CAREER EPISODE 2

MODELING OF ONE-STORY RCC BUILDING

2.1 Introduction

College	[redacted]
Duration	[redacted]
Location	Australia
Degree	[redacted]
Unit (code)	[redacted]
Year	[redacted]
Type of Project	[redacted]
Supervisor	[redacted]

2.2 Background

2.2.1 Overview of Capstone Project

Introduction of Capstone Project: This was a Capstone project selected for detailed investigation of reinforced conceret RCC building work and creating comprehensive 2D and 3D technical drawings using AutoCAD and SketchUp using project design and technical documentation. A major part of this project was to create structural drawings, cost estimations, collaboration with civil engineers and stakholders to discuss project matters and preparation of construction documentation by following project design and technical documentation to demonstrate the capabilities of civil draftsperson. The plans for executing the construction activities of RCC building were also provided by civil draftsperson to supervisors and engineers along with technical drawings to follow during project construction.

Demonstration of Project Design Specifications: The project was designed to withstand the self-weight of single storey RCC building, live loads by occupants, materials and furniture, and environmental loads acting on building. To achieve high structural performance a high strength concrete having f’c = 30MPa was used in project design, and high strength of steel rebars having

Fy = 500MPa was used with concrete to ensure the stability, sustainability and longevity of project. The dimensions of structural memebers were selected carefully following project design including a slab of thickness of 124mm, stroey height of building to 3m, and a building grid was selected to 17.5mx17.4m.

Understanding Australian Standards and Regulatory Compliance: The Australian Standards used during project were AS 3600, and AS 1100. The AS 3600 code was selected for design of RCC structure and Clause-5 design for strength was used to select the dimensions of beams, columns and slabs, similarly Clause-8 of AS 3600 was used for providing the concrete covers to RCC components. The clauses-8,9 and 10 were used for slab, column and beam designs and providing guidance during project.

The drafting code of AS 1100 was used for guidance in technical drawings of project. The sub clauses of AS 1100 including AS 1100.101 general principles, and AS 1100.201 for structural drawings, were selected for taking guidance duirng cerating technical drawings and using line types, scales of drawings, grid layouts, sectional hatching, title block preparation and using dimensions and annotations properly.

2.2.2 Objectives of Capstone Project

The objectives of capstone project of single storey RCC building were mentioned below:

- To create technical drawings of single-storey RCC building by employing AutoCAD for 2D drawings and SketchUp for 3D drawings using AS 1100 standard.
- To ensure that the drawings would be created by following the project design and adhering to AS 3600 for project stability, sustainability and long life.
- To achieve comprehensive cost estimates to assist civil engineers and stakholders for project budget ideas and financial concepts.
- To create and deliver code compliant and accurate constructable technical darwinsg to ensure the accuracy of construction activities and timely delivery of project.
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2.2.3 Nature of work for Capstone Project

Selection of Project Design from Avilable Options by Collaborative Effort: I looked at various layout and structural configuration and decided on the final structural design evaluating the feasibility, cost effectiveness and suitable technical components of the design by discussing with design engineers, structural engineers and stakholders. The single-story RCC structure was adopted instead of a multi-level configuration since it gave ease in load transfer, simplified the formwork requirement, lessened vertical reinforcement requirement and enhanced constructability. These dimensions were chosen to allow the distribution of columns in balance and make the most appropriate arrangement of inner space columns of 345 x 345 mm allowed. Thickness of the slab of 124 mm, and dimensions of a beam of 297 x 340 mm have picked along with strey height of building from project design.

Drafting of Single Storey RCC Building: Development of the structural and technical drawings and documentation was performed carefully and systematically utilizing AutoCAD and SketchUp and all the elements were created accurately. I started with creating proper grids were drawn with OSNAP tool to ensure that all reference points are defined setting in their correct positions, and I then proceeded to plot the position of each column and checked their alignment with DIMLINEAR tool. The walls have been built using OFFSET based parametric spacing, window and door apertures were introduced based on structural requirements mentioned in project design.

