Mòn Briyè Primary School

Mornes Brieux, Haiti

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ABSTRACT:

Journeyman International (JI) is a non-profit organization that pairs emerging professionals in the architectural, structural engineering, and construction management industries with humanitarian projects in underdeveloped countries overseeing the design and construction process. The Mòn Briyè Primary School is a JI project led and funded by The 610 Project, an Alabama-based non-profit organization dedicated to the sustainable success of developing Haitian communities through education. This primary school will be located in Mornes Brieux, Haiti and consists of three buildings: one classroom building for first to fourth grade, one classroom building for fifth to eighth grades, and one building for administration. The Mòn Briyè Primary School will be the first in the area to provide education and opportunity for over two hundred and fifty students as well as a guest house for teachers and visitors supporting the school. The project team consists of two architectural engineering students, an architecture graduate student and a construction management student. The design will be implemented by Third Lens, a construction management and design organization that provides services to front-line ministries in need of new facilities in order to spread the love of God. This report, created by the architectural engineering students, includes the background, research, challenges, significant impacts, structural design drawings and calculations for this project.

INTRODUCTION:

Journeyman International (JI) is a non-profit organization that oversees the design and construction processes of projects in developing countries. They do this by partnering and mentoring architecture, architectural engineering and construction management students who apply their knowledge to a humanitarian effort identified by JI. This report is about the project process of two architectural engineering students, Leah George and Devin Williams, working on the structural engineering design of Mòn Briyè Primary School located in Morne Brieux, Haiti.

Haiti has had a long history of natural disasters, including cyclones, hurricanes, tropical storms, torrential rains, floods and earthquakes. After the 7.0 magnitude earthquake in 2010, the government of Haiti estimated that 250,000 residences and 30,000 commercial buildings had collapsed or were severely damaged. In 2016,

Mòn Briyè Project Site

Hurricane Matthew devastated the country as a category 4 hurricane with extreme flooding and winds up to 145 mph. Over two million people were impacted by the storm and years later, they are still rebuilding from these natural disasters.

Morne Brieux is a rural area in southwest Haiti. The closest town, Les Cayes, is located seventeen kilometers away, and currently is where the closest school is located. Half of the children in the Morne Brieux community do not have access to transportation and therefore do not attend school. Those with available transportation have to travel the seventeen kilometers

each way to attend school in Les Cayes. The 610 Project, a partner organization that focuses on empowering Haitians with education, recognized this issue and brought the Mòn Briyè Primary School to life. This proposed primary school will provide education to two hundred and fifty students in the Morne Brieux community from first through eighth grade.

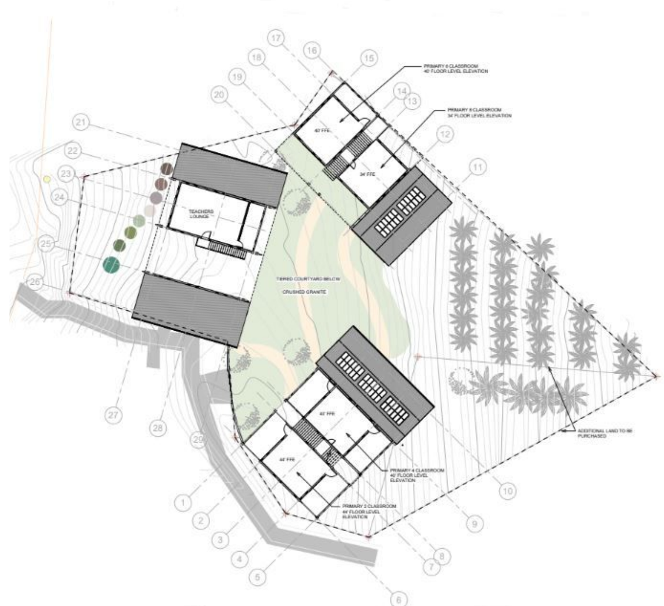
Location of Morne Brieux, Haiti

PROJECT DESCRIPTION:

The design team for this project consists of an architecture graduate student at Montana State University, Heather Bing, a construction management student, Owen Rice, and two architectural engineering students, Leah George and Devin Williams, at California Polytechnic State University, San Luis Obispo. This team has one goal: to design a structure that will withstand the natural disasters that Haiti is known for in order to give the children of Morne Brieux a permanent educational opportunity close to their homes.

The location for the Mòn Briyè Primary School was chosen because of the need for an educational facility in this rural area; as mentioned above, the closest school is currently

seventeen kilometers away. The proposed campus has three buildings: one classroom building for first through fourth grade students, one for fifth through eighth grade students, and the third for campus administration. Each classroom will need to support approximately twenty-five students. The administration building will house a cafeteria in the main part of the first floor, with additional rooms for an infirmary, bathrooms, and storage. A teacher's lounge will be located on the second floor. The building levels are tiered due to the steep and uneven terrain and in the center of the three buildings is a tiered courtyard where the students can play and enjoy the outdoors.



Mòn Briyè Primary School Campus Layout

The structural design for all buildings is a post and beam reinforced concrete and concrete moment frame system, with open engineered steel trusses for cross ventilation topped with corrugated metal as the roof system. Each building merges the indoor with the outdoor environment using an open air concept. The roof systems will support solar panels that will generate energy for the campus, making the area self-sustaining.

Rendering by Heather Bing

Throughout the country, 90% of the homes are constructed from concrete block and masonry made on site. The 2010 earthquake showed how ineffective these

traditional practices and materials were at resisting lateral forces. Due to the design demand of an open air concept, concrete moment frames were chosen as the lateral system. This allows continued use of available concrete and rebar without major modification to typical Haitian construction. At the same time, these structures will be able to withstand far greater lateral loads than traditional construction allowing occupants time to evacuate and thereby preventing fatalities in a natural disaster.

DELIVERABLES:

Structural calculations for the first to fourth grade classroom building can be found in Appendix B, followed by the corresponding structural drawings in Appendix C. These calculations and drawings may be used for the fifth to eighth grade classroom building due to similar layout and identical material use.

The design process started with preliminary calculations to estimate structural member sizes. These were used to create a preliminary load takeoff for gravity design. The load takeoff began with the roof metal trusses using RISA 2-D, with an assumed steel strength of 40,000 psi (Grade 40 ASTM 615). The RISA 2-D output can be found in Appendix B to show loading and deflection demands the members were designed for. The ACI (American Concrete Institute) 318-04 code book was used for the gravity member calculations. The assumed compressive strength was 1500 psi for concrete, and is reflective of the material quality and construction practices in Haiti. The final gravity calculation was the slab on grade that is based on the United States standard: 2” thick concrete slab overlay with #3 rebar at 6” on center each way.

Seismic and wind forces were calculated to determine the governing lateral force. The base shear of the building was found to be 23.5 kips from the S_{ds} value of 0.66 and a low building weight. This governed over a wind load demand of 23 kips. Concrete moment frames, as opposed to traditional shear walls, were chosen for the lateral system of the building to support the architectural design reliant on air flow throughout. The analysis software, ETABS, was used to model the tiered moment frame system in both directions. Load and deflection demands from the seismic forces applied in ETABS were used to obtain member sizes. These can be found in Appendix B.

To provide unambiguous construction layout, structural calculations are performed in english units but final design solutions are provided in english and metric units. The structural drawings are dimensioned and detailed in metric units for clarity for construstruction personnel in Haiti.

CHALLENGES:

This project presented many design and analysis obstacles. The first is that Haiti lacks formal design codes. Following the earthquake in January 2010, the unofficial code "Construction Code Study for Emergency Measures Haiti" was established. This document outlines construction guidelines and codes that are acceptable to be used in Haiti. These documents were difficult to navigate, especially when published in French.

Cal Poly instruction is based on material strengths obtained in the United States and the equations in the code are based on these values. This posed a challenge as Haitian materials such

as masonry block and concrete have much lower material strengths and thus simplified United States code equations may not be used. Haitian material strength and behavior was researched to ensure safe design without relying on equations from American code.

Additionally, typical Haitian buildings are constructed differently from those in the United States. Designing the Mòn Briyè School to accommodate customary building techniques was extremely important to the engineers of this project. By designing the building to common practice, the quality of the construction would be improved. It will also make it easier for Third Lens Ministries, the partner organization in charge of design and construction management, to work with locals. To do this, the structural engineers were in constant contact with Cal Poly faculty members, mentors, and other professionals who are familiar with Haitian construction.

In the professional design field, contact between the architect and engineer must occur frequently to ensure cohesive design development. This project presented another challenge in that the architect was working remotely and had already finished design development before the project was passed on to the engineering designers. For this reason, contact with the architect was seldom and very few adjustments to the design could be made.

Above all else, the greatest challenge on this project was designing an unfamiliar lateral system. It is arguably the most important aspect to the project, and requires special attention to connection design. However, throughout the undergraduate program at Cal Poly, students are taught how to read and analyze building codes. This made the challenge of learning a new section of the ACI code a manageable task.

INDEPENDENT LEARNING CURVE:

Throughout the research, analysis, and design process, the student engineers had to apply critical thinking, independent learning, and the pooling and utilization of available resources in order to complete the project successfully. The independent learning developed from the challenges faced, including deciphering foreign design code, adapting to foreign construction practices, and designing an unfamiliar lateral system.

To overcome these challenges, a variety of tactics were employed. The first resource was a Cal Poly professor, James Mwangi. Professor Mwangi is an expert on Haitian construction and has led workshops throughout Haiti to instruct local laborers on proper techniques. He provided his workshop information and images for understanding. The Journeyman International mentor for this project, Eric Lehmkuhl from KPFF San Diego, was another available resource. Mr. Lehmkuhl has experience with projects in Haiti subsequent to the 2010 earthquakes and provided practical knowledge and example projects to help further expand the engineers' design comprehension.

James Mwangi also provided unofficial building codes for Haiti. Many of these codes were written by other countries for Haiti and were published in French. The student engineers had to copy and paste sections of the code into Google Translate in order to extract the design criteria such as material strength and seismicity values for Mornes Brieux. This was an efficient and accurate tool providing further insight on Haitian construction. ASCE-7 was listed as a trusted prescription for design and was useful in calculations as a familiar reference.

The concrete moment frames were the greatest test of the engineering students capabilities. Analysis of the ETABS model results required understanding of acceptable

behavior of moment frames, and identification of what would govern the design. Concrete moment frame design is not covered in Cal Poly curriculum and therefore challenged the student engineers with a new chapter of ACI 318. The code communicated that connection reinforcement to properly resist earthquakes was critical. To do this, explicit detailing was a priority to ensure proper construction. The consultation of several faculty members allowed the student engineers to receive feedback on their calculations.

IMPACT:

Journeyman International has provided an opportunity for the student engineers on this project to have an impact in the world. The students attending Mòn Briyè Primary School are not the only ones who will benefit from the project. This design is the first school in this rural area of Haiti and will have economic, social, political, global, and environmental impacts.

First, this school will have considerable economic impacts. The construction will create jobs for local masons and laborers as a result of the student engineers staying true to typical construction. Financially, the project will be supported by fundraising efforts run by partner organizations along with a potential donor that is interested in providing support. Once the school is opened, further economic benefit will be handed to the educators and faculty of the school. Finally, the students receiving an education will be better prepared for taking profitable jobs, benefiting themselves and their communities.

The town of Mornes Brieux will be impacted socially and a sense of pride will arise from the construction of the school. The building will be built on the top of a hill above a main road,

and will be a beacon for opportunity for the community. Additionally, many of the students attending Mòn Briyè Primary School did not have the opportunity previously, or had to trek a long way for their education. The lifestyle of the Morne Brieux community will change since everyone will have the opportunity to receive an education.

Providing education and labor opportunities will increase the political status of the area of Mornes Brieux and the country as a whole. After Hurricane Matthew in 2016, the Haitian government experienced political unrest and the country was in a vulnerable state. The majority of Haitian citizens do not get along with their government. Haiti has a president that holds similar power as in the US. Lower administration broken down to three main divisions of departements, then arrondissements, and finally, comunes. If a city is located near a capital of departement, it is governed by that administration. However, in secluded rural areas such as Mornes Brieu, village elders have more power than government officials. For a project like Mon Briye to be approved, consent must be given by this bureaucratic leader who speaks for the community. A positive relationship with the community and organizations involved could result in this project being an example of simple, earthquake resistant construction that can be repeated. The company that spearheaded this project, The 610 Project, believes that education is the key to breaking the cycle of poverty in Haiti. The students attending Mòn Briyè Primary School will have the opportunity to grow to become future leaders and policy makers in order to create positive change in their community, their country, and beyond.

Currently, Haiti has a 60.7% literacy rate, which is the lowest rate in the western hemisphere. The construction of this school will have a global impact by raising that statistic. Although the design values used in this project are specific to Mornes Brieux, the concept and

construction practices may be replicated in most third world countries. Journeyman International will have the opportunity to share this project with other organizations and to implement these practices throughout other countries in need.

The Mòn Briyè Primary School is designed to be a strong, sustainable and "locally sourced" structure, minimizing any impact on the environment. The project will be located on a currently undeveloped area. The land being built on is sloped, but the architect has incorporated the slope into the building design to maintain the integrity of the land as much as possible. In the case of a natural disaster, the building has been engineered to provide a safe haven for all occupants, and would remain a strong and reliable structure for its lifetime. The masonry and concrete used will be mixed on site and reinforcement brought in from Port-au-Prince, Haiti. This local sourcing of labor and materials cuts down the carbon emissions otherwise released if materials were imported and therefore minimizes the negative environmental impact of construction.

CONCLUSION:

Completing this senior project has been a rewarding experience for both student engineers. This was their first opportunity to work on a real project from start to finish, and as a result, it has been pivotal to beginning a career in structural engineering. It was refreshing to design beyond the classroom and to know the building could be a reality.

Calculations and drawings will be submitted to J.I. who will pass them on to the partnering organizations. They will then be reviewed and accepted for construction to begin as soon as possible. Staying involved in the project is a priority, and the structural designers plan to

continue contributing as the project progresses. They hoped to visit the site before calculations started to meet who the project would potentially impact. Although there was not the opportunity during the course of this project, the students are determined to visit during the construction process or when construction is complete. The highest reward after the countless hours put into this project will be to see the final product, and the positive impact it has on its community.

PERSONAL REFLECTIONS:

LEAH GEORGE

Journeyman International provided an invaluable experience during the last quarter of my college career. This project was especially meaningful for me, as I hope to work on structural humanitarian projects as a regular part of my professional career. This process taught me how to incorporate what I learned at Cal Poly to situations very different from those in the United States. It was a difficult task, but the rewards far outweighed the challenges. I gained additional skills in time management, communication, and teamwork, which will benefit me in my future career.

What will make this project most rewarding is seeing it come to life. Even though I did not have the opportunity to travel to Haiti, I was continuously doing research that made me learn and appreciate the culture of Haiti and the Haitian people. I plan on staying involved in the project, and hope to work with Journeyman International again. Overall, I am extremely grateful for the opportunity that was provided to me through the partnership with Journeyman International, The 610 Project and Third Lens Ministries. I plan to do more structural

humanitarian projects like the Mòn Briyè Primary School in my future and throughout my career.

DEVIN WILLIAMS

This Journeyman International Project was my first exposure to structural humanitarian work. I am excited by the fact that although I have only gone through United States standard construction and codes in a classroom setting, I now have experience in applying general engineering and use of code for projects with unique location and design parameters. The most fulfilling work to me is using the knowledge and skills I have acquired to help others. I am grateful for the opportunity to begin what I hope is a long career of work that helps to improve the safety and lives of others. Learning as much as possible about the people and community that the project is planned to be built for was an essential part to the drive and fulfillment of my work. I hope that the opportunity presents itself to visit the construction site, or the completed school to see its actual impact and meet some of the individuals in the community that will be involved. This would be the greatest reward for our work.

At the start of this project, I had not taken any courses in concrete design. When Leah and I took on this project we did not think that would be a hindrance because there were many materials present in the project that I could design for while she focused on concrete. As the project progressed we decided that the design required all framing and lateral design to be concrete. Although it was a great challenge for me, it became a personally testament that I could

contribute as much as possible through learning code for a new material and with Leah's experience, create drawings that communicated the elaborate concrete moment frame connections the project required. This was a valuable experience for me in being pushed to learn on my own with resources in writing and people as guidance. For this reason I believe it was a perfect senior thesis project to prepare me to begin work for my professional career.

APPENDIX A

Architectural Design

Mòn Briyè Primary School

Mornes Brieux, Haiti

Drawings by:

Heather Bing

Journeyman International

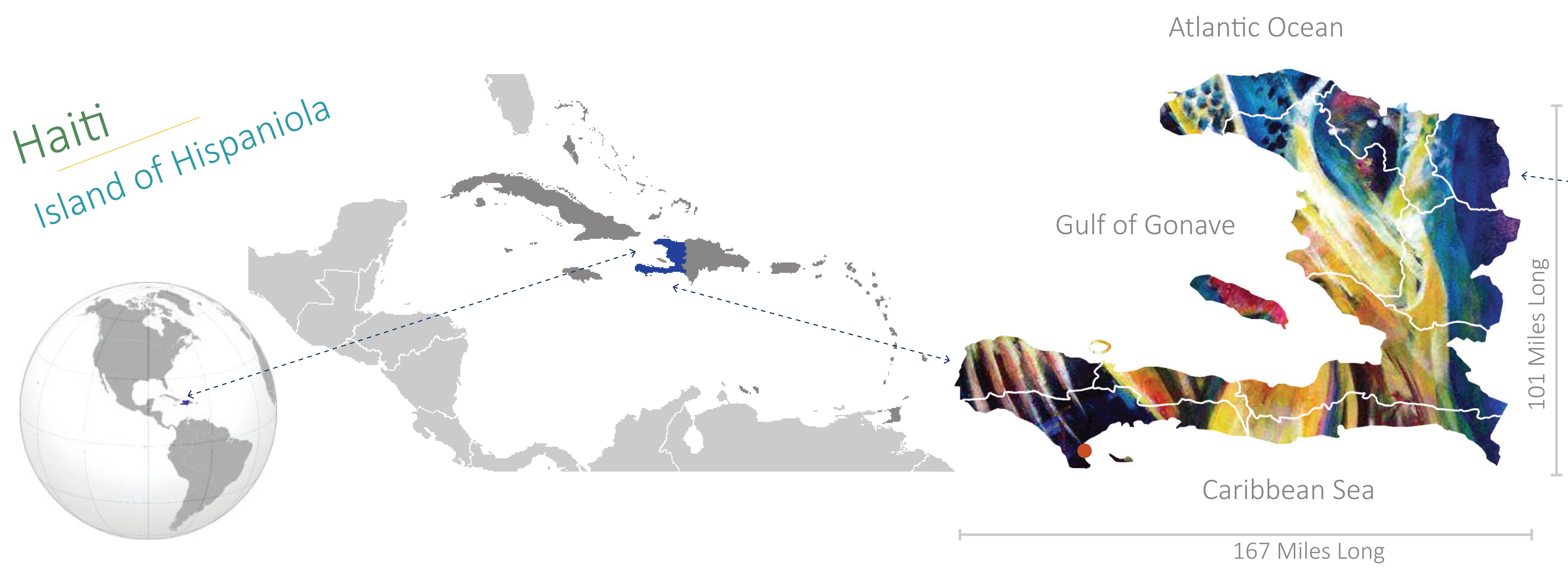
MÒN BRIYÈ PRIMARY SCHOOL

" Dye mon, gen mon.
Beyond the mountains, more mountains."

PEOPLE & PLACE

Design by:
HEATHER BING

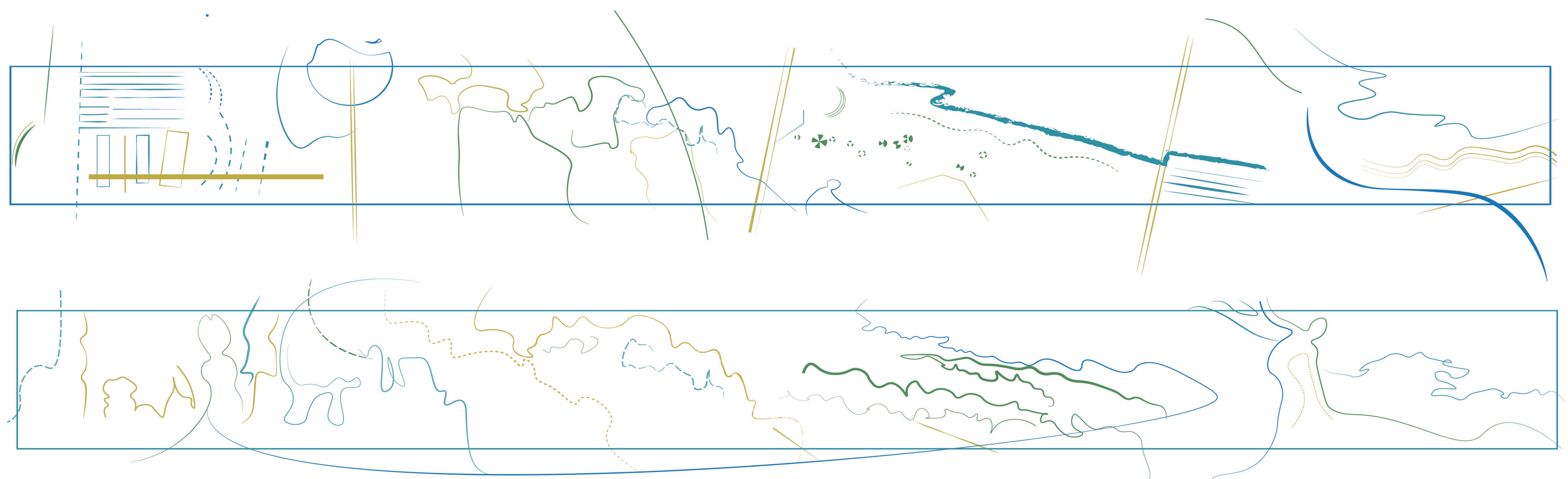
" Architecture begins to matter when it brings delight & sadness & perplexity & awe along with a roof over our heads"



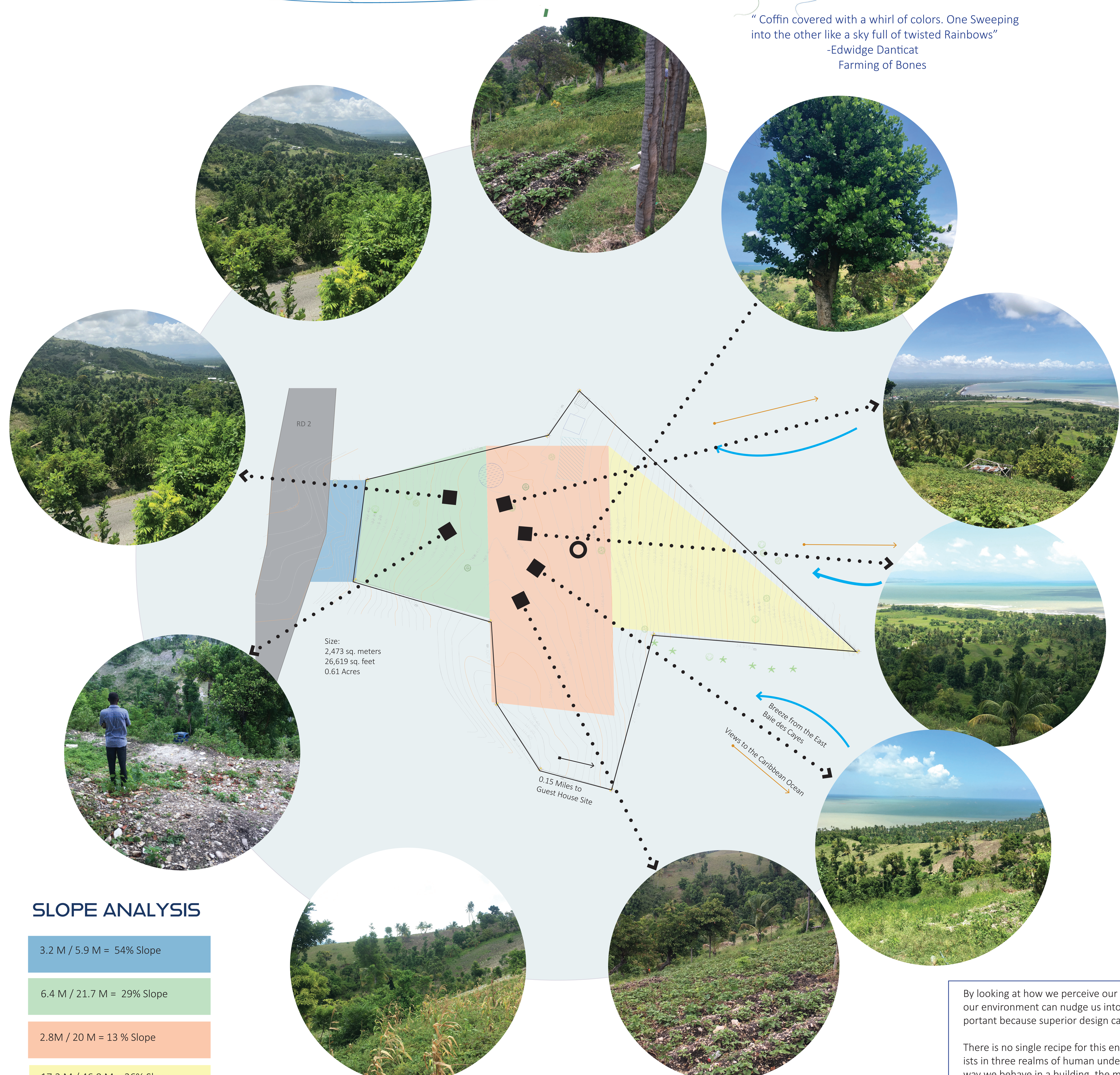
When we have a day
Of thousands of Sacrifices in a country of tears
People come here to rebuild their thoughts
Between the Sea, the beach, the mountains, &
the sky

On the distant horizon, the sun disappears
To refresh our souls.
We observe the sea & the sky
In harmony, awakening tenderness within us

While looking up to the mountains
They become neighbors to the sky
That carry the banner of our hope
Into another tomorrow, another sunrise.
-Angelo Borgela



" Coffin covered with a whirl of colors. One Sweeping into the other like a sky full of twisted Rainbows"
-Edwidge Danticat
Farming of Bones



SLOPE ANALYSIS

- 3.2 M / 5.9 M = 54% Slope
- 6.4 M / 21.7 M = 29% Slope
- 2.8M / 20 M = 13 % Slope
- 17.2 M / 46.8 M = 36% Slope

By looking at how we perceive our surroundings and the relationship between people and place, we see that our environment can nudge us into ways of being, thinking, and feeling. Perception and relationships are important because superior design can achieve goals beyond providing physical needs.

There is no single recipe for this endeavor, but to begin it is necessary to recognize that a building design exists in three realms of human understanding; behavioral, mental and emotional. The physical relates to the way we behave in a building, the mental, as we have thoughts that cross our minds as we experience a place, and we have emotions that arise based on our surroundings. It is essential that the designer imagine the interaction between her project and the individuals that will inhabit the space.

The tremendous influence our surroundings have on us makes design a tool we can use to promote stronger, healthy communities. The beautiful country of Haiti is located in the Caribbean, part of the Greater Antilles. Haiti has been devastated and destructed by earthquakes, hurricanes, flooding and tropical storms. I am proposing to design a Primary School located in Haiti as part of the island's continual rebuilding and growth. It will focus on designing spaces that are needed for physical shelter but transcend the requirements of shelter to include emotionally supportive and cognitively engaging environments.

The planning of the Primary School in Mornes Brieux, Haiti aims to provide a place for children to begin their education, focusing on children and education as a tool to move out of poverty. The rural area consists primarily of agricultural industry without a school for the rural children. The building needs to feel welcoming and inspiring for children, should fit in with the surrounding environment and act as a beacon for the community. The building should incorporate local materials and colors to blend with the lush surroundings and the beautiful ocean views. It will incorporate shaded areas to spend time outdoors and natural ventilation indoors to provide a comfortable learning environment. The architecture will aim to support students learning by including colors, texture and natural lighting. The school design will aspire to allow space for both the students and teachers to feel part of the school community and allow room for expression.

NATURAL DISASTERS

2004 — Hurricane Jeanne caused 36 hours of torrential rainfall over Hispaniola, hitting Gonaïves, killing 3,000 and flatting the city. Hurricane Ivan struck the southern peninsula.

2005 — Hurricane Dennis, hit the southern coast causing flash flooding and landslides. Hurricane Wilma caused mudslides & Tropical Storm Alpha hit the region of Grand'Anse and Nippes.

2006-2007 — Flooding caused significant crop and infrastructure damage, the collapse of bridges across Ravine Sable at Trou-Bonbon and the bridge between Ouanaminthe and Dajabón

2008 — Four storms hit causing significant crop damage, loss of an entire year crop harvest and cities damaged- Tropical Storm Fay, Hurricane Gustav, Hurricane Hanna & Hurricane Ike.

2010 — 7.0 Magnitude Earthquake with epicenter hitting the densely populated capital of Port-Au-Prince. Massive devastation, loss of life and destruction. Resulting in the death of over 300,000 people.

Immediately following the Earthquake was a Cholera outbreak, the lack of access to clean water and sanitation and no previous exposure caused the disease to spread quickly and widely.

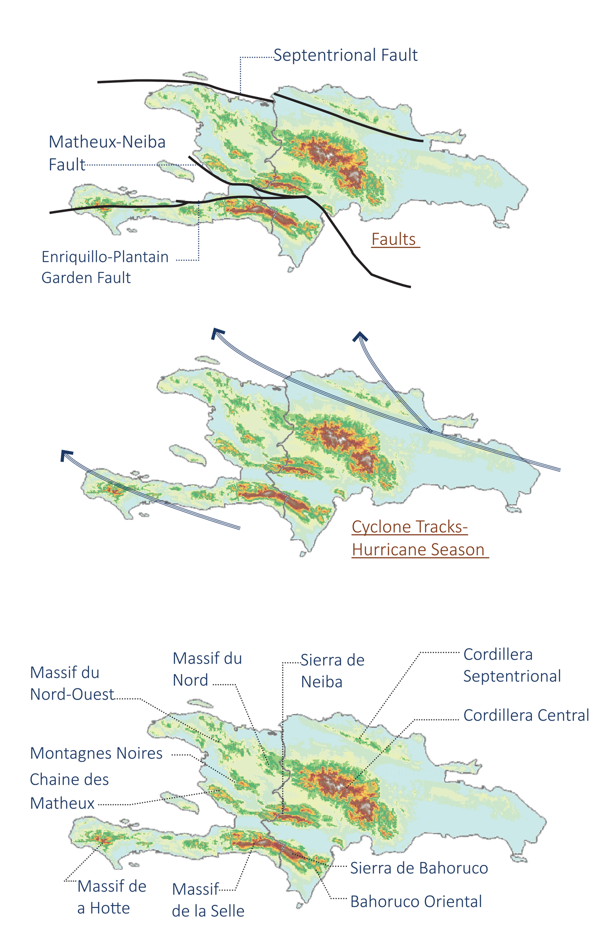
2016 — Hurricane Matthew caused catastrophic flooding, storm surges, destroying crops, infrastructure, buildings and homes with 145 mile-per-hour winds.

Submerged house in Mapou, after Hurricane Jeanne.

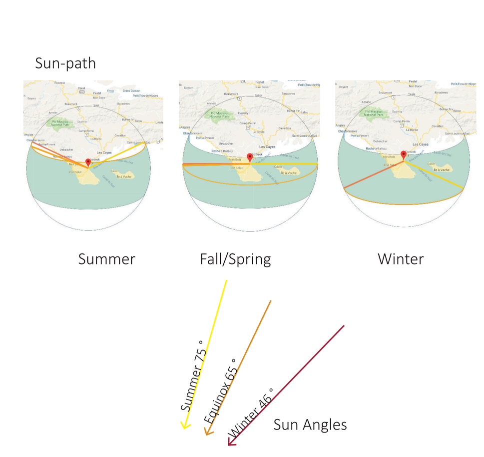
Port-Au-Prince devastation from the 2010 Earthquake.

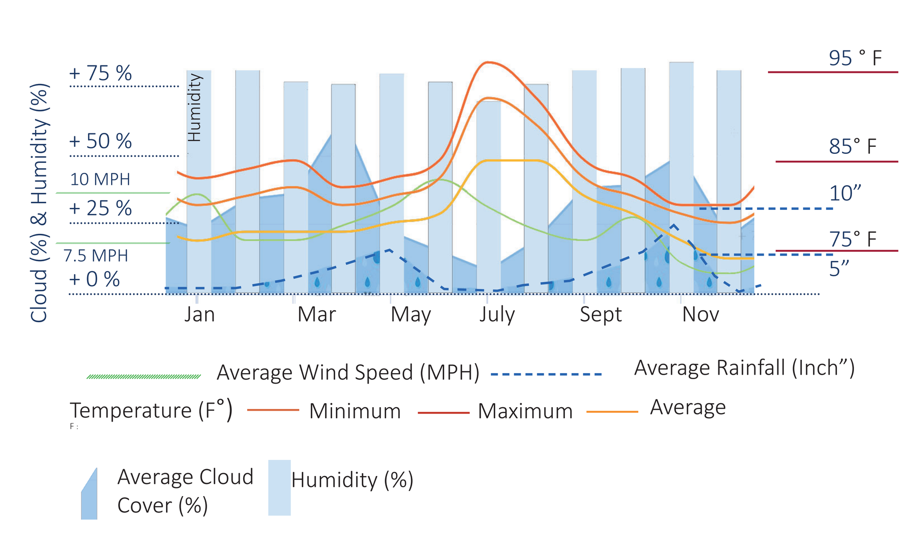
Les Cayes damage from Hurricane Matthew.

Project Location Before & After Hurricane Matthew



CLIMATE





PROJECT TEAM

THE 610 project
MOVERS, THE SHAKERS, THE REAL DIFFERENCE MAKERS

hac Haitian American Caucus — Journeyman International — third lens Ministries

Human Development Index Measures
Haiti is 163 out of 188 Countries

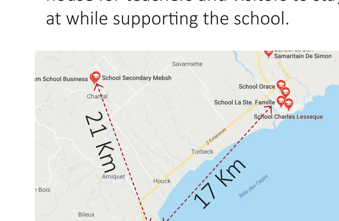
Education	Standard of living	Health
Adult Literacy Rate: 60 %	Gross Domestic Product per Capita: $739	Life Expectancy: 63 Years
Secondary Education: 32%	Population Living Below Poverty Line: 54%	Infant Mortality Rate: 52 (Per 1,000 births)
Years of Schooling: 5.2		

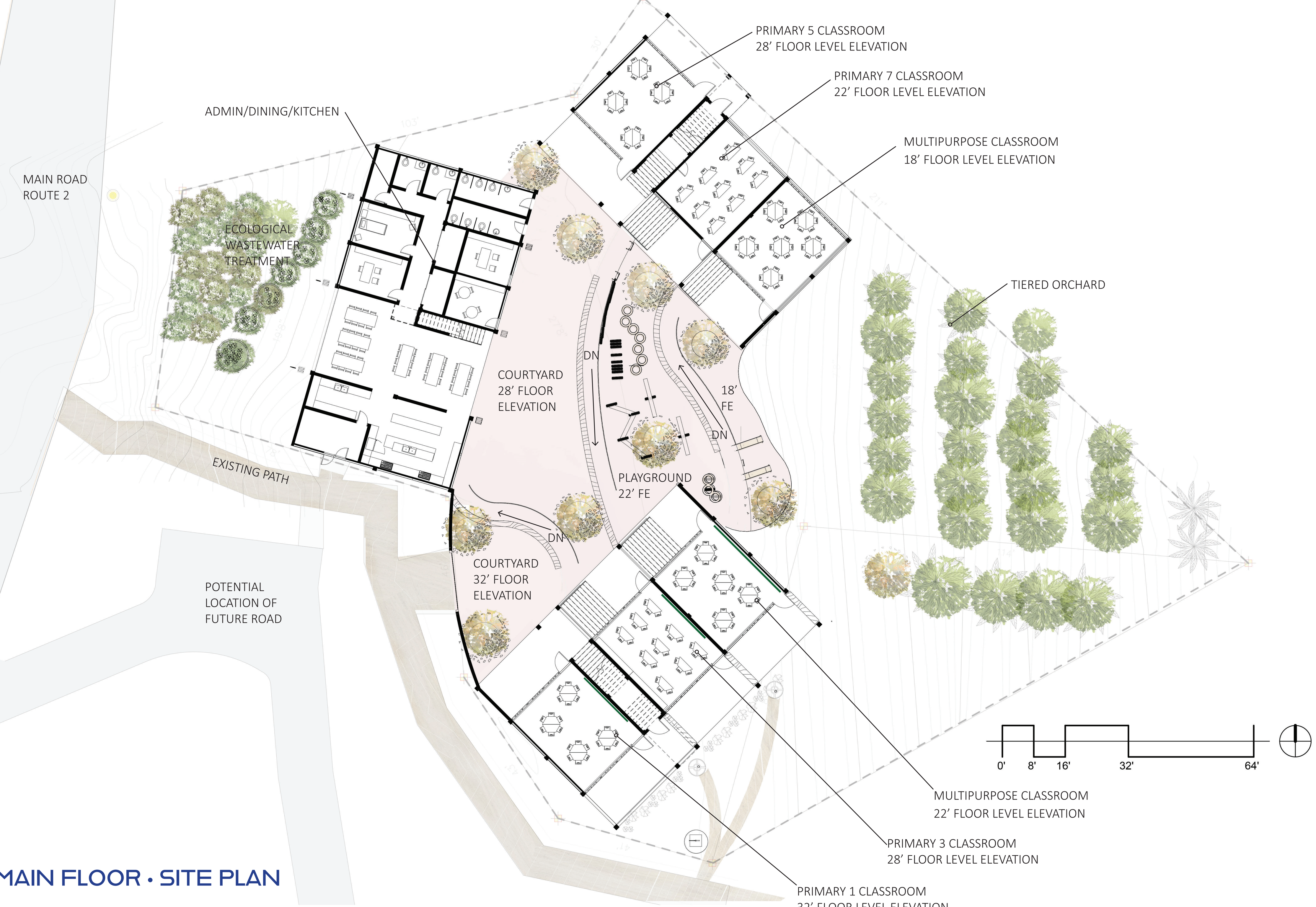
HAITIAN EDUCATION SYSTEM

The Haitian American Caucus opened a school in 2003 and has classes from 1st grade to 6th grade with over 450 students located in Croix-des-Bouquets on the outskirts of the capital city Port-Au-Prince. In the post-earthquake Haiti, many of the students have lost parents or family members, and many have never attended school before.

The 610 Project is partnering with the Haitian American Caucus to build a school in the rural region of Southern Haiti. This area currently does not have a school for its children to attend, many students are not attending school, and others are going to school in Les Cayes 17 km away or Chantel 21 km away. Most do not have an option for transportation, so they currently do not attend school.

The school will be the first primary school in the area and host 250 children of all ages along with a guest house for teachers and visitors to stay at while supporting the school.





MAIN FLOOR • SITE PLAN

ASPIRATIONS

Aspiration # 1
Community Driven

A. School located on hill above main road acts as a beacon for the community.

B. Tiered courtyards integrate with surrounding context and create tiered buildings working with topography

C. Diversity of spaces that encourage interaction and play

D. Visual interest at exterior, with vegetation and community water well to engage the sequence of entering and exiting with the surrounding village.

E. Classroom wings wrapped around tiered courtyard with views to the ocean and views to courtyard creating a connection to play space

Aspiration # 2
Resiliency

A. Self reliant design with roof water collection, solar panel for power generation, living system for wastewater treatment.

B. Curved tube steel trusses with triangular reinforced webbing and knee braces to secure roof to building.

C. Robust design of post and beam reinforced concrete structure for natural disaster resiliency.

D. Small rectangular grid for robust structure.

Aspiration # 3:
Flexibility

A Reuse and adaptability over time; post and beam structure with infill that can be modified in the future.

B. Mix of indoor and outdoor spaces, taking advantage of the sunny climate.

C. Power generation for future and current needs

D. Variety of shared spaces, with both small and large gathering areas, both covered and uncovered.

E. Small patios and balconies adjacent to classrooms could be used for future classroom expansion.

ASPIRATIONS

Aspiration # 4:
Sustainability

A. Maximize storm water management on site; recapture and re-use of water via cisterns located adjacent to on-site community well.

B. On-site renewable energy production with solar panel array.

C. Design supports site areas designated for natural vegetation at base of courtyards. Planting trees for shade, and saving existing large tree.

D. Maximize and redundant passive strategies for temperature control; high ceilings, large openings, opening facing predominant breeze, roof form to allow hot air to escape via stacked ventilation, large roof overhangs shading walls and openings.

E. Access to views of the exterior, prioritizing views to ocean and courtyard play spaces.

F. Natural daylighting to penetrate classroom with narrow building floor plates and large openings.

G. Advanced ecological engineered wastewater treatment system. Waste water pulses through different ecological systems that process and filter through biological process via bacteria and plants rather then transported and treated chemically.

Aspiration # 5:
Life-enhancing

A. Spaces that engage users cognitively; cheerful uplifting colors inspired by the surrounding landscape, exposed structure allowing users to imagine the building process, patterned window openings, signage and texture bamboo railings creating an engaging tactile human scale experience.

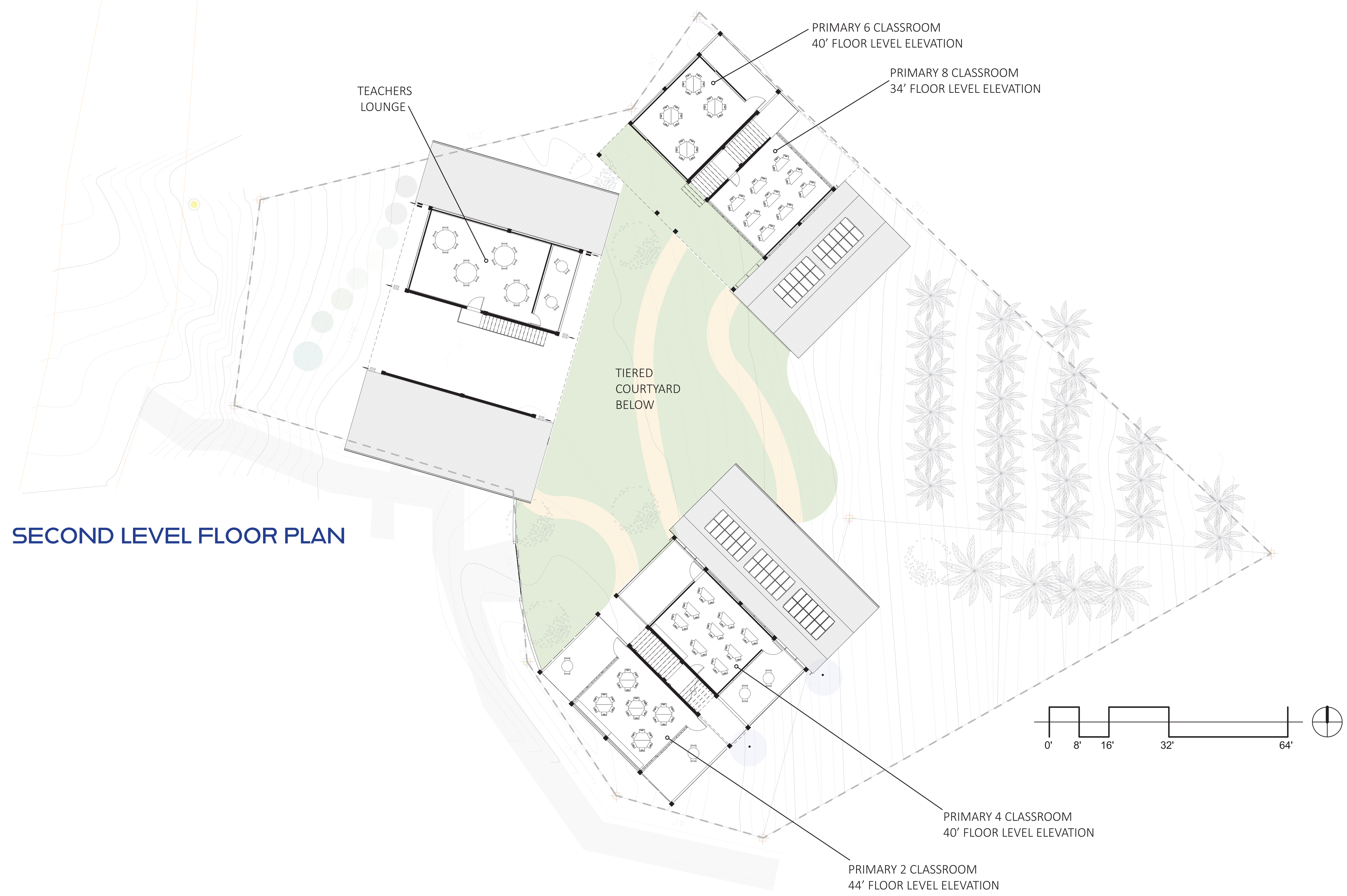
B. Inclusive, social cohesion with a variety of play spaces of varying sizes both covered and open. Nestled into sloping topography with tiered courtyards, embraced by the buildings.

