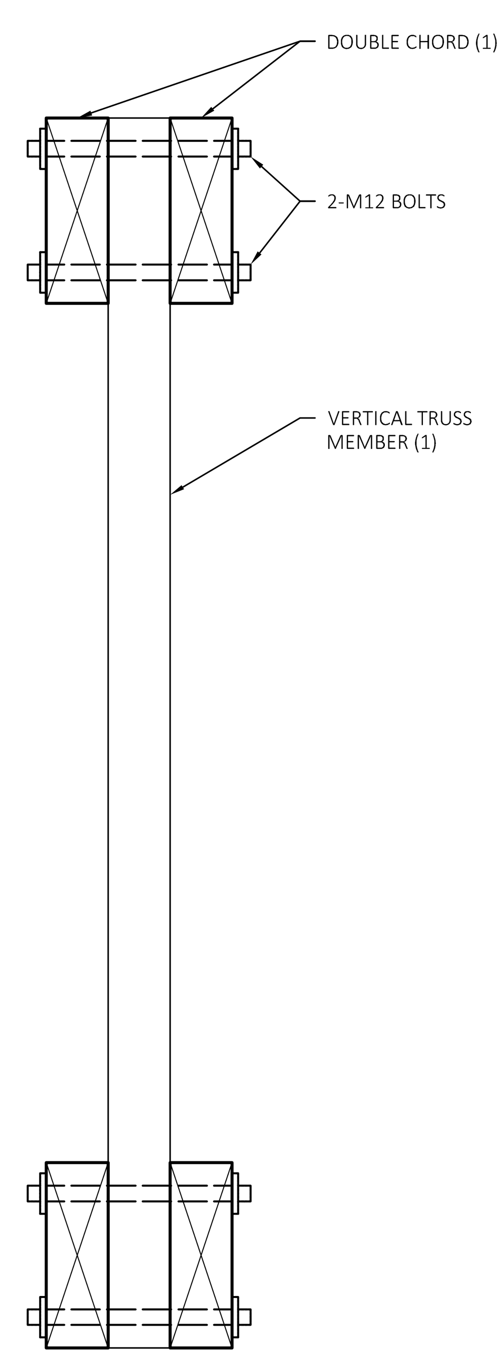


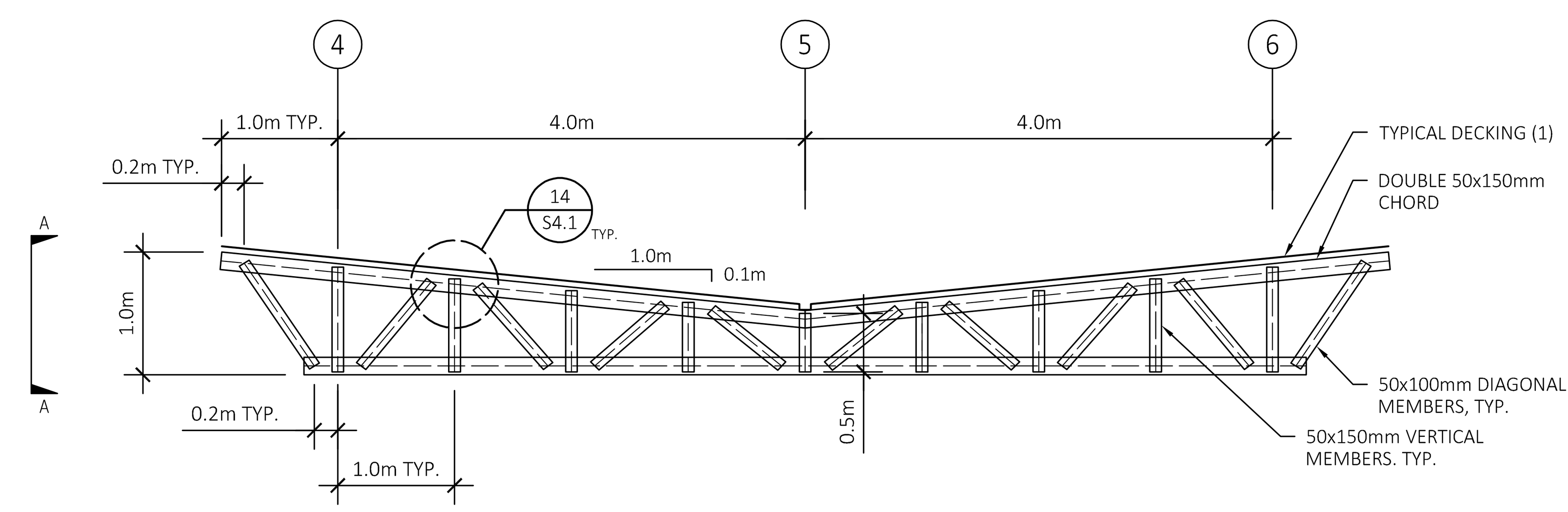
TRUSS CHORD ROD BRACING 32
N.T.S.



NOTES: (#)
1. SAFINTRA SAFLOK 700 DECKING w/ SL 700 CLIPS (AZ150 G550 PAINTED ALUMINUM-ZINC 0.5mm)

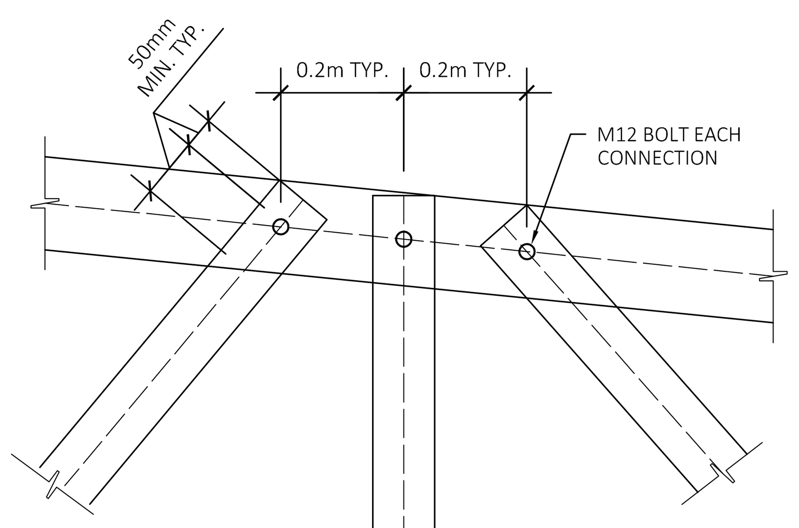
TRUSS B ELEVATION 12
N.T.S.