2.2.4 Organizational Chart

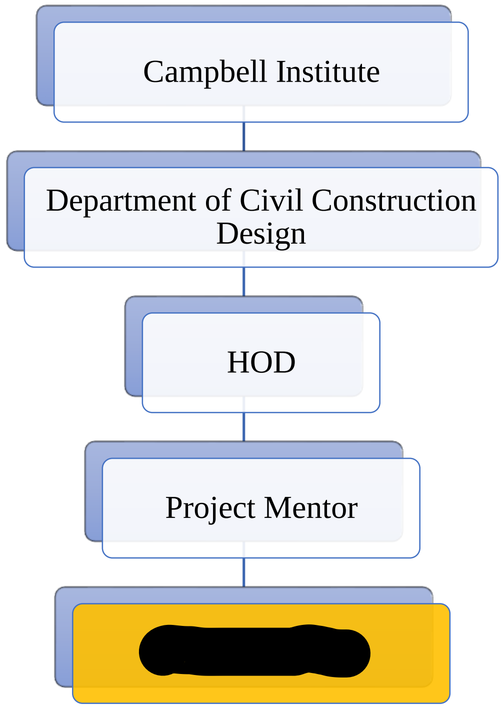


Figure 1: Organizational chart

2.2.5 Duties of Civil Draftsperson Duirng Capstone Project.

- To draft precise grid layouts in AutoCAD and generate complete floor plans and elevations.
- To create detailed three-dimensional, top, and multi-angle views in SketchUp for full spatial representation of the structure.
- To use proper line types, line weights, layer management techniques, annotation and symbols during drafting work by following AS 1100, AS 1100.101, and AS 1100,201.
- To provide help to engineers for contributing to data collection and conducting technical calculations under their guidance.
- To dicuss the drafting and technical issues with civil professional engineers and stakholders to resolve the issues on priority basis.

2.3 Personal Engineering Activities

2.3.1 Assisting and Helping Civil Engineers

Assisting Civil Engineers through providing Technical Drawings: I worked on project as a civil draftsperson who assisted the engineers in the translation of conceptual structural requirements to accurate technical drawings, which could be accurately interpreted to provide structural validation and construction planning. I made grid plans, column and beam alignment plans, internal and external wall plans, sectional plans and elevation plans and dimensioned everything properly, annotated them, and distinguished between layers and ensured that the engineers were given the accurate visual reference to check on the load distribution, beam placement, beam continuity, slab plans.

Assisting Civil Engineers in Cost Estimation: I was involved in supporting the engineering team by administration of a thorough cost estimation process which identified the volumes of earthwork, concrete and reinforcement, masonry, plastering, flooring and finishing materials that would be required. I calculated the final cost of the project based on manual computations of areas within the structure and use of unit cost rates, and this helped engineers to determine the material viability and budget target before the start of the construction.

Contributing to Technical Data Collection and Calculations: I worked under professional Civil Engineers and helped them by providing technical data required for project design and stcutural calculations to accurately determine the structural components and their geometry from different sources. I also participated in conducting basic technical caluclations and provided areas, volumes, reinforcemnt details and followed the steps guided by engineering team to enhance my technical knowledge.

2.3.2 Selection of Drafting Tools and Design Brief.

I selected AutoCAD because I wanted to create acceptable digital drawings and to have total control of structural dimensions. The other drafting tool selected was SketchUp applied to create three dimensional images with the help of which the final shape was visualized by engineers and stakholders. To achieve the spatial plan, I chose a building length of 17.4 m (Y-axis c/c) and 17.5 m (X-axis c/c). The reason for selecting story height of 3m was that the residents can have ample clearance. To make the profile symmetrical, I decided to make the roof 2.1 meters and the height 5.1 meters. Finding apertures, A slab deduction area of 5m x 12.4m was chosen in order to incorporate the apertures. To ensure the transmissions of the loads were balanced, I chose to have 22 columns. To fill in the frame grid, I chose total beam length 147.1m.

2.3.3 Contributing to Technical Calculations

I assisted civil engineers by helping with technical calculations and providing technical data gathered from various sources including survey information, hydrological, meteorological and geotechnical data to use for design development and technical calculations. I performed concrete and reinforcement calculations systematically and unit control with the calculation of the volume of a single column by its cross-sectional dimensions and height and multiplied it by 22 to calculate the total volume of 7.856 m^3. I calculated the volume of the beam by taking measurements of the sectional dimensions to the entire beam length of 147.10 m and this yielded to 14.854 m^3. For the slab, I subtracted 62 m^2 dimensions of the opening on the 304.50 m^2 of the footprint to calculate the net area of 242.50 m^2, which was then multiplied by the slab thickness, which was 0.124 m, giving a volume at 30.070 m^3. These volume values were added to obtain a total concrete volume of 52.780 m^3. I have calculated a reinforcement volume of 0.768m^3 by multiplying the steel ratio of 1.455% and the density of the steel gave me a figure of about 6.03 tons of reinforcements.