C. Energized shared spaces with views to vegetation and views to the ocean.

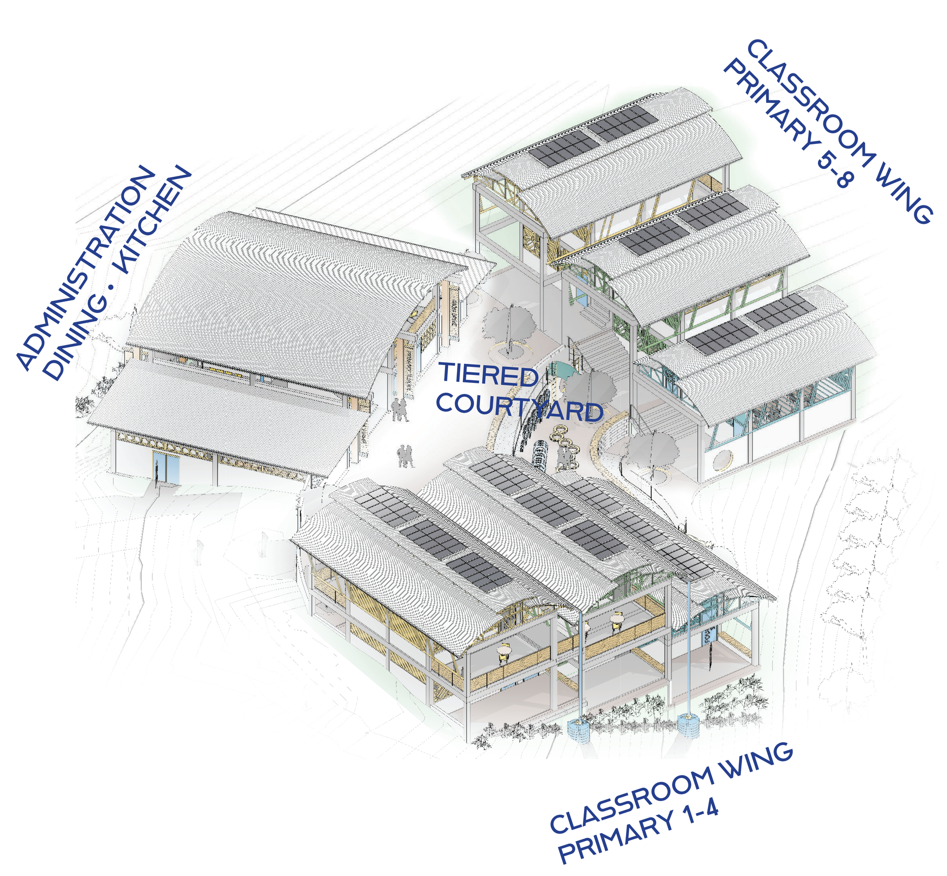
D. Daylight penetration, natural ventilation and views to integrate qualities of nature in the human made environment.

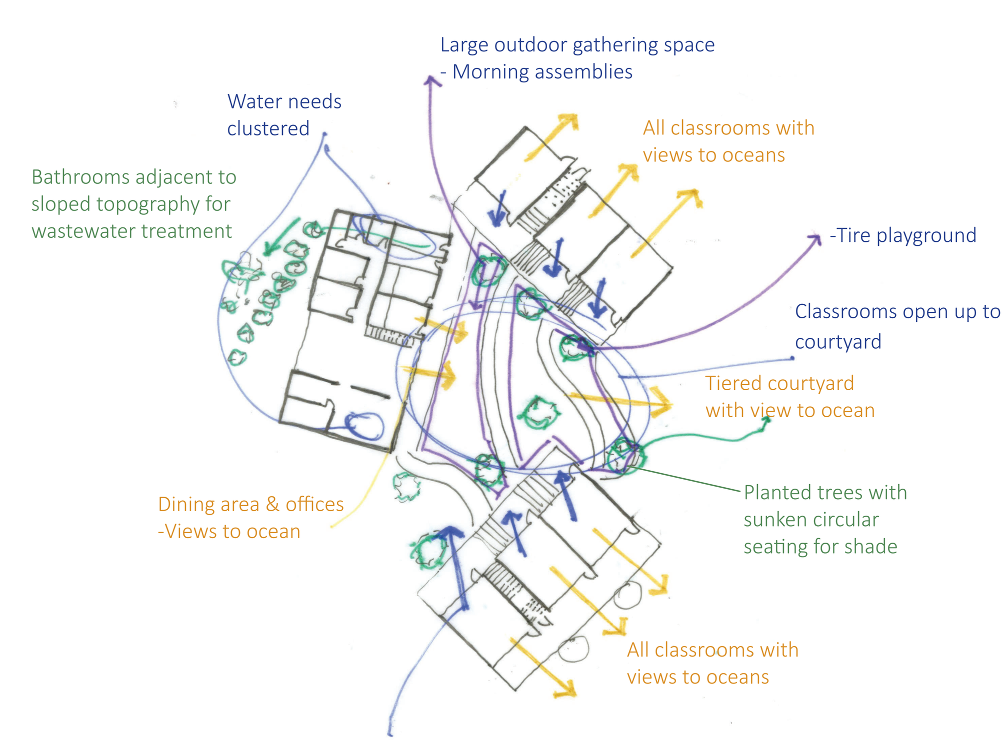
E. Welcoming, friendly and inviting that has a connectedness to the sight and an interesting form with optimism.

F. Surroundings that contain a balance of several action choices along with hints at how to behave. Multiple readings allowed by users.



SECOND LEVEL FLOOR PLAN





PROGRAM LOCATION • VIEWS DIAGRAM

MATERIALS

Reinforced Concrete Post & Beam Structure

CMU infill

Patterned Steel Window Openings

Woven Bamboo railing

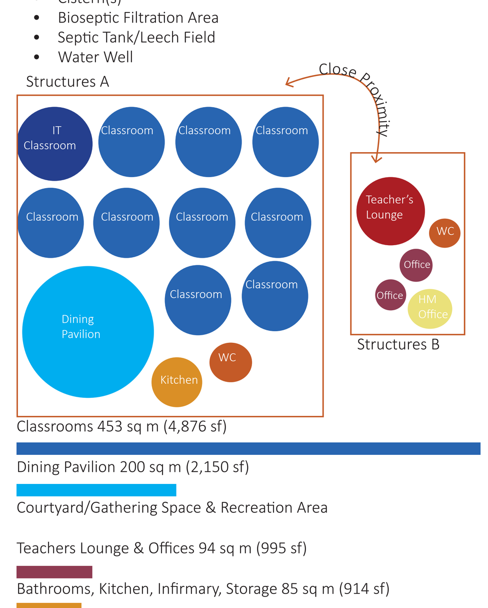
Engineered Steel Trusses

Mosaic Glass Wall

MÒN BRIYÈ PRIMARY SCHOOL PROGRAM REQUIREMENTS

Location: Mornes Brieux, Au Cayes 18 ° 6'33.68"N, 73° 51'4.88"W

- 8 x Primary School Classrooms......... 42 sq m (450 sf) each = 378 sq m
  - Desks for 25-35 students
  - Teaching Wall with chalk board movable or on wall
  - Cubbies & hooks along wall
  - Closet for cleaning/school supplies
- 2 IT Classroom..................................... 75 sq m (800 sf)
  - Desks
  - Projector
  - IT Closet/Storage
  - Closet for cleaning/school supplies
- Student Restrooms............................ ... 20 sq m (215 sf) total
  - 3 female and 3 male- WC & sinks
  - Detached from classrooms
- Dining Pavilion....................................... 200 sq m (2,150 sf)
  - Enclosed or open air.
  - Seating & tables for
- Exterior Play Area................................ 558 sq m (6,000sf)
  Recreation, playground
- Courtyard Gathering Area............................
- Kitchen- Attached or freestanding.......... 30 sq m (322 sf)
  - Propane 6 Burner Range
  - Prep Counter-top
  - Sinks
  - Refrigerator- If energy production supports*
  - Pantry for dry food
- Teacher's lounge.............................. 50 sq m (538 sf)
  - Hooks for coat storage
  - Movable chairs & tables
- Headmaster's Office......................... 14 sq m (150 sf)
  - Desk, 2 chairs, bookshelf
- Volunteer Office................................ 10 sq m (108 sf)
  - 4 chairs, sm table, bookshelf
- 610 Project /HAC Office.................... 10 sq m (108 sf)
  - Desk, 2 chairs, bookshelf
- Teacher's Restrooms......................... 10 sq m (108 sf) total
  - 1 female & 1 male- WC & sinks
- Infirmary .... 10 sq m (108 sq ft)
  - Twin Bed
  - (2) Chair
  - Cabinetry Storage on wall
- Storage... 15 sq m (161 sq ft)
  - Closet for Solar Panel Battery Storage
  - Mechanical Closet for water pump
  - School Supplies Storage
  - Kitchen Supply Storage Room
- Cistern(s)
- Bioseptic Filtration Area
- Septic Tank/Leech Field
- Water Well



Classrooms 453 sq m (4,876 sf)

Dining Pavilion 200 sq m (2,150 sf)

Courtyard/Gathering Space & Recreation Area

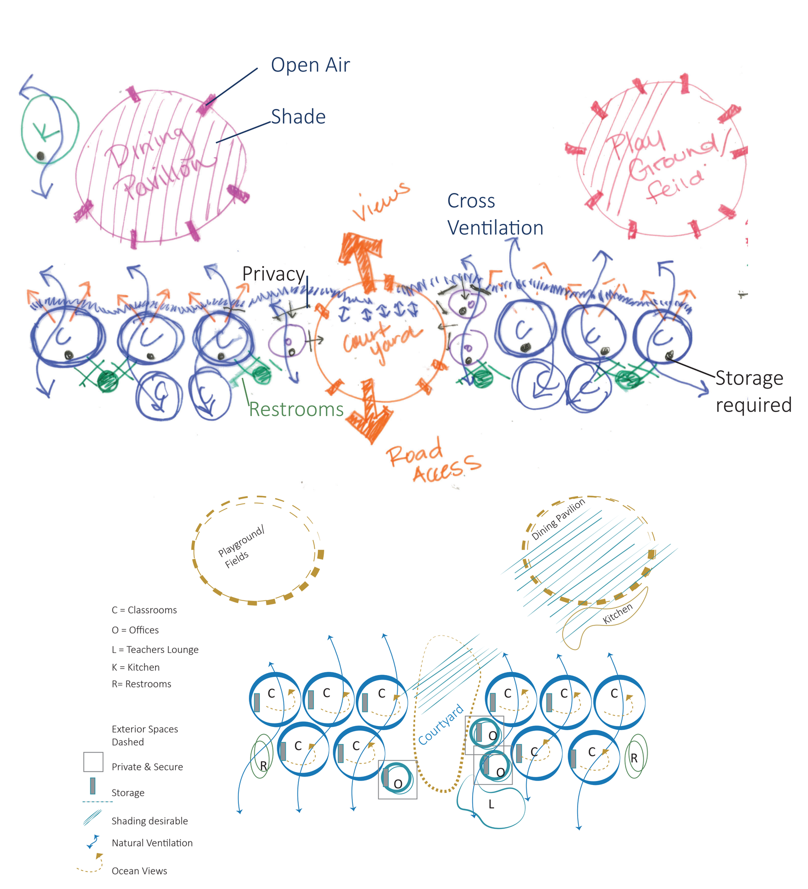
Teachers Lounge & Offices 94 sq m (995 sf)

Bathrooms, Kitchen, Infirmary, Storage 85 sq m (914 sf)

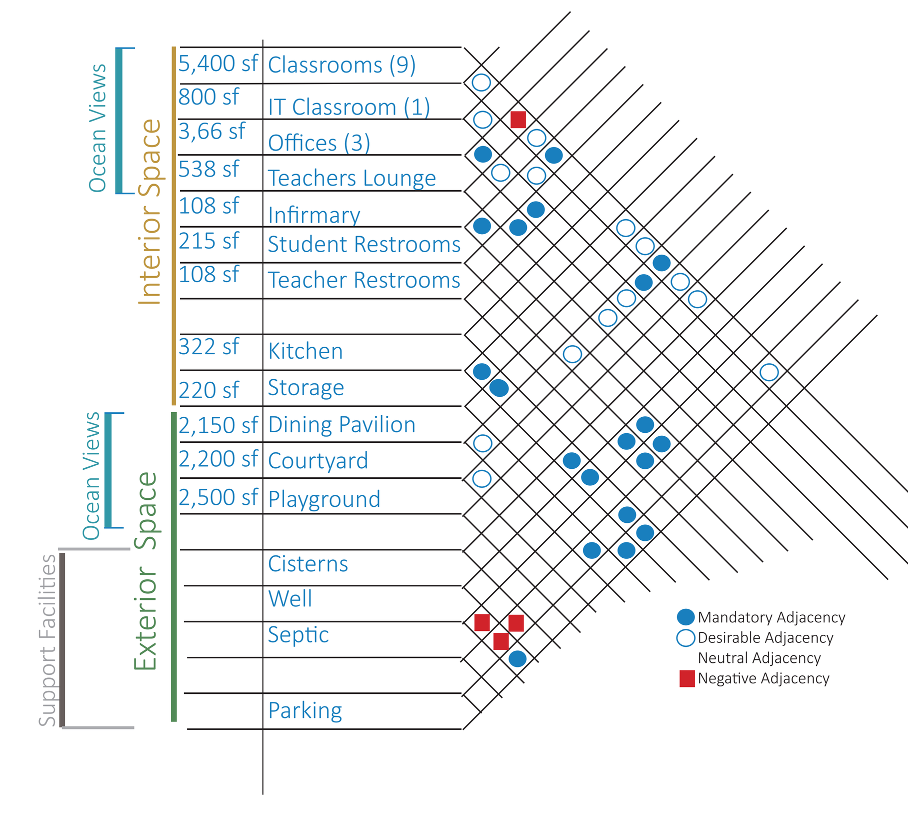
<u>Total School Net: 944 sq m (10,166 sf)</u>

Site Area is 2,473 sq. m 26,619 sf

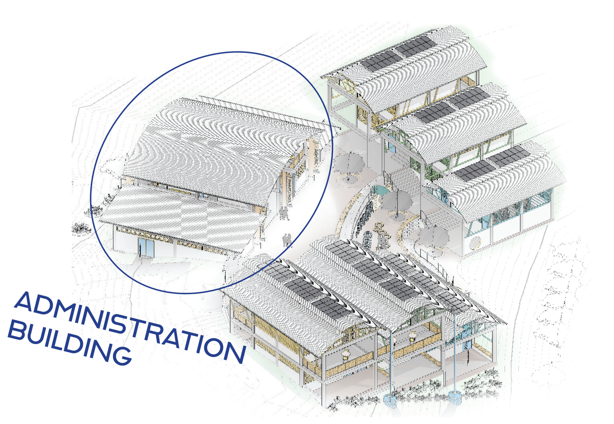
SPACE ADJACENCY DIAGRAM



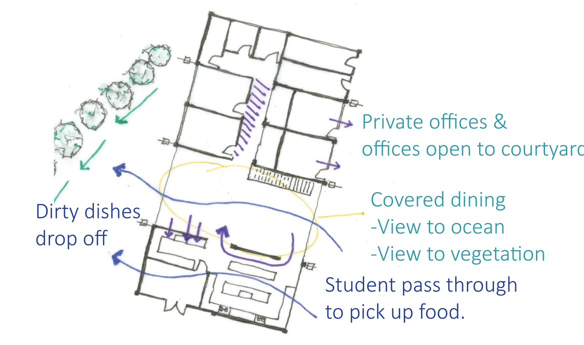
SPACE ADJACENCY MATRIX



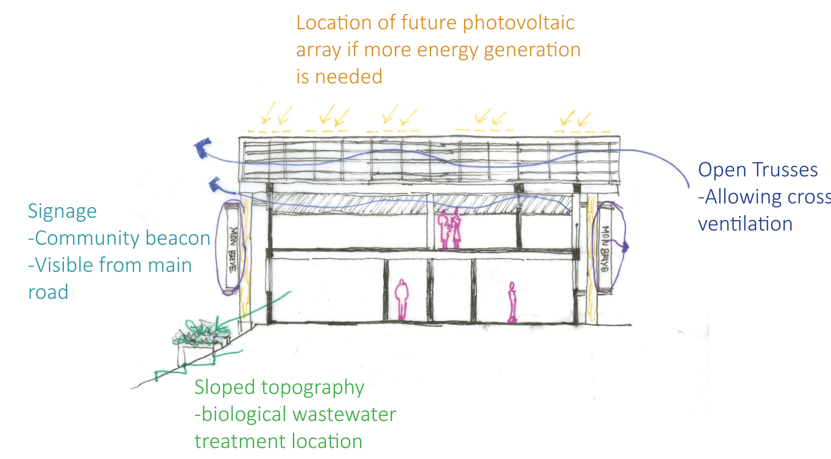
VIEW FROM MAIN ROAD TO ADMINISTRATION BUILDING



ADMINISTRATION BUILDING

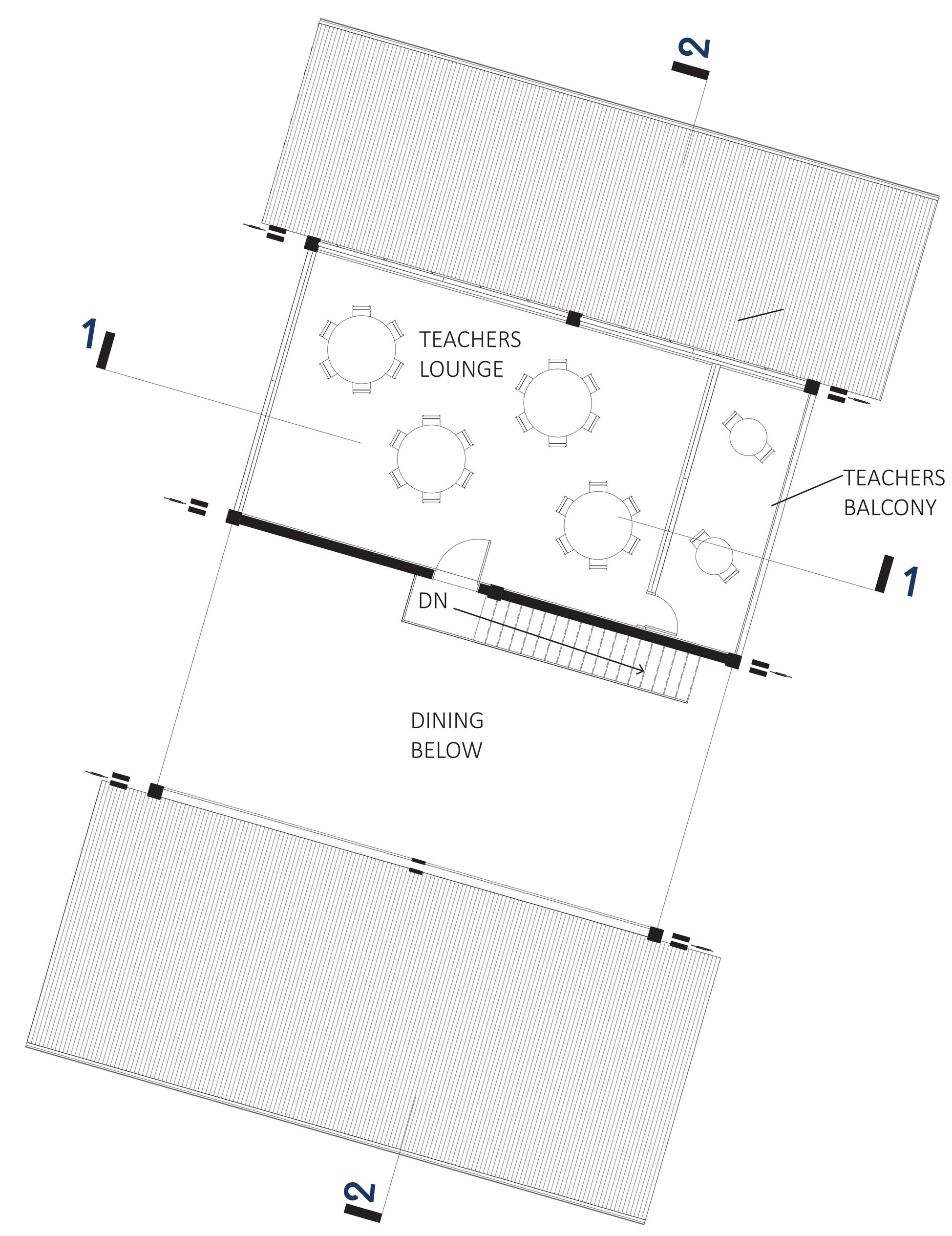


CIRCULATION · USER DIAGRAM

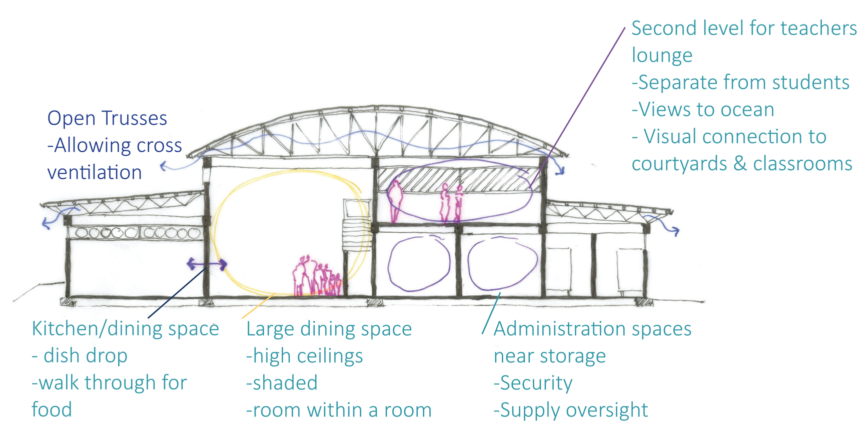


CLIMATE · USER · TOPOGRAPHIC RESPONSE DIAGRAM

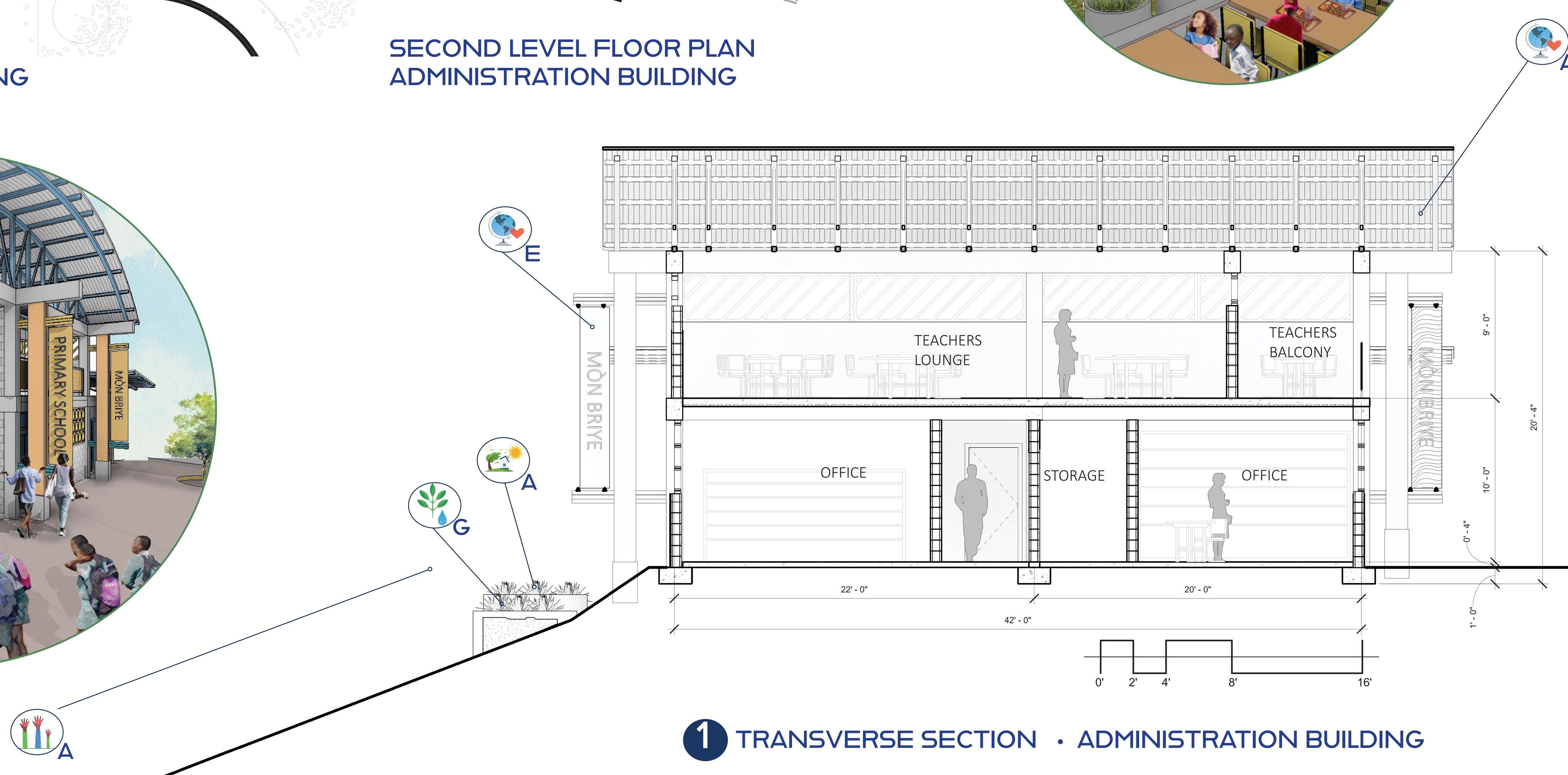
MAIN LEVEL FLOOR PLAN
ADMINISTRATION BUILDING



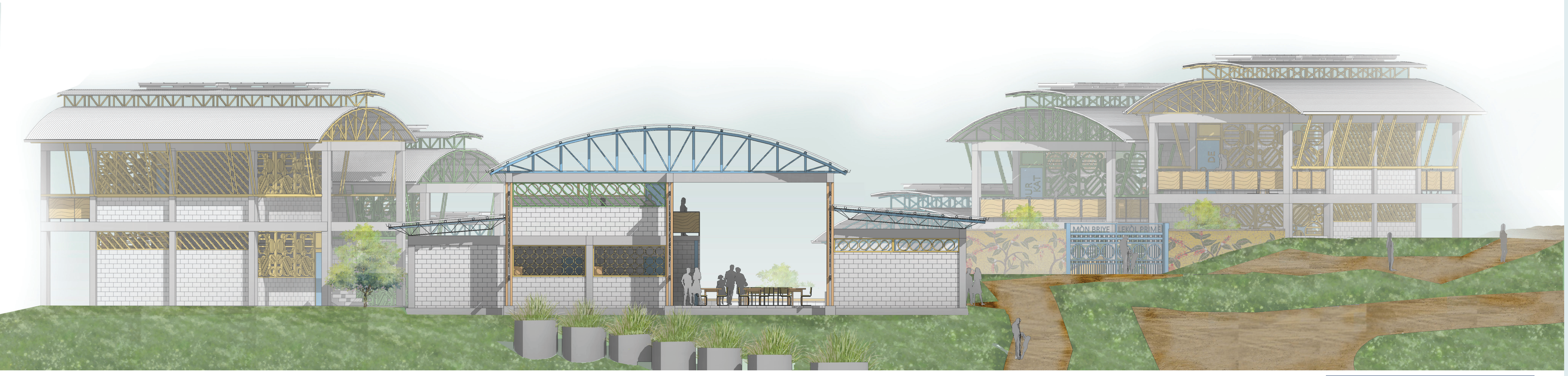
SECOND LEVEL FLOOR PLAN
ADMINISTRATION BUILDING



ADJACENCY · USER DIAGRAM

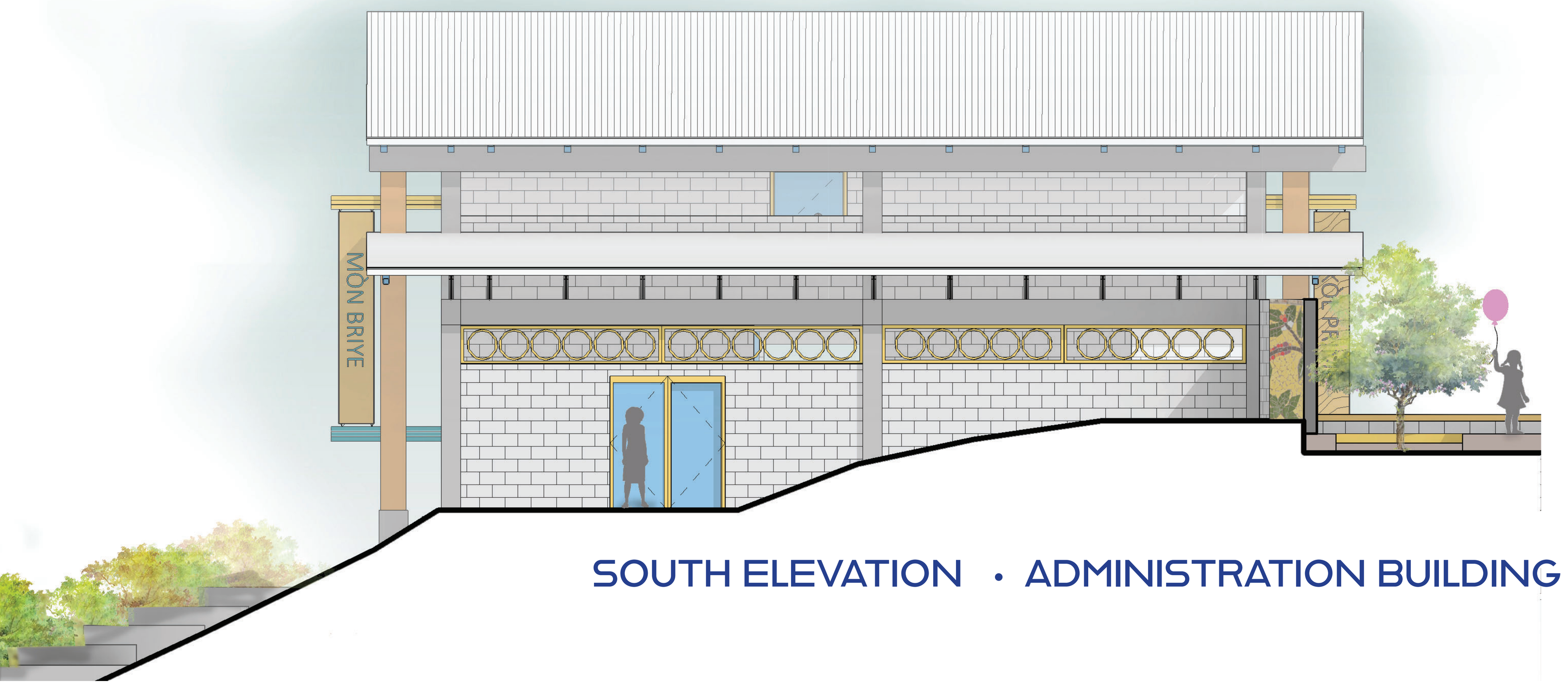


1 TRANSVERSE SECTION · ADMINISTRATION BUILDING

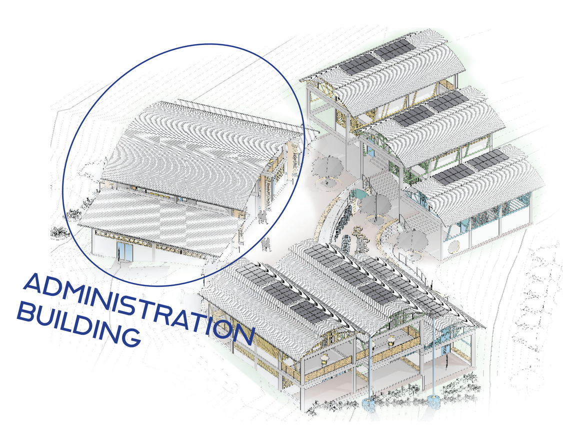


WEST ELEVATION

> " The qualities that we call beauty must grow from the realities of life "



SOUTH ELEVATION • ADMINISTRATION BUILDING



ECOLOGICALLY ENGINEERED WASTEWATER TREATMENT

(Information from: THE GREEN STUDIO HANDBOOK) LIVING MACHINE

Small System selected : 2500 GDP Wastewater load
Estimated 10 gallons per a day per student. 10 gallons x 250 students = 2500 GDP Wastewater load

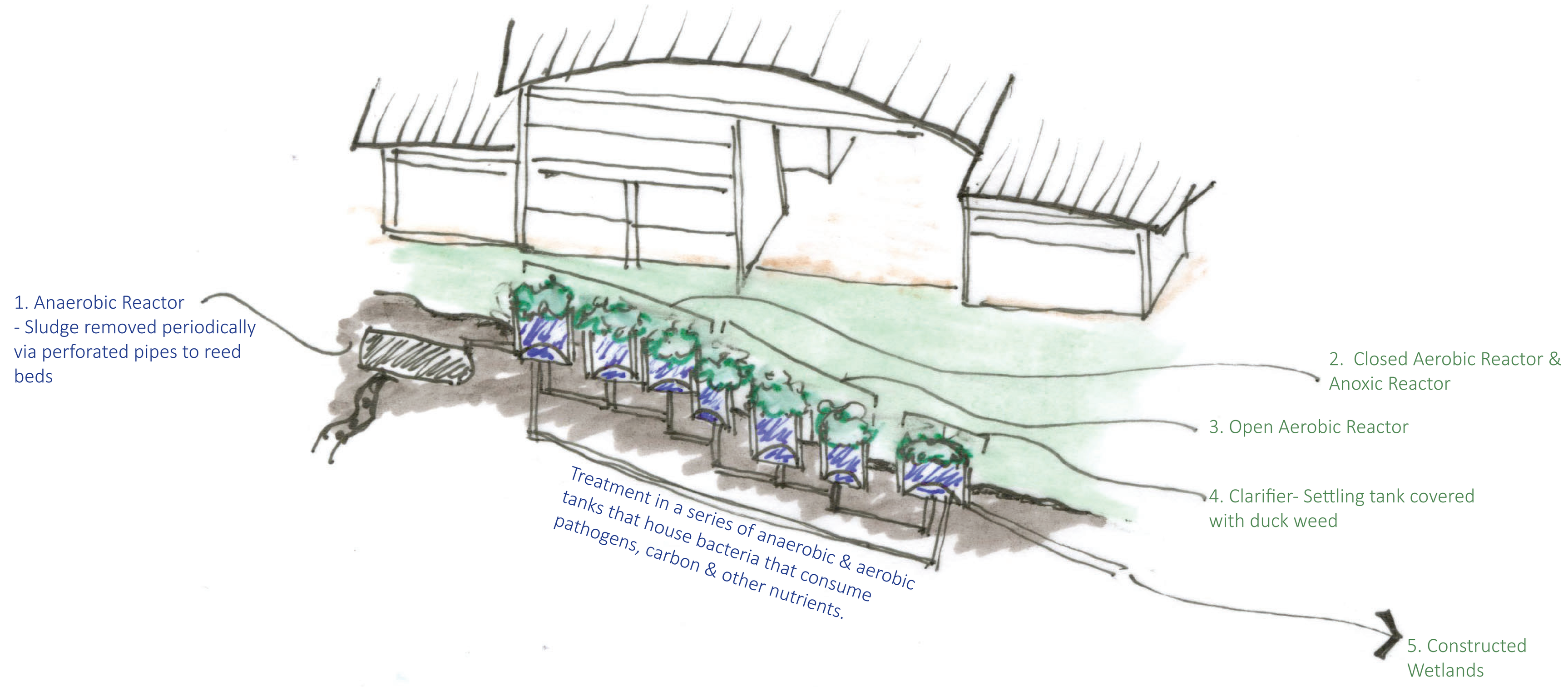
1. Holding Tank- Anaerobic Reactor (Similar in appearance to septic tank- Buried)

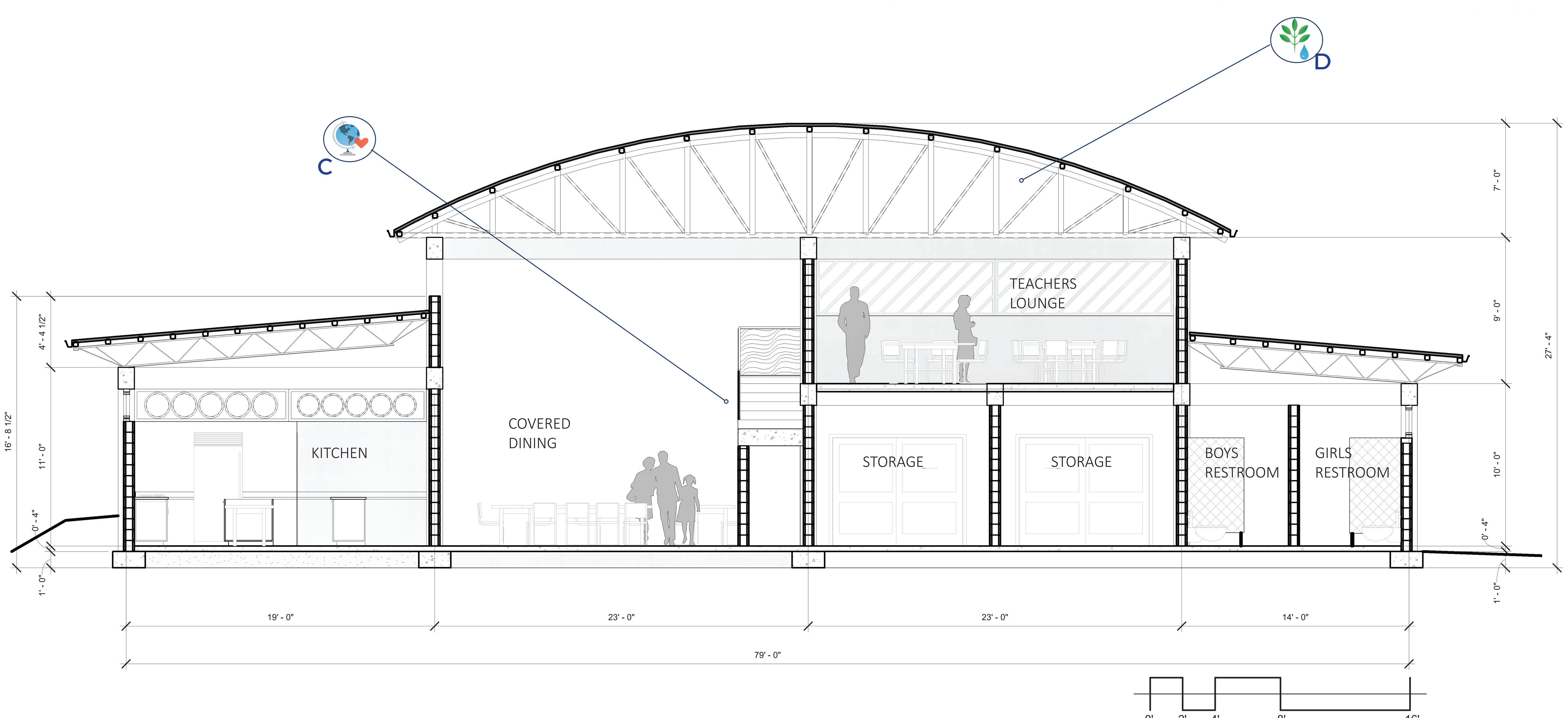
2. Closed Aerobic Reactor & Anoxic Reactor- Bubbly diffuser, biofilter over
   (3) 1500 gallon tanks 6 ft diameter x 3 ft high

3. Open Aerobic Reactor- Consecutive aerobic stages. Covered with vegetation, along with plants, fish and crabs can be in the end of the treatment cycle.
   (3) 1500 gallon tanks 6 ft diameter x 3 ft high (67 ° - 87 °)

4. Clarifier- Settling tank covered with duck weed
   700 gallons 8 ft diameter x 3 ft high

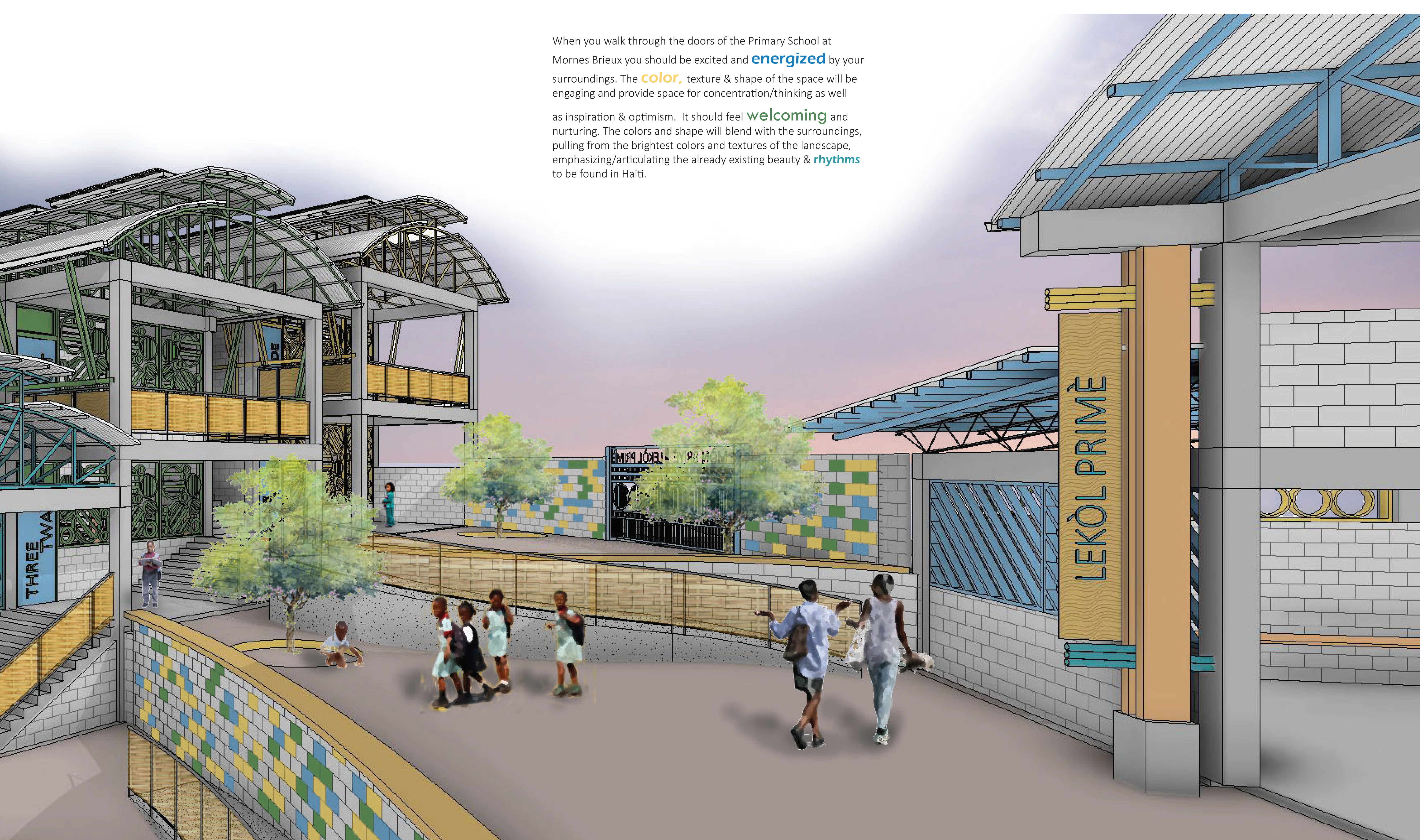
5. Constructed Wetlands
   15ft x 30ft x 3ft deep

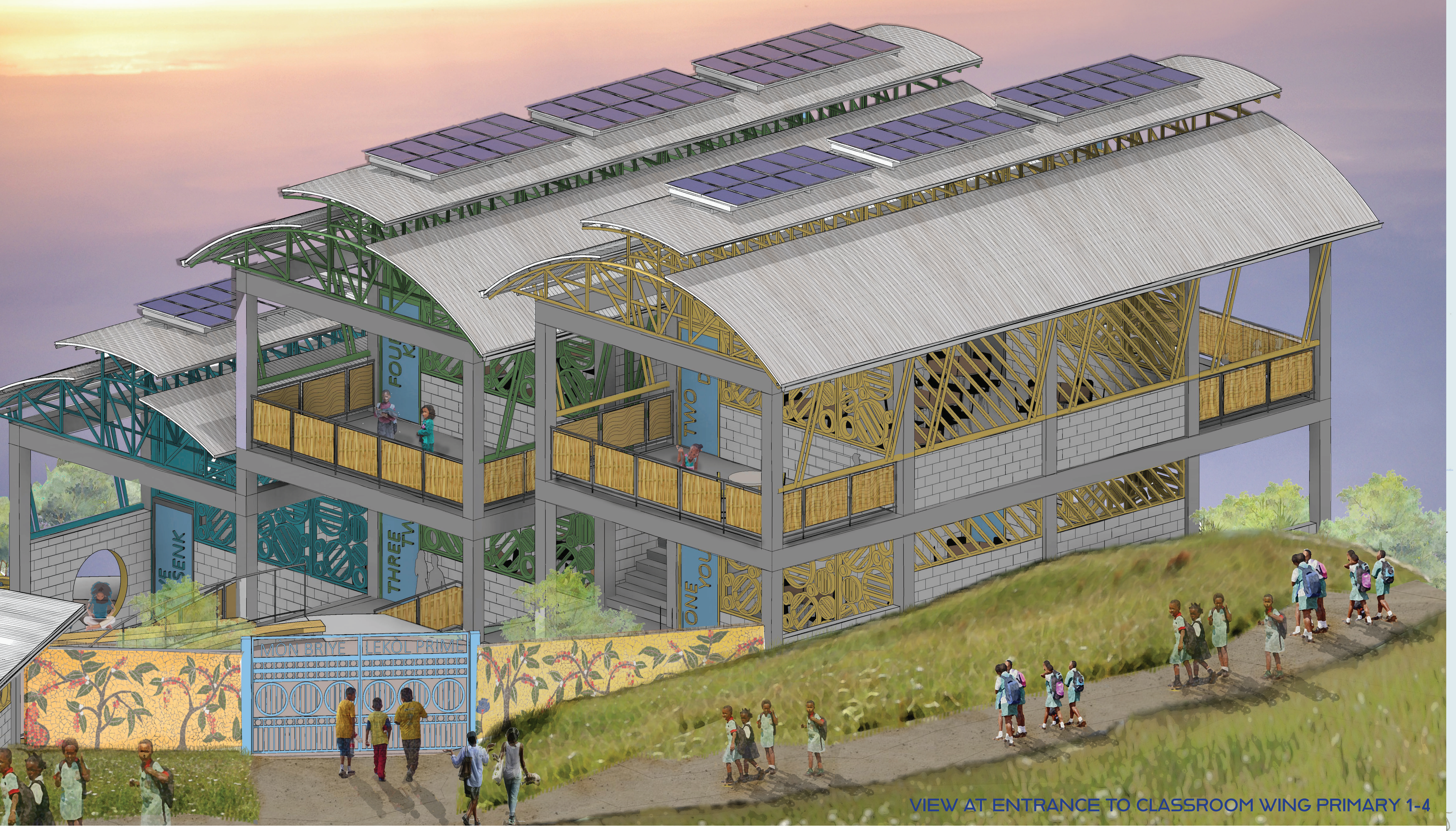




2 LONGITUDINAL SECTION • ADMINISTRATION BUILDING

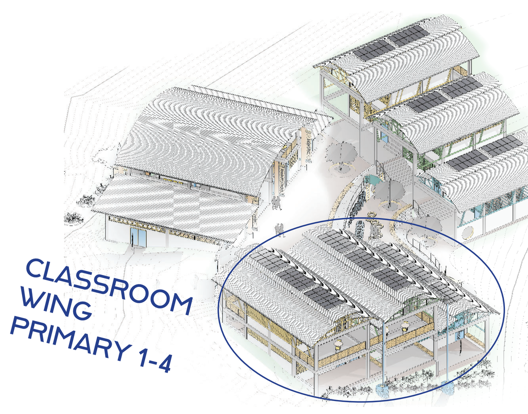
When you walk through the doors of the Primary School at Mornes Brieux you should be excited and **energized** by your surroundings. The **color,** texture & shape of the space will be engaging and provide space for concentration/thinking as well as inspiration & optimism. It should feel **welcoming** and nurturing. The colors and shape will blend with the surroundings, pulling from the brightest colors and textures of the landscape, emphasizing/articulating the already existing beauty & **rhythms** to be found in Haiti.