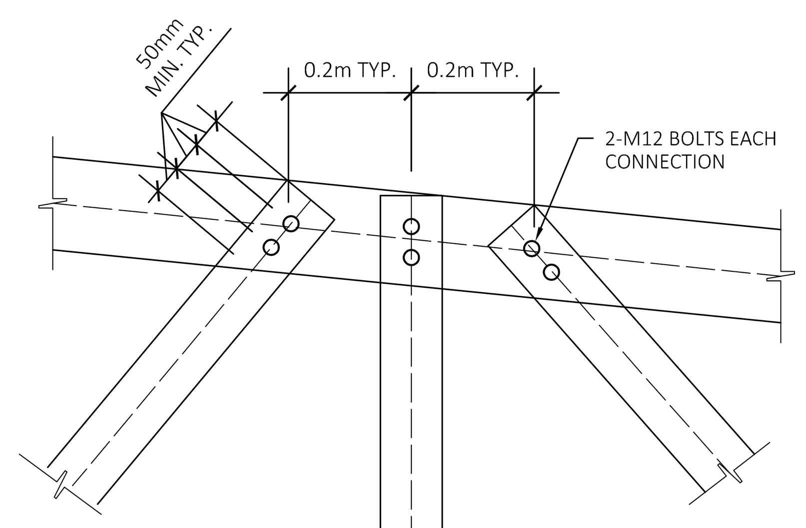


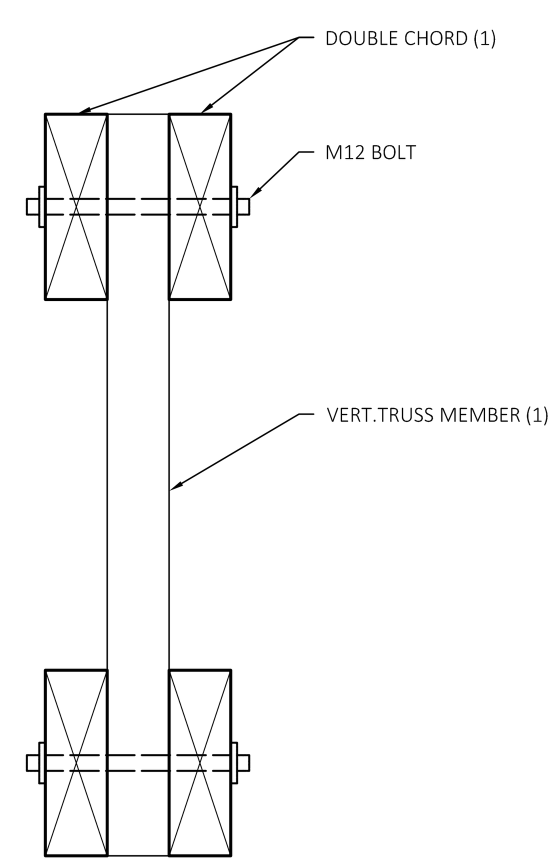


NOTES: (#)
1. SAFINTRA SAFLOK 700 DECKING w/ SL 700 CLIPS (AZ150 G550 PAINTED ALUMINUM-ZINC 0.5mm)

TRUSS C ELEVATION 13
N.T.S.







NOTES: (#)
1. SEE TRUSS ELEVATIONS FOR MEMBER SIZES ON DET 11, 12, 13/S4.1

SECTION B-B 44
N.T.S.

NOTES: (#)
1. SEE TRUSS ELEVATIONS FOR MEMBER SIZES ON DET 11, 12, 13/S4.1

SECTION A-A 34
N.T.S.

TRUSS BOLT CONNECTION 24
N.T.S.

TRUSS BOLT CONNECTION 14
N.T.S.

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DRAWINGS TO BE REVIEWED BY IN COUNTRY ARCHITECT/ENGINEER

DRAWINGS NOT FOR CONSTRUCTION

CLIENT:

JOURNEYMAN INTERNATIONAL
3471 N. MAIN ST.
PRINEVILLE, OR 97754

PROJECT:

RUBAGABAGA AGRICULTURAL TRAINING FACILITY AND COMMUNITY CENTER
RWANDA

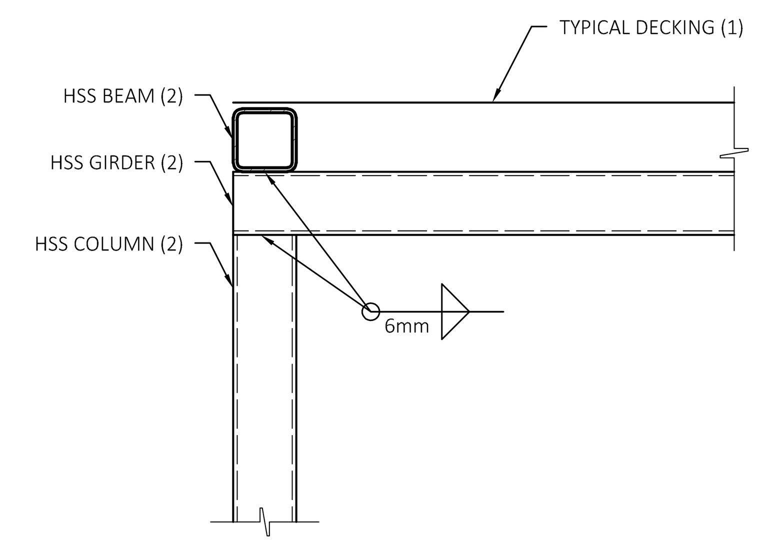
SHEET TITLE:

ROOF FRAMING DETAILS

DATE: 2019 - 06 - 06
SCALE: AS NOTED
DRAWN: JRD, JMW
DESIGNED: JRD, JMW
CHECKED: JM

SHEET:

S4.1

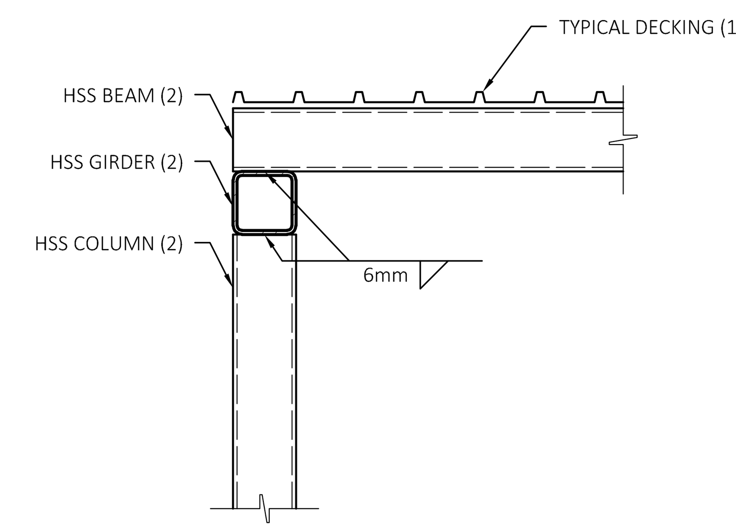


NOTES: (#)
1. SAFINTRA SAFLOK 700 DECKING w/ SL 700 CLIPS (AZ150 G550 PAINTED ALUMINUM-ZINC 0.5mm)
2. SEE PLAN FOR MEMBER SIZES

BEAM TO COLUMN

N.T.S.

21

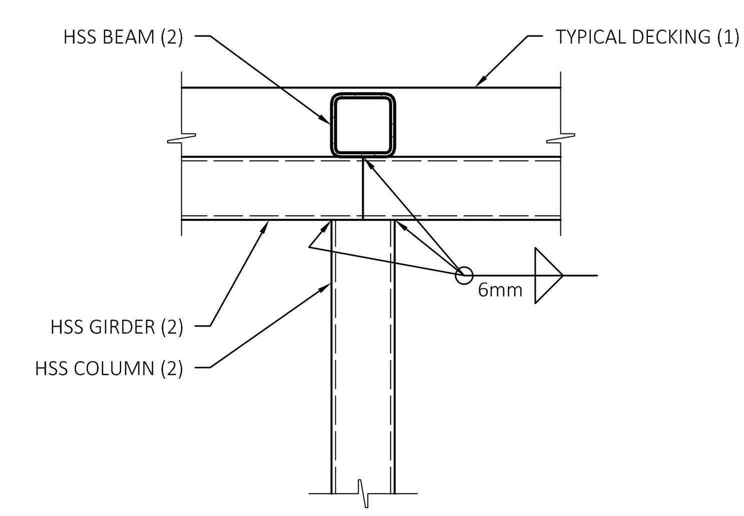


NOTES: (#)
1. SAFINTRA SAFLOK 700 DECKING w/ SL 700 CLIPS (AZ150 G550 PAINTED ALUMINUM-ZINC 0.5mm)
2. SEE PLAN FOR MEMBER SIZES

GIRDER TO COLUMN

N.T.S.