Concrete & Reinforcement Calculation (RCC Components)

- **Calculations of Columns**

i. Cross Sectional Area of Column

Cross sectional Area of Column = 0.345×0.345 = 0.11903m^2

ii. Volume of Column

Height of Column mentioned din project design = 3m

Volume for one column = 0.11903 ×3 = 0.35708m^3

Volume of all 22 columns = 0.35708 ×22 = 7.85565m^3

- **Calculations of Beams**

i. Cross Section Area of Beam

Area of Beam = 0.297×0.340 = 0.10098m^3

ii. Volume of Beams

Total length of beams = 147.10m

Volume = 0.10098×147.10 = 14.85416m^3

- **Calculations of Slab**

i. Area of Slab

Total Area of Slab = 17.5×17.4 = 304.50m^2

Deductions of openings from total area = 5×12.4 = 62m^2

Neat Area of Slab = 304.50-62 = 242.50m2

ii. Volume of Slab

Thickness of Slab given = 0.124m

Volume of Slab = 24.50×0.124 = 30.070m^3

- **Total Concrete Volume Caluclations**

Total RCC volume = Volume of columns + volume of beams+ volume of slabs

7.85565+14.85416+30.070 = 52.77981m^3

Reinforcement Steel (Rebar)

Assuming reinforcemnt for RCC building to 1.455percent of Conceret volume

- **Volume of Steel Calculations**

Volume of Steel = 1.455×52.77981 = 0.76795m^3

- **Weight of Steel caluclations**

Weight of Steel = 0.76795×7850 = 6.03 tons of steel required for project.

Other Technical Calculations

i. Internal and External Walls Volume = 50.23m^3
ii. Slab area for floor = 242.50m^2
iii. Plastering area = 177.15m^2
iv. Internal Plastering Area = 498.65m^2
v. Painting Area = 3×242.50 = 727.50m^2

2.3.4 Assisting Civil Engineers by Providing 2D AutoCAD Drawings

Setting the Drawings Units and Workplace: I initiated working on this project of a single storey RCC building by opening the window of AutoCAD and selecting units to meters as mentioned in technical calculations and project design. I selected architectural views from view options for creating accurate and code compliant drawings. I set the important commands, line types, line weights and other options that may help during drafting process Infront of me on AutoCAD workplace.

Preparing Layers and Setting of Annotations: To ensure that the drawings would be differentiated and technical information such as dimensions, lines, and information would not mix up, I created layers for each structural part, lines, selected line type in each layer and annotated the layers with proper annotations to avoid any misconception during construction process. I provided colors differently to each layer to facilitate the civil site engineers, supervisors and stakholders to recognize the information correctly and easily.

Layer#1 for grid plan: This layer was created for grid plan to show the geometry of building and location of walls and columns. The grey color was provided with this layer with dotted lines annotations.

Layer#2 for columns: This layer was prepared for columns to show at grid intersections and provided a pink color to this layer.

Layer #3 for beams: This layer was created for beam layout of building and provided red color with thick lines annotation.

Layer# 4 for walls: this layer was created for external and internal walls and provided thick hollow line annotations.

Layer#5 for windows and doors: this layer was created for windows and doors and provided a red and blue colors for two different views.

Layer#6 for text and dimesions: There was a single layer create for both text and dimesions and provided a red color to this layer.

Drafting of Grid System: The 2D drafting process was partially started by opening a new AutoCAD workspace which was to be in metric units to make the dimensions align with the project required. I initially prepared the grid system that was used as the structural reference system in the entire building layout. I was able to draw a vertical and horizontal grid of lines with spacing according to the footprint of the building of 17.5 m x 17.4 m using the LINE and OFFSET commands. I turned on OSNAP midpoint, intersection and endpoint snapping to ensure that the spacing was correct and I also used DIMLINEAR tool to ensure grid spacing. Once I was assured that all grid intersections were consistent with the design intent, I put the 22 structural columns where they were supposed to be in their grid intersections. The columns were drawn using RECTANGLE command and providing a cross-sectional size of 0.345mx0.345m and ensured similarity of structural plan.