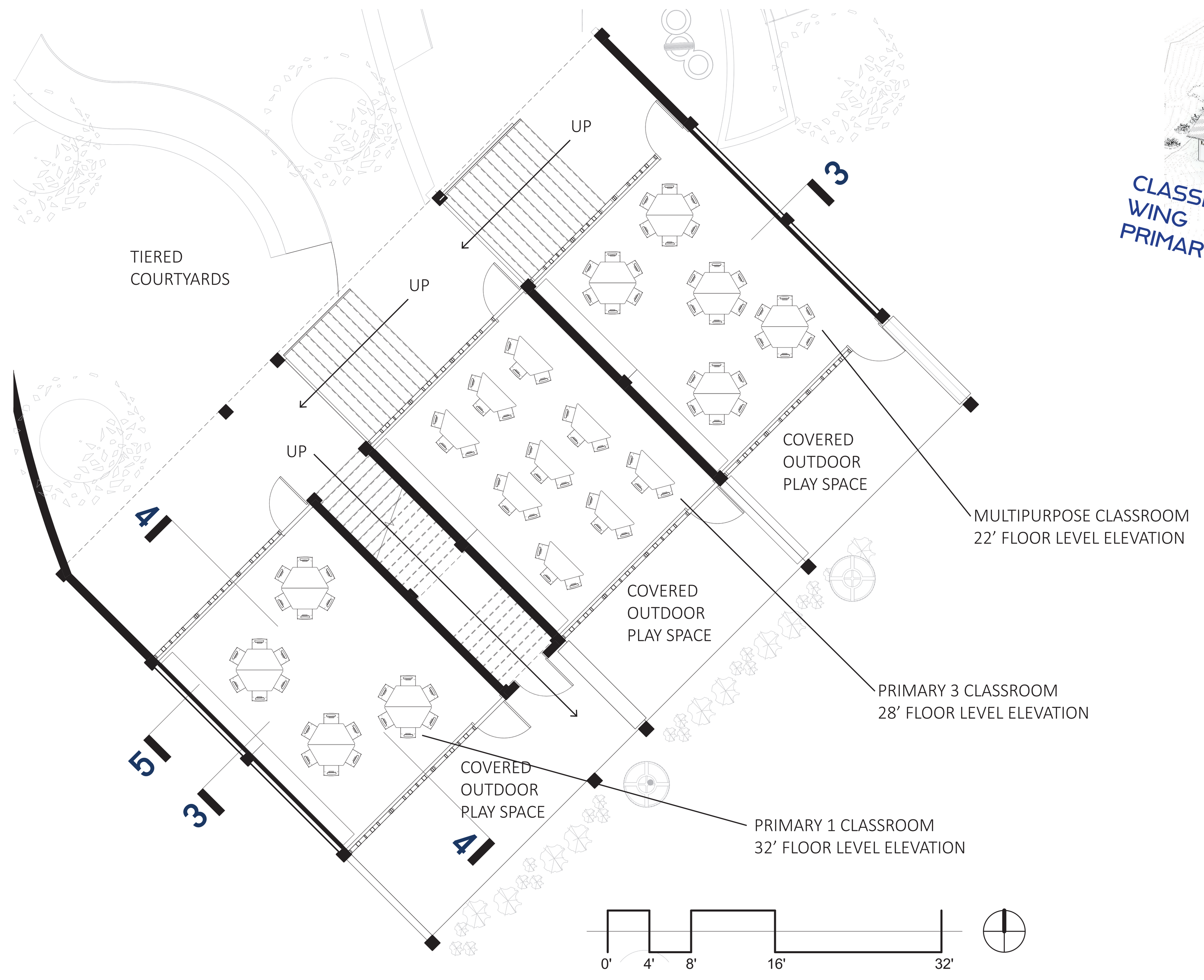




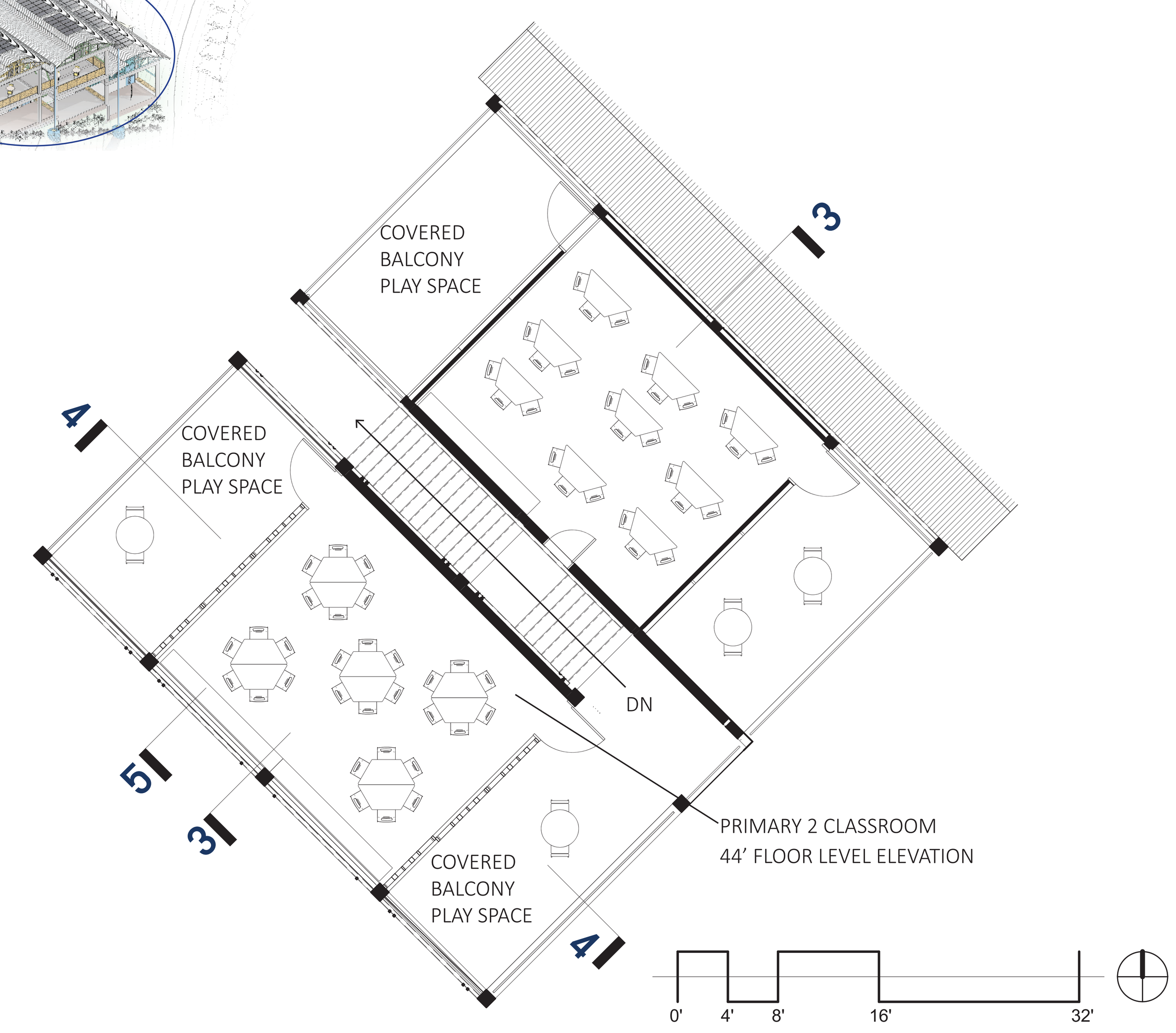
VIEW AT ENTRANCE TO CLASSROOM WING PRIMARY 1-4

"We want the architecture to think about the person who walks in the door"

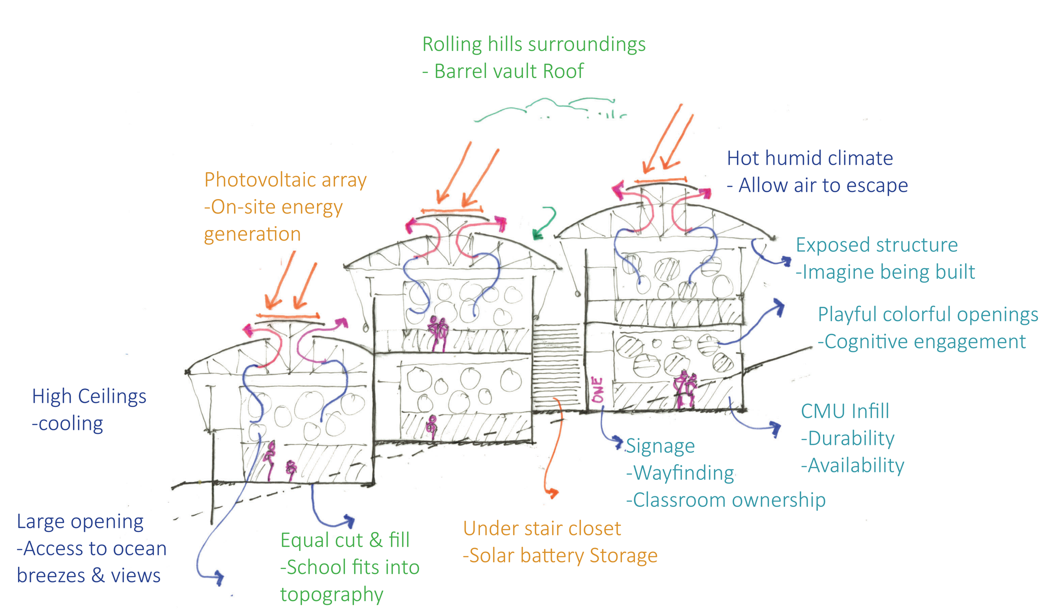




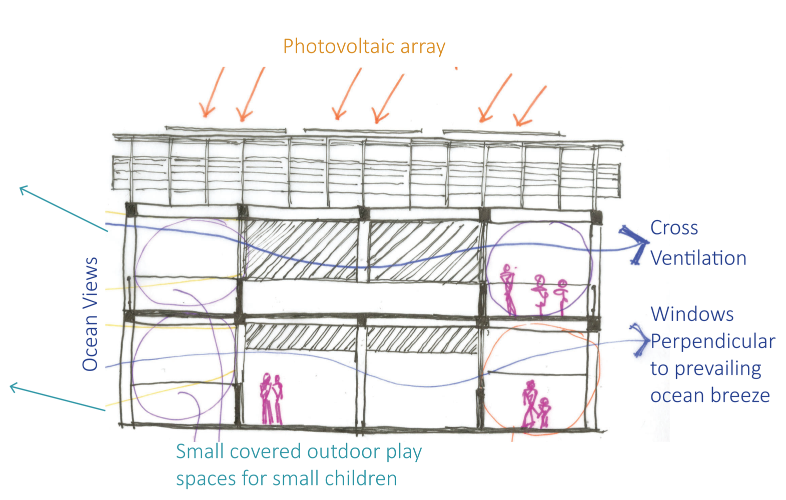
MAIN LEVEL FLOOR PLAN • CLASSROOM WING • PRIMARY 1-4



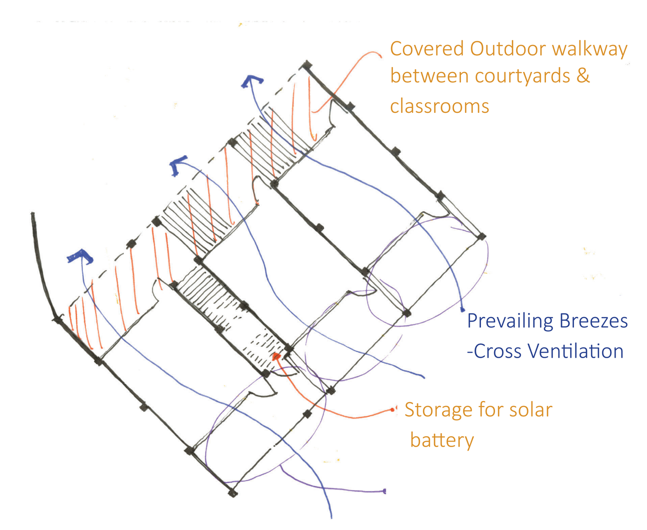
SECOND LEVEL FLOOR PLAN • CLASSROOM WING • PRIMARY 1-4



CLIMATE • USER • TOPOGRAPHIC RESPONSE DIAGRAM



PASSIVE VENTILATION • VIEWS DIAGRAM



CROSS VENTILATION • CIRCULATION DIAGRAM

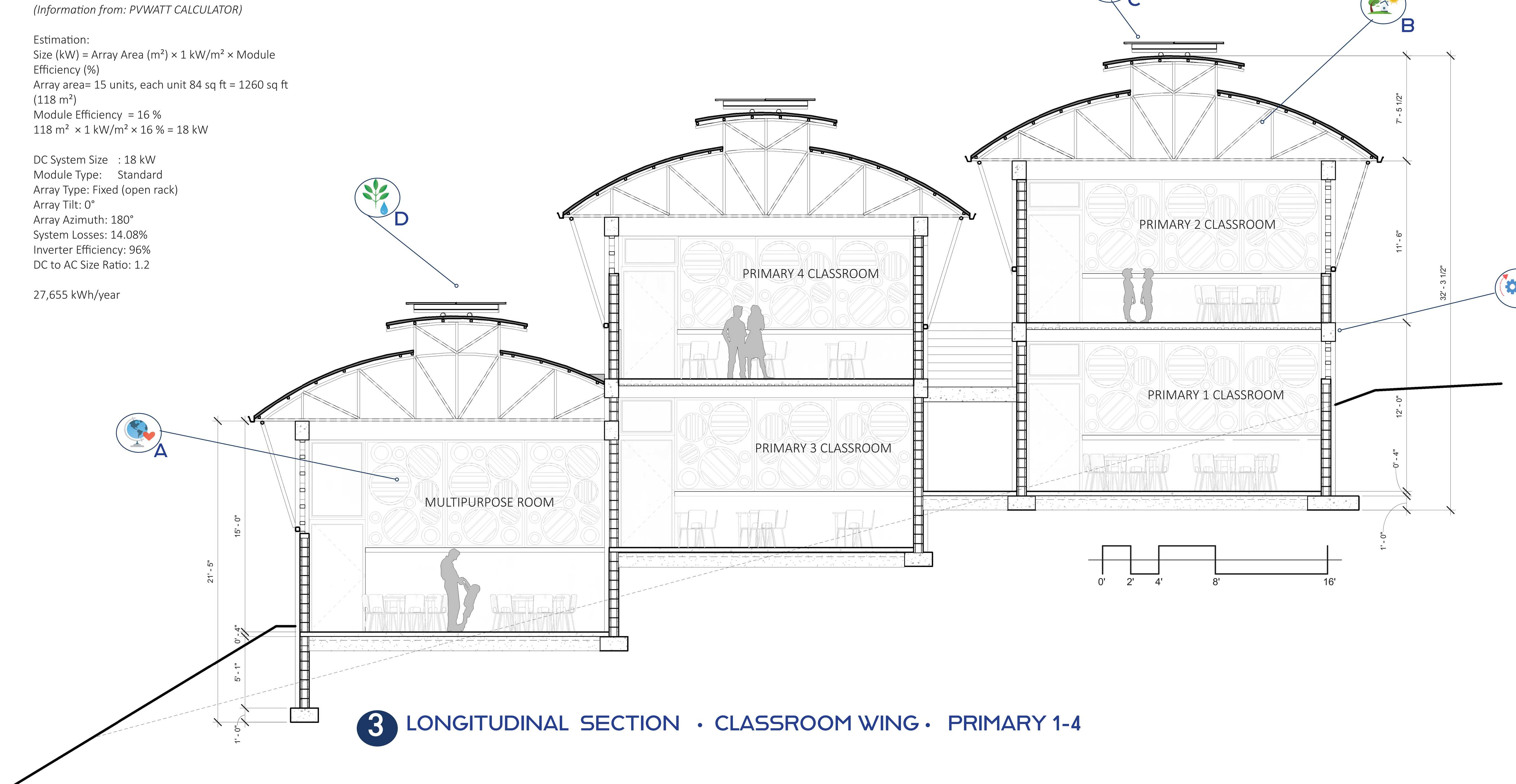
PHOTOVOLTAIC ARRAY

(Information from: PVWATT CALCULATOR)

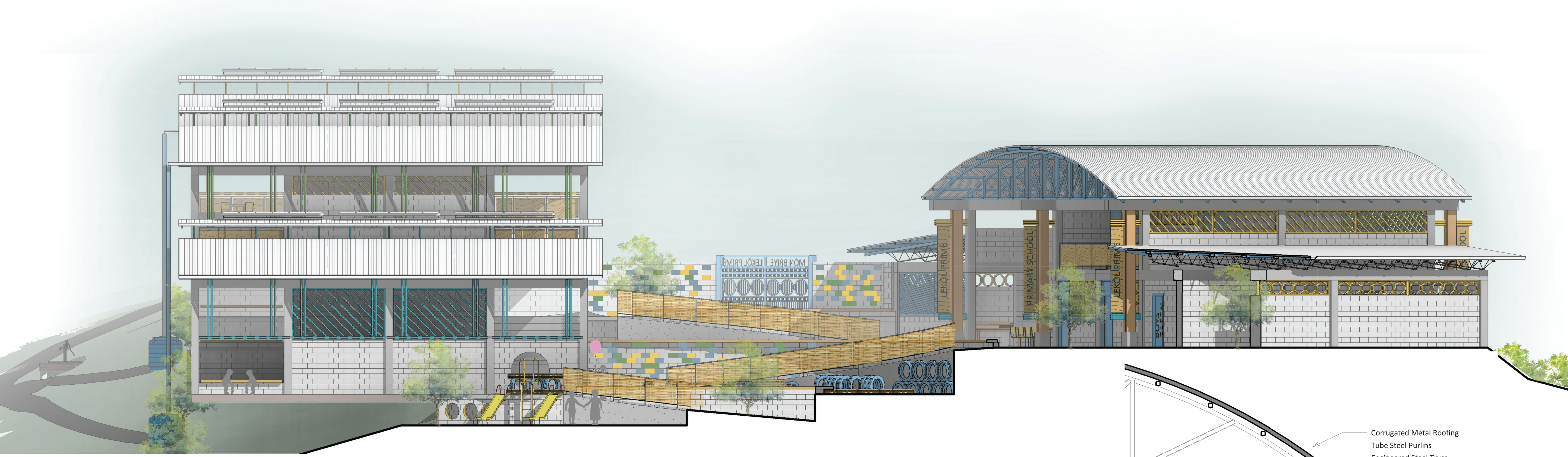
Estimation:
Size (kW) = Array Area (m^2) × 1 kW/m^2 × Module Efficiency (%)
Array area= 15 units, each unit 84 sq ft = 1260 sq ft (118 m^2)
Module Efficiency = 16 %
118 m^2 × 1 kW/m^2 × 16 % = 18 kW

DC System Size : 18 kW
Module Type: Standard
Array Type: Fixed (open rack)
Array Tilt: 0°
Array Azimuth: 180°
System Losses: 14.08%
Inverter Efficiency: 96%
DC to AC Size Ratio: 1.2

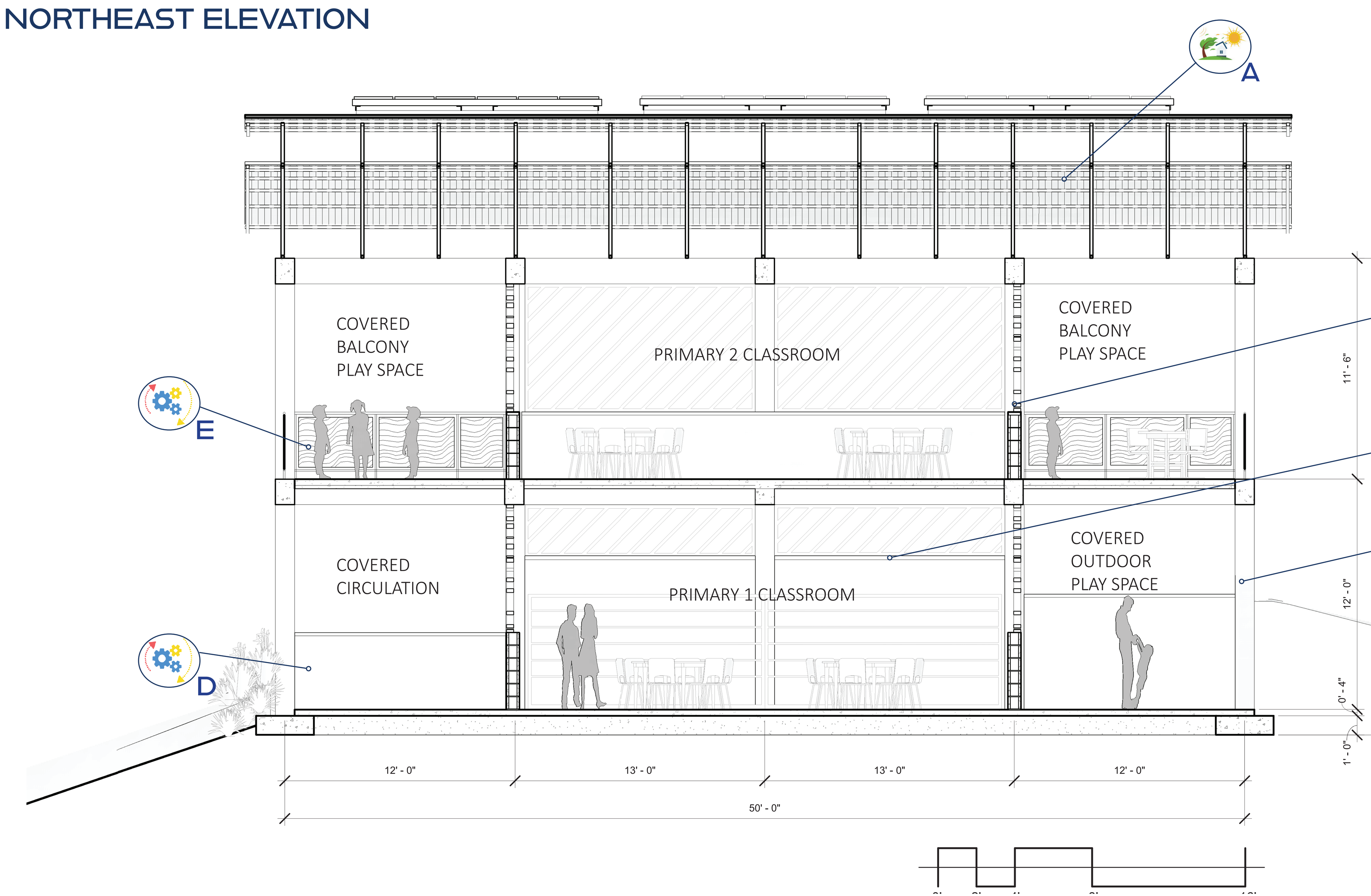
27,655 kWh/year

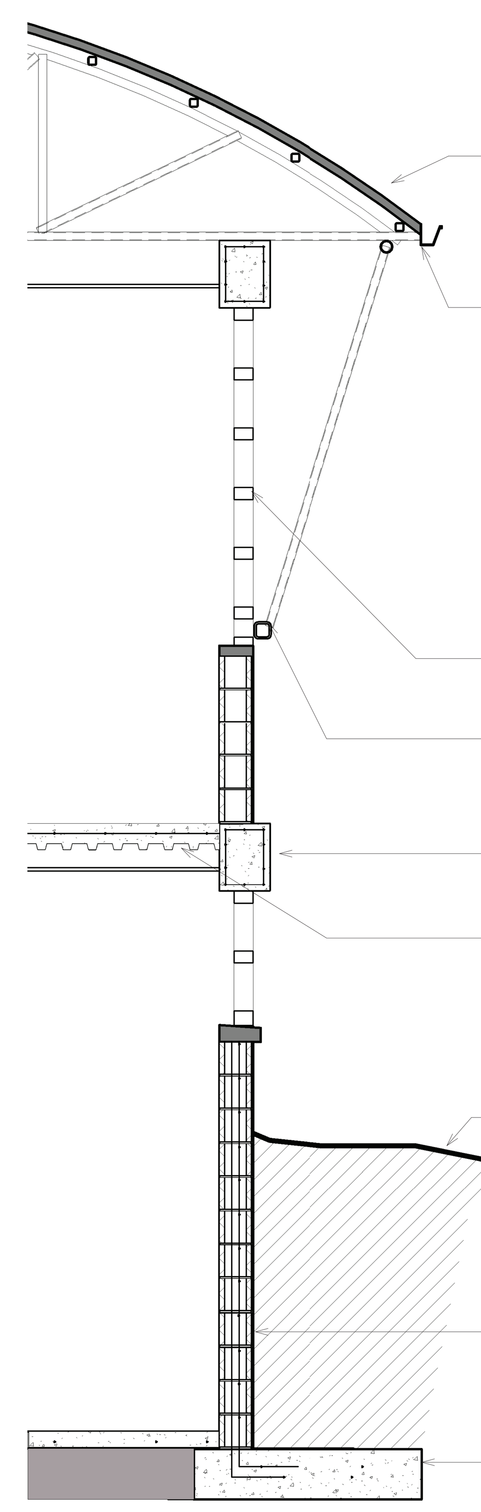


3 LONGITUDINAL SECTION • CLASSROOM WING • PRIMARY 1-4



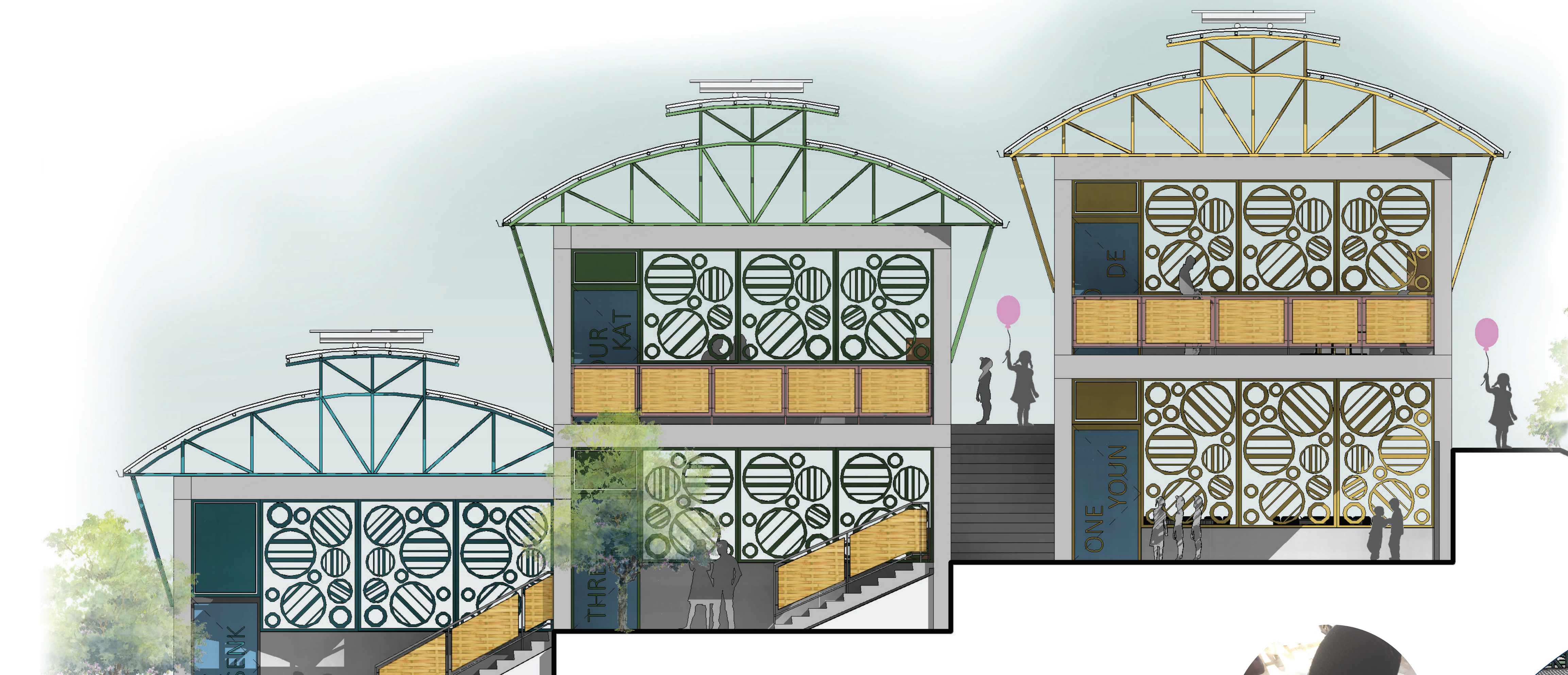
NORTHEAST ELEVATION





4 LONGITUDINAL SECTION • CLASSROOM WING • PRIMARY 1-4

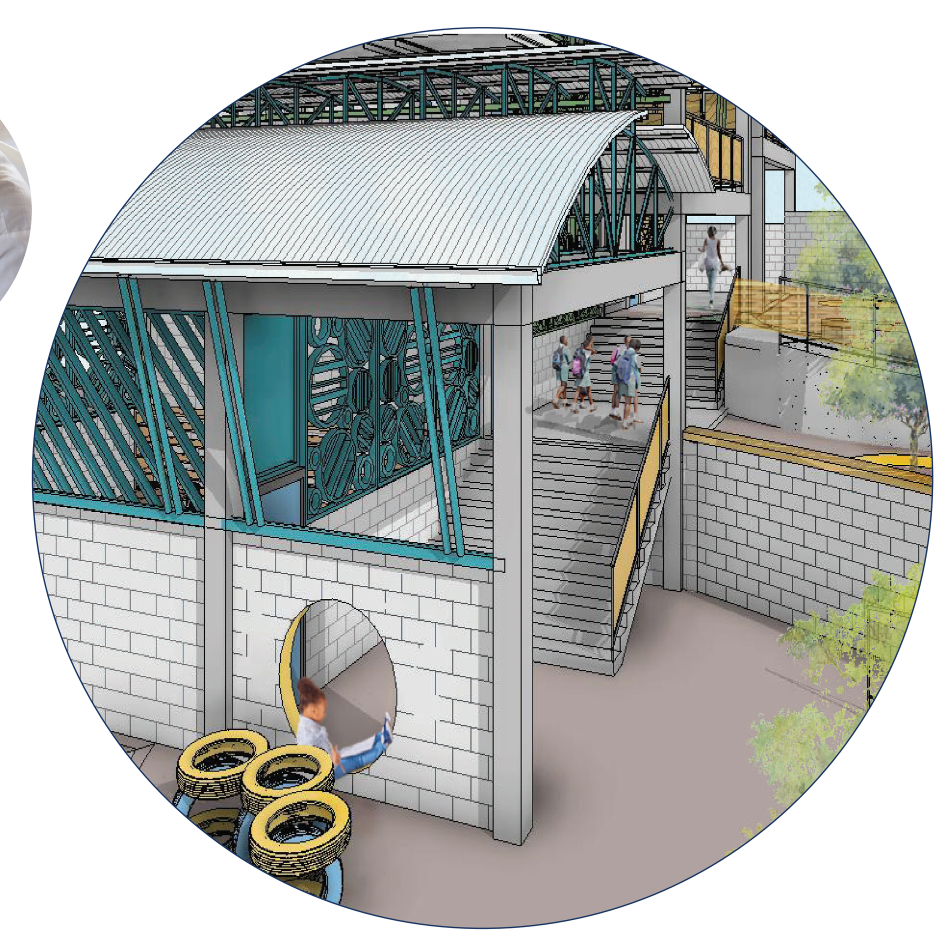
5 TYPICAL WALL SECTION



Rhythm

1. A strong, regular repeated **pattern** of movement or sound
2. The ***systematic arrangement*** of musical sounds, principally according to duration & periodic stress
3. A particular type of pattern formed by rhythm
4. An ordered recurrent alteration of strong and weak elements in the **flow** of sound & silence
5. Movement, fluctuation, or **variation** marked by the regular recurrence of natural flow of related elements
6. **Temporal**

NORTHWEST ELEVATION • CLASSROOM WING • PRIMARY 1-4



" A building has done a good job if it even lifts your spirits for a brief moment."

" The architecture product is not an end-in-itself but rather a means that allows us to address the human condition."

APPENDIX B

Structural Calculations

Mòn Briyè Primary School

Mornes Brieux, Haiti

Prepared by:

Leah George
Devin Williams

June 6, 2019

Journeyman International

TABLE OF CONTENTS

PROJECT DESCRIPTION

PROJECT: MÒN BRIYÈ PRIMARY SCHOOL
LOCATION: MORNE BRIEUX, HAITI

BUILDING CODE: 2015 INTERNATIONAL BUILDING CODE
ASCE 7-16
AIC 318-14
TMS 402/602-16
Étude code de construction, Mesures d'urgence Haïti 2010

STRUCTURAL SYSTEMS:
VERTICAL CONCRETE POST AND BEAM SYSTEM
CONCRETE FOOTING FOUNDATION
CONCRETE SLAB ON GRADE

LATERAL CONCRETE MOMENT FRAMES

STRUCTURAL MATERIALS

MATERIAL SPECIFICATIONS
TYPICAL UNLESS NOTED IN CALCULATIONS

CMU: 8 IN / 20.32 CM NOMINAL CONCRETE BLOCK
PARTIALLY GROUTED

CONCRETE: ALL CONCRETE f'c 1500 PSI / IN 28 DAYS MIN.
NORMAL WEIGHT

REINFORCING: ASTM A615 – GRADE 40

Leah George
Devin Williams

Reference	Calculations	P 2

LOAD TAKEOFF

ROOF

PV PANELS		4	PSF
CORRUGATED 26GA STEEL		1	PSF
ENGINEERED STEEL TRUSS		5	PSF
TUBE STEEL PURLINS		1	PSF
MEP/MISC		2	PSF
CONCRETE JOISTS	4X8	25.4	PSF
		38.4	PSF
CONCRETE COLUMNS	8X8	5.6	PSF
		44	PSF

FLOOR

STRUCTURAL STEEL DECKING		2	PSF
MASONRY BLOCK IN SLAB		50.4	PSF
2" STRUCTURAL SLAB (NW)		25	PSF
MEP/MISC		3	PSF
CONCRETE JOISTS	4X8	25.4	PSF
		105.8	PSF
CONCRETE GIRDERS	12X16	26.67	PSF
		132.47	PSF
REGULAR CONC COLUMNS 8X8		5.45	PSF
MOM FRAME COLUMNS 24X16		21.82	PSF
		159.74	PSF

WALLS

CMU WALLS

LW 8" THICK		
PARTIALLY GROUTED		
@ 24" O.C.	35	PSF

LIVE LOAD

ROOF	20	PSF
CLASSROOM	40	PSF
FIRST FLOOR CORRIDOR	100	PSF

Reference	Calculations		US		Metric	
	GRAVITY DESIGN					
	GRAVITY JOIST DESIGN TRY 4X8					
	SPAN =		13	ft	3.96	m
	TRIB WIDTH =		1.31	ft	0.4	m
	b =		4	in	10	cm
	d =		8	in	20	cm
	f'_c =		1500	psi	105	kg/cm^2
	f_y =		40	ksi	2182	kg/cm^2
	$ß_1$ =		0.85			
	d - COVER		6.81	in	17.3	cm
	LOADING					
	P_d =		138.86	plf		
	P_l =		52.5	plf		
	M_u DEMAND		6949.25	lbsin		
	V_u DEMAND		1629	lbs		
	MINIMUM REINFORCING		0.16	in^2		
	LL REDUCTION?	A_t =	17.06	ft^2		
		NO REDUCTION				
	a		0.23	in	1.13	cm
	$A_{s,req}$		0.029	in^2	As MIN GOVERNS	
	USE (4) #4 BARS					
ACI 318-14 9.3.3.1	TENSION CONTROLLED =		0.074	> .004 OK		
	NO SHEAR REINFORCEMENT REQUIRED					

GRAVITY JOIST DESIGN: 4 X 8 IN (10 X 20 CM)		
LONGTIUDINAL: (4) #4 BARS		

Reference	Calculations	US		Metric
	SLAB			
	REINFORCEMENT			
ACI 310 T7.6.1.1	MIN PRIMARY 0.002Ag =	0.048	in^2	
ACI 310 T24.4.3.2	MIN SECONDARY	0.002	in^2	
	SPACING			
ACI 318-14 24.3.2.1	f_s = 2/3(F_y)	26666.67	psi	
	MINIMUM SPACING			
	GREATEST OF:			
ACI 318-14 25.2.1	(a) 1"	1	in	
	(b) d_b	0.5	in	
	(c) (4/3)d_{agg}	1.33	in	GOVERNS
	MAXIMUM SPACING			
	Lesser of:			
ACI 310 7.7.2.3	(a) 3h	6	in	GOVERNS
	(b) 18"	18	in	
ACI 310 T24.3.2	(c) 15(40,000/fs)-2.5cc	19.38	in	
	(d) 12(40,000/fs)	18	in	

PRIMARY: #3 @ 6 IN (15.25 CM) O.C.
SECONDARY: #3 @ 6 IN (15.25 CM) O.C.

Leah George
Devin Williams

Reference	Calculations	US		Metric	
	<u>INNER GRAVITY BEAM DESIGN B4</u> TRY 18 X 28				
	SPAN =	22	ft	6.7056	m
	TRIB WIDTH =	13	ft	3.81	m
	b =	18	in	20	cm
	d =	28	in	40.6	cm
	f'_c =	1500	psi	105	kg/cm^2
	f_y =	40	ksi	2182	kg/cm^2
	d - COVER	26.81	in	37.6	cm
	LOADING				
	P_d =	2066.53	plf		
	P_l =	832	plf		
	M_u DEMAND	2104334	lbsin		
	V_u DEMAND	31883.85	lbs		
	$A_{s,min}$ = THE GREATER OF				
	(a) $(3*\sqrt{f'_c}/f_y)*b_w*d$	1.40	in^2	GOVERNS	
	(b) $(200/f_y)*b_w*d$	1.17	in^2		
	LL REDUCTION?	A_t =		286 ft^2	
		NO REDUCTION			
	a	4.12	in	12	cm
	$A_{s,req}$	2.36	in^2	A_s REQD GOVERNS	
	USE: 18X28 BEAM W/ (8) #5 BARS				
	SHEAR REINFORCING				
ACI 318-14 T21.2.1	ϕ	0.75			
ACI 318-14 22.5.1.1	ϕV_n	140190	lbs	> V_u OK	
	$\phi V_{s,req}$	3846	lbs		
ACI 318-14 9.7.6.2.2	$4\sqrt{f'c}bd$ =	78079	> $V_{s,reqd}$		
	MAXIMUM SPACING				
ACI 318-14 T9.7.6.2.2	LEAST OF:				
	(a) d/2	13.4	in	GOVERNS	
	(b) 24"	24	in		
	SPACING	111.5	in		
		MAX SPACING GOVERNS			
	V_s	29493.75	lbs	> $V_{s,reqd}$ OK	

Reference	Calculations	US		Metric	

GRAVITY BEAM DESIGN B4: 18 X 28 IN (46 X 71 CM)
LONGITUDINAL: (8) #5 BARS
TRANSVERSE: #4 TIES AT 12 IN (30.5 CM) O.C.