22

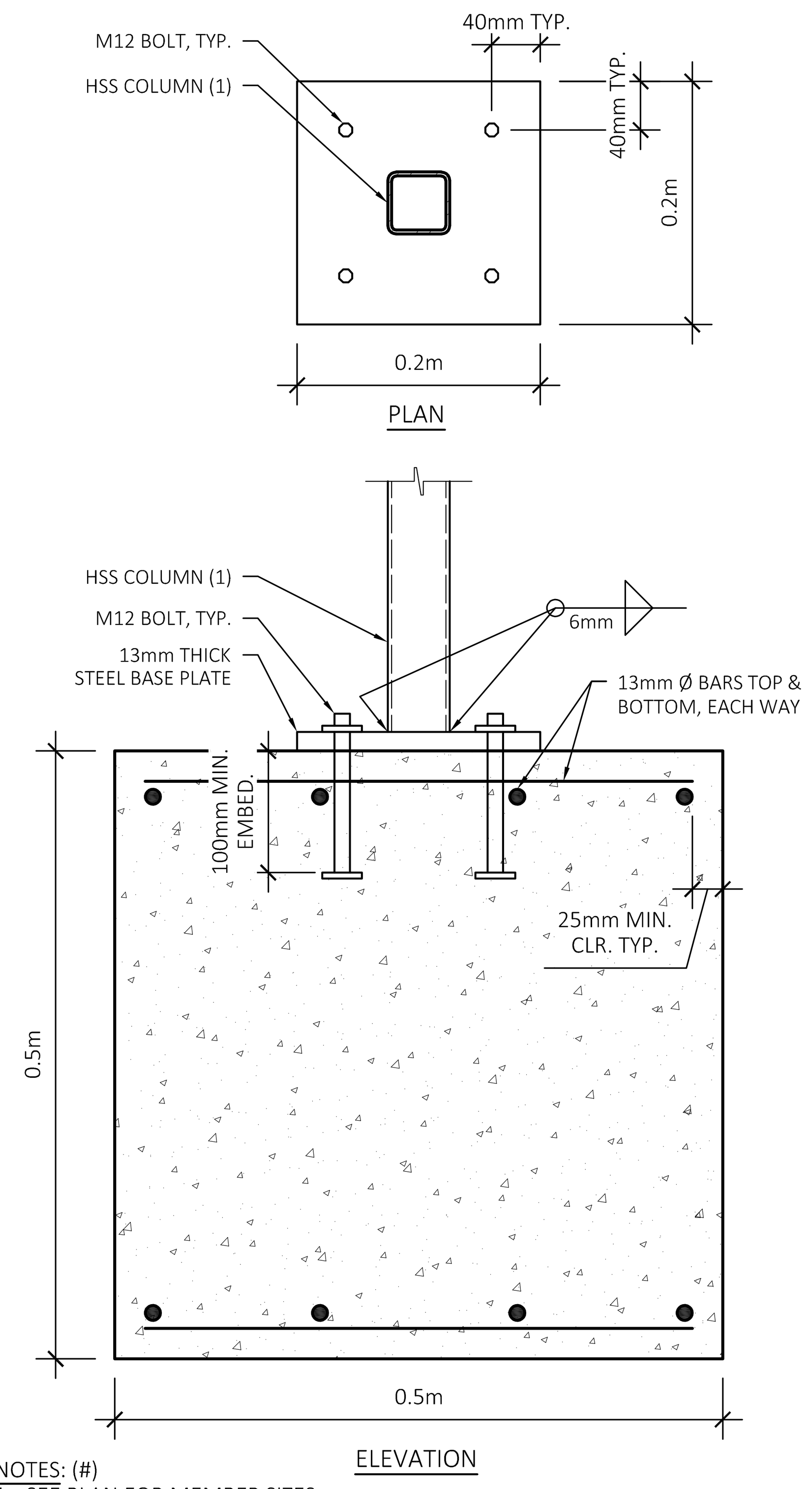


NOTES: (#)
1. SAFINTRA SAFLOK 700 DECKING w/ SL 700 CLIPS (AZ150 G550 PAINTED ALUMINUM-ZINC 0.5mm)
2. SEE PLAN FOR MEMBER SIZES

GIRDER SPLICE @ COLUMN

N.T.S.

23



NOTES: (#)
1. SEE PLAN FOR MEMBER SIZES

CANOPY PAD FOOTING

N.T.S.

12

REVISIONS: BY:

DRAWINGS TO BE REVIEWED BY IN COUNTRY ARCHITECT/ENGINEER

DRAWINGS NOT FOR CONSTRUCTION

CLIENT:

JOURNEYMAN INTERNATIONAL

3471 N. MAIN ST.
PRINEVILLE, OR 97754

PROJECT:

RUBAGABAGA AGRICULTURAL TRAINING FACILITY AND COMMUNITY CENTER

RWANDA

SHEET TITLE:

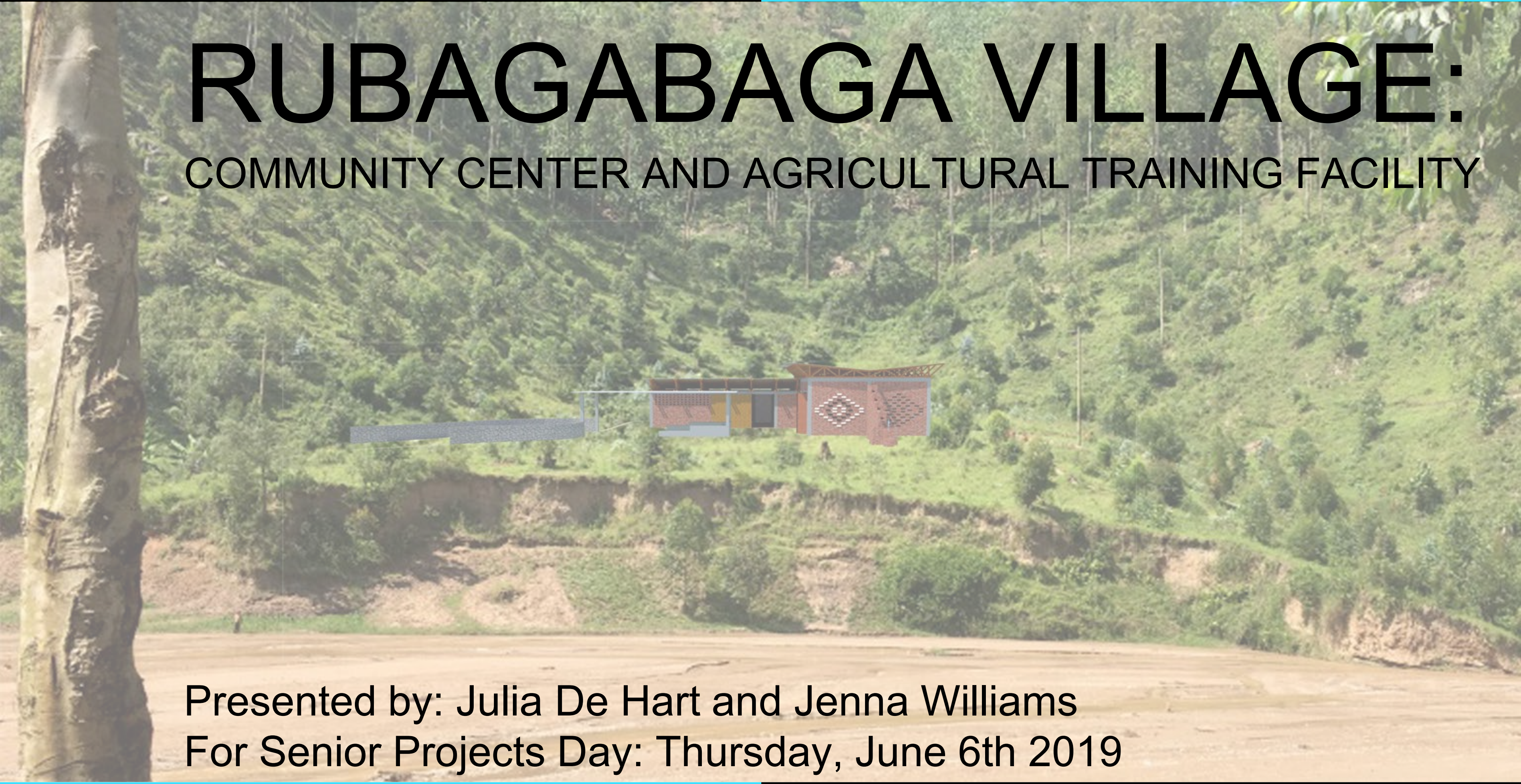
STEEL CANOPY DETAILS

DATE: 2019 - 06 - 06
SCALE: AS NOTED
DRAWN: JRD, JMW
DESIGNED: JRD, JMW
CHECKED: JM

SHEET:

S4.2

APPENDIX C: PRESENTATION



RUBAGABAGA VILLAGE:

COMMUNITY CENTER AND AGRICULTURAL TRAINING FACILITY

Presented by: Julia De Hart and Jenna Williams
For Senior Projects Day: Thursday, June 6th 2019

OUTLINE

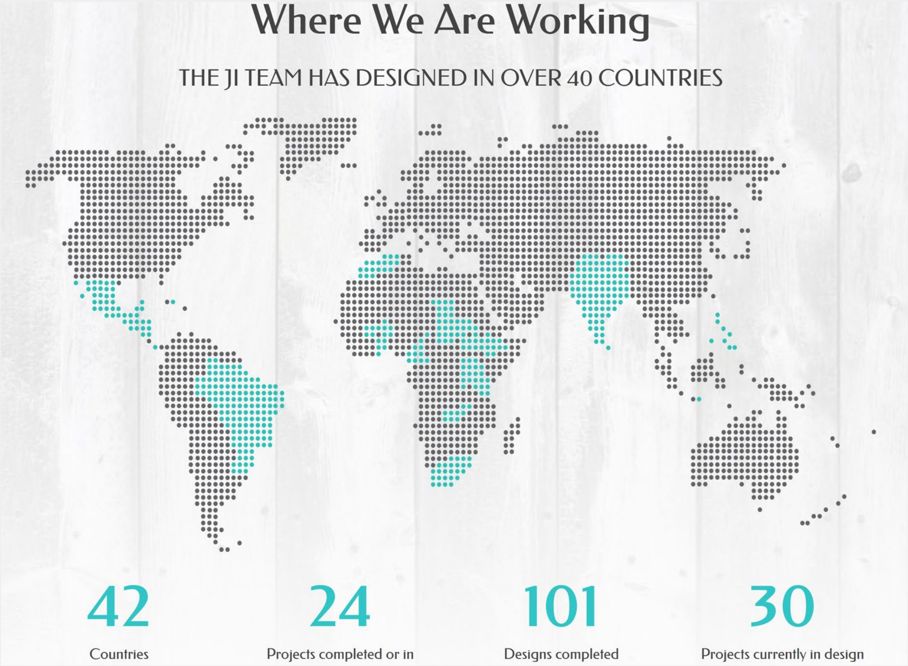
- ➢ Project Partners
- ➢ Project Description
- ➢ Structural Design
- ➢ Challenges
- ➢ Travel Experience
- ➢ Takeaways

PROJECT PARTNERS - Journeyman International

- Non-profit company founded in 2009

- Design and construction of international humanitarian projects

- “Build What Matters Most”



CAL POLY JI TEAM

Mackenzie Dias
Architecture

Jenna Williams
Architectural Engineering

Julia De Hart
Architectural Engineering

Jake Stom
Construction Management

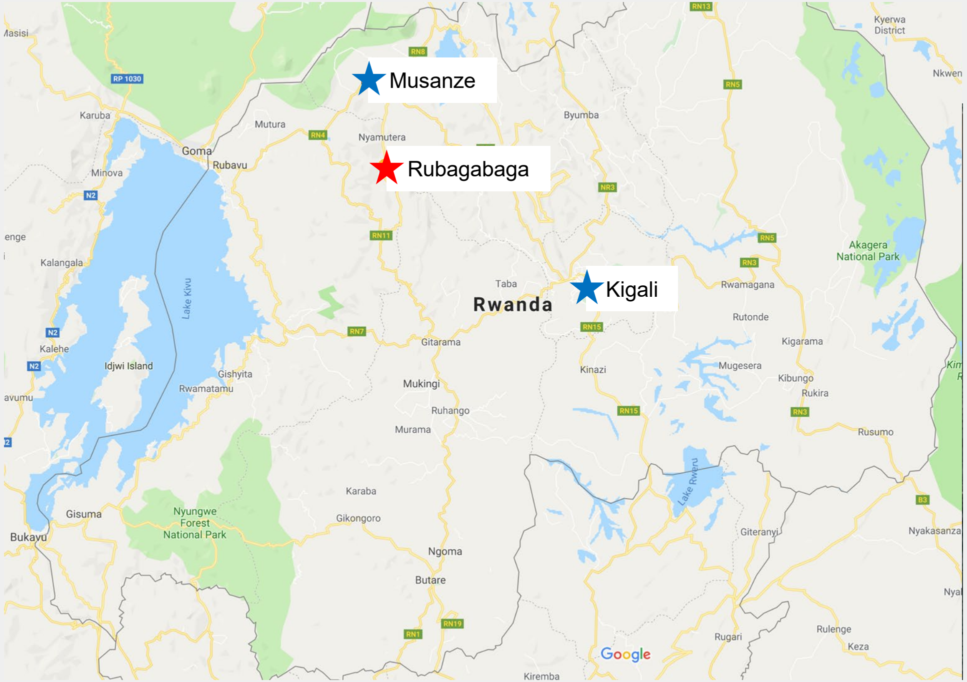
PROJECT PARTNERS - East African Power

- EmPOWERing Villages through Renewable Energy Development

- The 5 E's
  - Energy
  - Environment
  - Education
  - Entrepreneurship
  - Enjoyment