Drafting of Plan View: When the grid and columns were made, I began drafting of the plan views which I did at the external walls first. The boundary of the outer wall was created with the POLYLINE tool, and the thickness of the wall 0.220 m was attained with the help of the OFFSET command. I deleted overlapping and unnecessary lines and kept the edges straight. Internal walls came second in line as recommended in the project design. To achieve room division, e.g. kitchen (4.70 m), bathroom and bathtub (3.00 m), and parking (5.00 m), I applied OFFSET and TRIM to ensure that there were a perfect fit and demarcation of space. The ARC, BLOCK, and RECTANGLE tools were used to insert window and door opening, and they were placed as per the structural demands. Once the spatial layout was done, I used detailed annotations, room labels and the lines of dimensions to make a complete readable professional Ground Floor Plan.

Drafting of Elevation Views: The next step involved the drafting of elevation views (front, rear, left side, and right side) views. The geometry of the roof was built on expanding the wall line upwards and delimiting the roof slant to the overall height of the building of 5.1 m. Sectioned materials were represented by the HATCH effect and varied weights of the lines were used to make distinctions between structural and hidden objects. There were also specific details included like the details of windows, doors, roof profile, and the finish of a wall as well so that the elevations would be the accurate reflection of the exterior of the building. The final verification was followed by reviewing of all the drawings against the AS 1100 drafting standards to ensure that all the symbols, annotations and scales used and line types were used correctly. This controlled preparation approaches technically complete and build-to-the set of 2D drawings of the project.