OUTER GRAVITY BEAM DESIGN B1 TRY 16 X 16

Reference	Calculations	US		Metric	
	SPAN =	22	ft	6.71	m
	TRIB WIDTH =	6	ft	3.81	m
	b =	16	in	20	cm
	d =	16	in	40.6	cm
	f'_c =	1500	psi	105	kg/cm^2
	f_y =	40	ksi	2182	kg/cm^2
	d - COVER	14.81	in	37.60	cm
	LOADING				
	P_d =	953.78	plf		
	P_l =	384	plf		
	M_u DEMAND	971231.18	lbsin		
	V_u DEMAND	14715.62	lbs		
	MINIMUM REINFORCING	0.48	in^2		
	LL REDUCTION?	132	ft^2		
		NO REDUCTION			
	a	4.15	in	12	cm
	$A_{s,req}$	2.12	in^2	A_s REQD GOVERNS	
	USE: 16X16 CONCRETE JOIST W/ (7) #5 BARS				
	SHEAR REINFORCING				
ACI 318-14 T21.2.1	ϕ	0.75			
ACI 318-14 22.5.1.1	ϕV_n	68842	lbs	$> V_u$ OK	
	$\phi V_{s,req}$	947	lbs		
ACI 318-14 9.7.6.2.2	$4\sqrt{f'c}bd$ =	39659	$> V_{s,reqd}$		
	MAXIMUM SPACING				
ACI 318-14 T9.7.6.2.2	LEAST OF:				
	(a) d/2	7.4	in	GOVERNS	
	(b) 24"	24	in		

Leah George
Devin Williams

Reference	Calculations	US		Metric
	SPACING	250	in	
		MAX SPACING GOVERNS		
	V_s	16293.75	lbs	> $V_{s,reqd}$ OK

GRAVITY BEAM DESIGN B1: 16 X 16 IN (40.6 X 40.6 CM)
LONGITUDINAL: (7) #5 BARS
TRANSVERSE: #4 TIES AT 6 IN (15.25 CM) O.C.

Reference	Calculations	US		Metric	
	GRAVITY COLUMN DESIGN C1				
	INITIAL SIZING:				
	Ag TRIAL > P_u / (0.4(f'$_c$+f$_y$pg))	42.86	in^2	276.22	cm^2
	REQUIRED MINIMUM SIZE =	7x7	in		
	TRY 10x10 W/ (4) #5 BARS				
	A_g =	256	in^2	1651.61	cm^2
	Ast =	3.72	in^2	> .01A_g	
	d =	13.50	in		
	FROM SP COLUMN - MOMENT AND AXIAL ARE WITHIN PM DIAGRAM				
	TRANSVERSE REINFORCEMENT				
	ASSUME #4 TIES				
ACI 318-14 25.7.2.1	TIE SPACING:				
	(a) CLEAR SPACING OF AT LEAST =	1.33	in		
	(b) CENTER TO CENTER SPACING =				
	SMALLER OF:				
	(a) 16db LONG.	10	in	GOVERNS	
	(b) 48db TIE	24	in		
	(c) SMALLEST DIM. OF BEAM	18	in		
	USE #4 TIES AT 10" O.C.				

GRAVITY COLUMN DESIGN C1: 16 X 16 IN (41 X 41 CM)
LONGITUDINAL: (12) #5 REBAR
TRANSVERSE: #4 TIES @ 10 IN (25.4 CM) O.C.

Reference	Calculations	US	Metric
	FOUNDATION DESIGN - GRAVITY COLUMN C1		
	NO SOILS REPORT		
IBC T1806.2	Q_{all} 2000 psf ASSUMPTION FROM IBC WITH 1.33% INCREASE		
	MAX ROOF TRIB AREA C1 =	9504 in^2	
	MAX FLOOR TRIB AREA C1 =	4752 in^2	
	D	8175.35 lbs	
	L	4620 lbs	
	A_{req} = (D+L)/q_{all}		
	A_{req} =	6.40 ft^2	
IBC 1809.4	MINIMUM DEPTH AND WIDTH = 12"		
	TRY 3'-0" X 3'-0" A =	144 ft^2	
	P_u = 1.2D+1.6L		
	P_u =	17202 lbs	
	$q_s = P_u / A_f$		
	q_s =	119 psf	
	ASSUME DEPTH OF FOOTING =	1 ft	
	d =	10 in	
	PUNCHING SHEAR		
	$V_u = q_s$ x TRIB AREA		
	TRIB AREA =	6.22 ft^2	
	V_u	743 lbs	
	$V_c / \sqrt{f'_c} b_o d$ =		
	Minimum of:		
	(a) 2 + 4/β	6.71	
	(b) (αd/bo)+2	5.33	
	(c) 4	4 GOVERNS	
	β =		
	b_o = 120		
	α = 40		

Reference	Calculations	US		Metric
	ΦV_c =	139427	lbs	> V_u GOOD
	ONE WAY SHEAR			
	$V_u = q_s$ x TRIB AREA			
	TRIB AREA =	0.75	ft^2	
	V_u =	90	lbs	
ACI 318-14 22.5.5.1	$\Phi V_c = \Phi(2\surd f'_c b_w d)$			
	ΦV_c =	20914	lbs	> V_u GOOD
	FOOTING REINFORCEMENT			
	$M_u = wl^2/2$			
	M_u =	26280.79	lbs-ft	
	a =	0.80	in	
	$A_{s,reqd}$ =	0.91	in^2	
	DEVELOPMENT LENGTH			
ACI 318-14 25.4.2.3a	L_d = $(3/40)*(f_y/\surd f'_c)*(\Psi_t \Psi_e \Psi_s/(c_b+K_{tr}/d_b))$			
	L_d = 8.07 in			
	$L_{d,all}$ = 12.5 in			
	$L_{d,all} > L_d$ GOOD			

GRAVITY COLUMN FOUNDATION DESIGN:
3'-0" X 3'-0" X 1'-0" (.91 M X .91 M X .30 M)
LONGITUDINAL: (3) #5 BARS

Leah George
Devin Williams

References	Calculations		US	Metric
	LATERAL DESIGN			
	DESIGN CRITERIA			
	FROM HAITIAN BUILDING CODE:			
	S_{ms} =	0.99		
ASCE 7-16 11.4-3	$S_{ds} = (2/3)S_{ms}$	0.66		
ASCE 7-16 T12.2-1	R =	8		
	I_e =	1		
ASCE 7-16 12.8-1	$V = C_s*W$			
ASCE 7-16 12.8-2	$C_s = S_{ds}/(R/I_e)$ =	0.0825		
	C_s min = $.04*S_{ds}*I_e$ =	0.0264 < C_s OK		
	BUILDING WEIGHT			
	BUILDING 1:			
	LOAD TO ROOF =	68.56 kips x 2 roofs		
	LOAD TO FLOOR 2 =	216.03 kips		
	TOTAL WEIGHT =	353.15 kips		160186 kg
	BUILDING 2:			
	Load to Roof =	68.56 kips		
	Load to Floor 2 =	216.03 kips		
	Total Weight =	284.59 kips		129088 kg
	$V = C_s*W$			
	Building 1:		**29.14 kips**	**13215 kg**
	Building 2:		**23.48 kips**	**10650 kg**

Leah George
Devin Williams

Reference	Calculations		US	Metric
	Wind Lateral Force			
ASCE 7-16 Sect. 1.5-1				
HAITIAN CODE	STEP 1: RISK CATEGORY = II			
	STEP 2: BASIC WIND SPEED = 130 mph			
ASCE 7-16 Tbl 27.5-2	STEP 3: EXPOSURE CATEGORY = D		FACTOR:	1.18
	Kd =	0.85		
ASCE 26.8	TOPOGRAPHIC FACTOR $K_{zt} = (1 + K_1*K_2*K_3)^2$		(2D ESCARPMENT TOPOGRAPHY)	
	$K_1 = 0.95$		Lh INFINITE, x = 0	1
	$K_2 = (1 - \lvert x\rvert / \eta*Lh)$			
	$K_3 = e^{-\gamma z/Lh}$	1		
	$K_{zt} =$	3.80		
	Ke =	0.986		
	ENCLOSURE CLASSIFICATION: PARTIALLY ENCLOSED			
	GCpi =	0.55 -0.55		
	STEP 4: VELOCITY PRESSURE EXPOSURE COEFFICIENT			
	Kz = Kh =	1.16		
	STEP 5: VELOCITY PRESSURE			
	$qz = 0.00256*Kz*Kzt*Kd*Ke*V^2$		159.94 psf	
	qz = 0.613*Kz*Kzt*Kd*Ke*V2			7653.55 n/m^2
	STEP 6: EXTERNAL PRESSURE COEFFICIENT			
	GCpf =	0.542		
	STEP 7: WIND PRESSURE (p)			
	p = qh*(GCpf)- GCpi =		174.65 psf	
	V =		23054 lbs	
	V =		**23.05 k**	

Reference	Calculations	US		Metric	
	MOMENT FRAME FLOOR BEAM DESIGN B2				
	DIMENSIONAL LIMITS:				
	(a) CLEAR SPAN l_n SHALL BE AT LEAST 4d				
	(b) WIDTH b_w SHALL BE AT LEAST LEAST OF 0.3h AND 10"				
	(c) PROJECTION OF BEAM WIDTH SHALL NOT EXCEED LEAST OF c_2 AND $0.75c_1$				
	TRY: 18" x 28" CONCRETE BEAM				
	A_g =	504	in^2	3251.6	cm^2
	f'_c =	1500	psi	10342	kN/m^2
FROM ETABS	P_u =	7.57	kips	3433.69	kg
FROM ETABS	V_u =	58	kips	26308.35	kg
	LONGTIDUINAL REINFORCEMENT				
ACI 318-14 9.5.2.1	Pu < $0.1*f'_c*A_g$ =	75.60	kips	> P_u	
ACI 318-14 9.6.1.2	$A_{s,min}$ = THE GREATER OF				
	(a) $(3*\sqrt{f'_c})/f_y)*b_w*d$				
	(b) $(200/f_y)*b_w*d$				
ACI 318-14 T20.6.1.3.1	d = DEPTH - COVER - TIE ϕ - LONG. ϕ =	25.50	in	64.77	cm
	COVER = 1.5"				
	TIE ϕ: ASSUME #3				
	LONGITUDINAL: ASSUME MAX #10				
	(a) 1.12 in^2				
	(b) 2.30 in^2 GOVERNS				
	MAX MOMENT AT BEAM/COLUMN CONNECTION:				
	M_u = 1633680 lbsin				
	b = 18 in				
	a = 3.32 in				
	$A_s$req = 1.90 in^2 $A_{s,min}$ GOVERNS - USE (8) #5 BARS				
	MAX MOMENT AT CENTER OF BEAM				
	M_u = 1578000 lbsin				
	b = 18 in				
	a = 3.20 in				
	$A_s$req = 1.83 in^2 $A_{s,min}$ GOVERNS - USE (8) #5 BARS				
ACI 318-14 18.6.3.1	REINFORCEMENT RATIO =	0.0049	< .025 OK		
ACI 318-14 9.3.3.1	TENSION CONTROLLED =	0.0173	> .004 OK		

Reference	Calculations			US		Metric	
	USE: 45.75 cm x 71 cm CONC MOMENT FRAME FLOOR BEAM B2						
	W/ (7) #5 LONG. REBAR						
	TRANSVERSE REINFORCEMENT						
	ASSUME #4 TIES						
ACI 318-14 25.7.2.1	TIE SPACING:						
	(a) CLEAR SPACING OF AT LEAST =			1.33	in		
	(b) CENTER TO CENTER SPACING =						
	SMALLER OF:						
		(a) 16db LONG.		10	in	GOVERNS	
		(b) 48db TIE		24	in		
		(c) SMALLEST DIM. OF BEAM		18	in		
ACI 318-14 25.7.2.3	TIES SHALL BE ARRANGED EVERY CORNER AND ALTERNATE LONG. BAR						
ACI 318-14 25.5.5.1	$\phi V_c = 0.75(2\lambda\sqrt{f'c}bd)$					WHERE $\lambda = 1.0$	
ACI 318-14 25.5.1.2	$\phi V_s = 0.75(28\sqrt{f'c}bd)$						
	$\phi V_c =$			29.28	kips	13281.18	kg
	$\phi V_s =$			117.12	kips	53124.73	kg
FROM ETABS	$V_u =$			58	kips	26308.35	kg
	$V_{sreq} =$	$(V_u - \phi V_c)/\phi$		38.29	kips	17368.05	kg
	MAXIMUM SPACING						
ACI 318-14 9.7.6.2.2	$4\sqrt{f'c}bd =$			78.08	kips	$> V_{sreq}$	
ACI 318-14 T9.7.6.2.2	MAX SPACING = d/2			12.75	in	32.39	cm
	MINIMUM SPACING $A_{v,min}/s$						
ACI 318-14 T9.6.3.3	THE GREATER OF:						
	(a) $(0.75\sqrt{f'c}b_w)/f_{yt}$			0.013	in^2/s		
	(b) $50*(b_w/f_{yt})$			0.023	in^2/s		
	STIRRUP DESIGN						
	$V_{sreq} = (A_v*f_{yt}*d)/s$		s =	10.65	in	27.06	cm
				USE 10" SPACING			
	USE: #4 TIES AT 25.4 CM O.C.						

Reference	Calculations		US		Metric	
	SEISMIC HOOP DESIGN					
ACI 318-14 18.6.4.1	HOOPS MUST BE PROVIDED AT:					
	(a) OVER A LENGTH EQUAL TO 2*d FROM FACE OF SUPPORTING COLUMN TOWARDS MIDSPAN AT BOTH ENDS OF BEAM = 56"					
	(b) OVER LENGTHS EQUAL TO 2*d ON BOTH SIDES OF SECTION WHERE FLEXURAL YIELDING IS LIKELY TO OCCUR = 56"					
	MAXIMUM SPACING					
ACI 318-14 18.6.4.4	LEAST OF:					
	(a) $d/4$		6.38	in		
	(b) $6*d_b$		3.75	in	GOVERNS	
	(c) 6"		6	in		
	DESIGN FORCES					
ACI 318-14 18.6.5.2	(a) $V_e = (M_{pr1}+M_{pr2})/l_n \pm (w_u*l_n)/2$					
	w_u =		4.42	klf		
	V_e =		57.97	kips	> $V_u/2$	
	(b) $(A_g*f'_c)/20$ =		37.8	kips	> P_u OK	
	$V_u = (A_v f_{yt} d)/s$	s =	7.03	in	17.87	cm
		MAX SPACING 3.5" GOVERNS				

USE: #4 HOOPS @ 3.5 IN (9 CM) WHERE REQUIRED:
56 IN (142 CM) FROM FACE OF COLUMN
56 IN (142 CM) EITHER SIDE OF CENTER OF BEAM

MOMENT FRAME FLOOR BEAM B2: 18 X 28 IN (45.75 X 71 CM)
LONGITUDINAL: (8) #5 BARS
WHEN SEISMIC HOOPS ARE REQUIRED: #4 AT 3.5 IN (9 CM) O.C.
WHEN SEISMIC HOOPS ARE NOT REQUIRED: #4 AT 10 IN (25.4 CM) O.C.

Reference	Calculations	US		Metric	
	MOMENT FRAME ROOF BEAM DESIGN B3				
	DIMENSIONAL LIMITS:				
	(a) CLEAR SPAN l_n SHALL BE AT LEAST 4d				
	(b) WIDTH b_w SHALL BE AT LEAST LEAST OF 0.3h AND 10"				
	(c) PROJECTION OF BEAM WIDTH SHALL NOT EXCEED LEAST OF c_2 AND $0.75c_1$				
	TRY: 18" x 18" CONCRETE BEAM				
	A_g =	324	in^2	2090.32	cm^2
	f'_c =	1500	psi	10342	kN/m^2
FROM ETABS	P_u =	2.91	kips	1319.95	kg
FROM ETABS	V_u =	31	kips	14061.36	kg
	LONGTIDUINAL REINFORCEMENT				
ACI 318-14 9.5.2.1	Pu < $0.1*f'_c*A_g$ =	48.60	kips	> P_u	
ACI 318-14 9.6.1.2	$A_{s,min}$ = THE GREATER OF				
	(a) $(3*\sqrt{f'_c})/f_y)*b_w*d$				
	(b) $(200/f_y)*b_w*d$				
ACI 318-14 T20.6.1.3.1	d = DEPTH - COVER - TIE ϕ - LONG. ϕ =	15.50	in	39.37	cm
	COVER = 1.5"				
	TIE ϕ: ASSUME #3				
	LONGITUDINAL: ASSUME MAX #10				

(a)	0.81	in^2	
(b)	1.40	in^2	GOVERNS

MAX MOMENT AT BEAM/COLUMN CONNECTION:

M_u =	1018800	lbs - in	
b =	18	in	
a =	3.60	in	
$A_s$req =	2.07	in^2	USE (7) #5 BARS

MAX MOMENT AT CENTER OF BEAM

M_u =	1428000	lbs - in	
b =	18	in	
a =	2.87	in	
$A_s$req =	1.65	in^2	USE (7) #5 BARS

Reference	Calculations	US
ACI 318-14 18.6.3.1	REINFORCEMENT RATIO =	0.0067 < .025 OK
ACI 318-14 9.3.3.1	TENSION CONTROLLED =	0.0108 > .004 OK

Reference	Calculations			US		Metric	
	USE: 45.75 cm x 45.75 cm MOMENT FRAME ROOF BEAM B3						
	W/ (7) #5 LONG. REBAR						
	TRANSVERSE REINFORCEMENT						
	ASSUME #4 TIES						
ACI 318-14 25.7.2.1	TIE SPACING:						
	(a) CLEAR SPACING OF AT LEAST =			1.33	in		
	(b) CENTER TO CENTER SPACING =						
	SMALLER OF:						
		(a) 16db LONG.		10	in	GOVERNS	
		(b) 48db TIE		24	in		
		(c) SMALLEST DIM. OF BEAM		18	in		
ACI 318-14 25.7.2.3	TIES SHALL BE ARRANGED EVERY CORNER AND ALTERNATE LONG. BAR						
ACI 318-14 25.5.5.1	$\phi V_c = 0.75(2\lambda\sqrt{f'c}bd)$					WHERE $\lambda = 1.0$	
ACI 318-14 25.5.1.2	$\phi V_s = 0.75(28\sqrt{f'c}bd)$						
	$\phi V_c =$			16.21	kips	7351.98	kg
	$\phi V_s =$			64.83	kips	29407.94	kg
FROM ETABS	$V_u =$			31	kips	14061.29	kg
	$V_{sreq} =$	$(V_u - \phi V_c)/\phi$		19.72	kips	8945.74	kg
	MAXIMUM SPACING						
ACI 318-14 9.7.6.2.2	$4\sqrt{f'c}bd =$			43.22	kips	$> V_{sreq}$	
ACI 318-14 T9.7.6.2.2	MAX SPACING = d/2			7.75	in	19.69	cm
	MINIMUM SPACING $A_{v,min}/s$						
ACI 318-14 T9.6.3.3	THE GREATER OF:						
	(a) $(0.75\sqrt{f'c}b_w)/f_{yt}$			0.013	in^2/s		
	(b) $50*(b_w/f_{yt})$			0.023	in^2/s		
	STIRRUP DESIGN						
	$V_{sreq} = (A_v*f_{yt}*d)/s$		s =	12.57	in	31.94	cm
				USE 10" SPACING			
	USE: #4 TIES AT 25.4 CM O.C.						

Reference	Calculations		US		Metric	
	SEISMIC HOOP DESIGN					
ACI 318-14 18.6.4.1	HOOPS MUST BE PROVIDED AT:					
	(a) OVER A LENGTH EQUAL TO 2*d FROM FACE OF SUPPORTING COLUMN TOWARDS MIDSPAN AT BOTH ENDS OF BEAM = 31"					
	(b) OVER LENGTHS EQUAL TO 2*d ON BOTH SIDES OF SECTION WHERE FLEXURAL YIELDING IS LIKELY TO OCCUR = 31"					
	MAXIMUM SPACING					
ACI 318-14 18.6.4.4	LEAST OF:					
	(a) d/4		3.10	in	GOVERNS	
	(b) 6*d_b		3.75	in		
	(c) 6"		6	in		
	DESIGN FORCES					
ACI 318-14 18.6.5.2	(a) $V_e = (M_{pr1}+M_{pr2})/l_n \pm (w_u*l_n)/2$					
	w_u =		1.60	klf		
	V_e =		22.56	kips	> $V_u/2$	
	(b) $(A_g*f'_c)/20$ =		24.3	kips	> P_u OK	
	$V_u = (A_v f_{yt} d)/s$	s =	8.00	in	20.32	cm
		MAX SPACING 3.5" GOVERNS				

USE: #4 HOOPS @ 3.5 IN (9 CM) WHERE REQUIRED:
31 IN (78.74 CM) FROM FACE OF COLUMN
31 IN (78.74 CM) EITHER SIDE OF CENTER OF BEAM

MOMENT FRAME ROOF BEAM B3: 18 X 18 IN (45.75 X 45.75 CM)
LONGITUDINAL: (7) #5 BARS
WHEN SEISMIC HOOPS ARE REQUIRED: #4 AT 3.5 IN (9 CM) O.C.
WHEN SEISMIC HOOPS ARE NOT REQUIRED: #4 AT 10 IN (25.4 CM) O.C.

Reference	Calculations	US		Metric	
	MOMENT FRAME COLUMN DESIGN C2				
	DIMENSIONAL LIMITS:				
	(a) SHORTEST DIMENSION AT LEAST 12"				
	(b) RATIO OF b/d AT LEAST 0.4				
FROM SP COLUMN	**18x18 COLUMN W/ 16 #5 LONGITUDINAL REBAR**				
	A_g =	324	in^2	2090	cm^2
FROM ETABS	P_u =	85	kips	38555.35	kg
FROM ETABS	V_u =	10	kips	4535.92	kg
	REINFORCEMENT RATIO =	0.0153			
	A_{st} =	4.96	in^2		
ACI 318-14 18.7.4.1	$A_{st,min}$ = .01Ag	3.24	in^2		
	$A_{st,max}$ = .06Ag	19.44	in^2	A_{st} OK	
	TRANSVERSE REINFORCEMENT L_o REGION				
ACI 318-14 18.7.5.1	MINIMUM LENGTH OF L_o REGION:				
	GREATEST OF (USING WORSTCASE CLEAR HEIGHT 15')				
	(a) d	18	in		
	(b) $(1/6)l_e$	30	in	GOVERNS	
	(c) 18"	18	in		
	L_o REGION MUST BE AT LEAST 30"				
ACI 318-14					
18.7.5.2f	$P_u < 0.3A_gf'_c$?				
FROM ETABS	P_u =	85	kips		
	$0.3A_gf'_c$ =	145.8	kips	$> P_u$	
	MAXIMUM SPACING				
ACI 318-14 18.7.5.3	LEAST OF:				
	(a) (1/4)b	4.5	in		
	(b) $6d_b$	3.75	in	GOVERNS	
	(c) $4+(14-h_x)/3$	7.7	in		
	AMOUNT OF TRANSVERSE REINFORCEMENT A_{sh}/sb_c				
ACI 318-14	GREATER OF:				
T18.7.5.4	(a) $0.3((A_g/A_{ch})-1)(f'_c/f_{yt})$				
	(b) $0.09(f'_c/f_{yt})$				
	A_g =	324	in^2		
	A_{ch} =	225	in^2		

Reference	Calculations		US		Metric	
	(a)	0.005 GOVERNS				
	(b)	0.0034				
	A_{sh}/sb_c =	0.005				
	s =		8.08	in		
			MAX SPACING GOVERNS			
	TRANSVERSE REINFORCEMENT BEYOND Lo REGION					
	MAXIMUM SPACING					
ACI 318-14 18.7.5.5	LEAST OF:					
			3.75	in	GOVERNS	
	(b) 6"		6	in		
	#4 TIES @ 3.5" O.C. EVERY LONGITUDINAL BAR ALONG LENGTH OF COLUMN					
	SHEAR DESIGN					
ACI 318-14	M_{pr1}				239.85	kNm
18.7.6.1.1	M_{pr2}				235.37	kNm
	h_{clr}		162	in		
ACI 318-14 R18.6.5	Ve = $(M_{pr1}+M_{pr2})/h_{clr}$		26	kips		
	$V_n = V_c + V_s$					
ACI 318-14 25.5.5.1	$V_c = 0.75(2\lambda\sqrt{f'c}bd)$				WHERE λ = 1.0	
ACI 318-14 25.5.1.2	$V_s = 0.75(28\sqrt{f'c}bd)$					
	V_c =		25.10	kips		
	V_s =		100.39	kips		
	(a) Vu =		10	kips	< Ve	
	(b) Agf'c/20		24.3	kips	< Pu	
	TRANSVERSE REINFORCEMENT IS OK					

MOMENT FRAME COLUMN DESIGN C2: 18 X 18 IN (46 X 46 CM)
LONGITUDINAL: (16) #5 BARS
TRANSVERSE: #4 TIES AT 3.5 IN (9 CM) O.C.

Reference	Calculations		US		Metric
	FOUNDATION DESIGN - MOMENT FRAME COLUMN C2				
	NO SOILS REPORT				
IBC T1806.2	Q_{all} 2000 psf	ASSUMPTION FROM IBC WITH 1.33% INCREASE			
	MAX ROOF TRIB AREA =		19800	in^2	
	MAX FLOOR TRIB AREA =		9900	in^2	
	D		17032	lbs	
	L		9625	lbs	
	$A_{req} = (D+L)/q_{all}$				
	A_{req} =		13.33	ft^2	
IBC 1809.4	MINIMUM DEPTH AND WIDTH = 12"				
	TRY 9'-0" X 9'-0"	A =	81	ft^2	
	P_u FROM ETABS =		86.00	kips	
	M_u FROM ETABS =		73	kft	
	SELF WEIGHT =		24.3	kips	
	d =		20	in	
	$e = M_u/P_u$		0.66	ft	
	KERN = L/6		1.50	ft	INSIDE KERN
	d =		20	in	
	$q_{max,min} = Q/wL(1 \pm e/(l/6))$				
	q_{max} =		1962.55	plf < q_{all} GOOD	
	q_{min} =		760.91	plf < q_{all} GOOD	
	RESISTING MOMENT		95706	lbsft	
	OVERTURNING MOMENT		73000	lbft	
	M_u DIFFERENCE		22706	lbft	

Reference	Calculations	US		Metric
	a =	0.11		
	$A_{s,reqd}$ =	0.41	in^2	USE (2) #5 REBAR
	PUNCHING SHEAR			
	$V_u = q_s$ x TRIB AREA			
	TRIB AREA =	70.97	ft^2	
	V_u =	75353	lbs	
	$V_c / \sqrt{f'_c} b_o d$ =			
	Minimum of:			
	(a) 2 + 4/β	4.67		
	(b) (αd/bo)+2	8.67		
	(c) 4	4	GOVERNS	
	b_o = 120			
	α = 40			
	β = 1.5			
	ΦVc =	0	lbs	> V_u GOOD
	ONE WAY SHEAR			
	$V_u = q_s$ x TRIB AREA			
	TRIB AREA =	22.13	ft^2	
	V_u =	23491	lbs	
	$\Phi V_c = \Phi(2\sqrt{f'_c} b_w d)$			
	ΦV_c =	209141	lbs	> V_u GOOD

MOMENT FRAME FOUNDATION DESIGN:
9'-0" X 9'-0" X 2'-0" (2.74 M X 2.74 M X .61 M)
LONGITUDINAL: (2) #5 BARS

Leah George
Devin Williams

REFERENCE	CALCULATIONS	US	METRIC

CONFINED MASONRY WALLS

TMS 402 SECTION B.2.1.2

ISOLATION JOINT MIN = 3/8" OR 0.375" (0.95 cm) TO ACCOMMODATE DISPLACEMENTS OF BOUNDING FRAME

MAX DISPLACEMENT OF FRAME = 0.2" < 0.375" OK

SECTION B.2.2

CONNECTORS SUPPORTING WALL AGAINST OUT OF PLANE LOADS SHALL:
(a) BE ATTACHED TO BOUNDING FRAME
(b) NOT TRANSFER IN-PLANE FORCES
(c) DESIGNED TO SATISFY REQS OF ASCE 7
(d) BE SPACED AT MAX OF 4' (121 cm) ALONG PERIMETER OF WALL
(e) BE DESIGNED TO RESIST OUT OF PLANE BENDING BETWEEN CONNECTORS

ASCE 7-16 SECTION 13.3
(EQN 13.3-1)
TABLE 13.5-1

(c) SEISMIC HORIZONTAL FORCE DEMAND:
$F_p = (0.4*a_p*S_{DS}*W_p)*(1 + 2*(z/h))*(I_p/R_p)$ (SHEAR PERPENDICULAR TO EDGE)
$a_p = 1.0$ $R_p = 2.5$ z = 0 (attached to base)
Ip = 1.0

F_p = (0.4*SDS*Wp)/Rp 0.1056 $*W_p$ *applied at center of gravity
V = 0.2*SDS*Wp = 0.132 *Wp

HEIGHTS OF WALLS	WEIGHT (W_p) (lbs)	F_p (lbs)	P_u (lbs)
3' - 6"	80.06	8.45	10.57
4' - 0"	91.50	9.66	12.08
6' - 0"	137.25	14.49	18.12
8' - 0"	183.00	19.32	24.16

TRY SIMPSON STRONG TIE 1/2" TITEN HD
ALLOWABLE SHEAR PERPENDICULAR TO EDGE = 160 lbs > F_p OK

PLACEMENT OF REBAR - 3'x13' WALL GOVERNS

rho hor + rho vertical MUST BE GREATER THAN 0.002bh
.002bh = 0.549 in^2

rho hor MUST BE GREATER THAN .0007bh
.0007bh = 0.19215 in^2

rho vert MUST BE GREATER THAN .0007bh
.0007bh = 0.19215 in^2

USE #4 @ 12" O.C. BOTH WAYS

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REFERENCE	CALCULATIONS	US		METRIC	
	CMU WALL TIE BEAM				
CONFINED MASONRY DESIGN GUIDE	**TIE BEAM MEMBER SIZE:**				
	MINIMUM DIMENSIONS: 150 mm * WALL THICKNESS				
	USE BASE DIMENSION = WALL THICKNESS =	7.625	in	19.40	cm
	MINIMUM HEIGHT OF BEAM =	6	in	15.24	cm
	8" X 8" TIE BEAM SUFFICIENT				
	USE: 20 X 20 CM TIE BEAM				

TIE BEAM REINFORCEMENT:

LONGITUDINAL
(a) #4 BAR
(b) LAP SPLICES OVER LENGTH OF 7' - 4" FROM FACE OF COLUMN
(c) NO MORE THAN TWO BARS SPLICED @ ANY ONE PLACE
(d) LAP LENGTH MINIMUM 20" (50 cm)

TIES
(a) #3 BAR
(b) SPACING = 200 mm MAX EXCEPT FOR HIGH SEISMIC ZONES, 100 mm AT DISTANCE FROM FACE OF COLUMN THE GREATER OF:

(1) 2*WIDTH OF COLUMN =	36	in	GOVERNS
(2) HEIGHT OF WALL / 6 =	16	in	

SPACE TIES AT 4" (10 CM) OVER DISTANCE 36" (91.5 CM) FROM COLUMN FACE
EVERYWHERE ELSE SPACE TIES AT 7.5 IN (19 CM)

TIE BEAM: 8 X 8 IN (20 X 20 CM)
LONGITUDINAL: (4) #4 BARS
TRANSVERSE: #3 BARS AT 4 IN (10 CM) O.C. FROM COLUMN FACE WHERE REQUIRED AND 7.5 IN (19 CM) O.C. EVERYWHERE ELSE

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Reference	Calculations	US		Metric
	CMU WALL FOUNDATION			
	8' TALL CMU WALL			
	SELF WEIGHT	280	plf	
	$q_{all} =$	1500	psf	
	$D/q_{all} =$	0.19	ft	
	ASSUME 1' WIDE			
	REQUIRED STRENGTH = 1.4D	392	plf	
	$\Phi V_c = \Phi(2\sqrt{f'_c} b_w d)$			
	$\Phi V_c =$	1525	lbs	
	$V_u =$	857.5	lbs	< ΦVc GOOD
	FOOTING REINFORCEMENT			
	$M_u =$	22.81	lbft	
	$A_{s,min} =$	0.26	in^2	
	a =	0.0025	in	
	$A_{s,req} =$	0.095	in^2	AS MIN GOVERNS

CMU WALL FOOTING DESIGN: 1'-0" X 1'-0" X 1'-0" (.3 M X .3 M X .3 M)
LONGITUDINAL: (1) #5 BAR

References	Calculations		US		Metric	
	TRUSS DESIGN					
LOAD TAKE OFF	DL TO TRUSS =		13	psf		
ASCE 7-16	LL =		20	psf		
WIND LOAD CALCS	WIND LOAD =		174.65	psf		
SEE ROOF PLAN	LARGEST TRIB WIDTH =		6.5	ft		
	W_D		84.5	plf		
	W_L		130	plf		
	FROM RISA: MAX COMPRESSION REQ (P_u) =					
			4.22	kips	18.77	kN
	FROM RISA: MAX TENSION REQ (P_u) =					
			2.98	kips	13.26	kN
	MAX UNBRACED LENGTH =		5	ft		
	E =		29000	ksi		
	F_y =		40	ksi		
AISC TC-A-7.1	$A_{g,req}$ =	$P_u/\phi F_y$ =	0.12	in^2		
	LOCAL BUCKLING					
AISC T1-12	EFFECTIVE LENGTH = KL/r	K = 1.0 (PINNED)				
AISC TB4.1a	**TRY: HSS 2x2x1/8**		r = 0.761 in		A = 0.84 in^2 OK	
	EFFECTIVE LENGTH = 7 ft	ϕP_n =	15.5 kips > 4.22 kips OK			
	b/t MAX = $1.4(E/F_y)^{1/2}$=		37.70			
	b/t		14.2	< 37.7 OK		

USE: HSS 2x2x1/8 ALL WEB MEMBERS

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References	Calculations	US		METRIC
	TRUSS CONNECTION WELDS			
AISC TABLE J2.2	DEPTH OF WELD = (5/8)R where R = 2t = 1/4"			
	DEPTH OF WELD =	3/16	in	5 mm
	MIN SIZE = 1/8" < 3/16" OK			
AISC EQ J2-4				
	BASE METAL ALLOWABLE STRENGTH = $\phi R_n = F_{nBM} * A_{BM}$, ϕ =	0.75		(LRFD)
	A_{BM} = 0.84 in^2 FnBM =	40	ksi	
	BASE METAL ϕRn =	25.20	kips	>2.98 kips OK
AISC EQ J2-4	WELD METAL ALLOWABLE STRENGTH = $\phi R_n = F_{nw} * A_{we}$ =			
	F_{nw} = $0.6 * F_{exx}$ *ASSUME WEAKEST	36	ksi	
	A_{we} = THROAT DEPTH * I =	0.28		
	REQUIRED: ϕRn =	7.59	ksi	
			> 3 ksi OK	
	USE: 1.5" (38 mm) WELD LENGTH EACH SIDE OF MEMBER			

FOR ALL TRUSS CONNECTIONS: FILLET WELD 3/16" (5 MM) DEEP WITH LENGTH OF 1.5" (38 MM) ON EACH SIDE OF TRUSS MEMBER

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References	Calculations	US	METRIC

TRUSS CHORD CAPACITY

Wind pressure = 174.65 psf
tributary area = 96 ft^2

Axial Load to Bottom Truss = 16.77 kips > 15.5 kips RESIZE

unbraced length = 4'

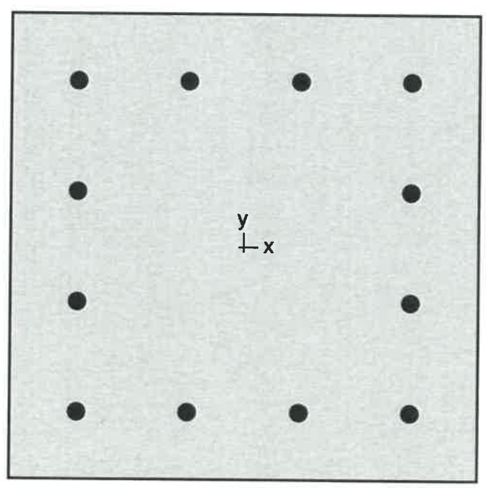
TRY: HSS2x2x1/4 r = 0.704

effective length = 6' ϕPn = 31.6 > 15.5k OK

USE: HSS 2x2x1/4 ALL CHORD MEMBERS

spColumn (TM)

spColumn v6.00
Computer program for the Strength Design of Reinforced Concrete Sections



GRAVITY COLUMN

StructurePoint

Contents

List of Figures

1. General Information

File Name	u:\ji\gravity column.col
Project	Morne Briye Primary School
Column	Moment Frame
Engineer	---
Code	ACI 318-14
Bar Set	ASTM A615
Units	Metric
Run Option	Investigation
Run Axis	Biaxial
Slenderness	Not Considered
Column Type	Structural

2. Material Properties

2.1. Concrete

Type	Standard
f'_c	13.79 MPa
E_c	17453.4 MPa
f_c	11.7215 MPa
ε_u	0.003 mm/mm
β_1	0.85

2.2. Steel

Type	Standard
f_y	275.79 MPa
E_s	200000 MPa
ε_{yt}	0.00137895 mm/mm

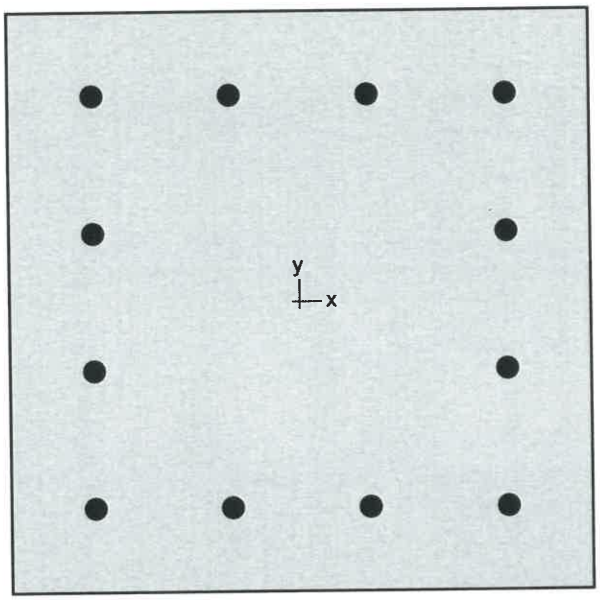
3. Section

3.1. Shape and Properties

Type	Rectangular
Width	406.4 mm
Depth	406.4 mm
A_g	165161 mm²
I_x	2.27318e+009 mm⁴
I_y	2.27318e+009 mm⁴
r_x	117.318 mm
r_y	117.318 mm
X_o	0 mm
Y_o	0 mm

16" x 16"

3.2. Section Figure



Rectangular 406.4 x 406.4 mm   1.45% reinf.