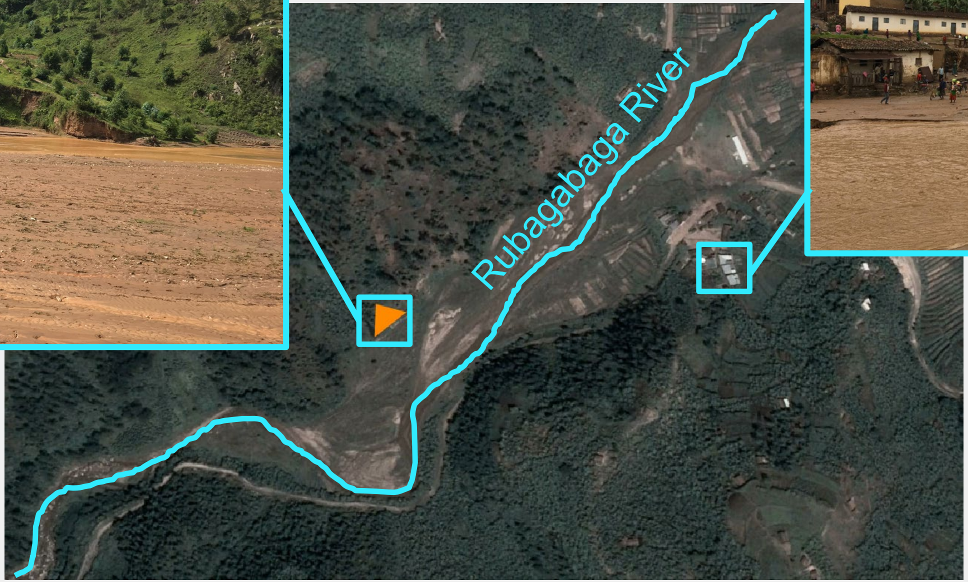
PROJECT PARTNERS - East African Power

PROJECT DESCRIPTION - LOCATION



PROJECT DESCRIPTION - LOCATION

Project Site



Kaseke Village

PROJECT DESCRIPTION - EVC and ATF

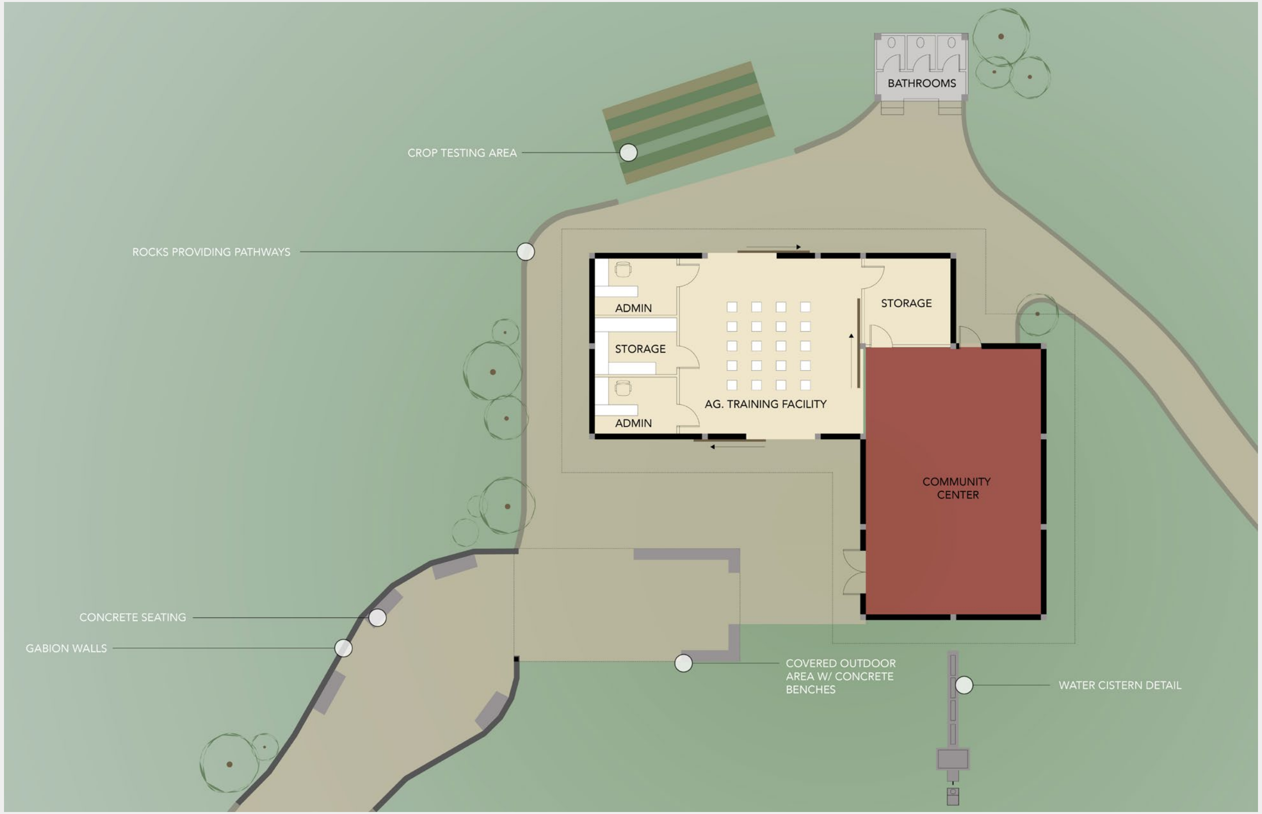
- **Empowering Villages Center (EVC)**

  "To provide space for assembly, social programs, skills trainings, and recreation"

- **Agricultural Training Facility (ATF)**

  "To allow local farmers to adopt innovative strategies that can make their land more profitable - even to a commercial level"

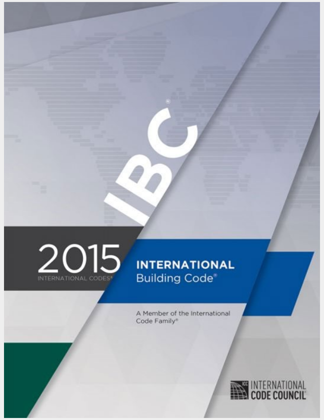
PROJECT DESCRIPTION - EVC and ATF

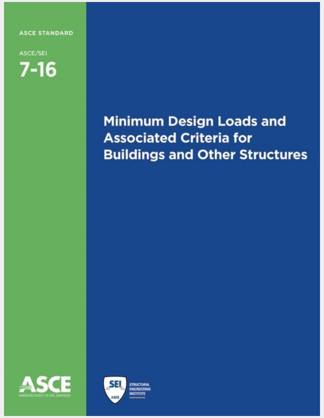


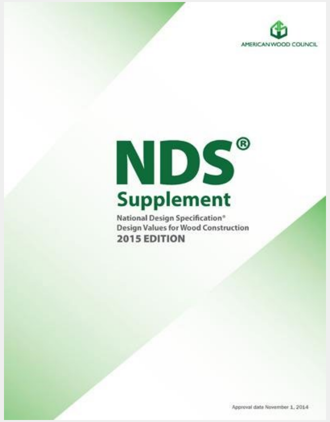
PROJECT DESCRIPTION - THE DELIVERABLES

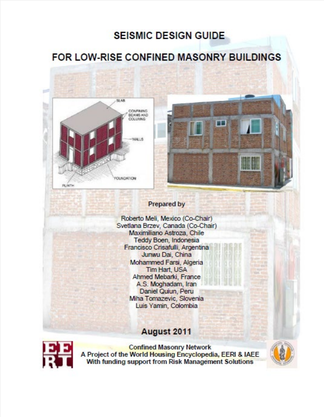
- Architectural Design and Drawings
- Structural Calculations and Drawings
- Construction Costs and Quantity Take-Offs