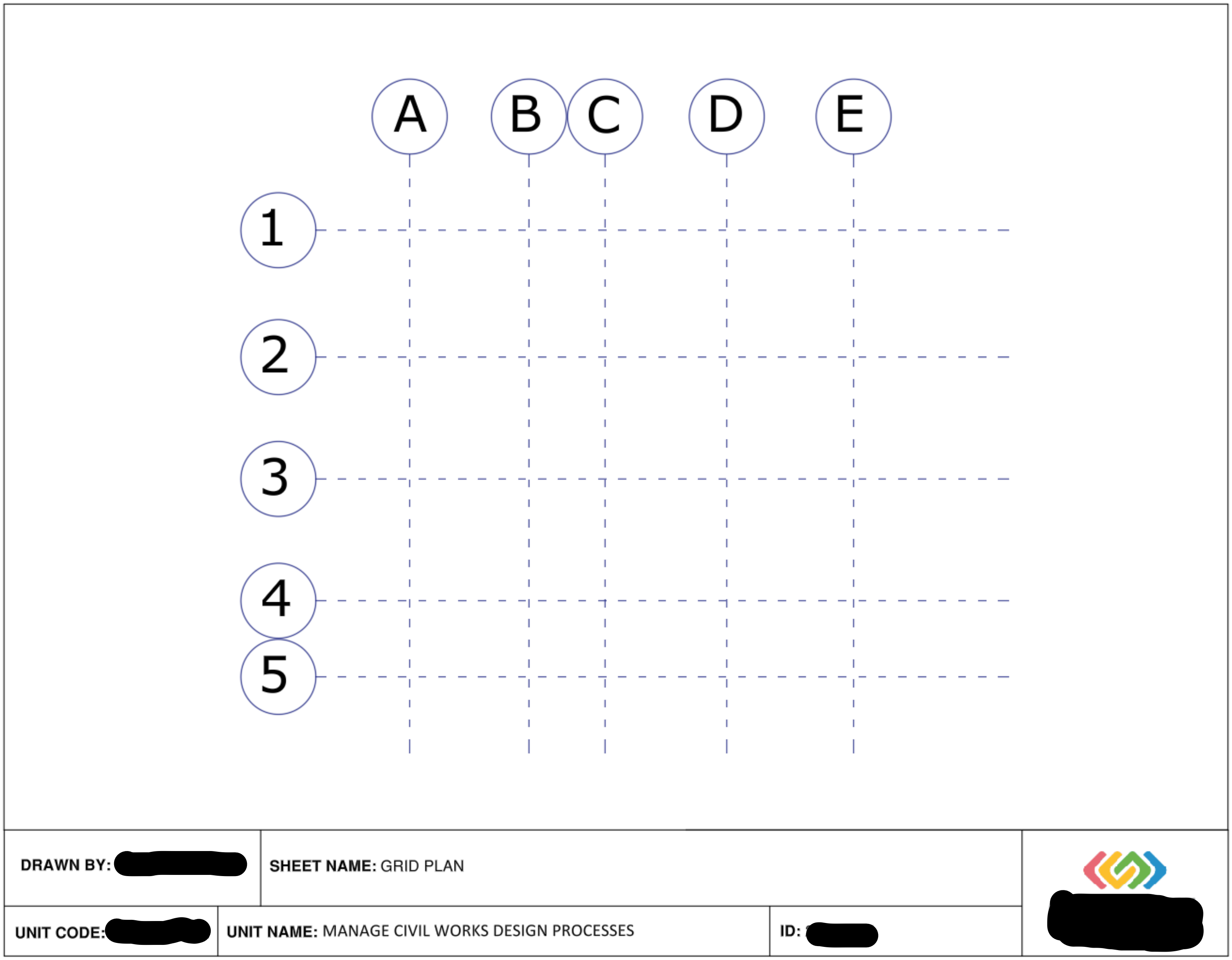


Figure 2: Grid layout

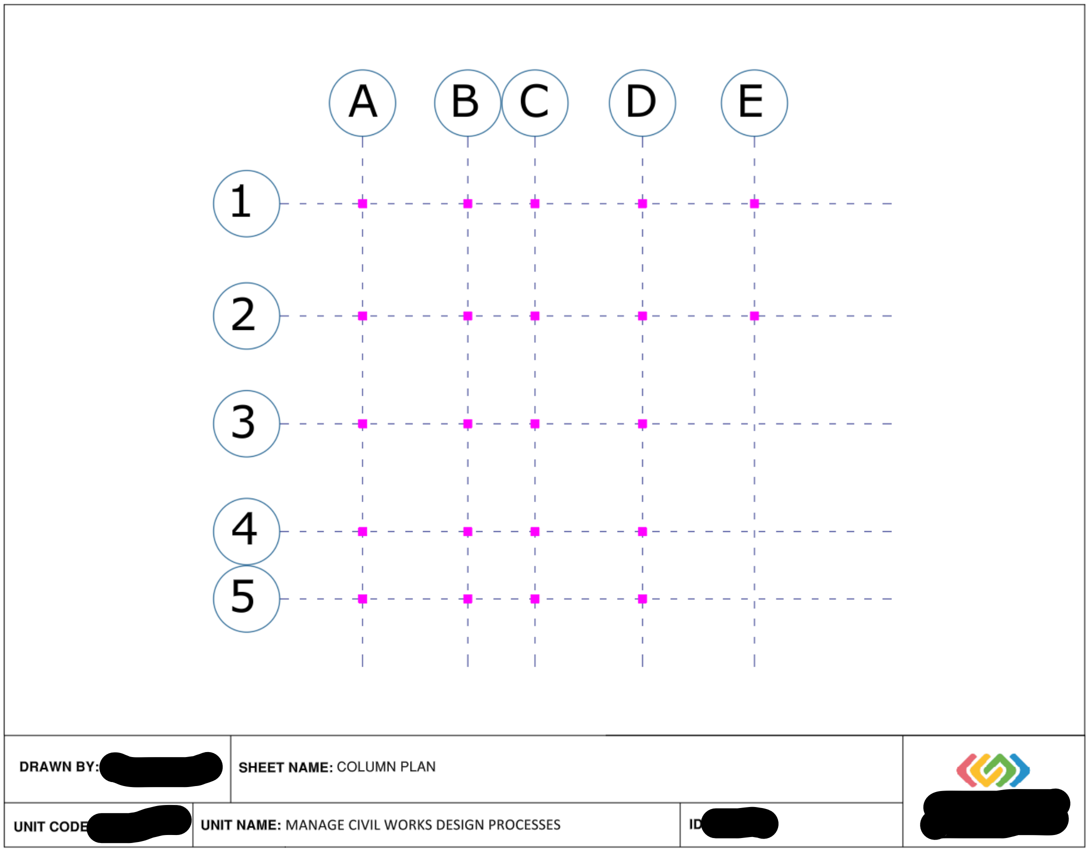