Figure 1: Column section

REINFORCEMENT RATIO GOVERNED

4. Reinforcement

4.1. Bar Set: ASTM A615

Bar	Diameter mm	Area mm²	Bar	Diameter mm	Area mm²	Bar	Diameter mm	Area mm²
#3	9.53	70.97	#4	12.70	129.03	#5	15.88	200.00
#6	19.05	283.87	#7	22.23	387.10	#8	25.40	509.68
#9	28.65	645.16	#10	32.26	819.35	#11	35.81	1006.45
#14	43.00	1451.61	#18	57.33	2580.64			

4.2. Confinement and Factors

Confinement type	Tied
For #10 bars or less	#3 ties
For larger bars	#4 ties
Capacity Reduction Factors	
Axial compression, (a)	0.8
Tension controlled ϕ, (b)	0.9
Compression controlled ϕ, (c)	0.65

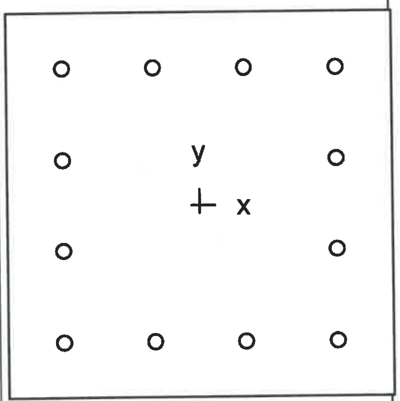
4.3. Arrangement

Pattern	All sides equal
Bar layout	Rectangular
Cover to	Longitudal bars
Clear cover	50.8 mm
Bars	12 #5

Total steel area, A_s	2400 mm²
Rho	1.45 %
Minimum clear spacing	80 mm

5. Factored Loads and Moments with Corresponding Capacities

No	P_u	M_{ux}	M_{uy}	ϕM_{nx}	ϕM_{ny}	$\phi M_n/M_u$	NA Depth	d_t Depth	ε_t	ϕ
	kN	kNm	kNm	kNm	kNm		mm	mm		
1	75.61	0.89	0.00	103.67	0.00	116.353	90	348	0.00853	0.900
2	75.61	0.00	1.13	0.00	103.67	91.743	90	348	0.00853	0.900



406.4 x 406.4 mm

Code: ACI 318-14

Units: Metric

Run axis: Biaxial

Run option: Investigation

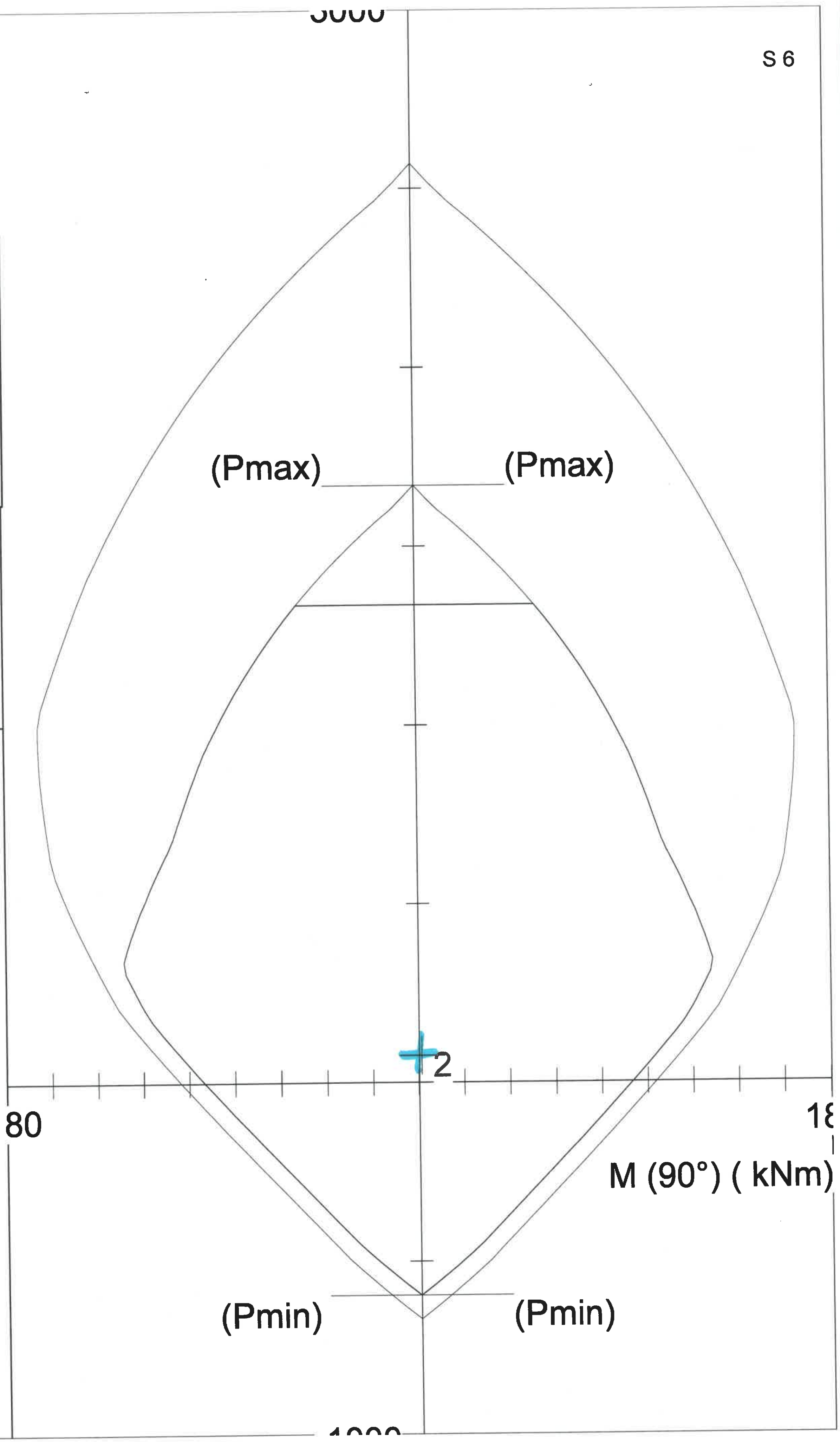
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 06/06/19

Time: 16:33:52



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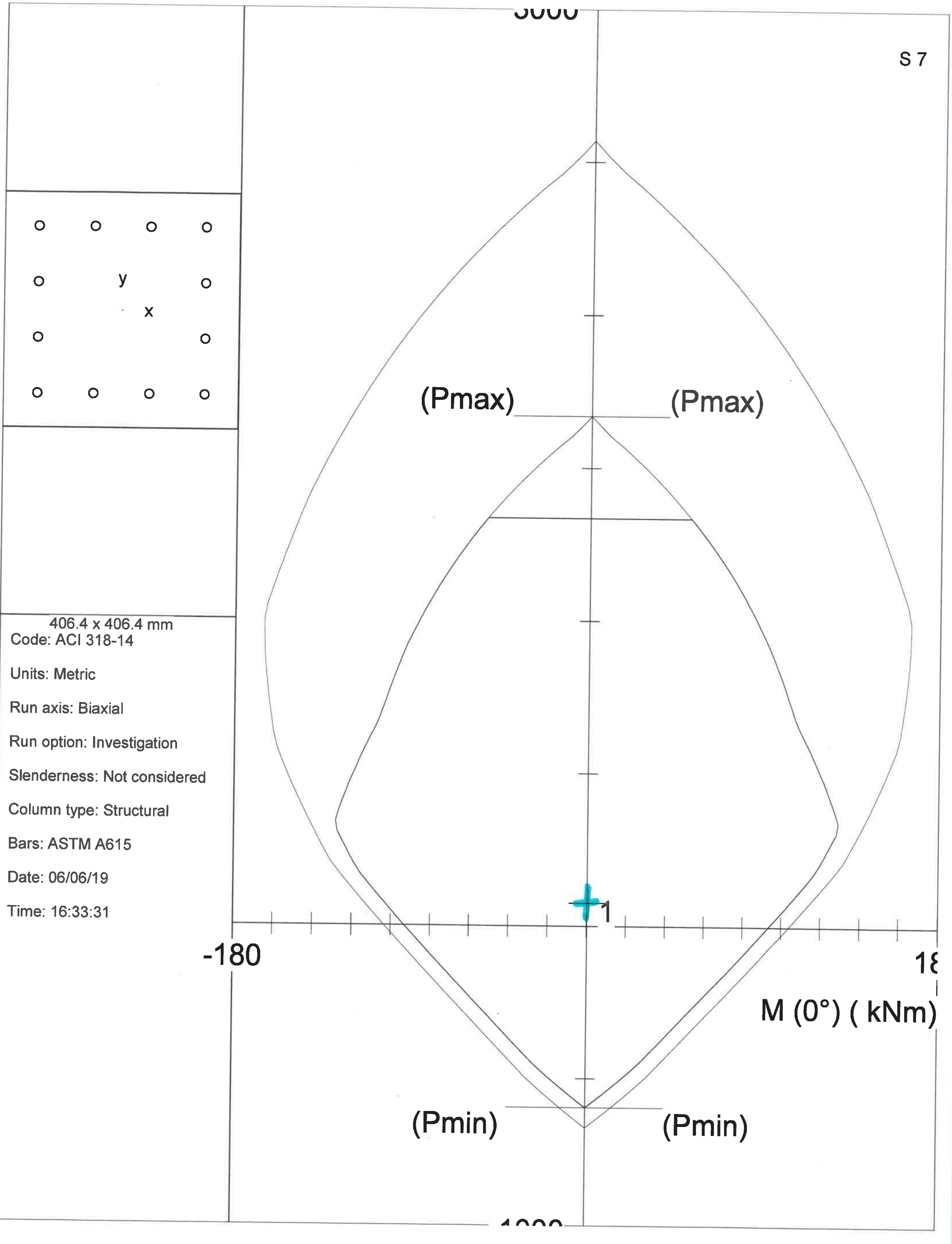


406.4 x 406.4 mm

Code: ACI 318-14

Units: Metric

Run axis: Biaxial

Run option: Investigation

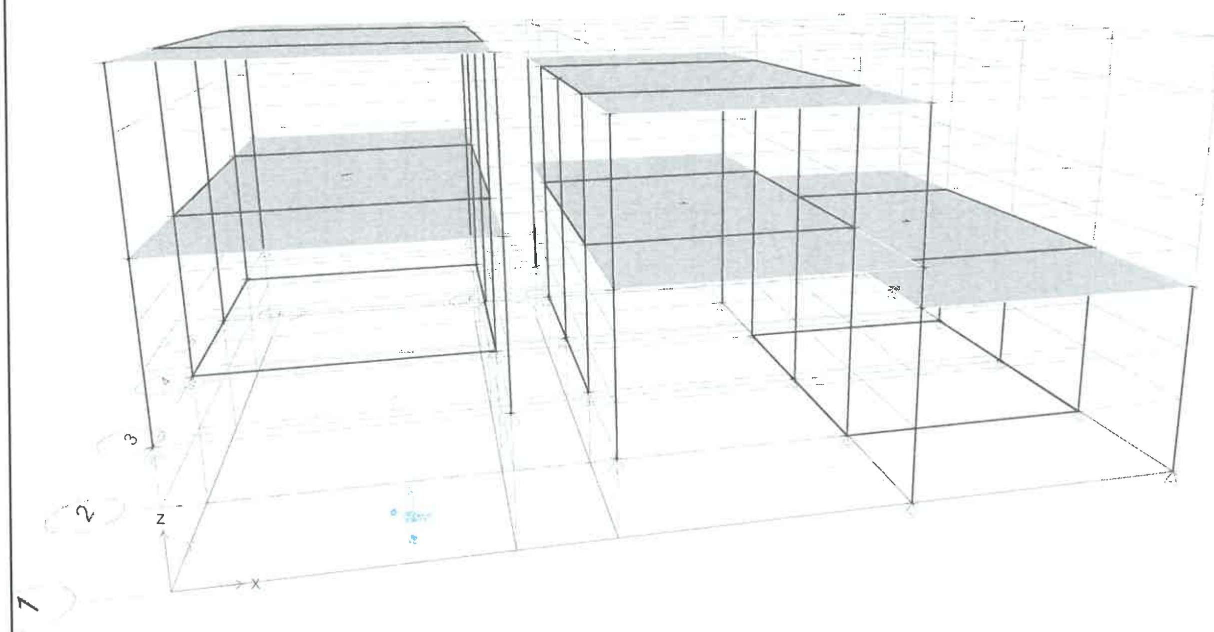
Slenderness: Not considered

Column type: Structural

Bars: ASTM A615

Date: 06/06/19

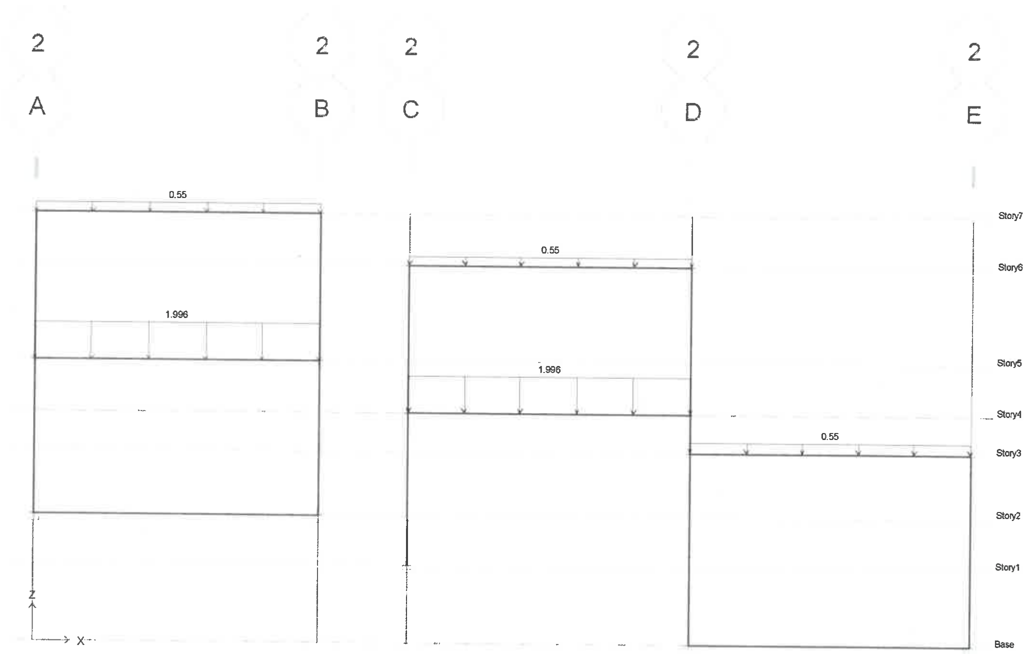
Time: 16:33:31


3
2
1
Z
X

ETABS 17.0.0

6/6/2019

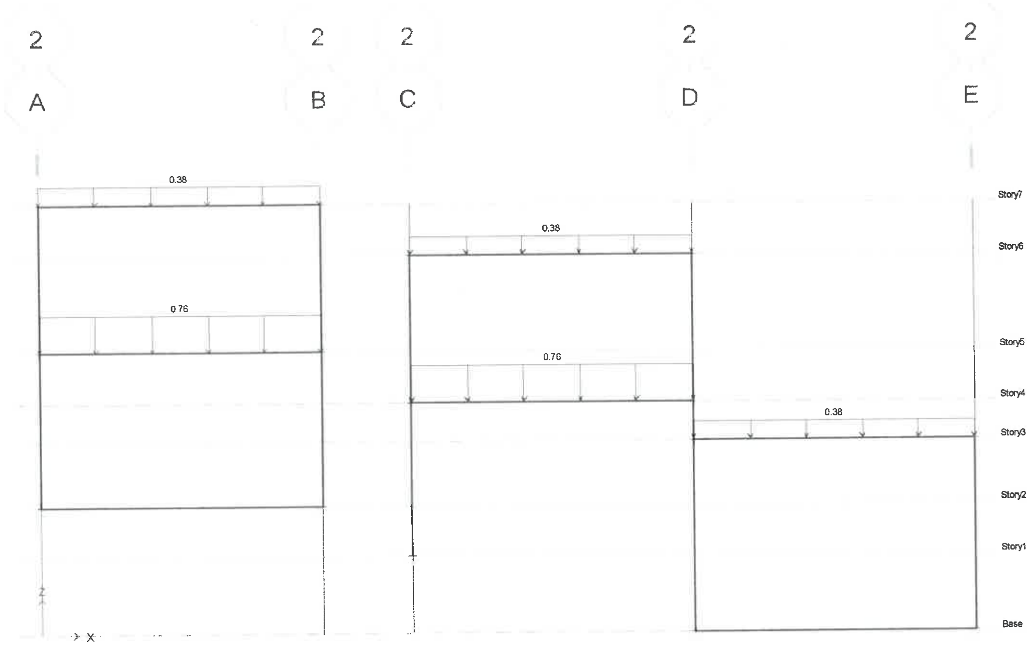
APPLIED DEAD LOAD



MF.EDB

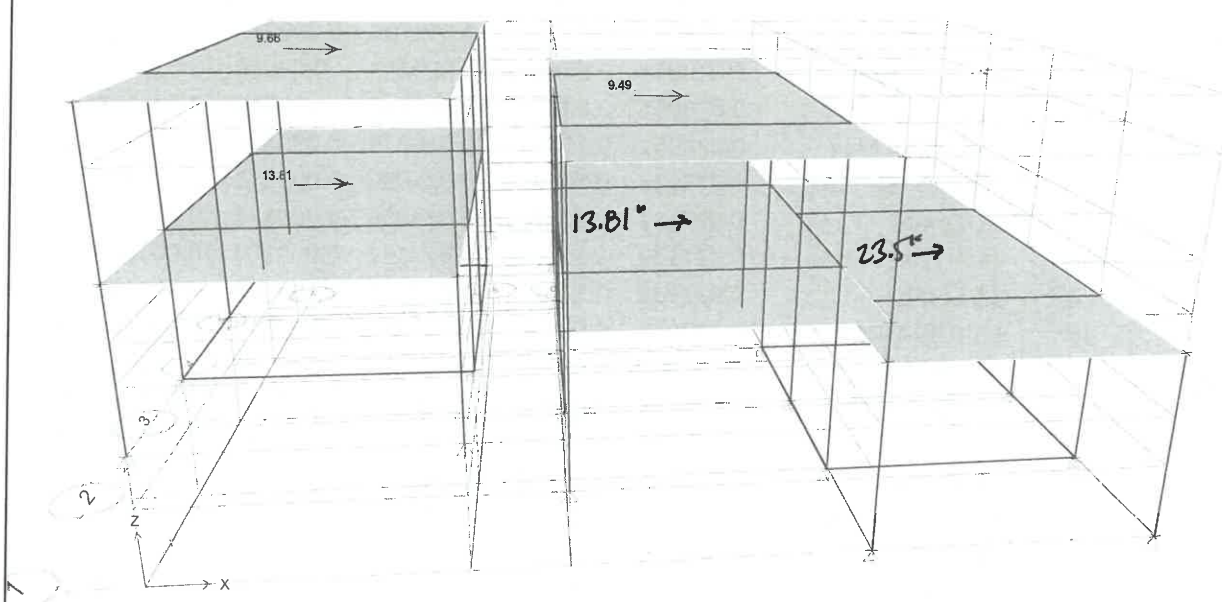
Elevation View - 2 Frame Span Loads (Dead)

APPLIED LIVE LAOD



Elevation View - 2 Frame Span Loads (Live)

EARTHQUAKE LOADS



MAX X DISPLACEMENT FROM ETABS
LOADED IN Y DIRECTION

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Devin Williams

TABLE: Joint Displacements

Story	Label	Name	Load Combo	UX	UY	UZ	RX	RY	RZ
				in	in	in	rad	rad	rad
Story6	17	53	1.2D+1.6L	0.037822	0.008634	-0.018212	-0.000004	0.000197	0.000068
Story6	17	53	Comb1	0.037822	0.008634	-0.018212	-0.000004	0.000197	0.000068
Story6	17	53	Comb4 Max	0.037822	0.102301	-0.011656	-0.000004	0.000197	0.000068
Story6	19	57	1.2D+1.6L	0.037822	0.026549	-0.031819	-0.00012	0.000151	0.000068
Story6	19	57	Comb1	0.037822	0.026549	-0.031819	-0.00012	0.000151	0.000068
Story6	19	57	Comb4 Max	0.037822	0.119885	-0.020364	-0.00012	0.000151	0.000068
Story6	17	53	1.2D+Ev+Eh+L	0.036723	0.102301	-0.018212	-0.00014	0.000176	0.000067
Story6	17	53	Comb2	0.036723	0.102301	-0.018212	-0.00014	0.000176	0.000067
Story6	19	57	1.2D+Ev+Eh+L	0.036723	0.119885	-0.031819	-0.000316	0.000087	0.000067
Story6	19	57	Comb2	0.036723	0.119885	-0.031819	-0.000316	0.000087	0.000067
Story6	3	13	1.2D+1.6L	0.028051	0.008634	-0.016597	-0.000131	0.000597	0.000068
Story6	3	13	Comb1	0.028051	0.008634	-0.016597	-0.000131	0.000597	0.000068
Story6	3	13	Comb4 Max	0.028051	0.102301	-0.008798	-0.000117	0.000597	0.000068
Story6	4	14	1.2D+1.6L	0.028051	0.026549	-0.029248	-0.00016	-0.000458	0.000068
Story6	4	14	Comb1	0.028051	0.026549	-0.029248	-0.00016	-0.000458	0.000068
Story6	4	14	Comb4 Max	0.028051	0.119885	-0.016039	-0.000139	-0.000305	0.000068
Story6	3	13	1.2D+Ev+Eh+L	0.027132	0.102301	-0.015086	-0.000171	0.000595	0.000067
Story6	3	13	Comb2	0.027132	0.102301	-0.015086	-0.000171	0.000595	0.000067
Story6	4	14	1.2D+Ev+Eh+L	0.027132	0.119885	-0.027132	-0.000204	-0.000469	0.000067
Story6	4	14	Comb2	0.027132	0.119885	-0.027132	-0.000204	-0.000469	0.000067
Story6	17	53	0.9D-Ev+Eh	0.023054	0.099481	-0.011656	-0.00014	0.000105	0.000042
Story6	17	53	Comb3	0.023054	0.099481	-0.011656	-0.00014	0.000105	0.000042
Story6	17	53	Comb4 Min	0.023054	0.008634	-0.018212	-0.00014	0.000105	0.000042
Story6	19	57	0.9D-Ev+Eh	0.023054	0.110629	-0.020364	-0.000275	0.000031	0.000042
Story6	19	57	Comb3	0.023054	0.110629	-0.020364	-0.000275	0.000031	0.000042
Story6	19	57	Comb4 Min	0.023054	0.026549	-0.031819	-0.000316	0.000031	0.000042
Story6	30	83	1.2D+1.6L	0.017465	0.017592	0	0	0	0.000068
Story6	30	83	Comb1	0.017465	0.017592	0	0	0	0.000068
Story6	30	83	Comb4 Max	0.017465	0.111093	0	0	0	0.000068
Story6	24	66	1.2D+1.6L	0.017465	0.008634	-0.020301	0.000019	0.000227	0.000068
Story6	24	66	Comb1	0.017465	0.008634	-0.020301	0.000019	0.000227	0.000068
Story6	24	66	Comb4 Max	0.017465	0.102301	-0.011086	0.000019	0.000227	0.000068
Story6	25	78	1.2D+1.6L	0.017465	0.026549	-0.032274	0.000027	-0.0001	0.000068
Story6	25	78	Comb1	0.017465	0.026549	-0.032274	0.000027	-0.0001	0.000068
Story6	25	78	Comb4 Max	0.017465	0.119885	-0.017748	0.000027	-0.000072	0.000068
Story6	35	27	1.2D+1.6L	0.01726	0.017777	0	0	0	0.000068
Story6	35	27	Comb1	0.01726	0.017777	0	0	0	0.000068
Story6	35	27	Comb4 Max	0.01726	0.111275	0	0	0	0.000068
Story6	3	13	0.9D-Ev+Eh	0.016973	0.099481	-0.008798	-0.000117	0.000379	0.000042
Story6	3	13	Comb3	0.016973	0.099481	-0.008798	-0.000117	0.000379	0.000042
Story6	3	13	Comb4 Min	0.016973	0.008634	-0.016597	-0.000171	0.000379	0.000042
Story6	4	14	0.9D-Ev+Eh	0.016973	0.110629	-0.016039	-0.000139	-0.000305	0.000042
Story6	4	14	Comb3	0.016973	0.110629	-0.016039	-0.000139	-0.000305	0.000042
Story6	4	14	Comb4 Min	0.016973	0.026549	-0.029248	-0.000204	-0.000469	0.000042

TABLE: Joint Displacements

Story	Label	Name	Load Combo	UX	UY	UZ	RX	RY	RZ
				in	in	in	rad	rad	rad
Story3	5	10	1.2D+Ev+Eh+L	0.076268	0.021216	-0.00734	-0.000084	-0.000771	0.000072
Story3	5	10	Comb2	0.076268	0.021216	-0.00734	-0.000084	-0.000771	0.000072
Story3	5	10	Comb4 Max	0.076268	0.021216	-0.004353	-0.000056	-0.000388	0.000072
Story3	11	37	1.2D+Ev+Eh+L	0.053823	0.021216	-0.00529	0.00001	-0.000245	0.000072
Story3	11	37	Comb2	0.053823	0.021216	-0.00529	0.00001	-0.000245	0.000072
Story3	11	37	Comb4 Max	0.053823	0.021216	-0.003259	0.000049	-0.000061	0.000072
Story3	21	61	1.2D+Ev+Eh+L	0.086628	0.021216	-0.007675	-0.000118	0.000481	0.000072
Story3	21	61	Comb2	0.086628	0.021216	-0.007675	-0.000118	0.000481	0.000072
Story3	21	61	Comb4 Max	0.086628	0.021216	-0.004912	-0.000022	0.000481	0.000072
Story3	22	63	1.2D+Ev+Eh+L	0.043463	0.021216	-0.007675	-0.000118	0.000241	0.000072
Story3	22	63	Comb2	0.043463	0.021216	-0.007675	-0.000118	0.000241	0.000072
Story3	22	63	Comb4 Max	0.043463	0.021216	-0.004912	-0.000022	0.000241	0.000072
Story3	33	78	1.2D+Ev+Eh+L	0.065045	0.021216	-0.004959	0.000005	0.000038	0.000072
Story3	33	78	Comb2	0.065045	0.021216	-0.004959	0.000005	0.000038	0.000072
Story3	33	78	Comb4 Max	0.065045	0.021216	-0.003148	0.000008	0.000147	0.000072
Story3	5	10	0.9D-Ev+Eh	0.068912	0.019517	-0.004353	-0.000065	-0.000388	0.000064
Story3	5	10	Comb3	0.068912	0.019517	-0.004353	-0.000065	-0.000388	0.000064
Story3	11	37	0.9D-Ev+Eh	0.049008	0.019517	-0.003259	-0.000006	-0.000061	0.000064
Story3	11	37	Comb3	0.049008	0.019517	-0.003259	-0.000006	-0.000061	0.000064
Story3	21	61	0.9D-Ev+Eh	0.078099	0.019517	-0.004912	-0.000108	0.000434	0.000064
Story3	21	61	Comb3	0.078099	0.019517	-0.004912	-0.000108	0.000434	0.000064
Story3	22	63	0.9D-Ev+Eh	0.039821	0.019517	-0.004912	-0.000108	0.000221	0.000064
Story3	22	63	Comb3	0.039821	0.019517	-0.004912	-0.000108	0.000221	0.000064
Story3	33	78	0.9D-Ev+Eh	0.05896	0.019517	-0.003148	0.000002	0.000147	0.000064
Story3	33	78	Comb3	0.05896	0.019517	-0.003148	0.000002	0.000147	0.000064
Story3	38	30	1.2D+Ev+Eh+L	0.064959	0.013121	0	0	0	0.000072
Story3	38	30	Comb2	0.064959	0.013121	0	0	0	0.000072
Story3	38	30	Comb4 Max	0.064959	0.013121	0	0	0	0.000072
Story3	38	30	0.9D-Ev+Eh	0.058884	0.012339	0	0	0	0.000064
Story3	38	30	Comb3	0.058884	0.012339	0	0	0	0.000064
Story3	31	84	1.2D+Ev+Eh+L	0.065045	0.01172	0	0	0	0.000072
Story3	31	84	Comb2	0.065045	0.01172	0	0	0	0.000072
Story3	31	84	Comb4 Max	0.065045	0.01172	0	0	0	0.000072
Story7	2	12	0.9D-Ev+Eh	0.109761	0.011244	-0.012723	-0.000012	-0.00027	0.000106
Story7	2	12	Comb3	0.109761	0.011244	-0.012723	-0.000012	-0.00027	0.000106
Story7	2	12	Comb4 Max	0.109761	0.011244	-0.012723	0.000005	-0.00027	0.000106
Story7	7	23	0.9D-Ev+Eh	0.076831	0.011244	-0.008797	0.000022	-0.000013	0.000106
Story7	7	23	Comb3	0.076831	0.011244	-0.008797	0.000022	-0.000013	0.000106
Story7	7	23	Comb4 Max	0.076831	0.011244	-0.008797	0.000041	-0.000013	0.000106
Story7	15	49	0.9D-Ev+Eh	0.061632	0.011244	-0.011656	-0.000004	0.000245	0.000106
Story7	15	49	Comb3	0.061632	0.011244	-0.011656	-0.000004	0.000245	0.000106
Story7	15	49	Comb4 Max	0.061632	0.011244	-0.011656	0.000026	0.000245	0.000106
Story7	16	51	0.9D-Ev+Eh	0.12496	0.011244	-0.011656	-0.000004	0.000332	0.000106
Story7	16	51	Comb3	0.12496	0.011244	-0.011656	-0.000004	0.000332	0.000106

TABLE: Joint Displacements									
Story	Label	Name	Load Combo	UX	UY	UZ	RX	RY	RZ
				in	in	in	rad	rad	rad
Story6	4	14	1.2D+Ev+Eh+L	0.027132	0.119885	-0.027132	-0.000204	-0.000469	0.000067
Story6	4	14	Comb2	0.027132	0.119885	-0.027132	-0.000204	-0.000469	0.000067
Story6	4	14	Comb4 Max	0.028051	0.119885	-0.016039	-0.000139	-0.000305	0.000068
Story6	9	35	1.2D+Ev+Eh+L	0.006351	0.119885	-0.020783	0.000026	-0.000216	0.000067
Story6	9	35	Comb2	0.006351	0.119885	-0.020783	0.000026	-0.000216	0.000067
Story6	9	35	Comb4 Max	0.00688	0.119885	-0.013106	0.000111	-0.000137	0.000068
Story6	19	57	1.2D+Ev+Eh+L	0.036723	0.119885	-0.031819	-0.000316	0.000087	0.000067
Story6	19	57	Comb2	0.036723	0.119885	-0.031819	-0.000316	0.000087	0.000067
Story6	19	57	Comb4 Max	0.037822	0.119885	-0.020364	-0.00012	0.000151	0.000068
Story6	20	59	1.2D+Ev+Eh+L	-0.00324	0.119885	-0.031819	-0.000316	0.000013	0.000067
Story6	20	59	Comb2	-0.00324	0.119885	-0.031819	-0.000316	0.000013	0.000067
Story6	20	59	Comb4 Max	-0.002284	0.119885	-0.020364	-0.00012	0.000022	0.000068
Story6	25	78	1.2D+Ev+Eh+L	0.016742	0.119885	-0.030476	0.000007	-0.000108	0.000067
Story6	25	78	Comb2	0.016742	0.119885	-0.030476	0.000007	-0.000108	0.000067
Story6	25	78	Comb4 Max	0.017465	0.119885	-0.017748	0.000027	-0.000072	0.000068
Story6	35	27	1.2D+Ev+Eh+L	0.01654	0.111275	0	0	0	0.000067
Story6	35	27	Comb2	0.01654	0.111275	0	0	0	0.000067
Story6	35	27	Comb4 Max	0.01726	0.111275	0	0	0	0.000068
Story6	30	83	1.2D+Ev+Eh+L	0.016742	0.111093	0	0	0	0.000067
Story6	30	83	Comb2	0.016742	0.111093	0	0	0	0.000067
Story6	30	83	Comb4 Max	0.017465	0.111093	0	0	0	0.000068
Story6	4	14	0.9D-Ev+Eh	0.016973	0.110629	-0.016039	-0.000139	-0.000305	0.000042
Story6	4	14	Comb3	0.016973	0.110629	-0.016039	-0.000139	-0.000305	0.000042
Story6	9	35	0.9D-Ev+Eh	0.003797	0.110629	-0.013106	-0.000023	-0.000137	0.000042
Story6	9	35	Comb3	0.003797	0.110629	-0.013106	-0.000023	-0.000137	0.000042
Story6	19	57	0.9D-Ev+Eh	0.023054	0.110629	-0.020364	-0.000275	0.000031	0.000042
Story6	19	57	Comb3	0.023054	0.110629	-0.020364	-0.000275	0.000031	0.000042
Story6	20	59	0.9D-Ev+Eh	-0.002284	0.110629	-0.020364	-0.000275	0.000022	0.000042
Story6	20	59	Comb3	-0.002284	0.110629	-0.020364	-0.000275	0.000022	0.000042
Story6	25	78	0.9D-Ev+Eh	0.010385	0.110629	-0.017748	-0.000003	-0.000072	0.000042
Story6	25	78	Comb3	0.010385	0.110629	-0.017748	-0.000003	-0.000072	0.000042
Story6	35	27	0.9D-Ev+Eh	0.010257	0.105171	0	0	0	0.000042
Story6	35	27	Comb3	0.010257	0.105171	0	0	0	0.000042
Story6	30	83	0.9D-Ev+Eh	0.010385	0.105055	0	0	0	0.000042
Story6	30	83	Comb3	0.010385	0.105055	0	0	0	0.000042
Story6	3	13	1.2D+Ev+Eh+L	0.027132	0.102301	-0.015086	-0.000171	0.000595	0.000067
Story6	3	13	Comb2	0.027132	0.102301	-0.015086	-0.000171	0.000595	0.000067
Story6	3	13	Comb4 Max	0.028051	0.102301	-0.008798	-0.000117	0.000597	0.000068
Story6	8	25	1.2D+Ev+Eh+L	0.006351	0.102301	-0.012043	0.000052	0.00028	0.000067
Story6	8	25	Comb2	0.006351	0.102301	-0.012043	0.000052	0.00028	0.000067
Story6	8	25	Comb4 Max	0.00688	0.102301	-0.007705	0.000123	0.00028	0.000068
Story6	17	53	1.2D+Ev+Eh+L	0.036723	0.102301	-0.018212	-0.00014	0.000176	0.000067
Story6	17	53	Comb2	0.036723	0.102301	-0.018212	-0.00014	0.000176	0.000067
Story6	17	53	Comb4 Max	0.037822	0.102301	-0.011656	-0.000004	0.000197	0.000068

From ETABS Maximum X Direction Displacement
Loaded in X Direction

Leah George
Devin Williams

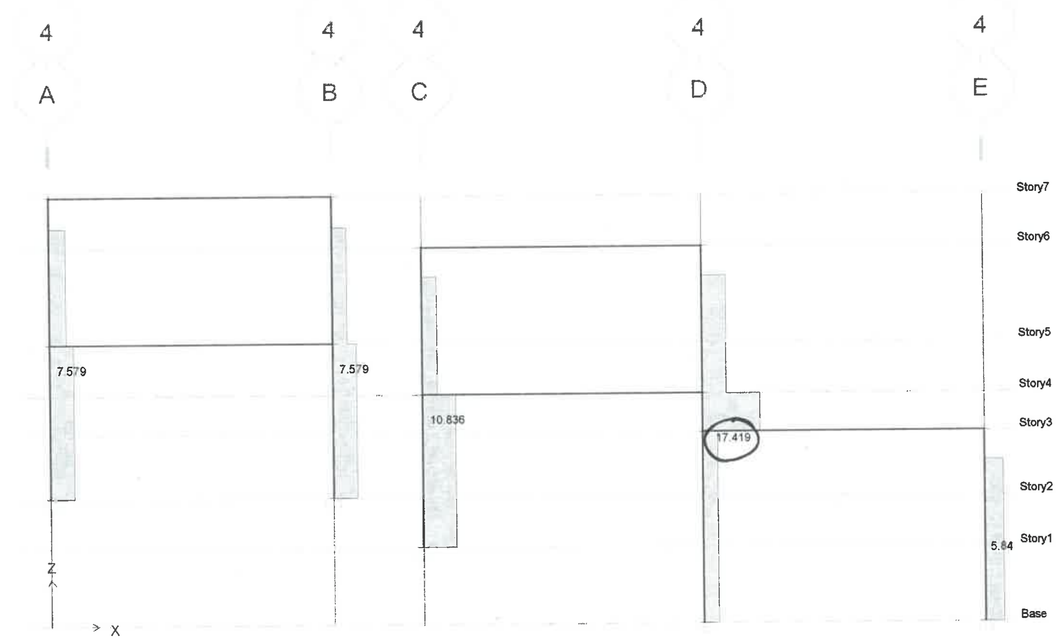
TABLE: Joint Displacements

Story	Label	Name	Load Combo	UX	UY	UZ	RX	RY	RZ
				in	in	in	rad	rad	rad
Story6	17	53	1.2D+Ev+Eh+L	0.151238	-0.02162	-0.018212	0.000045	0.000381	0.000088
Story6	17	53	Comb2	0.151238	-0.02162	-0.018212	0.000045	0.000381	0.000088
Story6	17	53	Comb4 Max	0.151238	-0.008638	-0.011656	0.000045	0.000381	0.000088
Story6	19	57	1.2D+Ev+Eh+L	0.151238	0.001491	-0.031819	0.000013	0.000556	0.000088
Story6	19	57	Comb2	0.151238	0.001491	-0.031819	0.000013	0.000556	0.000088
Story6	19	57	Comb4 Max	0.151238	0.003793	-0.020364	0.000032	0.000556	0.000088
Story6	3	13	1.2D+Ev+Eh+L	0.138632	-0.02162	-0.019895	0.000001	0.000841	0.000088
Story6	3	13	Comb2	0.138632	-0.02162	-0.019895	0.000001	0.000841	0.000088
Story6	3	13	Comb4 Max	0.138632	-0.008638	-0.011037	0.000008	0.000841	0.000088
Story6	4	14	1.2D+Ev+Eh+L	0.138632	0.001491	-0.036949	0.000053	-0.000503	0.000088
Story6	4	14	Comb2	0.138632	0.001491	-0.036949	0.000053	-0.000503	0.000088
Story6	4	14	Comb4 Max	0.138632	0.003793	-0.021453	0.000067	-0.000232	0.000088
Story6	17	53	0.9D-Ev+Eh	0.137974	-0.018206	-0.011656	0.000034	0.00034	0.000083
Story6	17	53	Comb3	0.137974	-0.018206	-0.011656	0.000034	0.00034	0.000083
Story6	19	57	0.9D-Ev+Eh	0.137974	0.003793	-0.020364	0.000001	0.000481	0.000083
Story6	19	57	Comb3	0.137974	0.003793	-0.020364	0.000001	0.000481	0.000083
Story6	3	13	0.9D-Ev+Eh	0.125975	-0.018206	-0.011037	-0.000008	0.000515	0.000083
Story6	3	13	Comb3	0.125975	-0.018206	-0.011037	-0.000008	0.000515	0.000083
Story6	4	14	0.9D-Ev+Eh	0.125975	0.003793	-0.021453	0.00002	-0.000232	0.000083
Story6	4	14	Comb3	0.125975	0.003793	-0.021453	0.00002	-0.000232	0.000083
Story6	30	83	1.2D+Ev+Eh+L	0.124976	-0.010064	0	0	0	0.000088
Story6	30	83	Comb2	0.124976	-0.010064	0	0	0	0.000088
Story6	30	83	Comb4 Max	0.124976	-0.007207	0	0	0	0.000088
Story6	28	64	1.2D+Ev+Eh+L	0.124976	-0.02162	-0.0121	0.000027	0.000417	0.000088
Story6	28	64	Comb2	0.124976	-0.02162	-0.0121	0.000027	0.000417	0.000088
Story6	28	64	Comb4 Max	0.124976	-0.008638	-0.007591	0.000027	0.000417	0.000088
Story6	32	66	1.2D+Ev+Eh+L	0.124976	0.001491	-0.018138	0.000037	0.000152	0.000088
Story6	32	66	Comb2	0.124976	0.001491	-0.018138	0.000037	0.000152	0.000088
Story6	32	66	Comb4 Max	0.124976	0.003793	-0.011324	0.000041	0.000189	0.000088
Story7	14	47	1.2D+Ev+Eh+L	0.12496	-0.018371	-0.018212	0.000044	0.000332	0.000106
Story7	14	47	0.9D-Ev+Eh	0.12496	-0.01662	-0.011656	0.000034	0.000332	0.000106
Story7	14	47	Comb2	0.12496	-0.018371	-0.018212	0.000044	0.000332	0.000106
Story7	14	47	Comb3	0.12496	-0.01662	-0.011656	0.000034	0.000332	0.000106
Story7	14	47	Comb4 Max	0.12496	-0.004582	-0.011656	0.000044	0.000332	0.000106
Story7	16	51	1.2D+Ev+Eh+L	0.12496	0.009493	-0.018212	0.000006	0.000332	0.000106
Story7	16	51	0.9D-Ev+Eh	0.12496	0.011244	-0.011656	-0.000004	0.000332	0.000106
Story7	16	51	Comb2	0.12496	0.009493	-0.018212	0.000006	0.000332	0.000106
Story7	16	51	Comb3	0.12496	0.011244	-0.011656	-0.000004	0.000332	0.000106
Story7	16	51	Comb4 Max	0.12496	0.011244	-0.011656	0.000026	0.000332	0.000106
Story6	35	27	1.2D+Ev+Eh+L	0.124711	-0.009825	0	0	0	0.000088
Story6	35	27	Comb2	0.124711	-0.009825	0	0	0	0.000088
Story6	35	27	Comb4 Max	0.124711	-0.006979	0	0	0	0.000088
Story6	30	83	0.9D-Ev+Eh	0.112975	-0.007207	0	0	0	0.000083
Story6	30	83	Comb3	0.112975	-0.007207	0	0	0	0.000083

ETABS 17.0.0

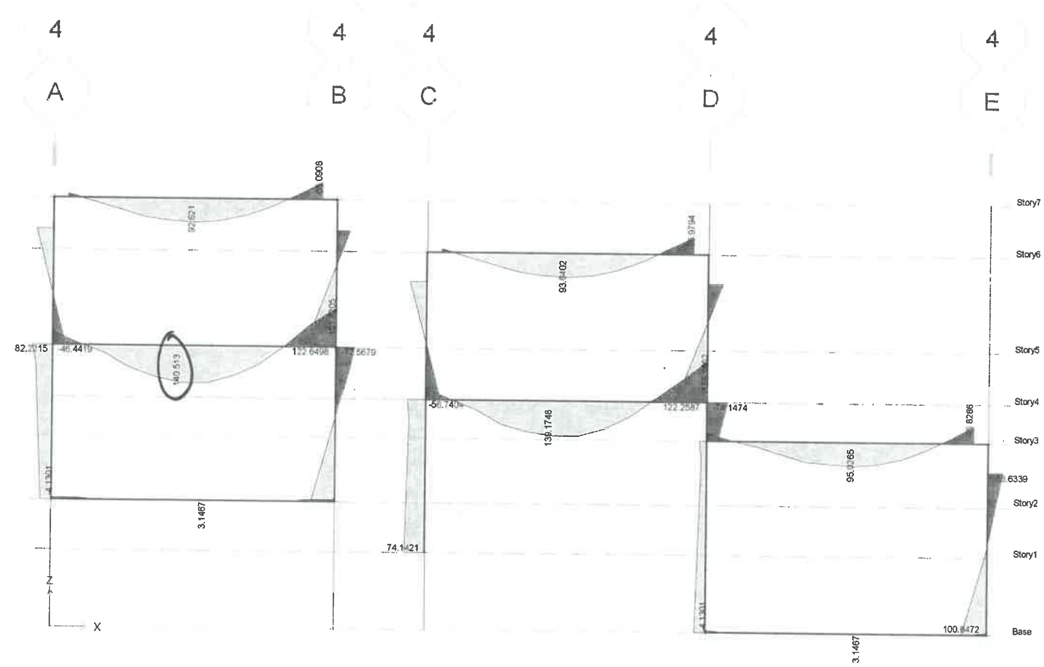
6/6/2019

MF Y DIRECTION
MAX SHEAR DIAGRAM



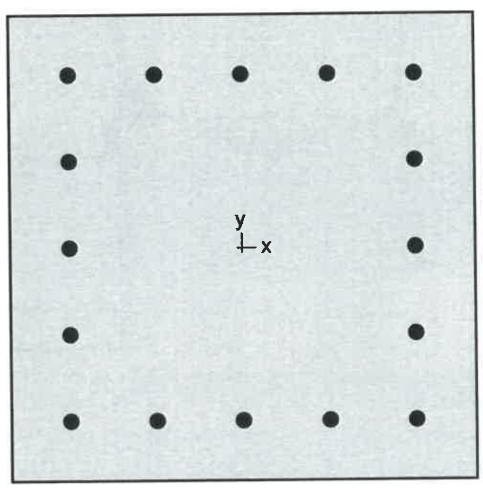
MF Y.EDB Elevation View - 4 Shear Force 3-3 Diagram (Comb4) [kip]

MF X DIRECTION
MOMENT DIAGRAM



spColumn (TM)

spColumn v6.00
Computer program for the Strength Design of Reinforced Concrete Sections



MOMENT FRAME COLUMN

StructurePoint

Contents

List of Figures

1. General Information

File Name	u:\ji\max mf column.col
Project	Morne Briye Primary School
Column	Moment Frame
Engineer	---
Code	ACI 318-14
Bar Set	ASTM A615
Units	Metric
Run Option	Investigation
Run Axis	Biaxial
Slenderness	Not Considered
Column Type	Structural

2. Material Properties

2.1. Concrete

Type	Standard
f'_c	13.79 MPa
E_c	17453.4 MPa
f_c	11.7215 MPa
ε_u	0.003 mm/mm
β_1	0.85

2.2. Steel

Type	Standard
f_y	275.79 MPa
E_s	200000 MPa
ε_{yt}	0.00137895 mm/mm

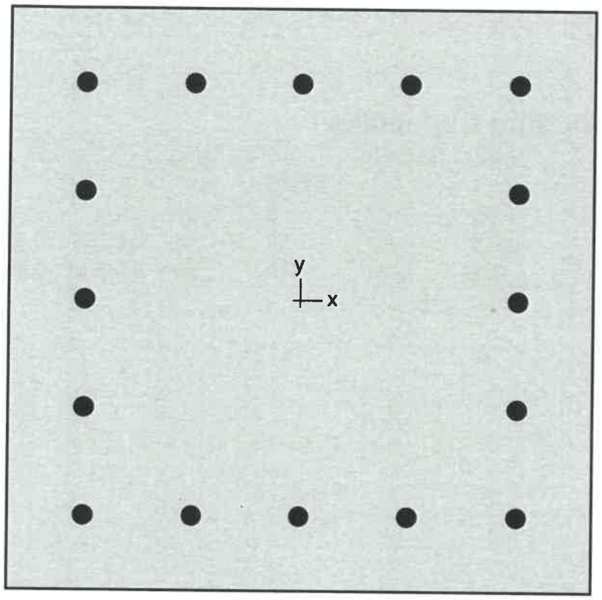
3. Section

3.1. Shape and Properties

Type	Rectangular
Width	457.2 mm
Depth	457.2 mm
A_g	209032 mm^2
I_x	3.64119e+009 mm^4
I_y	3.64119e+009 mm^4
r_x	131.982 mm
r_y	131.982 mm
X_o	0 mm
Y_o	0 mm

18" x 18"

3.2. Section Figure



Rectangular 457.2 x 457.2 mm 1.53% reinf.