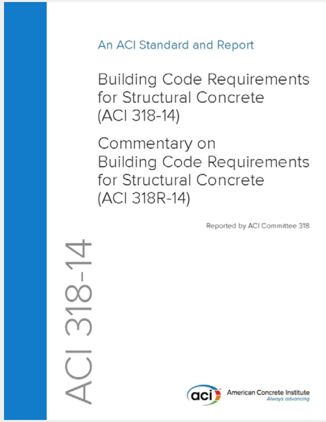
STRUCTURAL DESIGN – THE CODES

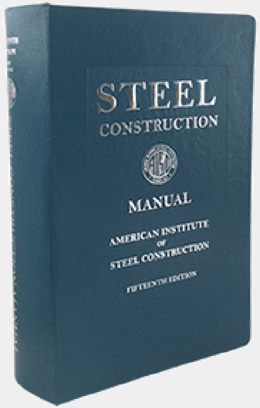




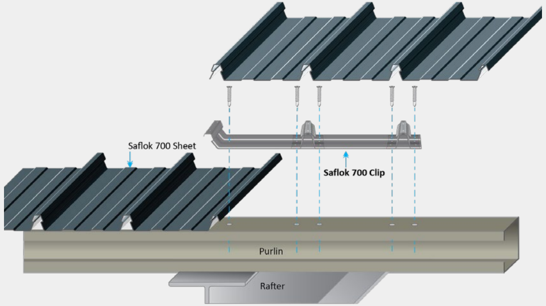








STRUCTURAL DESIGN - MATERIALS



Steel Decking

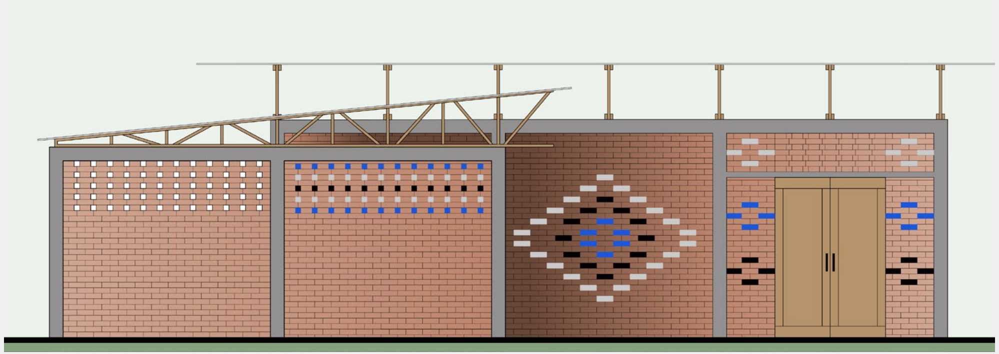
Milled Eucalyptus

Handmade Clay Bricks

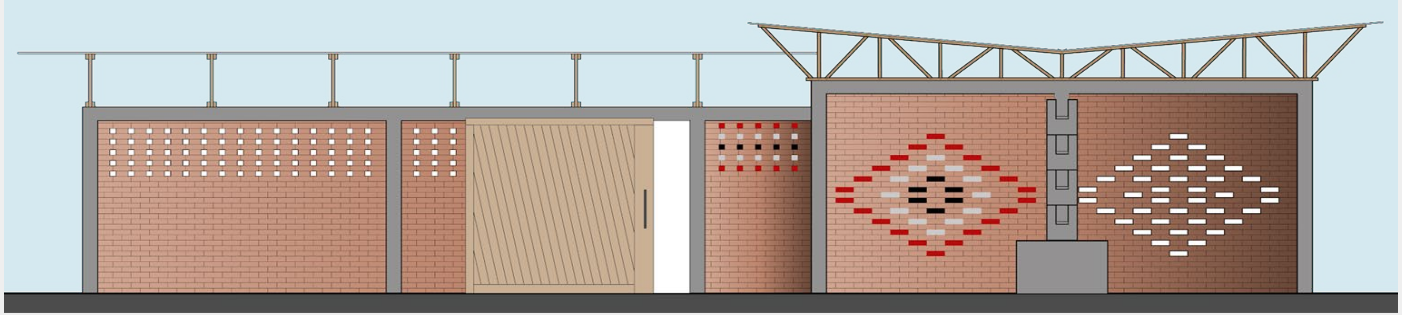
Concrete

STRUCTURAL DESIGN - COMPONENTS

- Steel Decking
- Eucalyptus Purlins with Steel Rod Bracing
- Eucalyptus Trusses
- Confined Masonry Walls
- Concrete Slab/Foundations