Figure 3: Column layout

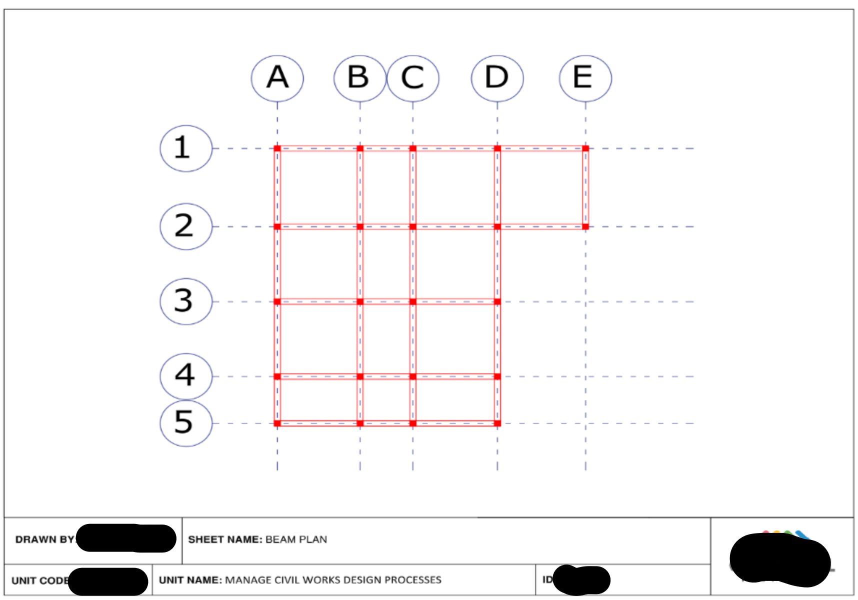


Figure 4: Beam layout

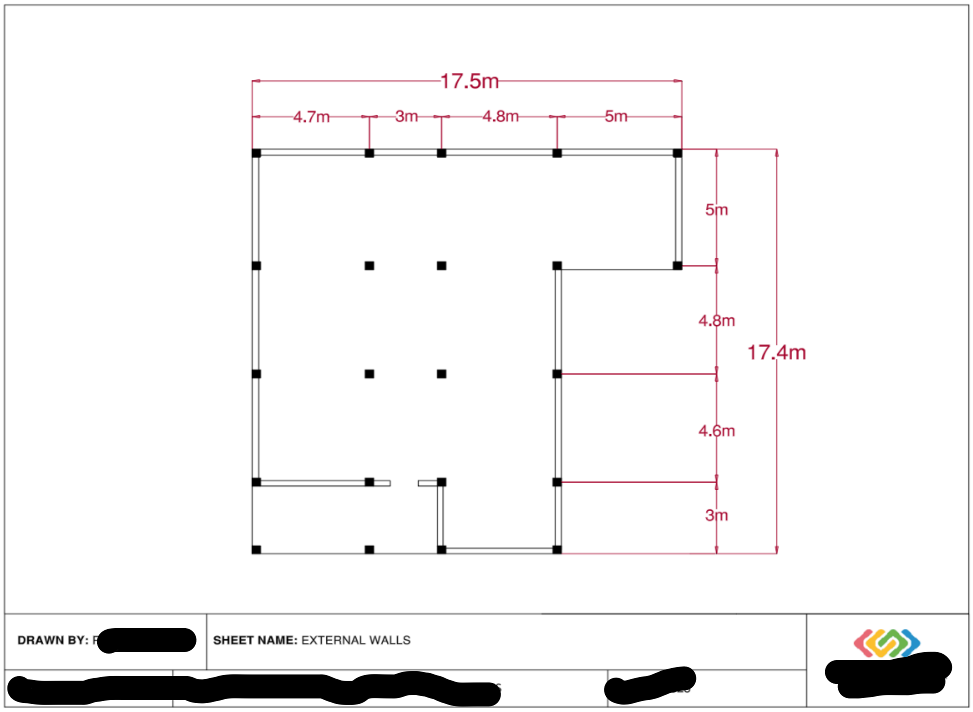