Figure 1: Column section

4. Reinforcement

4.1. Bar Set: ASTM A615

Bar	Diameter mm	Area mm^2	Bar	Diameter mm	Area mm^2	Bar	Diameter mm	Area mm^2
#3	9.53	70.97	#4	12.70	129.03	#5	15.88	200.00
#6	19.05	283.87	#7	22.23	387.10	#8	25.40	509.68
#9	28.65	645.16	#10	32.26	819.35	#11	35.81	1006.45
#14	43.00	1451.61	#18	57.33	2580.64			

4.2. Confinement and Factors

Confinement type	Tied
For #10 bars or less	#3 ties
For larger bars	#4 ties
Capacity Reduction Factors	
Axial compression, (a)	0.8
Tension controlled ϕ, (b)	0.9
Compression controlled ϕ, (c)	0.65

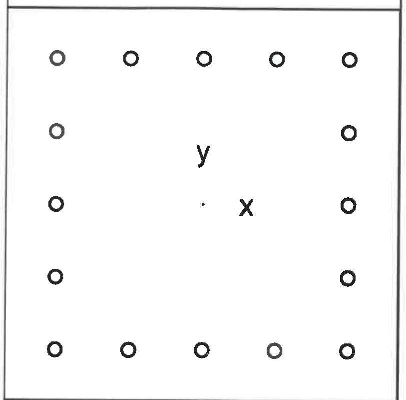
4.3. Arrangement

Pattern	Equal spacing
Bar layout	Rectangular
Cover to	Longitudal bars
Clear cover	50.8 mm
Bars	16 #5

Total steel area, A_s	3200	mm^2
Rho	1.53	%
Minimum clear spacing	69	mm

5. Factored Loads and Moments with Corresponding Capacities

No	P_u	M_{ux}	M_{uy}	ϕM_{nx}	ϕM_{ny}	$\phi M_n/M_u$	NA Depth	d_t Depth	ε_t	ϕ
	kN	kNm	kNm	kNm	kNm		mm	mm		
1	320.27	0.00	61.01	0.00	183.47	3.007	133	398	0.00597	0.900
2	370.05	103.00	0.00	188.65	0.00	1.832	142	398	0.00542	0.900



457.2 x 457.2 mm

Code: ACI 318-14

Units: Metric

Run axis: Biaxial

Run option: Investigation

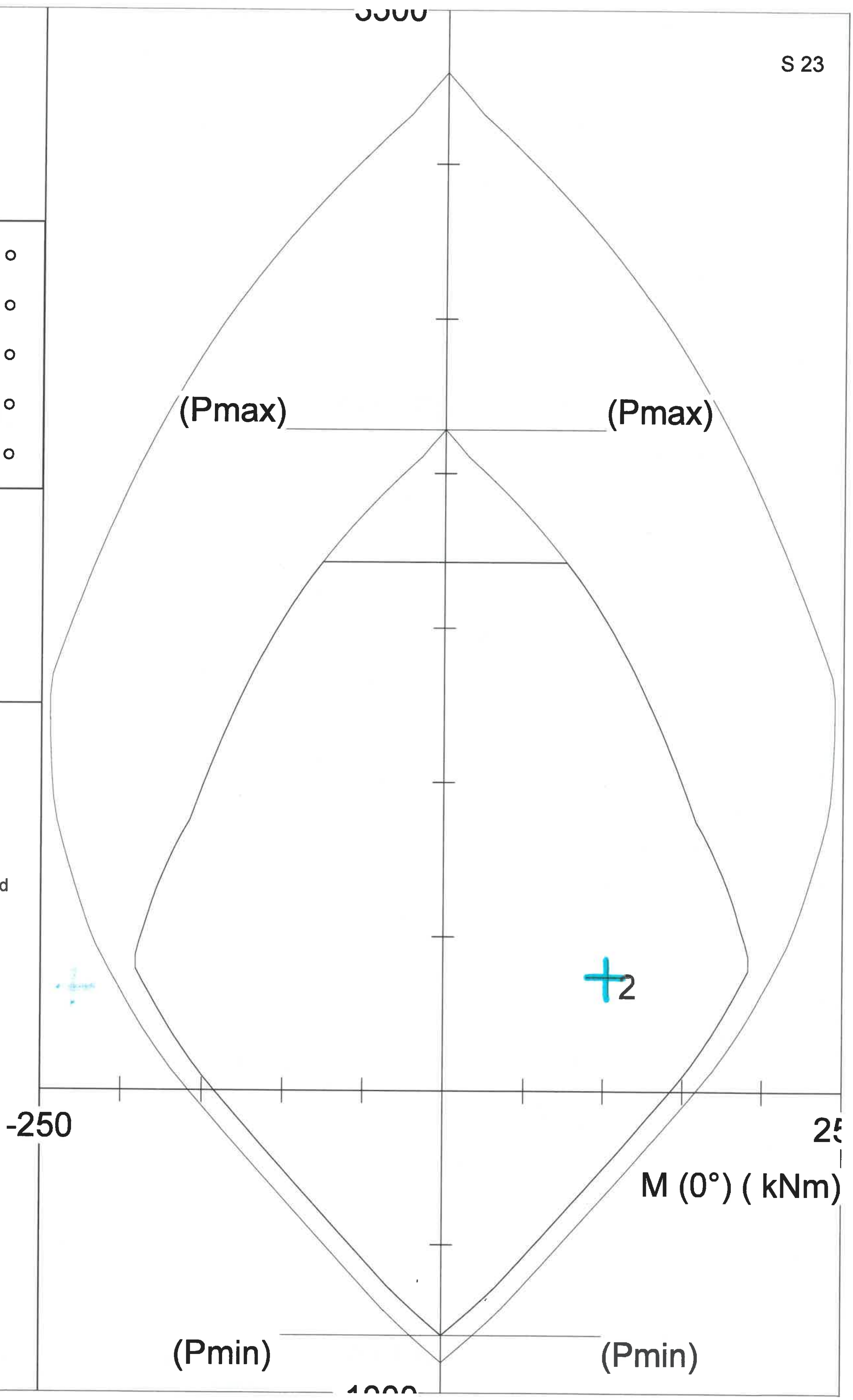
Slenderness: Not considered

Column type: Structural

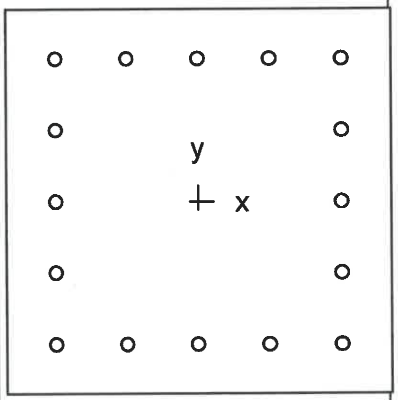
Bars: ASTM A615

Date: 06/06/19

Time: 16:32:24



S 24



457.2 x 457.2 mm

Code: ACI 318-14

Units: Metric

Run axis: Biaxial

Run option: Investigation

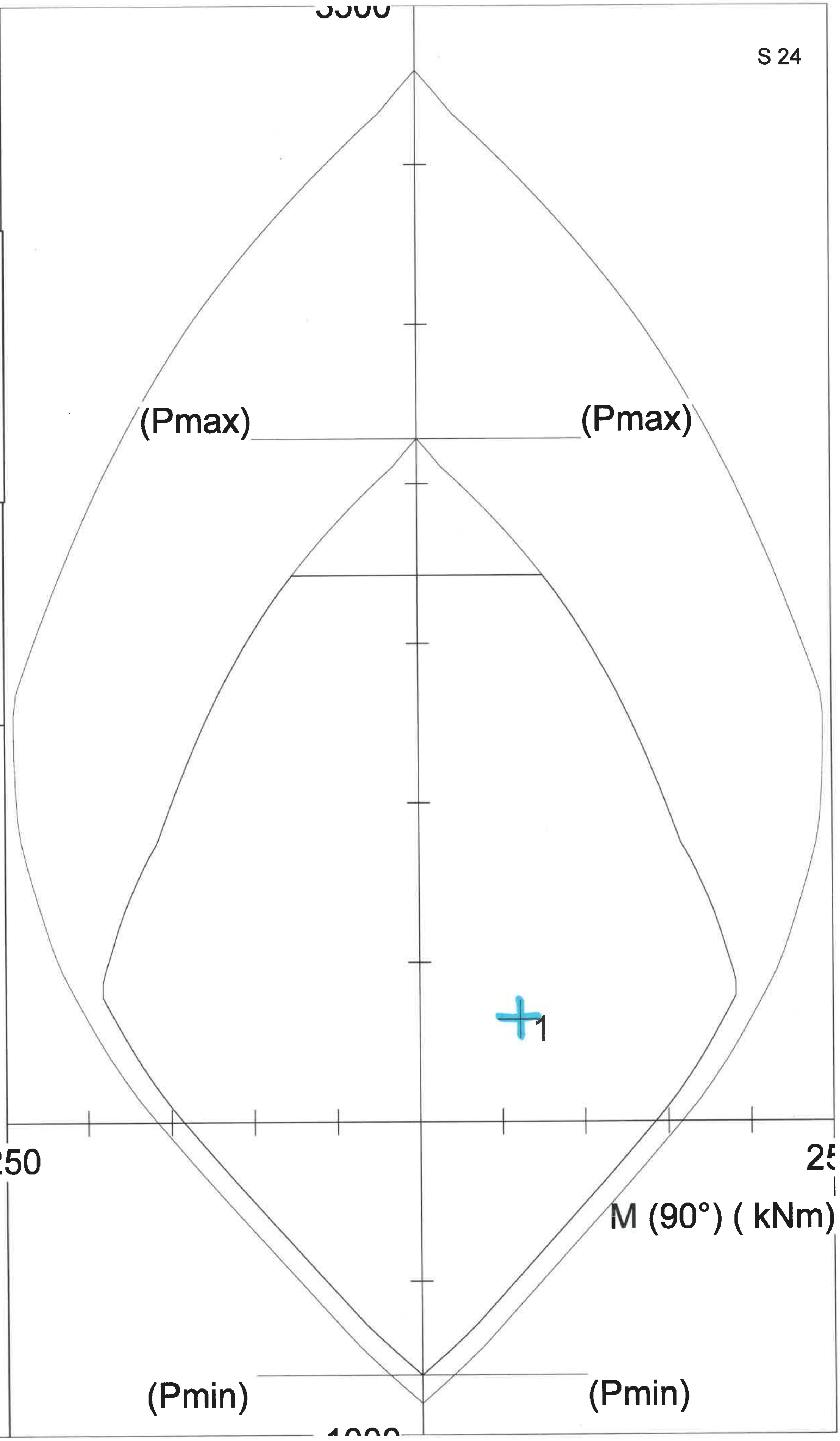
Slenderness: Not considered

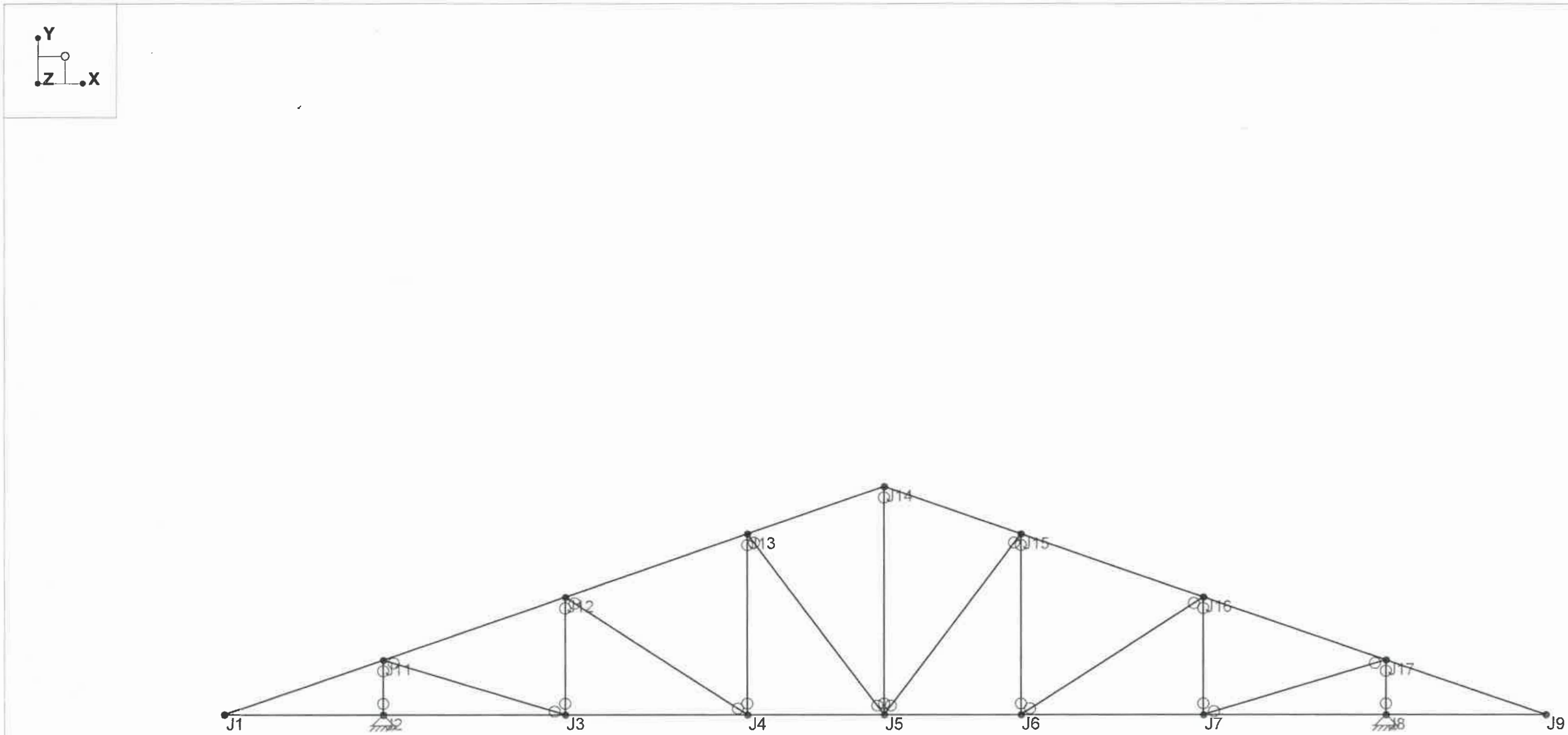
Column type: Structural

Bars: ASTM A615

Date: 06/06/19

Time: 16:32:49





Envelope Only Solution

		SK - 1
		June 6, 2019 at 4:16 PM
	TRUSS MODEL	Truss.r2d

Load Combinations

	Description	Solve	PDelta	S...	B...	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																
2	1.2D+1.6L	Yes			DL	1.2	LL	1.6																

Member Distributed Loads (BLC 1 : dead)

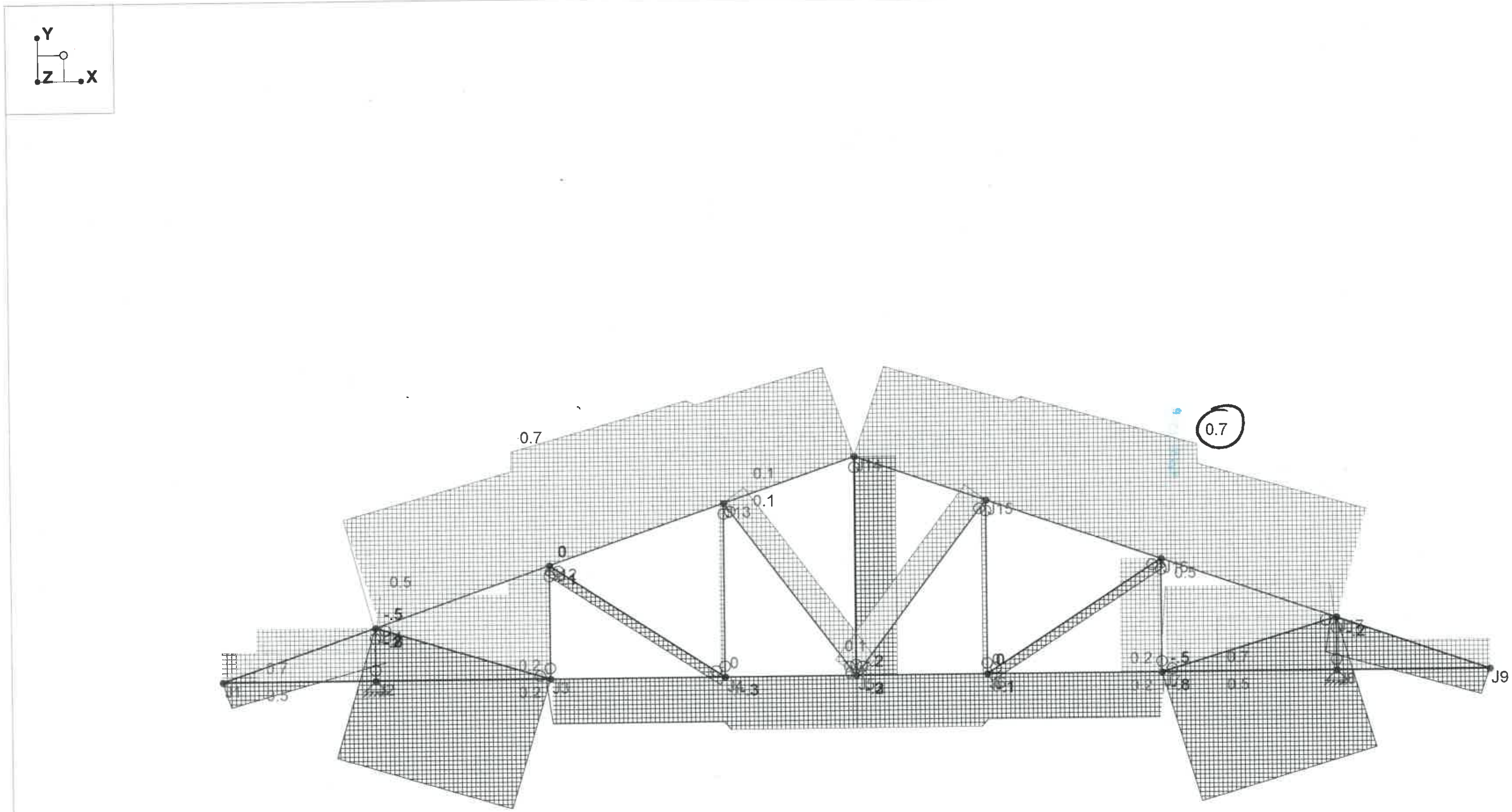
	Member Label	Direction	Start Magnitude[k/ft,...	End Magnitude[k/ft,F,...	Start Location[ft,%]	End Location[ft,%]
1	M3	Y	-.011	-.011	0	29
2	M4	Y	-.011	-.011	0	29

Member Distributed Loads (BLC 2 : live)

	Member Label	Direction	Start Magnitude[k/ft,...	End Magnitude[k/ft,F,...	Start Location[ft,%]	End Location[ft,%]
1	M3	Y	-.02	-.02	0	29
2	M4	Y	-.02	-.02	0	29

Envelope Joint Displacements

	Joint		X [in]	LC	Y [in]	LC	Rotation [rad]	LC
1	J1	max	0	2	-.001	1	-2.555e-05	1
2		min	0	1	-.002	2	-3.726e-05	2
3	J2	max	0	1	0	1	-4.922e-06	1
4		min	0	2	0	2	-7.176e-06	2
5	J3	max	0	1	-.003	1	-6.857e-05	1
6		min	0	2	-.005	2	-9.997e-05	2
7	J4	max	0	1	-.005	1	-5.641e-06	1
8		min	0	2	-.007	2	-8.225e-06	2
9	J5	max	0	2	-.005	1	5.058e-07	2
10		min	0	1	-.007	2	3.469e-07	1
11	J6	max	0	2	-.005	1	1.039e-05	2
12		min	0	1	-.007	2	7.123e-06	1
13	J7	max	0	2	-.003	1	9.817e-05	2
14		min	0	1	-.005	2	6.733e-05	1
15	J8	max	0	2	0	1	9.164e-06	2
16		min	0	1	0	2	6.285e-06	1
17	J9	max	0	1	0	1	4.185e-05	2
18		min	0	2	-.001	2	2.87e-05	1
19	J11	max	0	1	0	1	-2.883e-05	1
20		min	0	2	0	2	-4.203e-05	2
21	J12	max	0	2	-.003	1	-6.804e-05	1
22		min	0	1	-.005	2	-9.921e-05	2
23	J13	max	0	2	-.005	1	6.667e-05	2
24		min	0	1	-.007	2	4.573e-05	1
25	J14	max	0	1	-.004	1	7.144e-07	2
26		min	0	2	-.007	2	4.899e-07	1
27	J15	max	0	1	-.005	1	-4.483e-05	1
28		min	0	2	-.007	2	-6.537e-05	2
29	J16	max	0	1	-.003	1	1.009e-04	2
30		min	0	2	-.005	2	6.92e-05	1
31	J17	max	0	2	0	1	4.24e-05	2
32		min	0	1	0	2	2.908e-05	1



Envelope Only Solution
Member Axial Forces (k) (Enveloped)

AXIAL DIAGRAM

SK - 1
June 6, 2019 at 4:20 PM
Truss.r2d

APPENDIX C

Structural Drawings

Mòn Briyè Primary School

Mornes Brieux, Haiti

Prepared by:

Leah George
Devin Williams

June 14, 2019

Journeyman International

DESIGN CRITERIA & BUILDING CODES

THE DESIGN AND CONSTRUCTION OF THIS PROJECT IS MOSTLY GOVERNED BY THE "**INTERNATIONAL BUILDING CODE (IBC)", 2015 EDITION**, HEREAFTER REFERRED TO AS THE IBC, AS ADOPTED AND MODIFIED TO BE CONSTRUCTED IN VILLA TAPIA, DOMINICAN REPUBLIC.

WIND DESIGN:
MAIN WIND FORCE RESISTING SYSTEM
BASIC WIND SPEED..130 MPH
EXPOSURE CATEGORY..C
WIND IMPORTANCE..I = 1.0
TOPOGRAPHIC FACTOR...K_{zr} = 1.0

SEISMIC DESIGN:
SEISMIC DESIGN CATEGORY................................SDC = D
RESPONSE MODIFICATION FACTOR........................R = 8
SYSTEM OVERSTRENGTH FACTOR...............OMEGA = 3
DEFLECTION AMPLIFICATION FACTOR...................C_d = 5.5
SITE CLASSIFICATION PER ASCE 7-16...........SITE CLASS D
SEISMIC IMPORTANCE FACTOR
PER ASCE 7-16...I_e = 1.0
SRA (SHORT PERIOD)..S_s = 0.99
SRA (1-SEC PERIOD)..S_1 = 0.33
SDR COEFFICIENT (SHORT PERIOD)....................S_{DS} = 0.66
SEISMIC RESPONSE COEFFICIENT.........................C_s = 8.25%
BASE SHEAR GOVERNED BY: SEISMIC
SEISMIC ANALYSIS PROCEDURE USED:
EQUIVALENT LATERAL FORCE PROCEDURE

DESIGN LIVE LOADS:
ROOF LIVE: 20 PSF
CLASSROOMS: 40 PSF
FIRST FLOOR CORRIDORS: 100 PSF

ABBREVIATIONS

@ AT
A.B. ANCHOR BOLT
ARCH ARCHITECT; ARCHITECTURAL
BM BEAM
CL CENTERLINE
COL COLUMN
CONC CONCRETE
CONT CONTINUOUS
DIM DIMENSION
DO DITTO
EA EACH
EQ EQUAL
EXT EXTERIOR
FOC FACE OF COLUMN
FND FOUNDATION
FTG FOOTING
INT INTERIOR
MAX MAXIMUM
MIN MINIMUM
MISC MISCELLANEOUS
MTL METAL
NO. NUMBER
NTS NOT TO SCALE
OC ON CENTER
REQ REQUIRED
REINF REINFORCEMENT
SCHED SCHEDULE
STD STANDARD
STL STEEL
THK THICK
TYP TYPICAL
W/ WITH

GENERAL

1. THESE DRAWINGS ARE INSTRUMENTS OF SERVICE AND ARE THE PROPERTY OF JOURNEYMAN INTERNATIONAL. THE DESIGN AND INFORMATION REPRESENTED ON THESE DRAWINGS ARE EXCLUSIVE FOR THE PROJECT INDICATED AND SHALL NOT BE TRANSFERRED OR OTHERWISE REPRODUCED WITHOUT EXPRESS WRITTEN PERMISSION OF JOURNEYMAN INTERNATIONAL.
2. STRUCTURAL DRAWINGS SHALL BE USED IN CONJUCTION WITH THE SPECIFICATIONS AND OTHER PROJECT DRAWINGS BY OTHER DISCIPLINES.
3. CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND ELEVATIONS RELATING TO EXISTING CONDITIONS BY MAKING FIELD SURVEYS AND MEASUREMENTS PRIOR TO COMMENCING FABRICATION OR CONSTRUCTION.
4. CONTRACTOR SHALL ENSURE THAT ALL CONSTRUCTION METHODS USED WILL NOT CAUSE DAMAGE TO UTILITIES OR THE PROPERTY. THIS IS PARTICULARLY IMPORTANT DURING FOUNDATION INSTALLATION.
5. CONTRACTOR SHALL COMPARE AND COORDINATE THE DRAWINGS OF ALL DISCIPLINES AND REPORT ANY DISCREPANCIES BETWEEN THE DRAWINGS TO THE ARCHITECT AND ENGINEER.
6. DETAILS LABLED "TYPICAL" SHALL APPLY TO ALL SITUATIONS THAT ARE THE SAME OR SIMILAR TO THOSE SPECIFICALLY DETAILED.
7. WHERE CONFLICTS EXIST BETWEEN STRUCTURAL DOCUMENTS, THE STRICTEST REQUIREMENTS, AS INDICATED BY THE STRUCTURAL ENGINEER, SHALL GOVERN.
8. THE GENERAL CONTRACTOR SHALL REVIEW AND DETERMINE THAT DIMENSIONS ARE COORDINATED BETWEEN ARCHITECTURAL AND STRUCTURAL DRAWINGS PRIOR TO FABRICATION OR START OF CONSTRUCTION.
9. NO STRUCTURAL MEMBER SHALL BE CUT OR NOTCHED OR OTHERWISE REDUCED IN STRENGTH UNLESS APPROVED BY THE STRUCTURAL ENGINEER.
10. THE GENERAL CONTRACTOR SHALL COORDINATE ARCHITECTURAL, MECHANICAL, ELECTRICAL AND LUMBING DRAWINGS FOR ANCHORED, EMBEDDED OR UPPORTED ITEMS. NOTIFY THE ARCHITECT AND ENGINEER OF ANY ISCREPANCIES.

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 OF 3000 PSI NORMAL WEIGHT.
3. ALL STRUCTURAL CONCRETE MIXES SHALL BE TYPE II CEMENT AND SHALL BE DESIGNED BY AN APPROVED LABORATORY.
4. NORMAL WEIGHT CONCRETE AGGREGATES SHALL CONFORM TO ASTM C-33.
5. NO MORE THAN ONE GRADE OF CONCRETE SHALL BE ON THE JOB SITE AT ANY ONE TIME.
6. 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" UNLESS NOTED OTHERWISE.
7. 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.
8. DEFECTIVE CONCRETE (VOIDS, ROCK POCKETS, HONEYCOMBS, CRACKING, ETC.) SHALL BE REMOVED AND REPLACED AS DIRECTED BY THE OWNER'S REPRESENTATIVE.

REINFORCEMENT

1. BARS SHALL BE FIRMLY SUPPORTED AND ACCURATELY PLACED AS REQUIRED BY THE A.C.I. STANDARDS, 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.
2. DRAWINGS SHOW TYPICAL REINFORCING CONDITIONS. CONTRACTOR SHALL PREPARE DETAILED PLACEMENT DRAWINGS OF ALL CONDITIONS SHOWING QUANTITY, SPACING, SIZE, CLEARANCES, LAPS, INTERSECTIONS AND COVERAGE
3. 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.
4. 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 GS-101 BY QUICKSAND TECHNOLOGIES, DATED 12-10-2016 AND SUPPLEMENTAL REPORT ENTITLED GS-102, DATED 12-10-2016.
2. THE GEOTECHNICAL INVESTIGATION REPORT AND ITS RECOMMENDATIONS SHALL BE FOLLOWED AND SHALL BE CONSIDERED MINIMUM REQUIREMENTS UNLESS MORE STRIGENT REQUIREMENTS ARE PRESENTED IN THE SPECIFICATIONS OR ON THE DRAWINGS.
3. PER GEOTECHNICAL INVESTIGATION REPORT, THE ALLOWABLE SOIL BEARING PRESSURES ARE AS FOLLOWS:
   A. SPREAD FOOTINGS: 4000 POUNDS PER SQUARE FOOT
   B. ALLOWABLE BEARING VALUES MAY BE INCREASED BY 33 PERCENT FOR SHORT TERM LOADING.
4. 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, BAKFILL MATERIALS AND BACK FILLING PROCEDURES.
5. LOCATE AND PROTECT EXISTING UTILITIES TO REMAIN DURING AND/OR AFTER CONSTRUCTION.
6. REMOVE ABANDONED FOOTINGS, UTILITIES, ETC. WHICH INTERFERE WITH NEW CONSTRUCTION, UNLESS OTHERWISE INDICATED.
7. NOTIFY THE OWNER'S REPRESENTATIVE IF ANY BURIED STRUCTURES NOT INDICATED, SUCH AS CESSPOOLS, CISTERNS, FOUNDATIONS, ETC., ARE FOUND.
8. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR EXCAVATION PROCEDURES INCLUDING LAGGING, SHORING, UNDERPINNING AND PROTECTION OF EXISTING CONSTRUCTION.
9. 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.

Leah George & Devin Williams
Journeyman International

SEAL:

DATE:06/6/2019

PROJECT:
Mornes Briye Primary School

SITE:
Mornes Brieux, Haiti

REVISIONS

No:	DESC.	DATE

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PLOT DATE:
6/14/2019 12:40:12 AM

SHEET NAME:
General Notes

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SHEET No.:1

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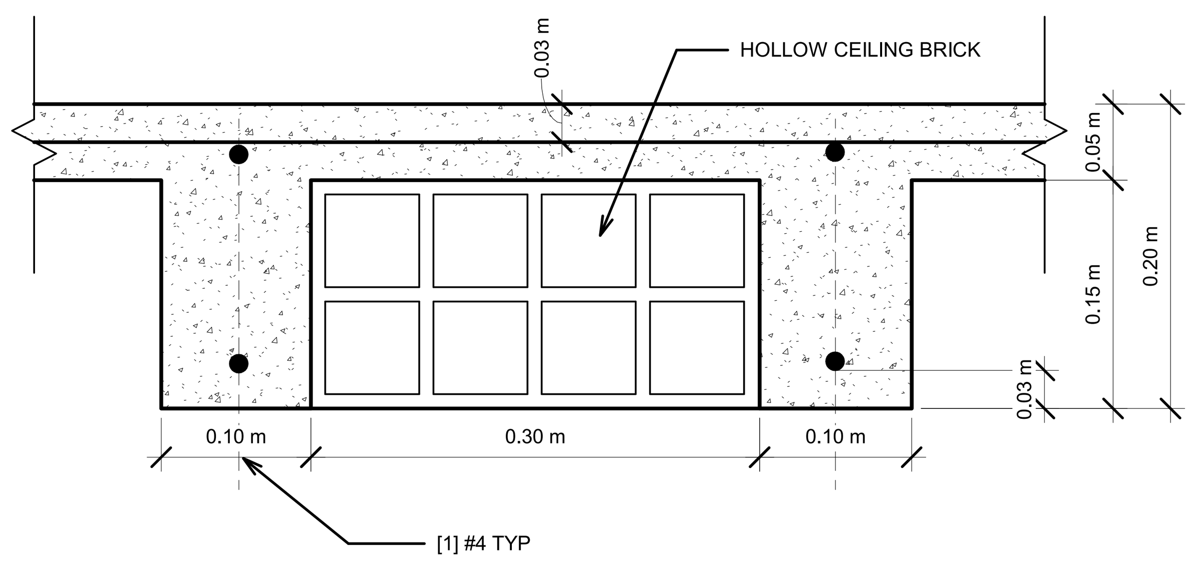
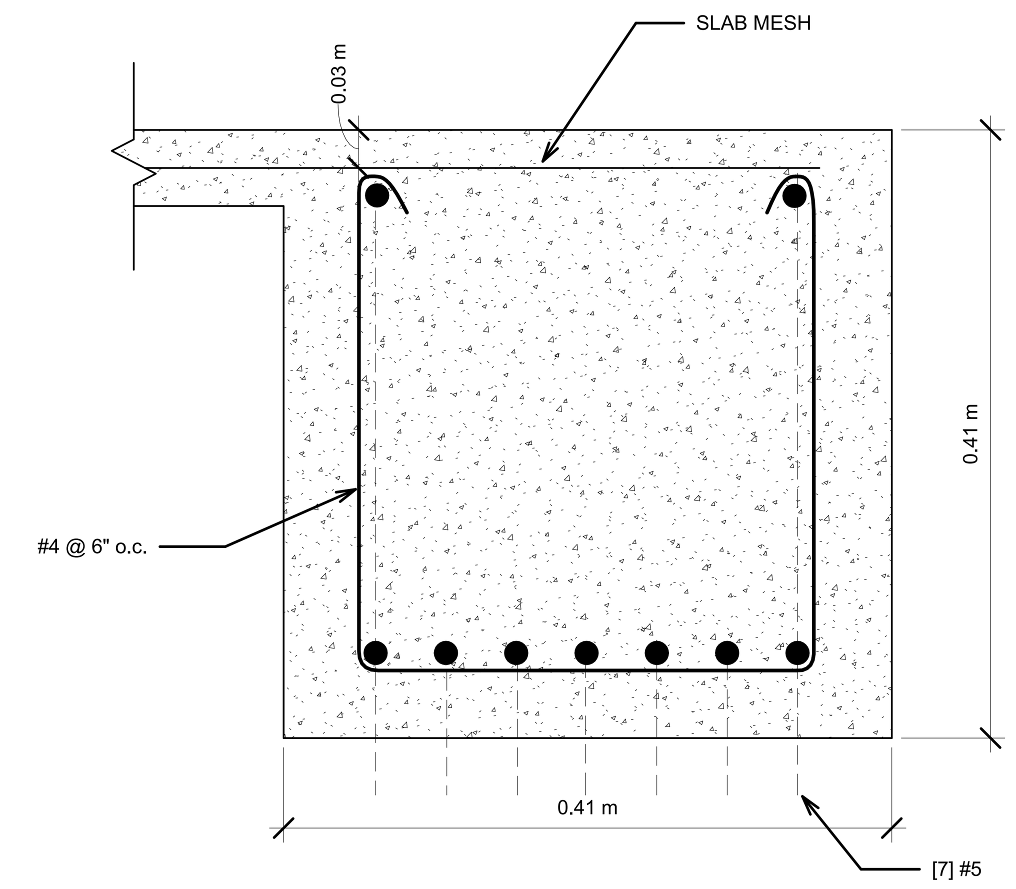
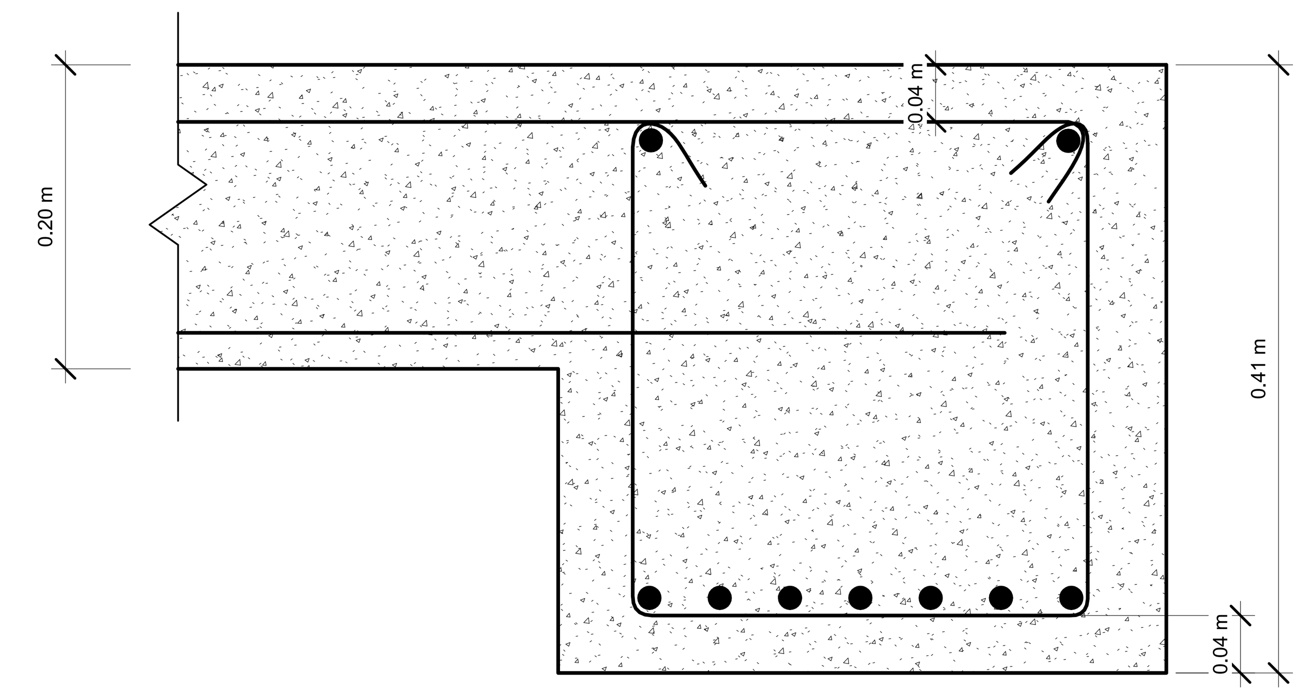


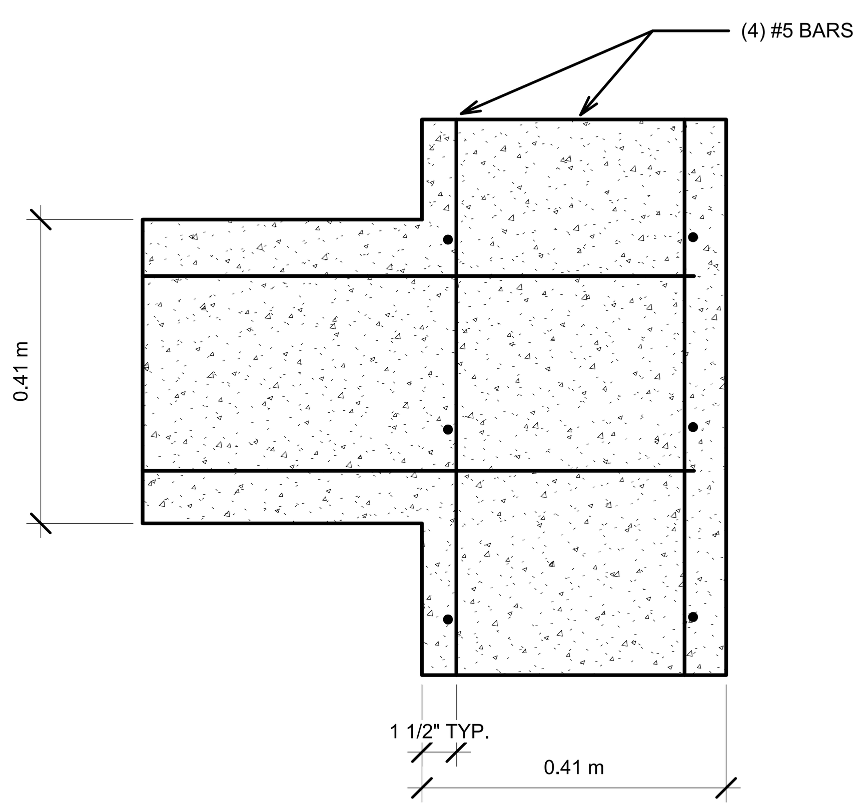
1 Slab and Joist Section
1 : 4



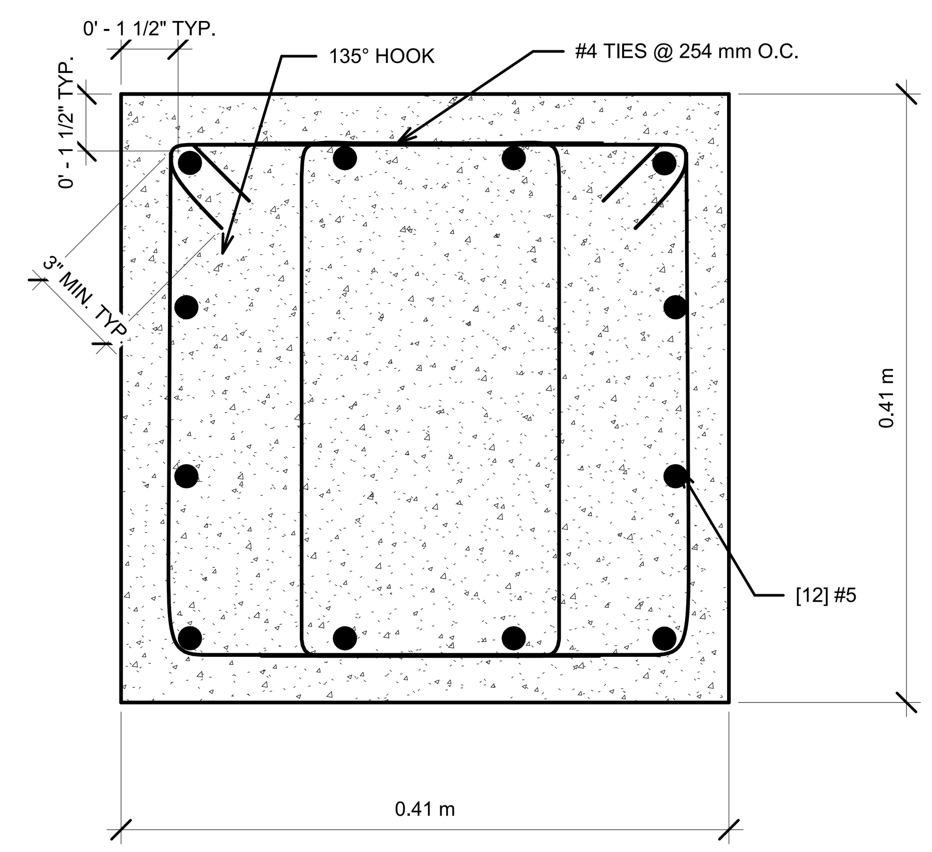
2 Slab and Beam B1 Section
1 : 4



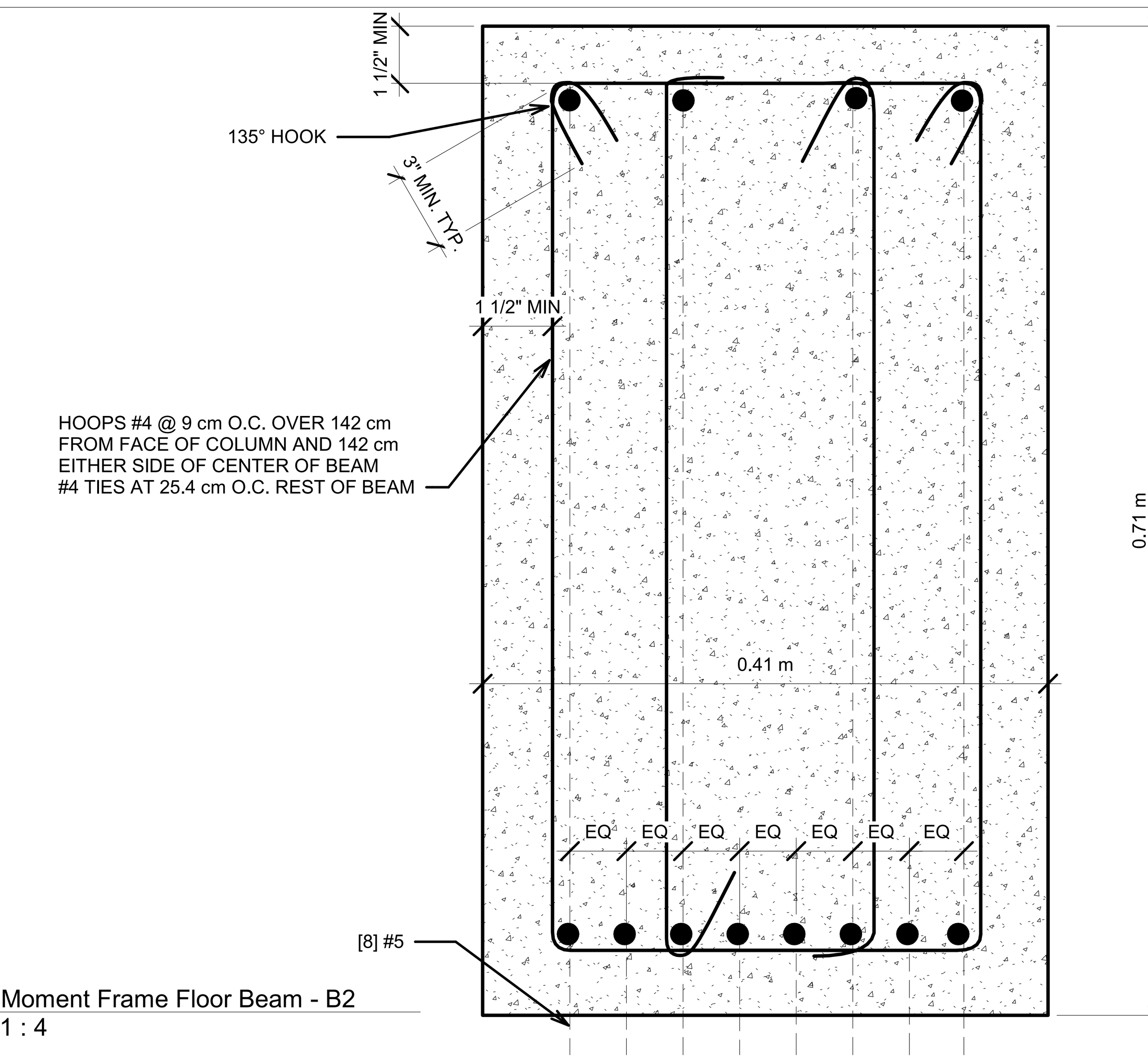
3 Joist to Beam
1 : 4



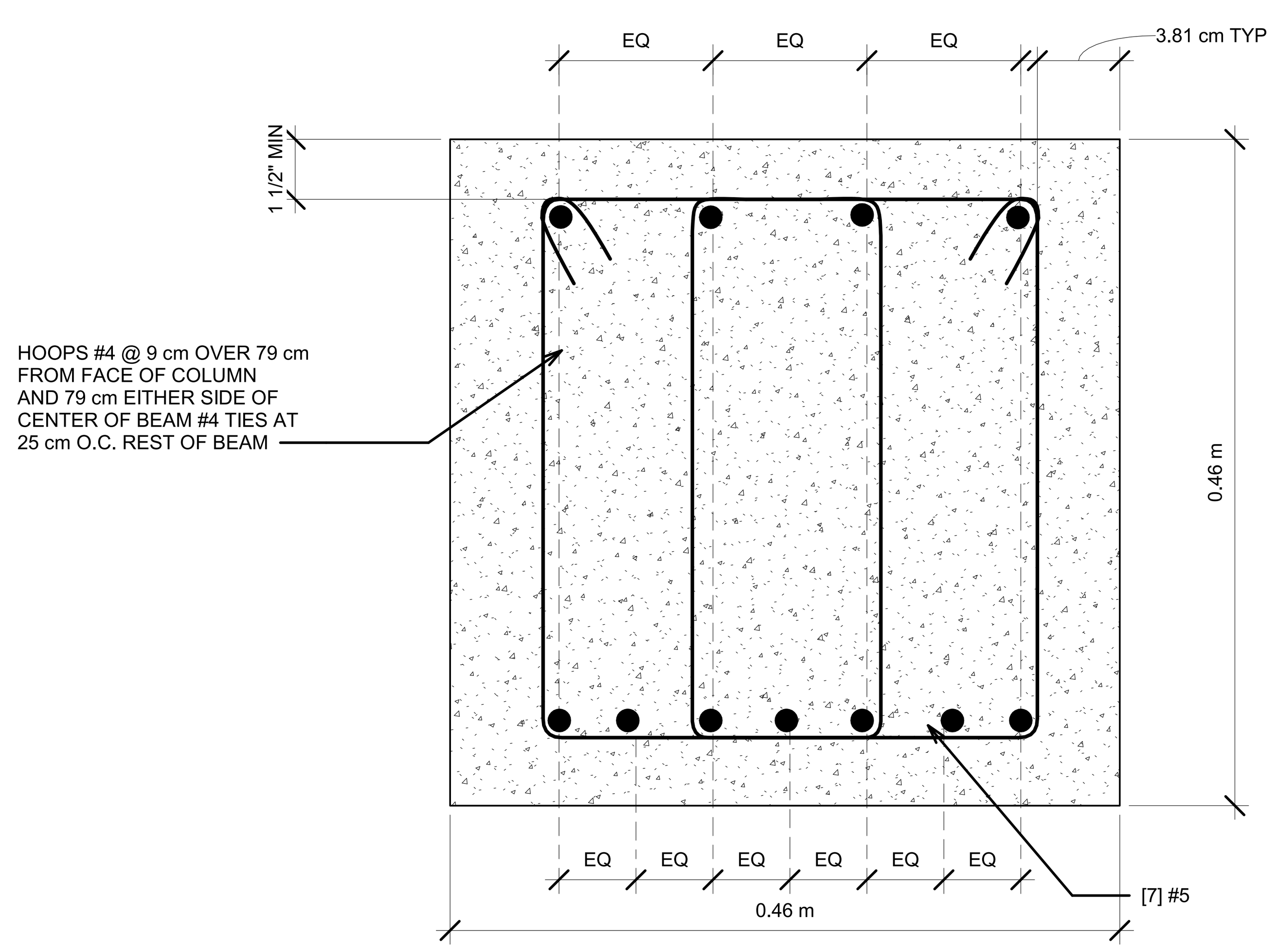
4 Gravity Beam B1 to Gravity Column C1
1 : 8