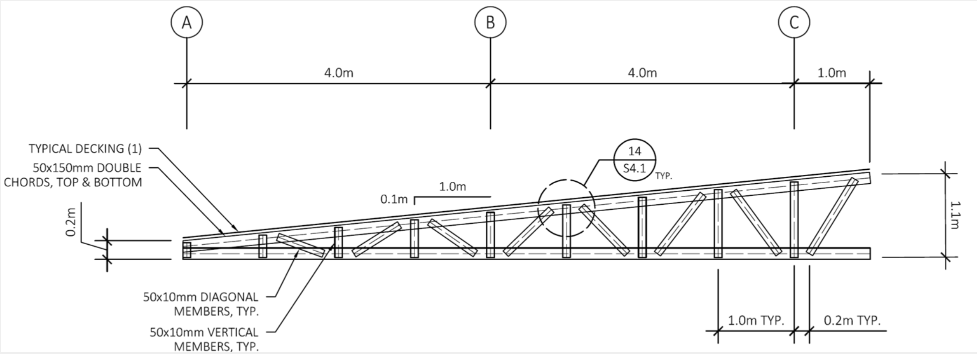
North Elevation

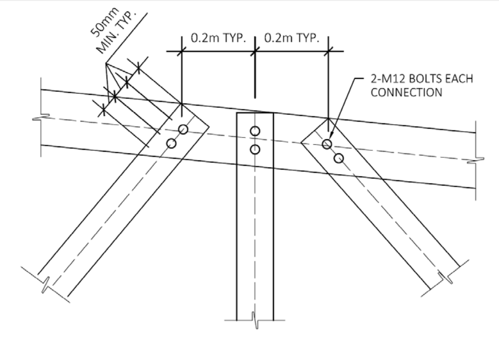


South Elevation

STRUCTURAL DESIGN – TRUSSES

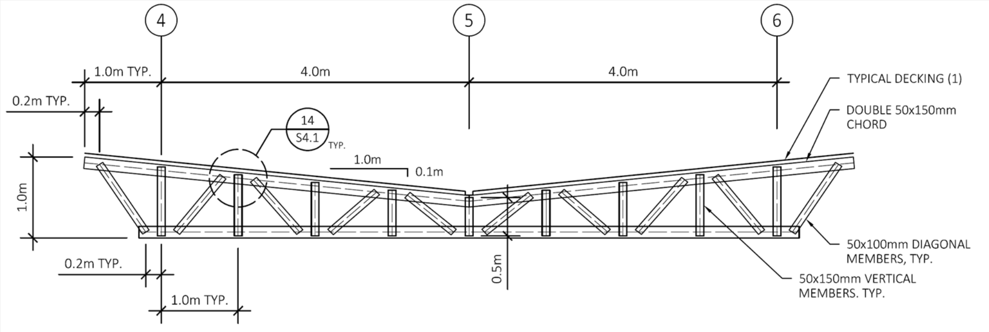
ATF Truss



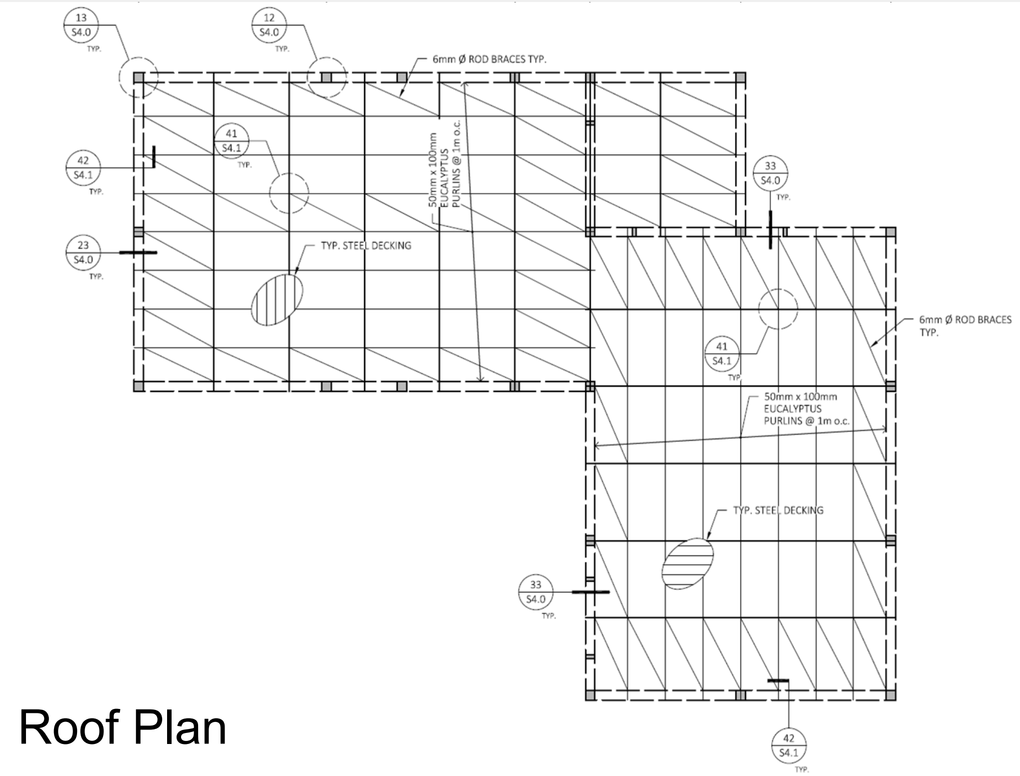


Truss Connection Detail

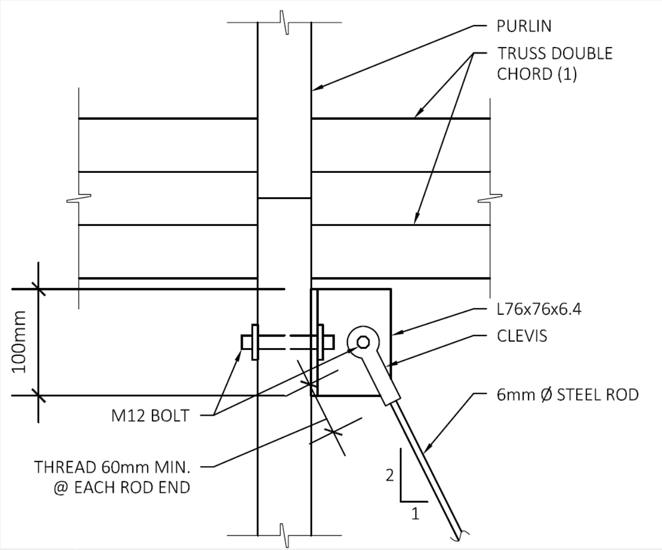
EVC Truss



STRUCTURAL DESIGN – DIAPHRAGM BRACING

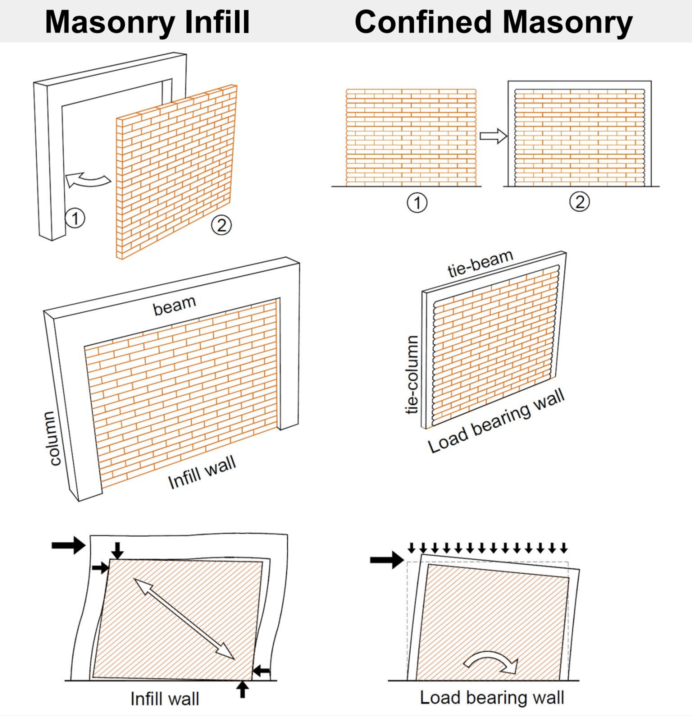


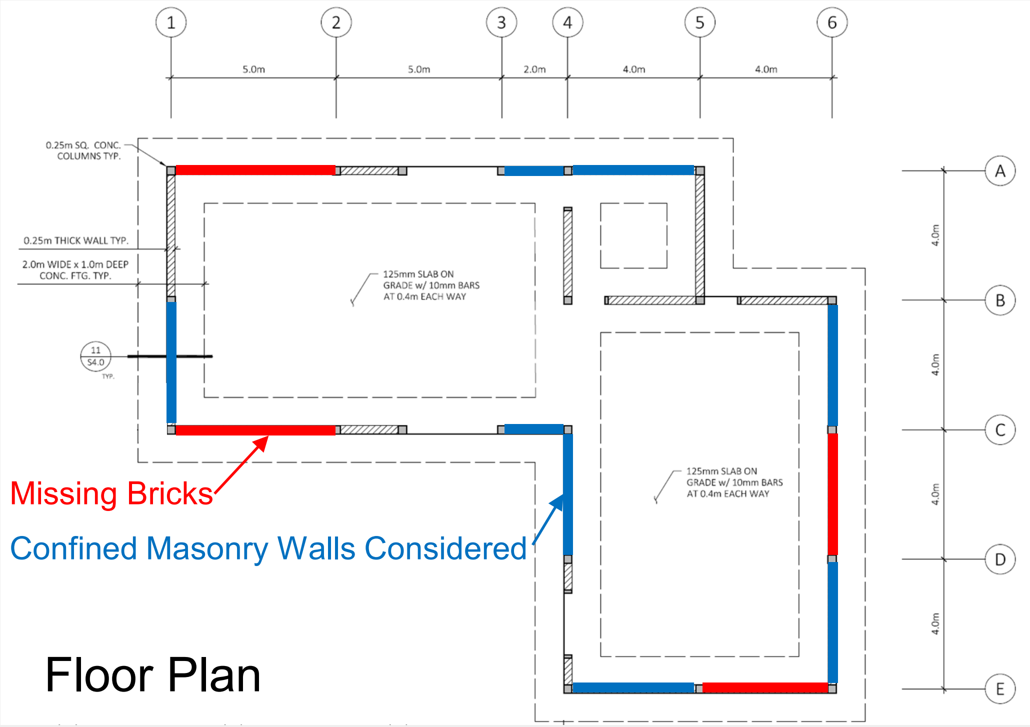
Roof Plan



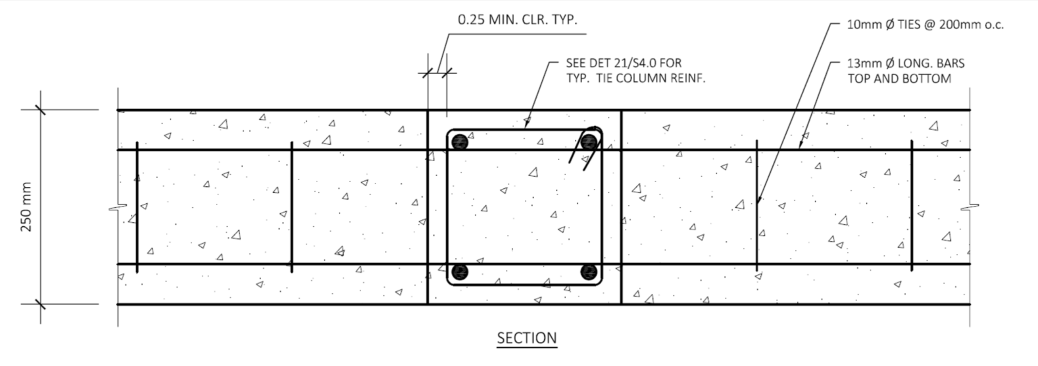
Rod to Purlin Detail

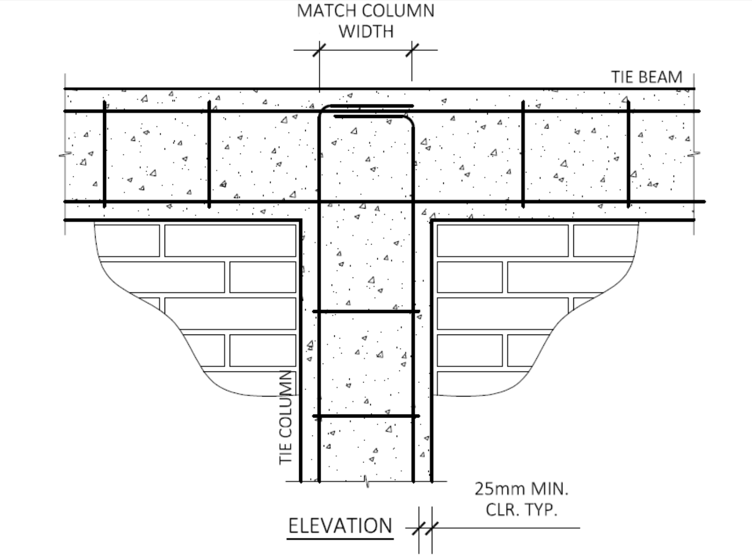
STRUCTURAL DESIGN – CONFINED MASONRY



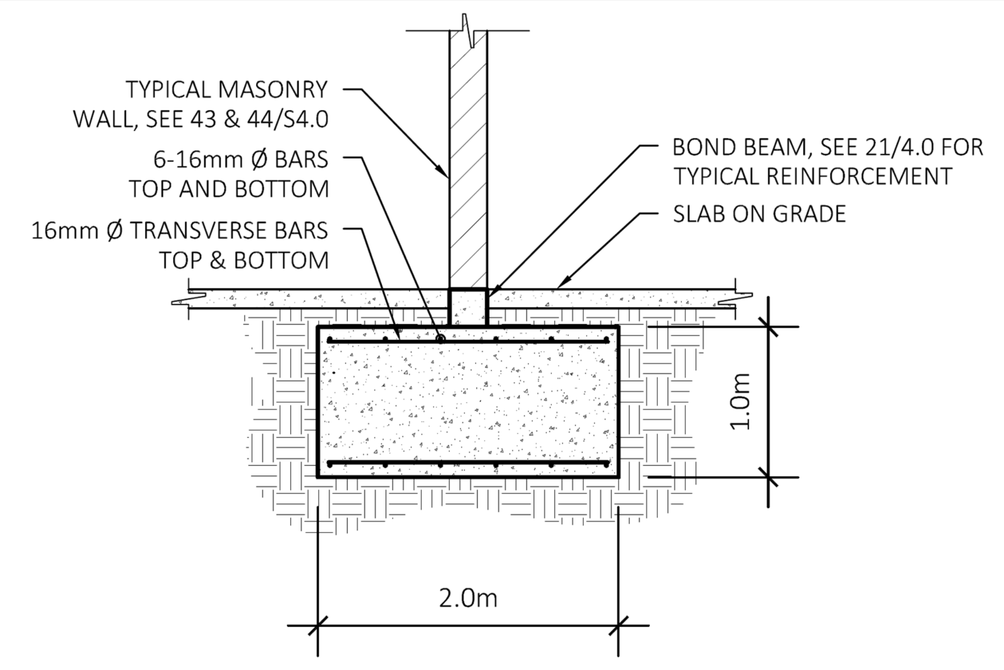