Figure 5: External wall

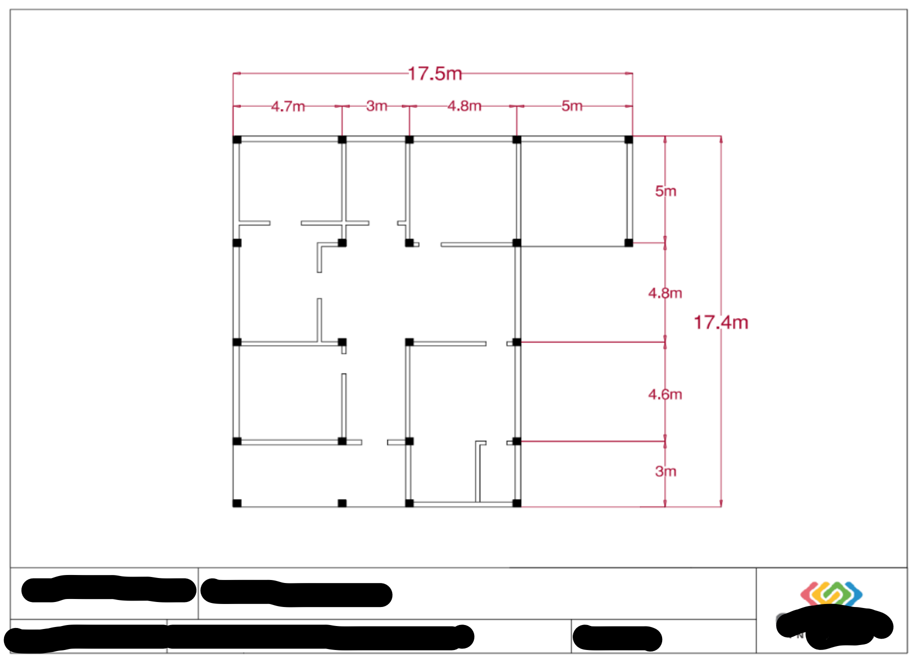


Figure 6: Internal wall

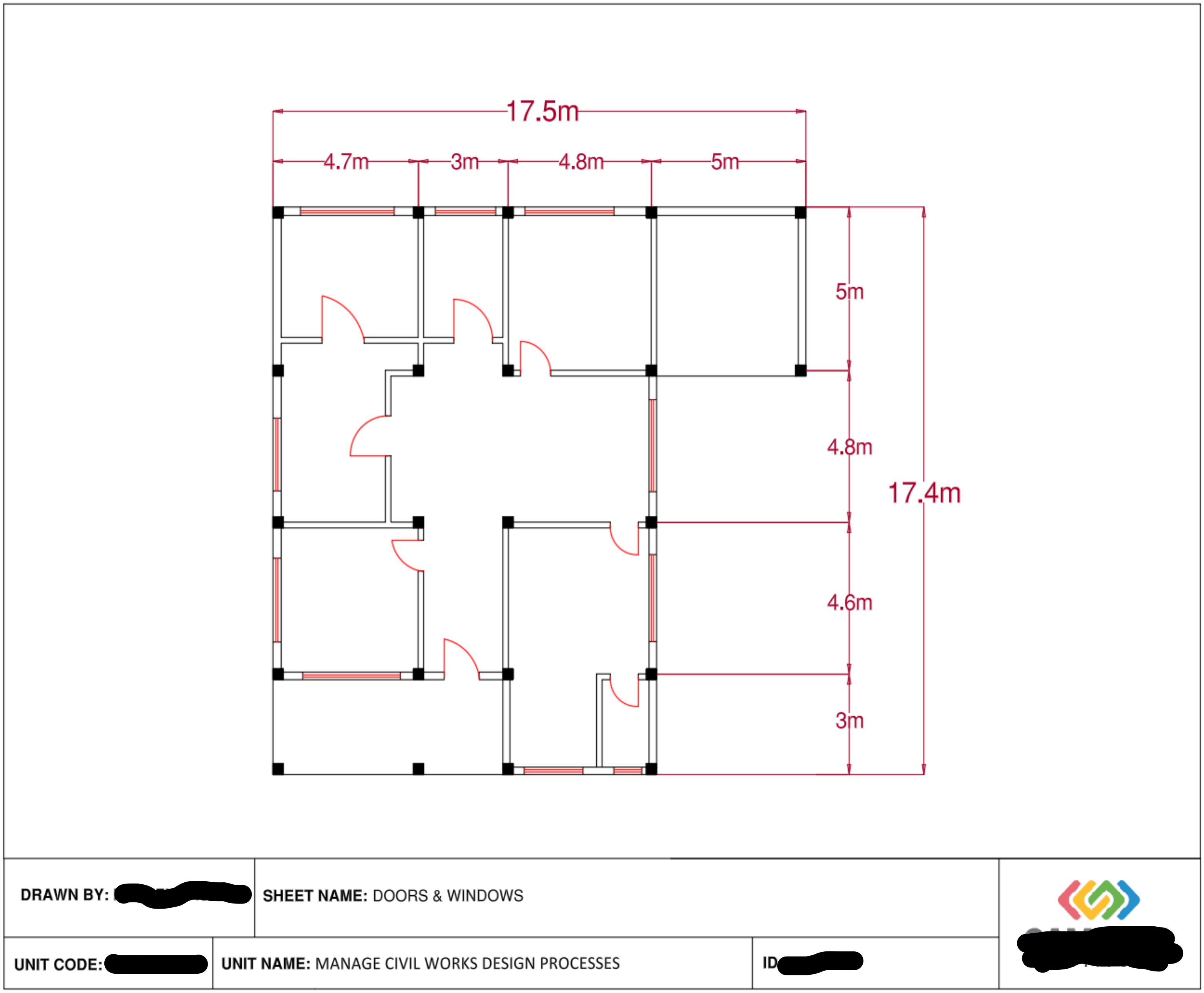