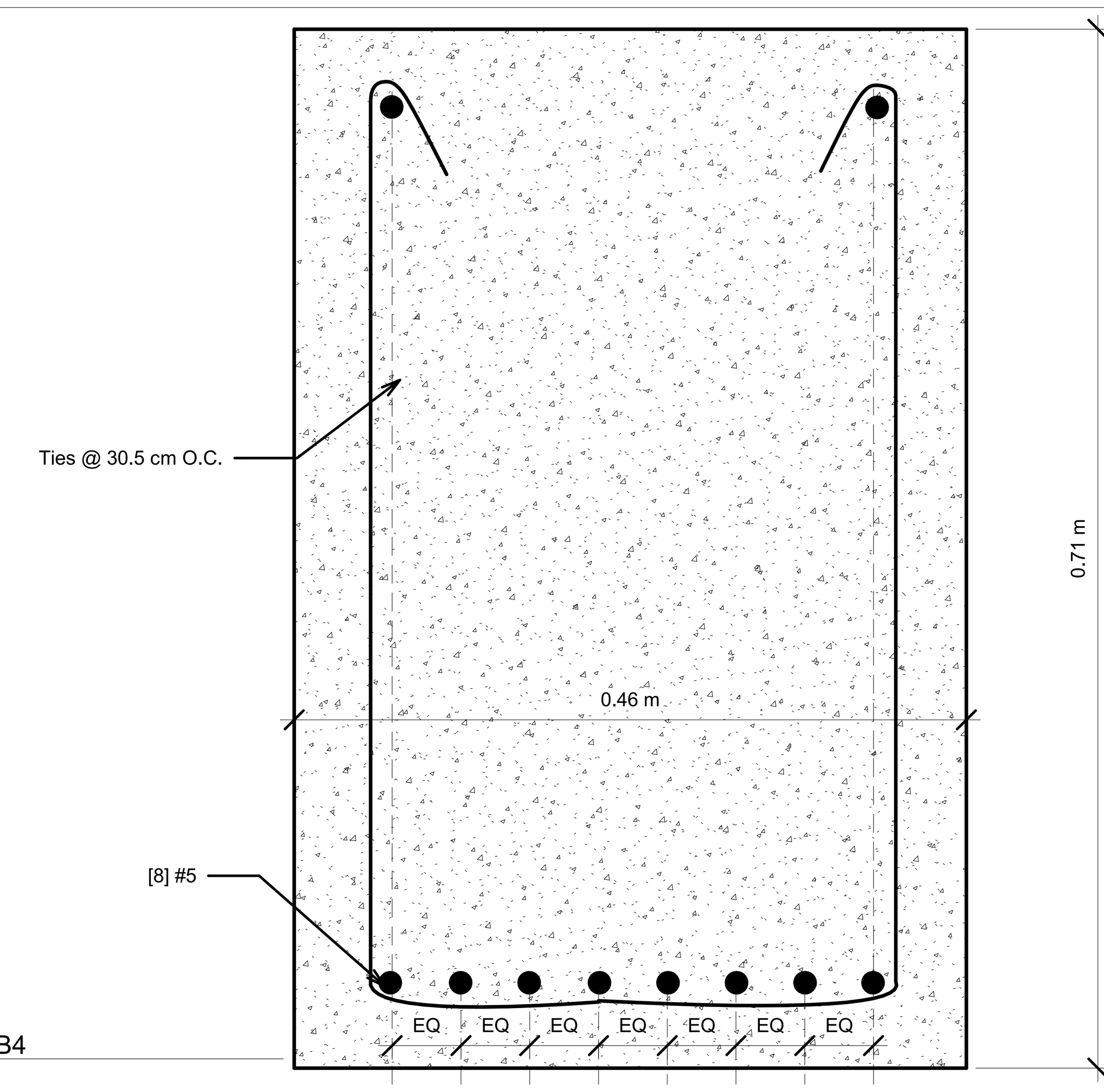
5 Gravity Column C1
1 : 4



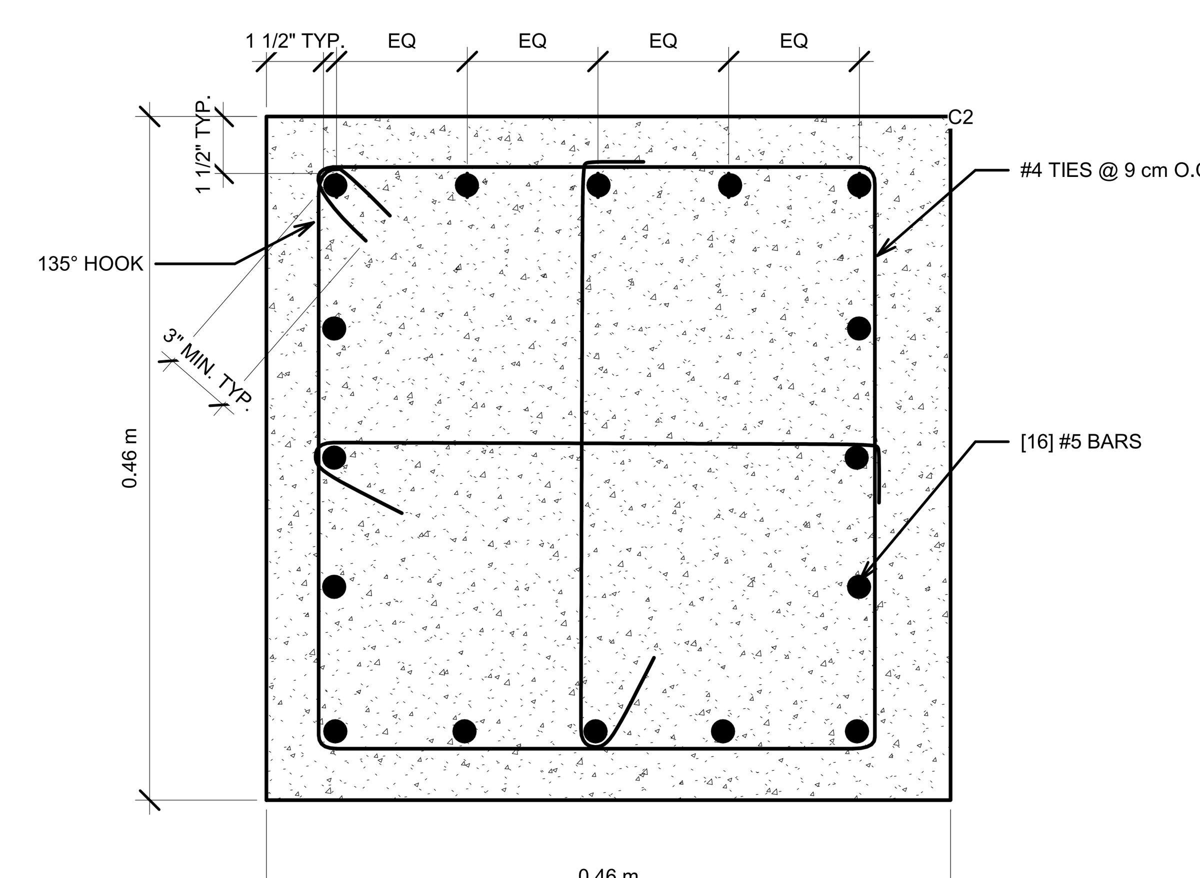
6 Moment Frame Floor Beam - B2
1 : 4



7 Moment Frame Roof Beam B3
1 : 4



8 Gravity Beam B4
1 : 4



9 Moment Frame Column C2
1 : 4

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SHEET NAME:

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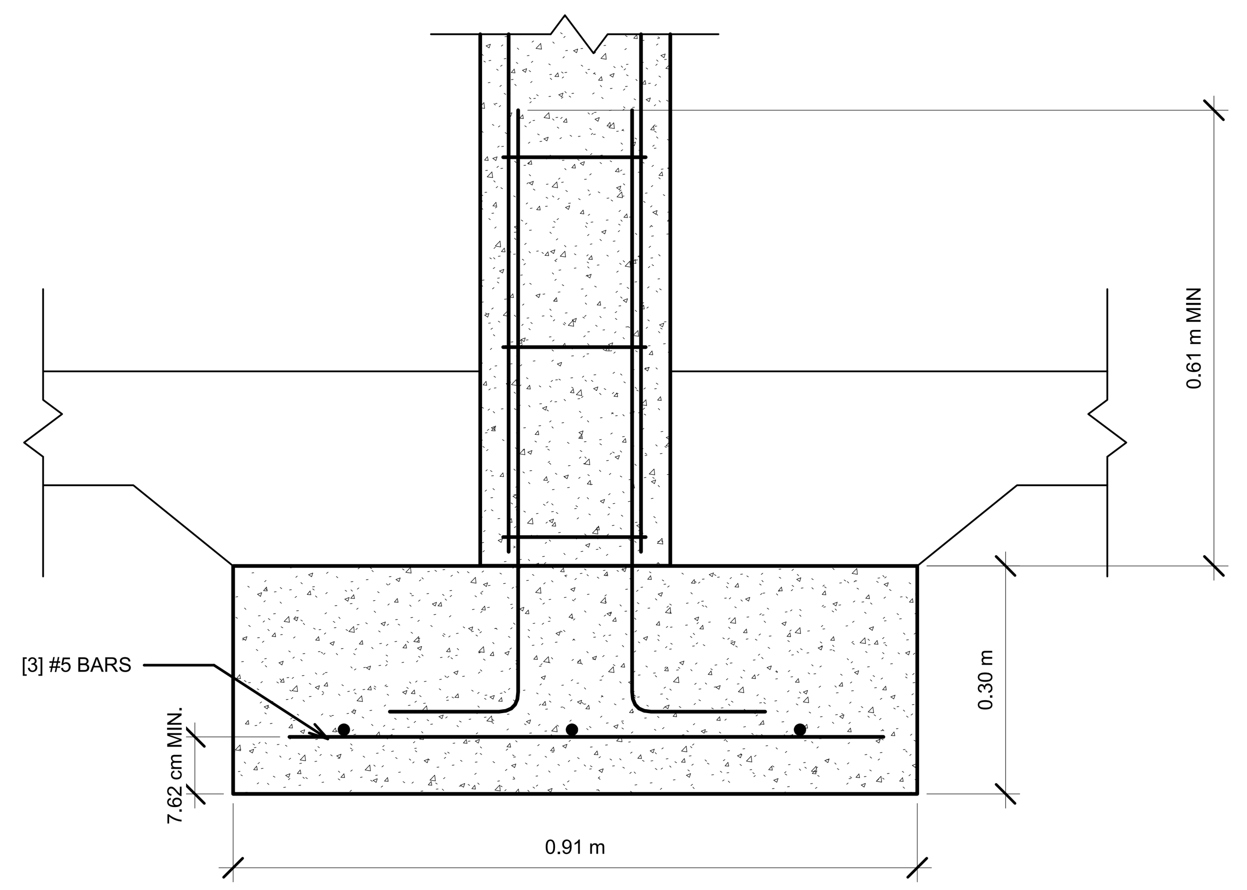
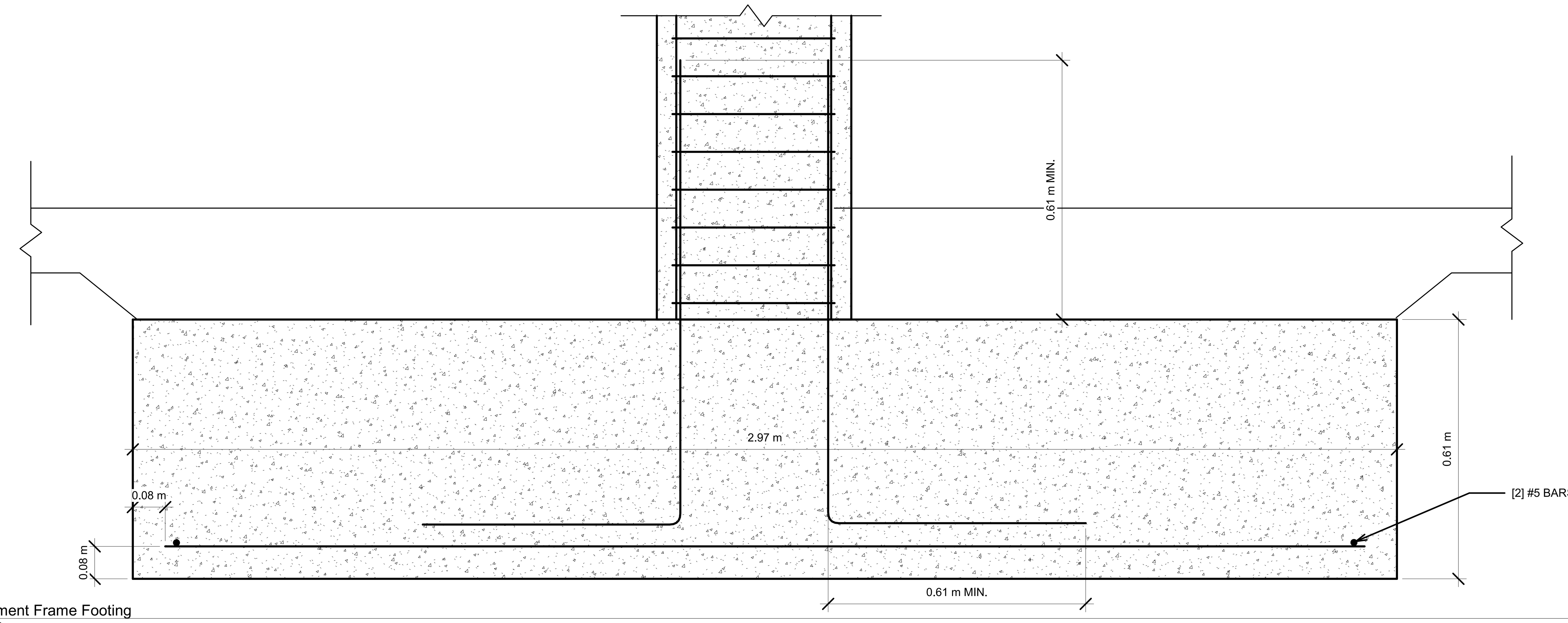
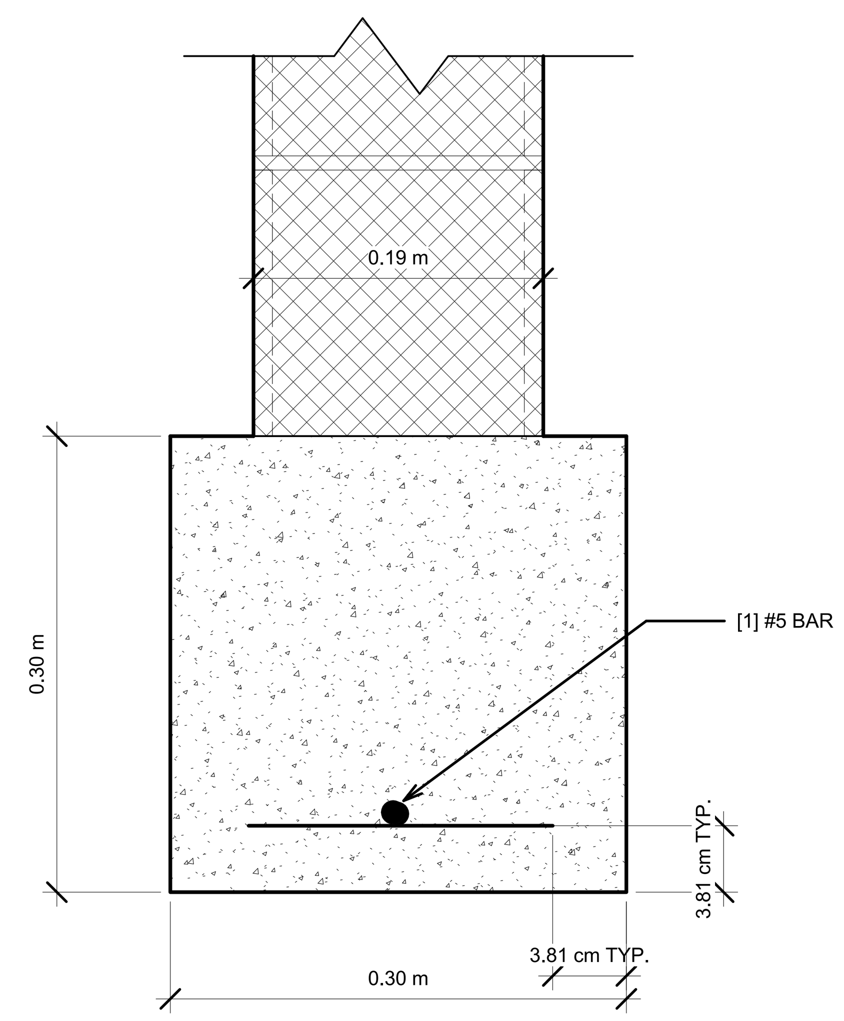


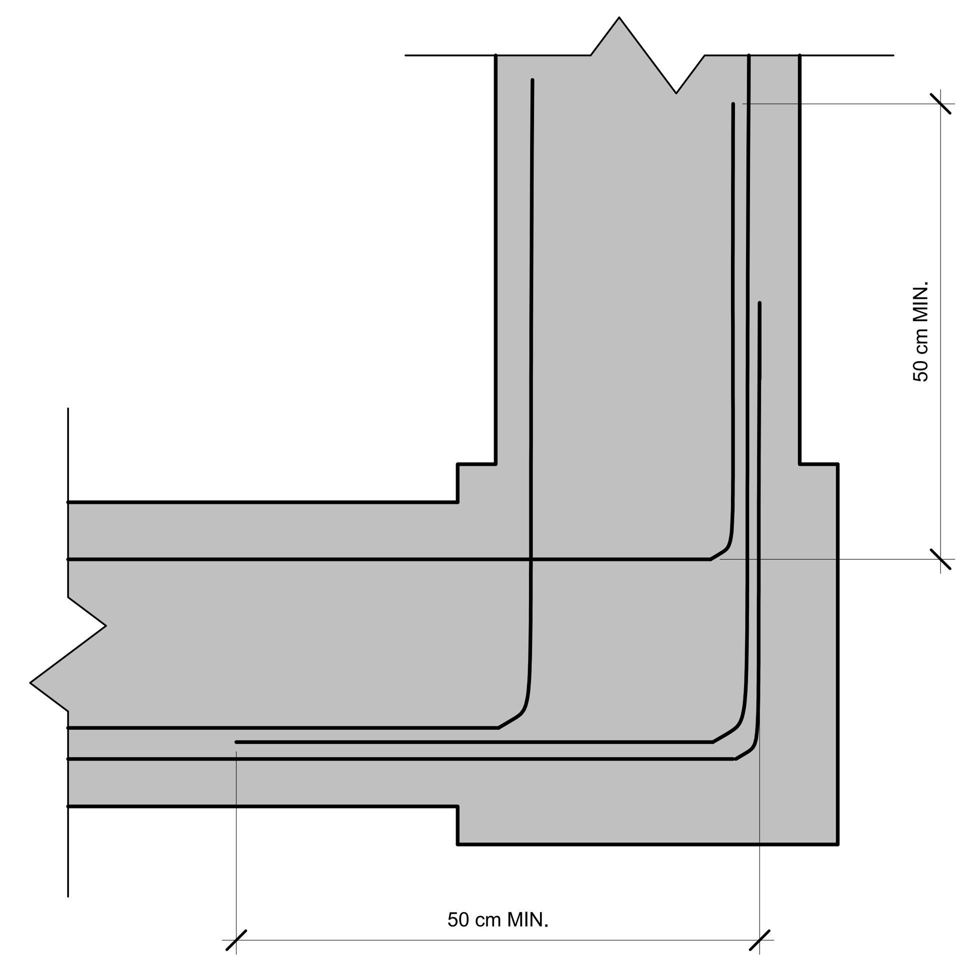
1 Gravity Column C1 Footing
1 : 8



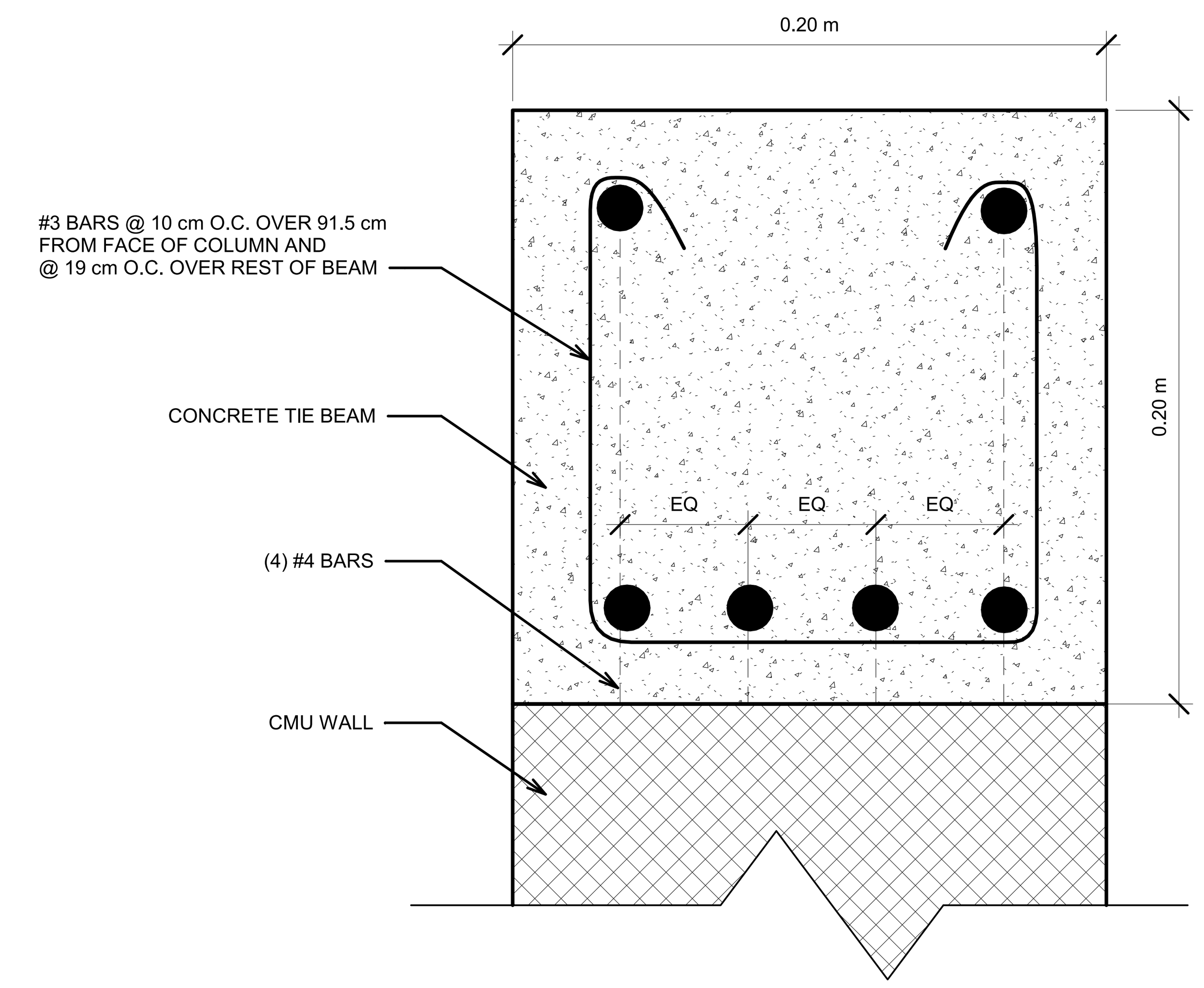
2 Moment Frame Footing
1 : 8



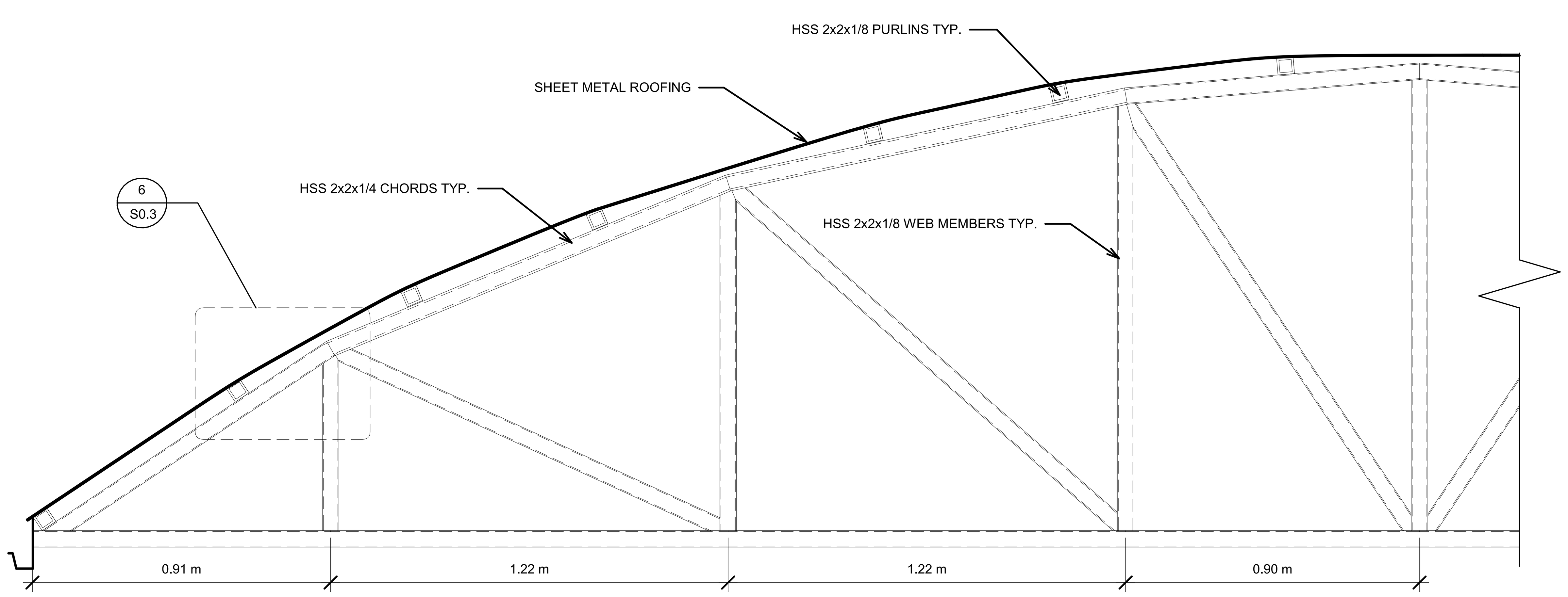
3 CMU Wall Foundation
1 : 4



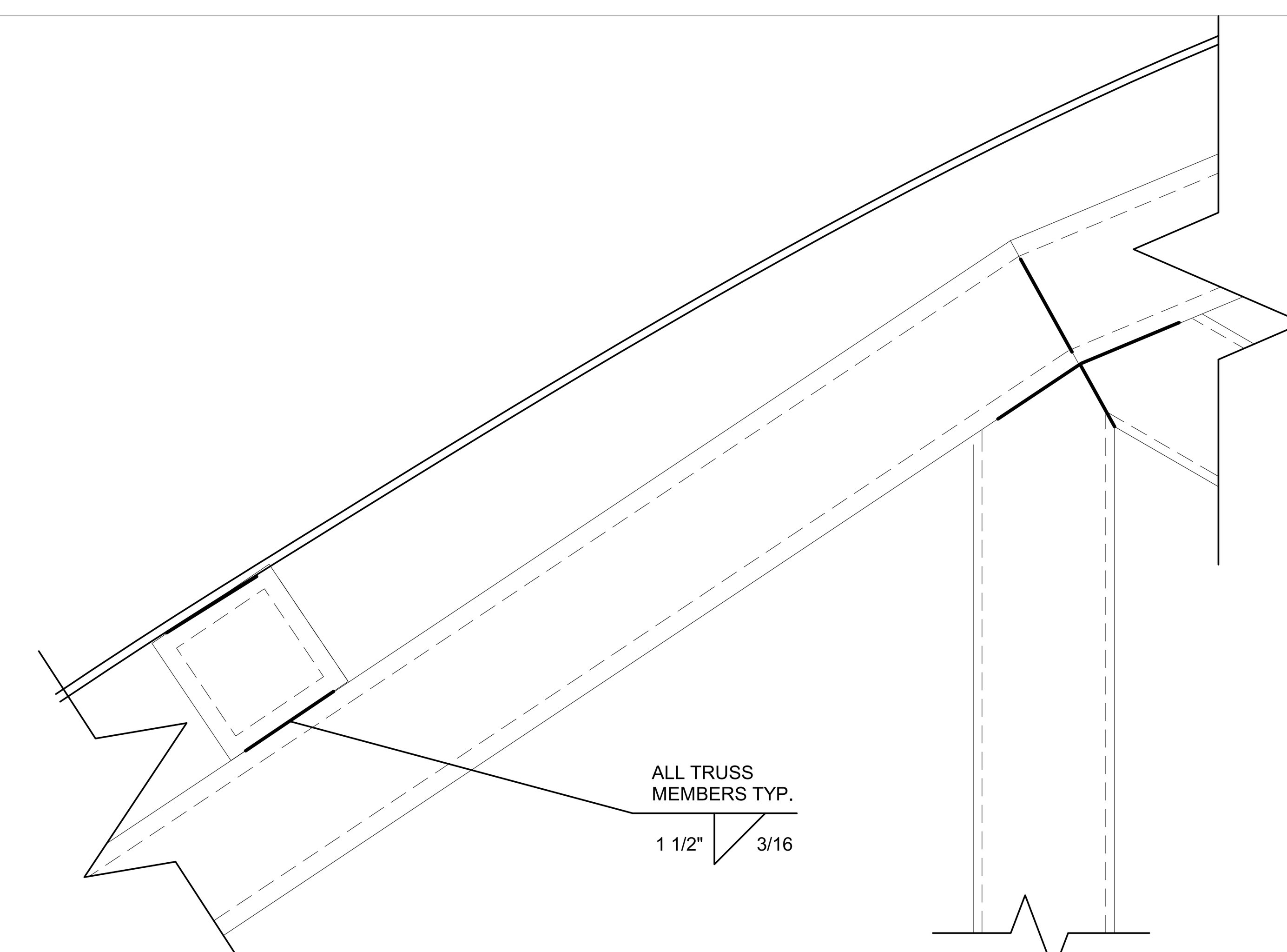
4 TYP. Construction of Column to Beam Connection Plan View
1 : 4



7 CMU Wall Tie Beam
1 : 2



5 Truss Elevation
1 : 12



6 Truss Weld
1 : 2

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Mornes Briye Primary School

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Mornes Brieux, Haiti

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As indicated

SHEET No.:1

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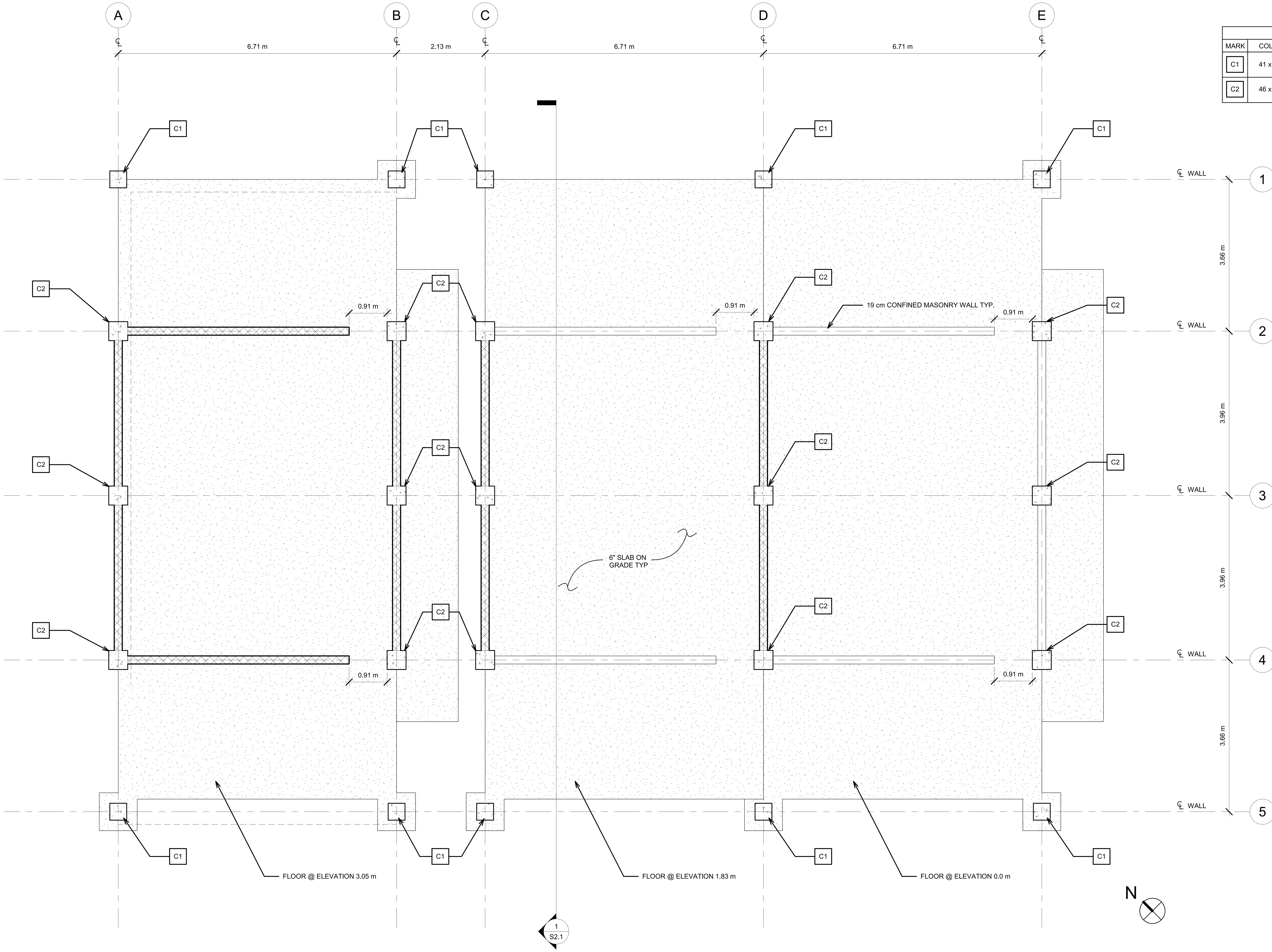

1 First Floor Plan
1 : 48

COLUMN AND FOOTING SCHEDULE				
MARK	COL. SIZE	COL. DETAIL	FTG SIZE	FTG DETAIL
C1	41 x 41 cm	5 / S0.2	76 x 76 x 20 cm	1 / S0.3
C2	46 x 46 cm	9 / S0.2	297 cm wide 51 cm deep	2 / S0.3

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SHEET NAME:

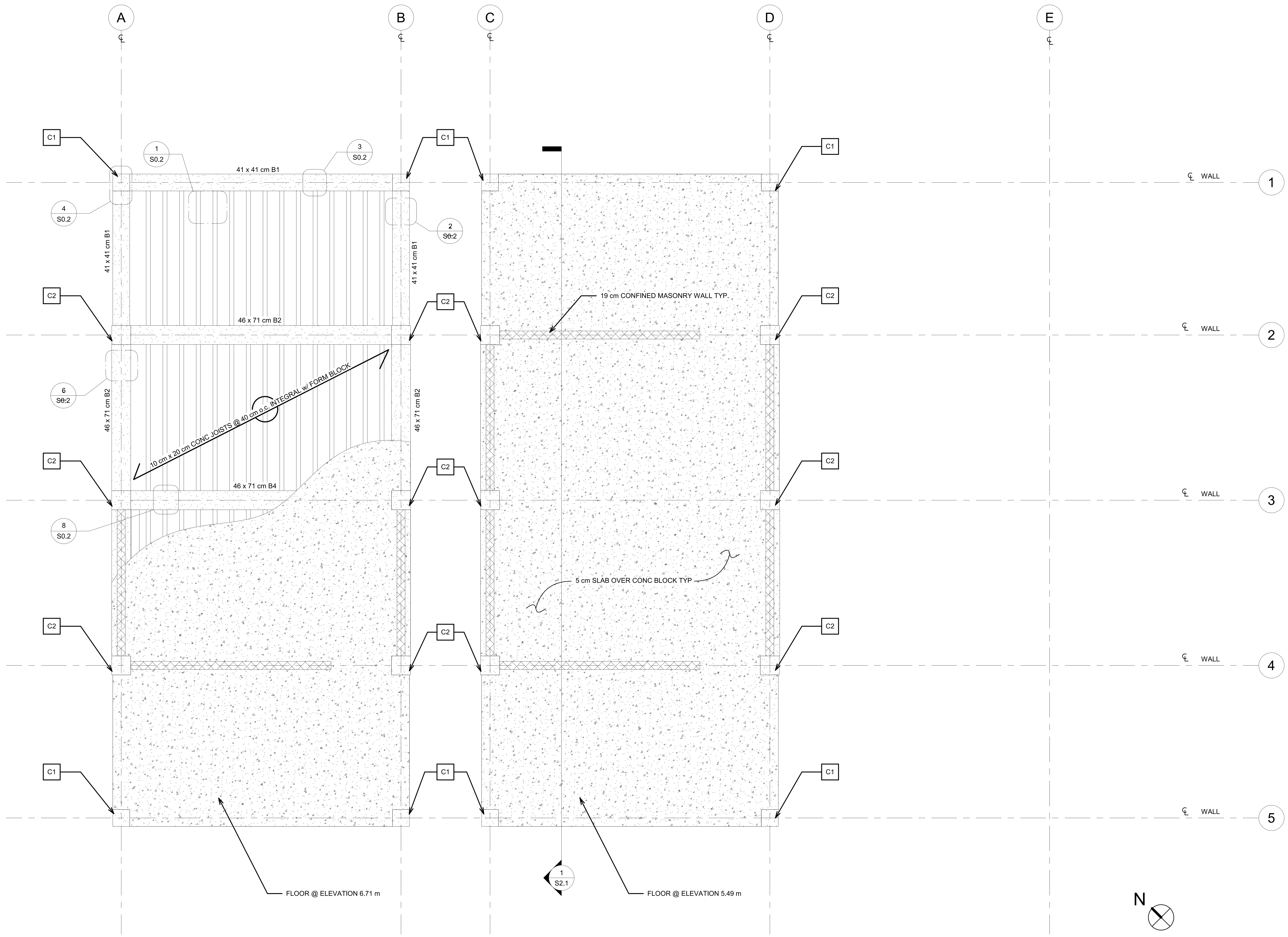
First Floor Plan

SCALE:

1 : 48

SHEET No.:1

S1.0



1 Second Floor Plan
1 : 48

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Mornes Briye Primary School

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Mornes Brieux, Haiti

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SHEET NAME:

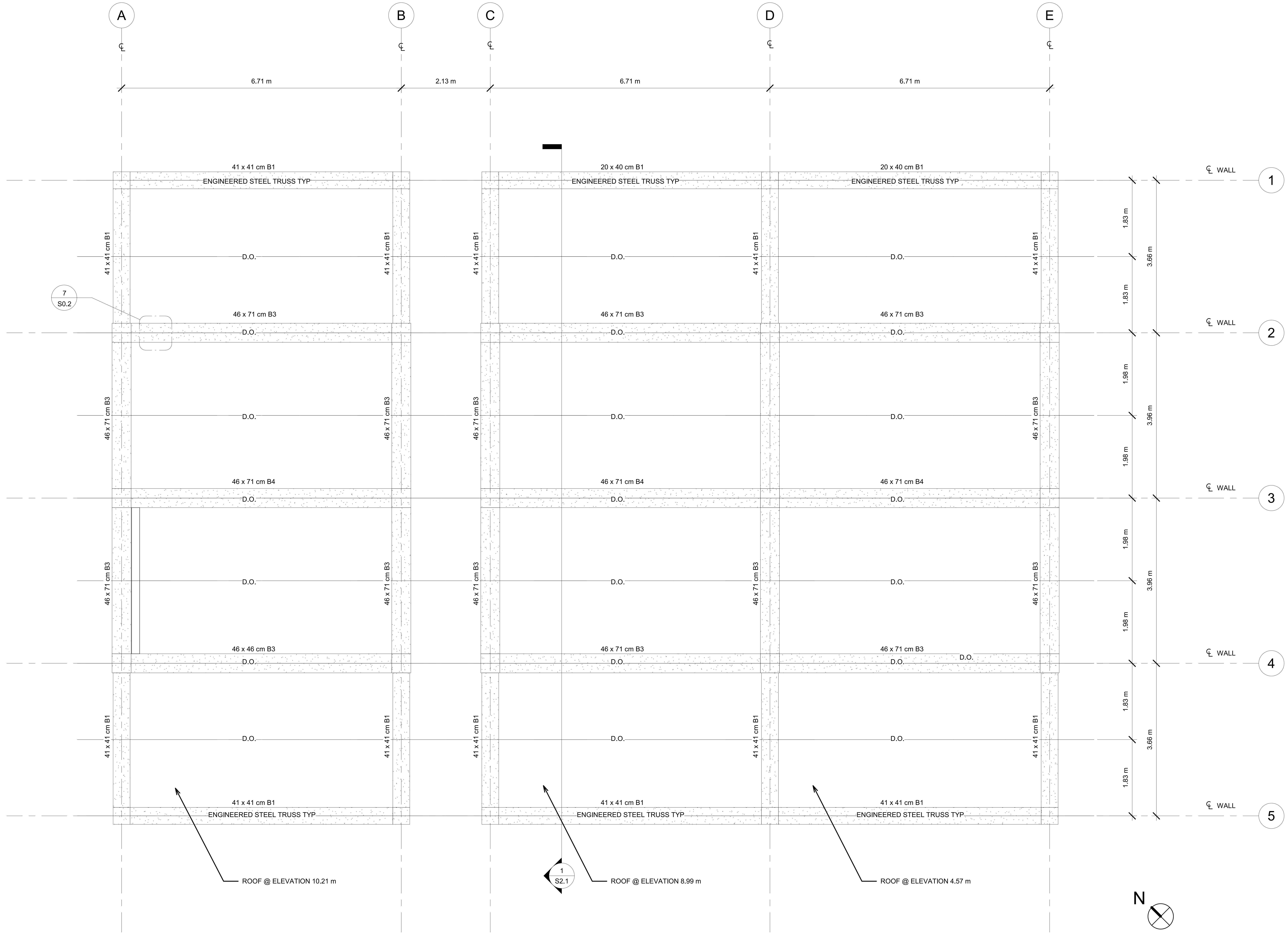
Second Floor Plan

SCALE:

1 : 48

SHEET No.:1

S1.1



1 Roof Plan
1 : 48

Leah George & Devin Williams

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SEAL:

DATE:06/6/2019

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Mornes Briye Primary School

SITE:

Mornes Brieux, Haiti

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CHECKED BY:

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SHEET NAME:

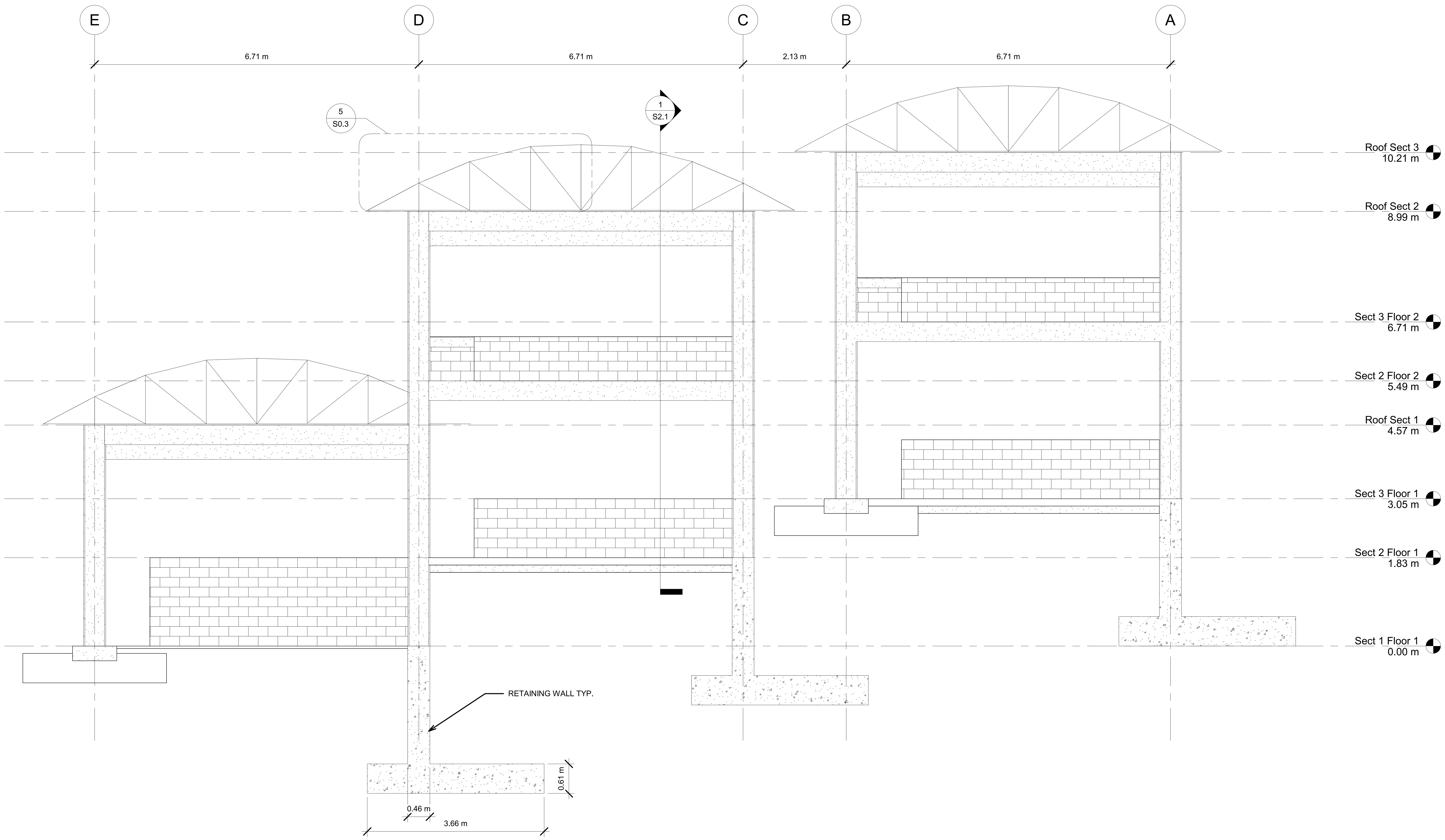
Roof Plan

SCALE:

1 : 48

SHEET No.:1

S1.2



1 North Elevation
1 : 48

Leah George & Devin Williams

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SEAL:

DATE:06/6/2019

PROJECT:

Mornes Briye Primary School

SITE:

Mornes Brieux, Haiti

REVISIONS

No:	DESC.	DATE

DRAWN BY:

CHECKED BY:

PLOT DATE:

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SHEET NAME:

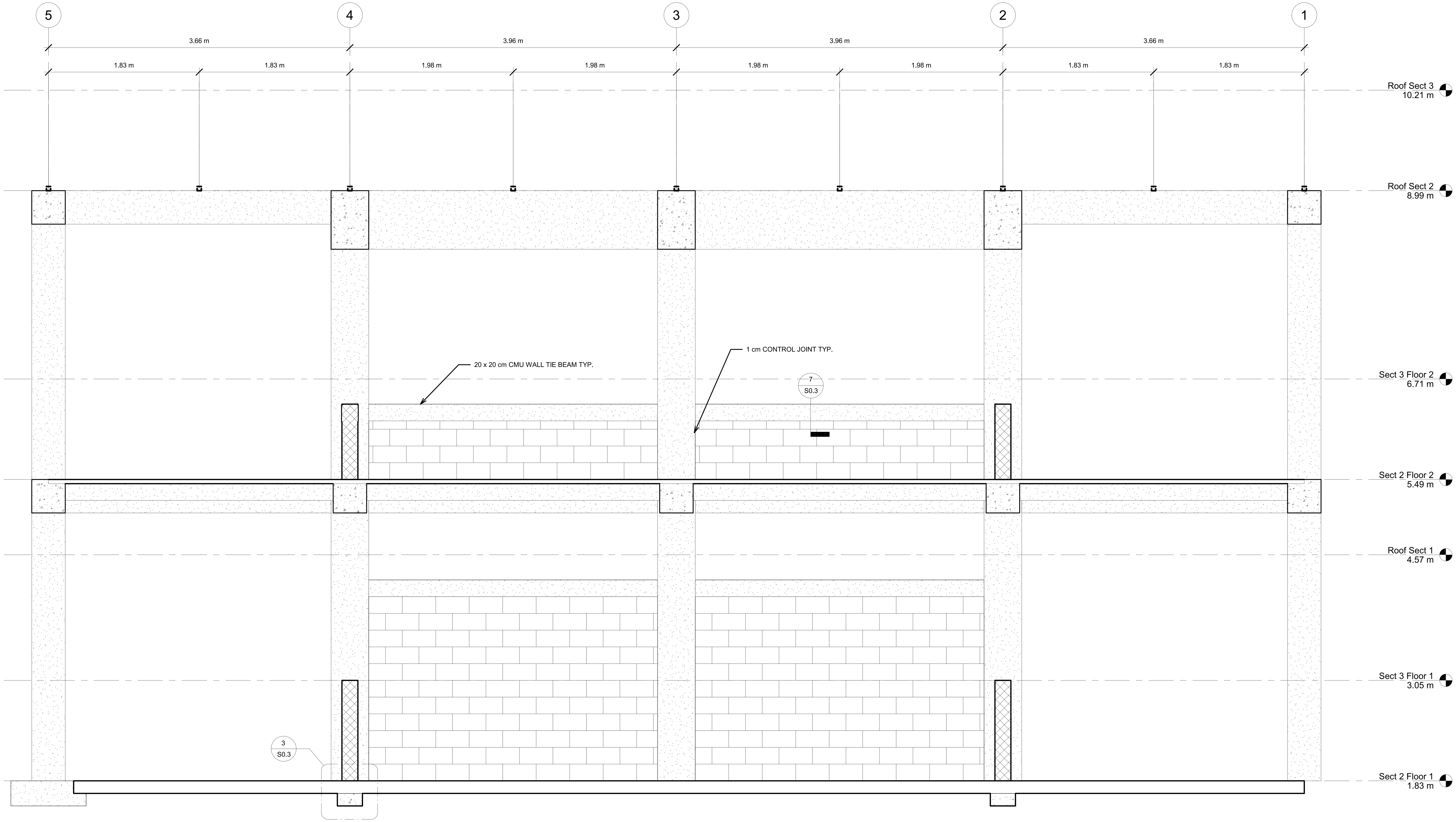
North Elevation

SCALE:

1 : 48

SHEET No.:1

S2.0



1 Section Through Middle Classroom
1 : 24

Leah George & Devin Williams

Journeyman International

SEAL:

DATE:06/6/2019

PROJECT:

Mornes Briye Primary School

SITE:

Mornes Brieux, Haiti

REVISIONS

No:	DESC.	DATE

DRAWN BY:

CHECKED BY:

PLOT DATE:

6/13/2019 11:33:11 PM

SHEET NAME:

Classroom Section

SCALE:

1 : 24

SHEET No.:1

S2.1

APPENDIX D

Project Presentation Slides

Mòn Briyè Primary School

Mornes Brieux, Haiti

Prepared by:

Leah George
Devin Williams

June 14, 2019

Journeyman International

Mòn Briyè Primary School
Mornes Brieux, Haiti

Journeyman International
Leah George
Devin Williams

Overview

- Project Description
- Structural Design
- Challenges
- Impacts

Thank you to these organizations for providing us with this opportunity!

JOURNEYMAN INTERNATIONAL

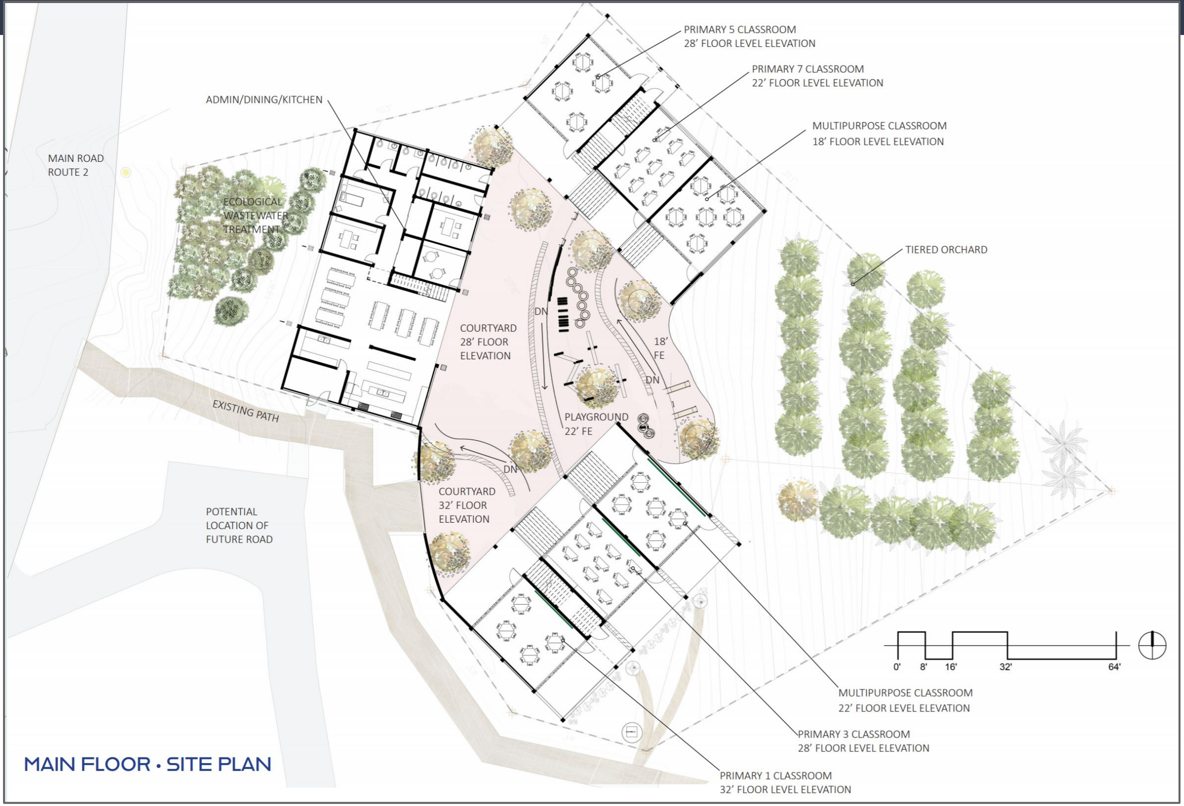
THE 610 project

MOVERS, THE SHAKERS, THE REAL DIFFERENCE MAKERS

third lens MINISTRIES

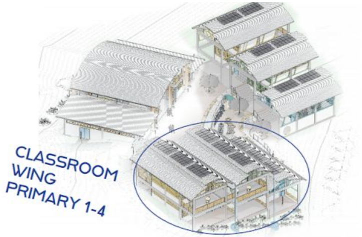
MORNES BRIEUX

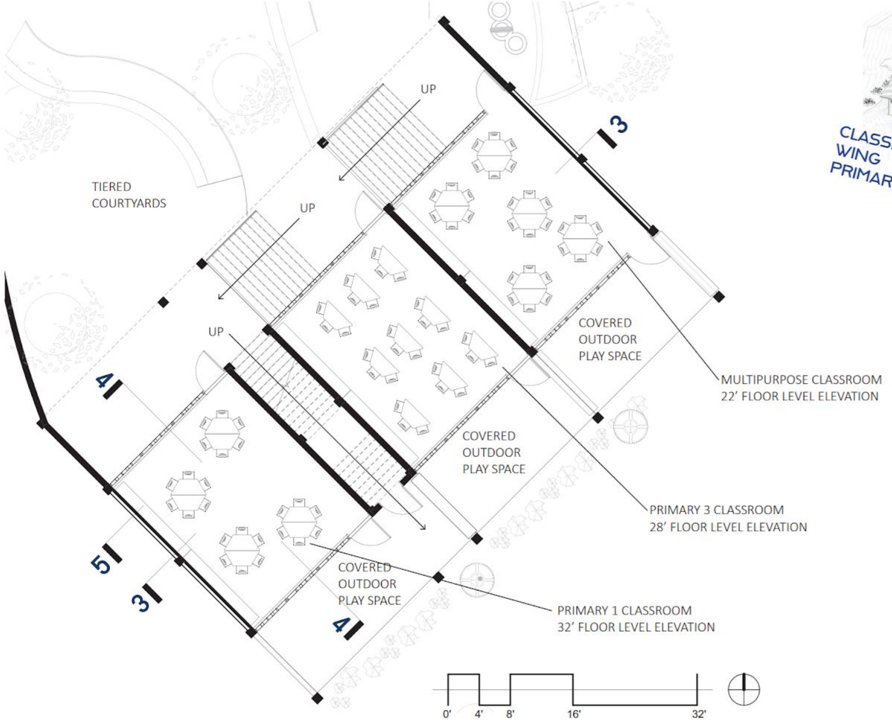
PROJECT DESCRIPTION



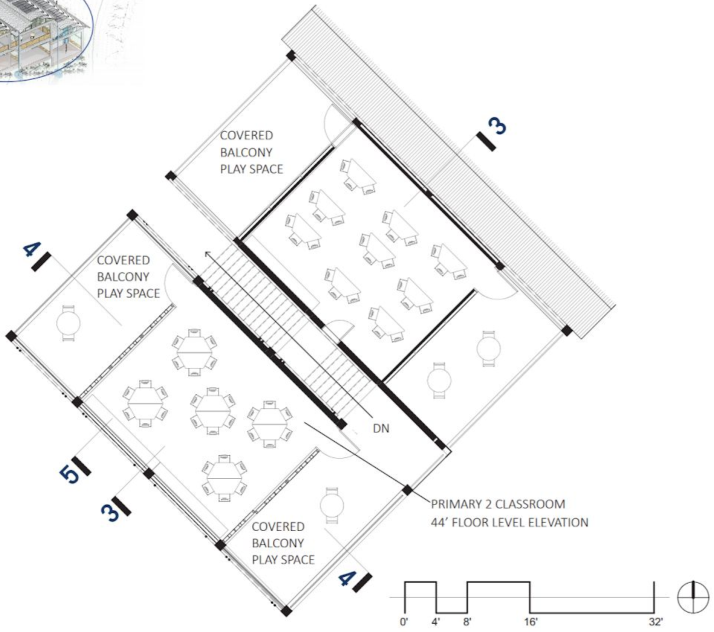

Little by little the bird
EIGHT UIT
TEN DIS

"'We want the architecture to think about the person who walks in the door"





MAIN LEVEL FLOOR PLAN • CLASSROOM WING • PRIMARY 1-4



SECOND LEVEL FLOOR PLAN • CLASSROOM WING • PRIMARY 1-4

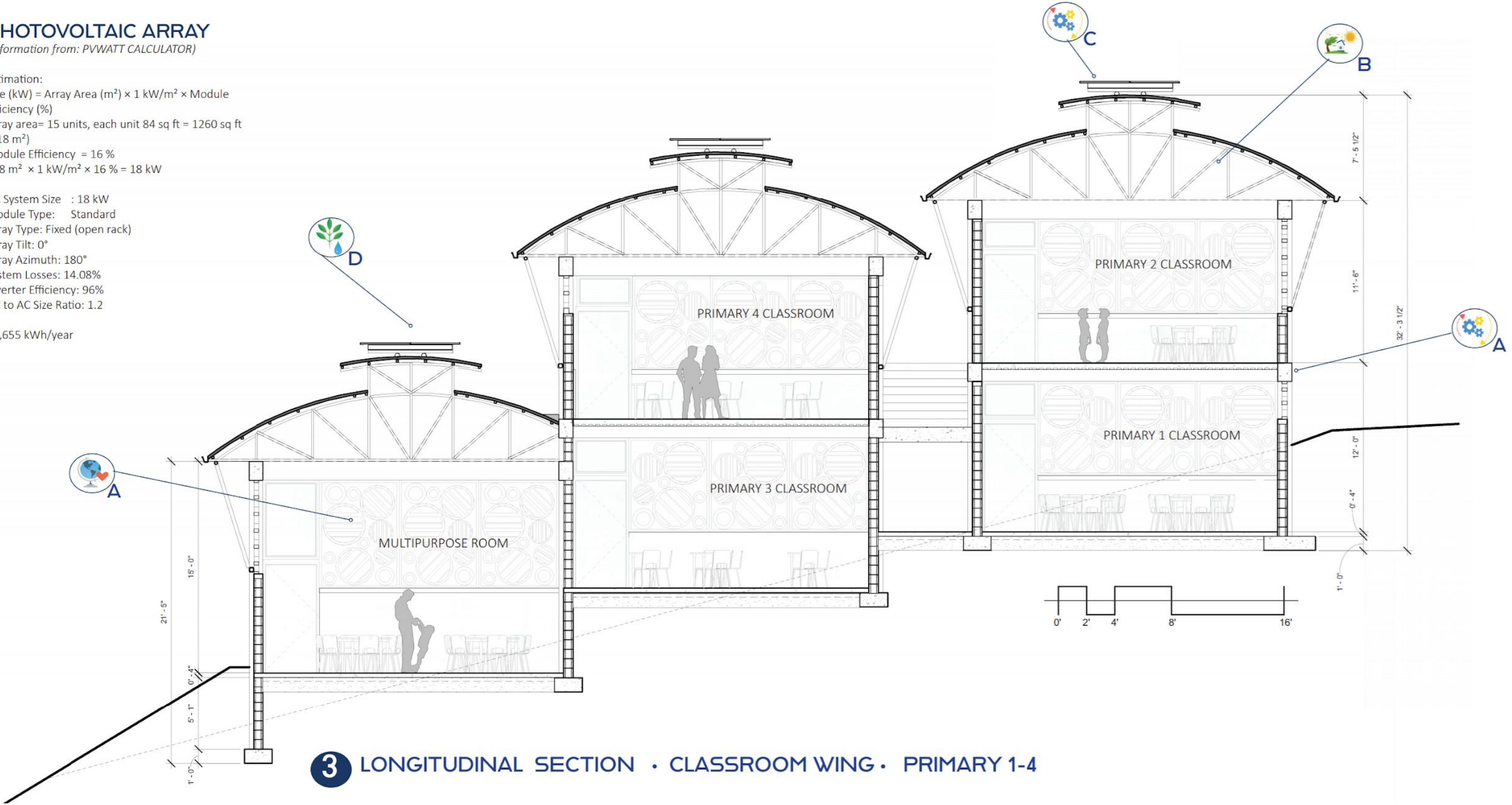
PHOTOVOLTAIC ARRAY

(Information from: PVWATT CALCULATOR)

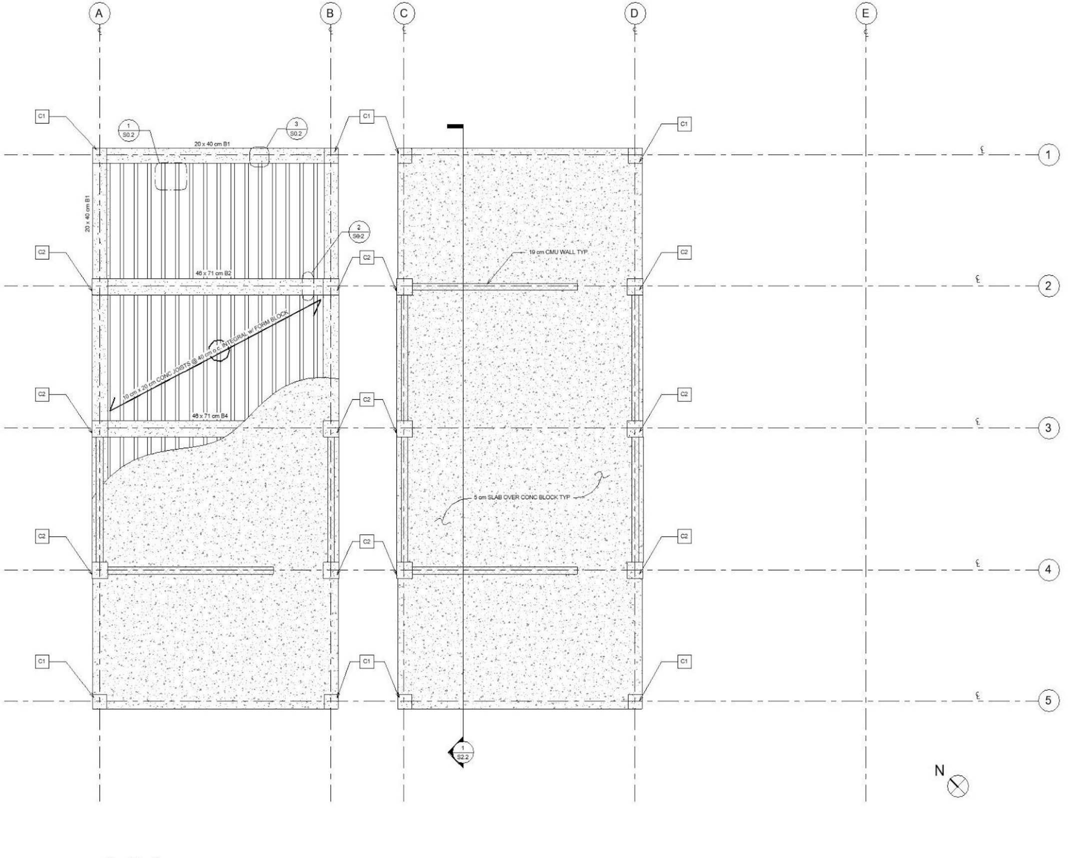
Estimation:
Size (kW) = Array Area (m²) × 1 kW/m² × Module Efficiency (%)
Array area= 15 units, each unit 84 sq ft = 1260 sq ft (118 m²)
Module Efficiency = 16 %
118 m² × 1 kW/m² × 16 % = 18 kW

DC System Size : 18 kW
Module Type: Standard
Array Type: Fixed (open rack)
Array Tilt: 0°
Array Azimuth: 180°
System Losses: 14.08%
Inverter Efficiency: 96%
DC to AC Size Ratio: 1.2

27,655 kWh/year



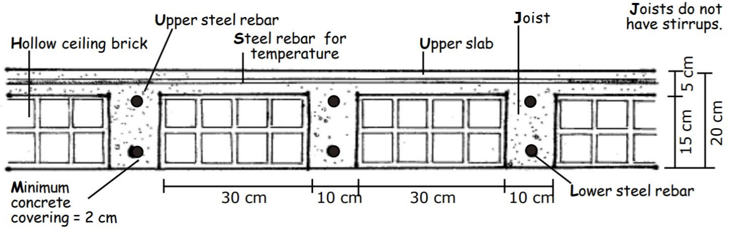
3 LONGITUDINAL SECTION • CLASSROOM WING • PRIMARY 1-4

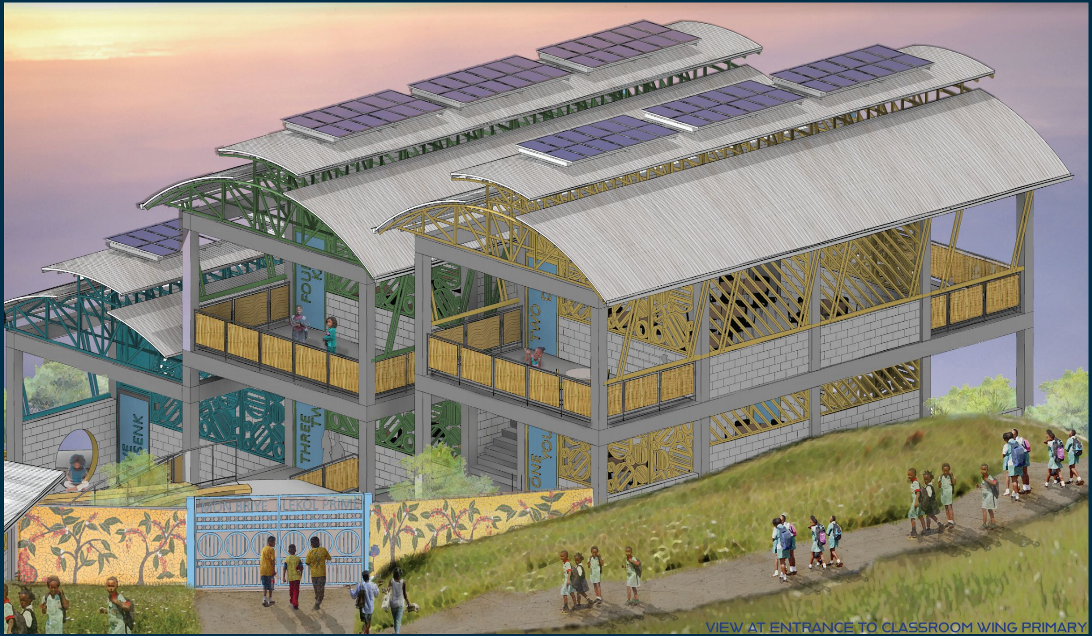


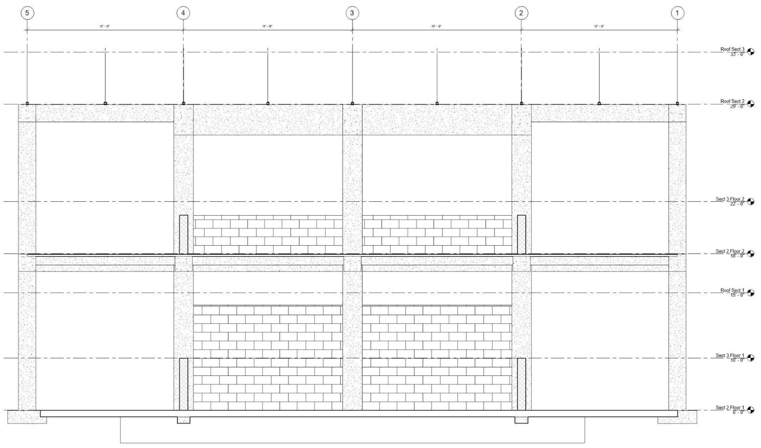
Second Floor Plan
1/4" = 1'-0"

Component dimensions

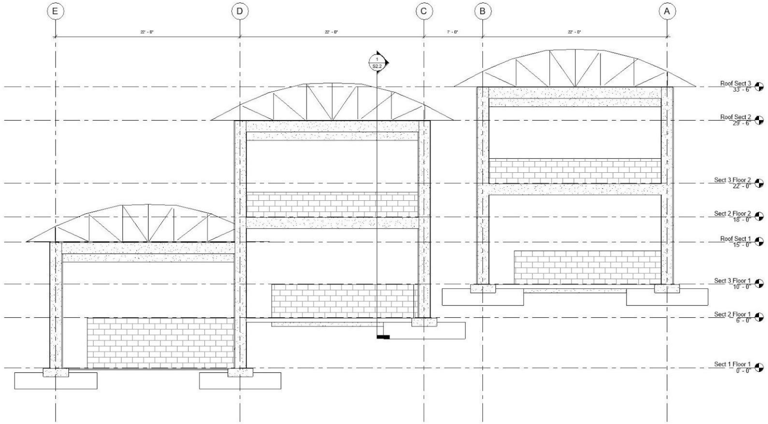
The hollow ceiling bricks must be perfectly aligned and the slab has to be level.



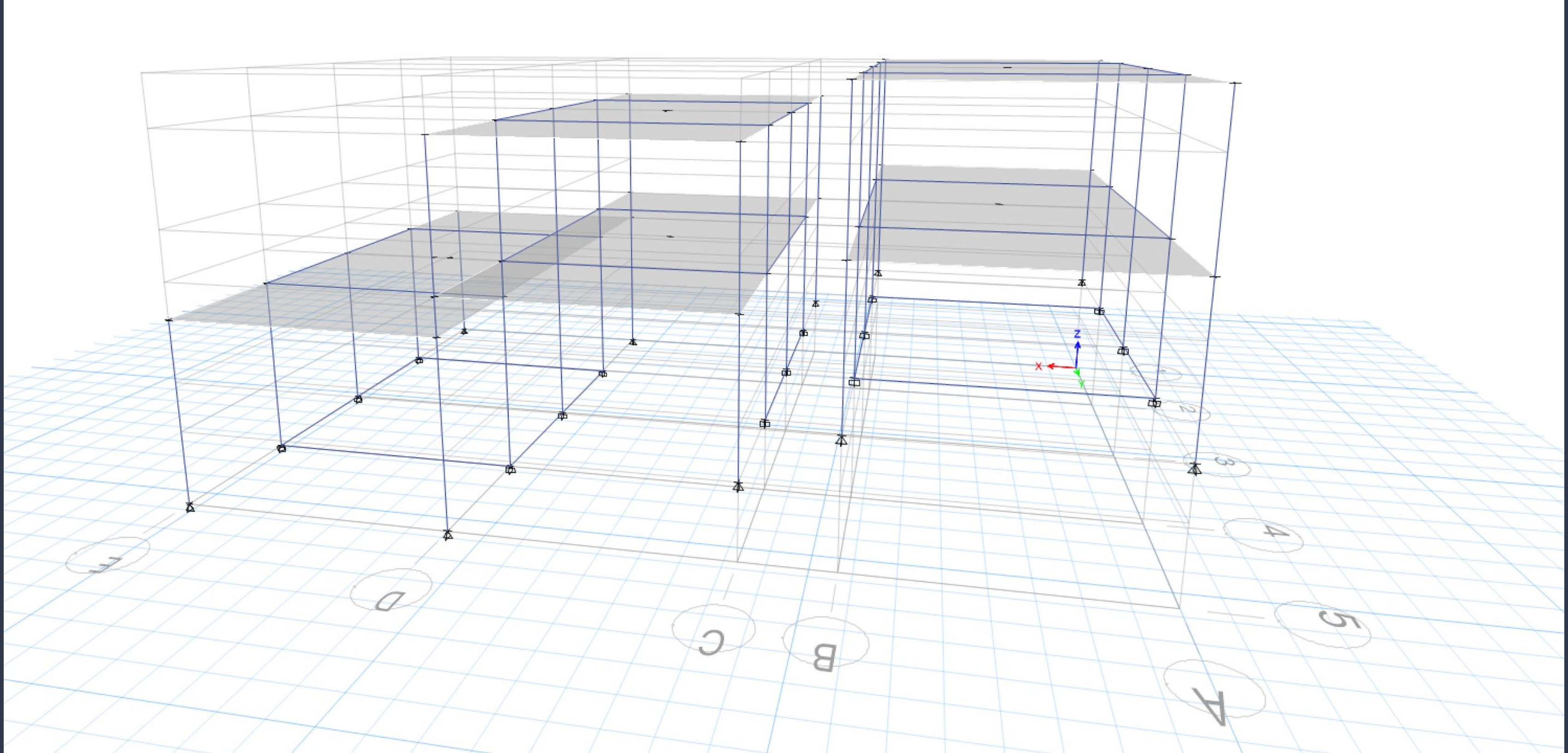




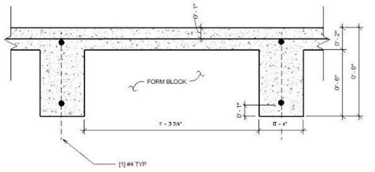
① Section Through Middle Classroom
1/2" = 1'-0"



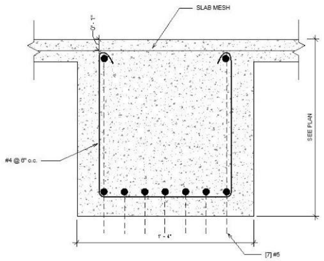
① North Elevation
1/4" = 1'-0"



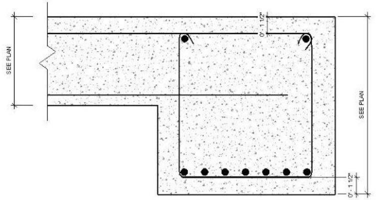
Z
X
Y
D
C
B
A
2
3
4
5



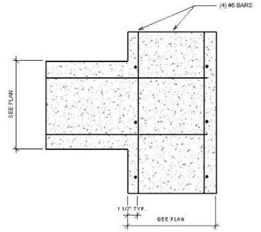
1 Slab and Joist Section
3" = 1'-0"



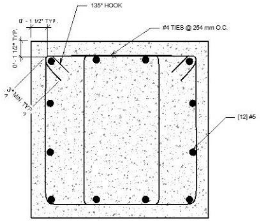
2 Slab and Beam B1 Section
3" = 1'-0"



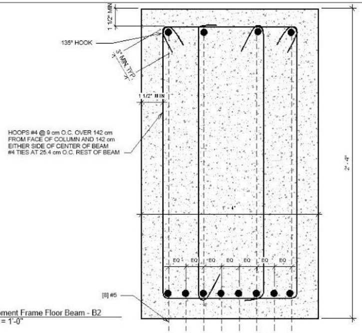
3 Joist to Beam
3" = 1'-0"



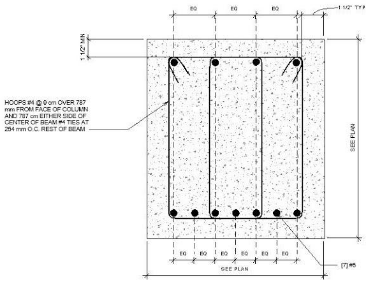
4 Gravity Beam B1 to Gravity Column C1
1 1/2" = 1'-0"



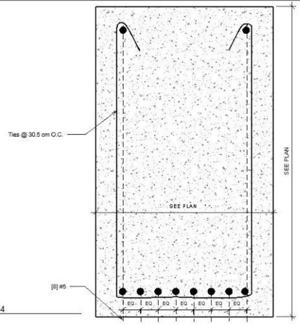
5 Gravity Column C1
3" = 1'-0"



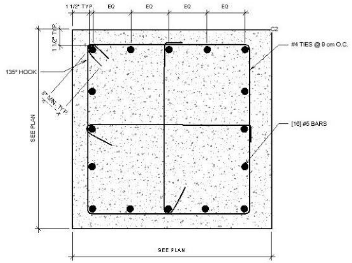
6 Moment Frame Floor Beam - B2
3" = 1'-0"



7 Moment Frame Roof Beam B3
3" = 1'-0"



8 Gravity Beam B4
3" = 1'-0"



9 Moment Frame Column C2
3" = 1'-0"

Leah George & Devin Williams

California Polytechnic State University College of Architecture and Environmental Design

SEAL:

DATE:02/26/2018

PROJECT:

Mornes Briye Primary School

SITE:

Mornes Brioux, Haiti

REVISIONS

No:	DESC.	DATE

DRAWN BY: Author

CHECKED BY:

PLOT DATE:

6/5/2019 10:29:33 AM

SHEET NAME:

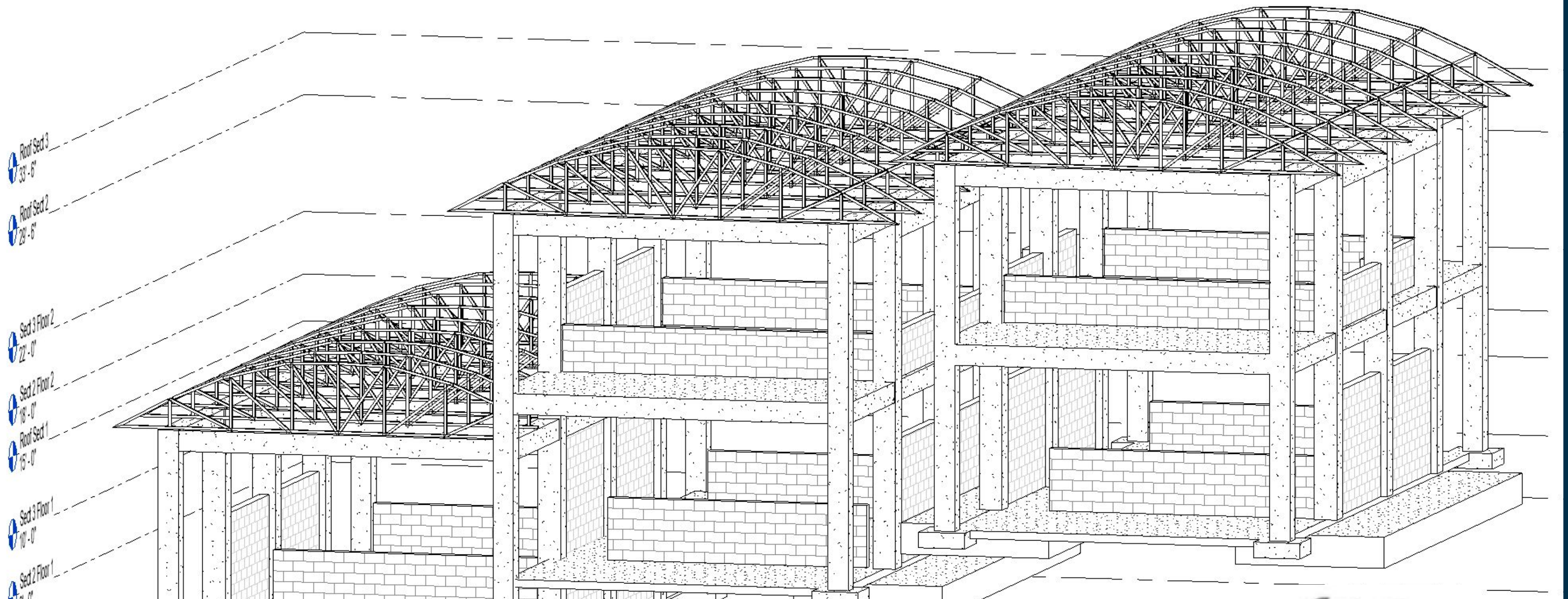
Details (1)

SCALE:

As indicated

SHEET No.:1

S0.2


Roof Sect 3
33' - 6"
Roof Sect 2
29' - 6"
Sect 3 Floor 2
22' - 0"
Sect 2 Floor 2
18' - 0"
Roof Sect 1
15' - 0"
Sect 3 Floor 1
10' - 0"
Sect 2 Floor 1
6' - 0"
Sect 1 Floor 1
0' - 0"


"These kids are going to change their world."
MELISSA DANIEL BAIN | FOUNDER