STRUCTURAL DESIGN – TIE BEAMS / COLUMNS

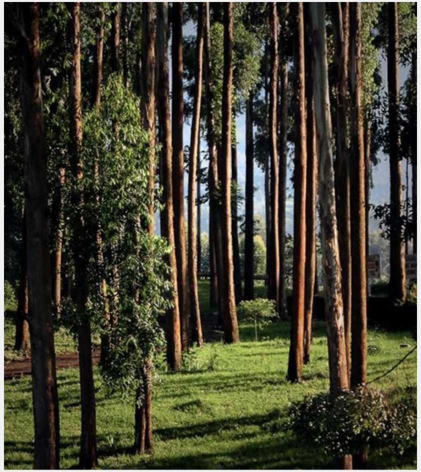




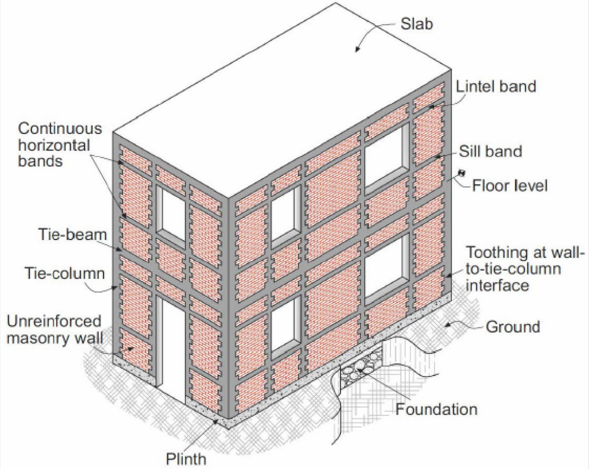
STRUCTURAL DESIGN – FOUNDATIONS



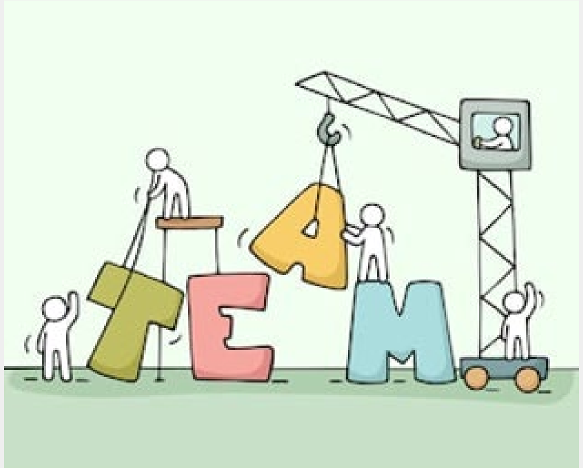
CHALLENGES



Material Availability



Confined Masonry Design



Interdisciplinary Teamwork

TRAVEL EXPERIENCE

TAKEAWAYS

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Journeyman International:
Daniel Weins and Carly Althoff

East African Power:
Daniel Klinck and Brad Sanders

California Polytechnic State University:
Dr. James Mwangi

QUESTIONS?

APPENDIX D: WORKS CITED

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