Figure 7: Plan with Windows & Doors

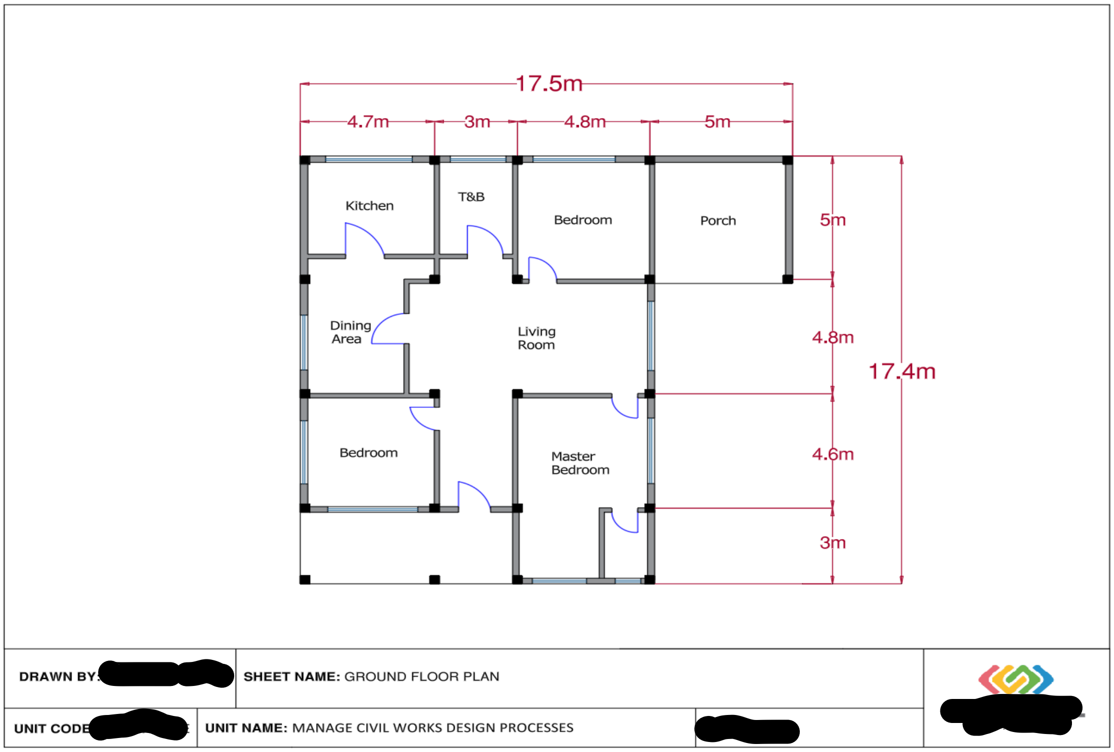


Figure 8: GF plan

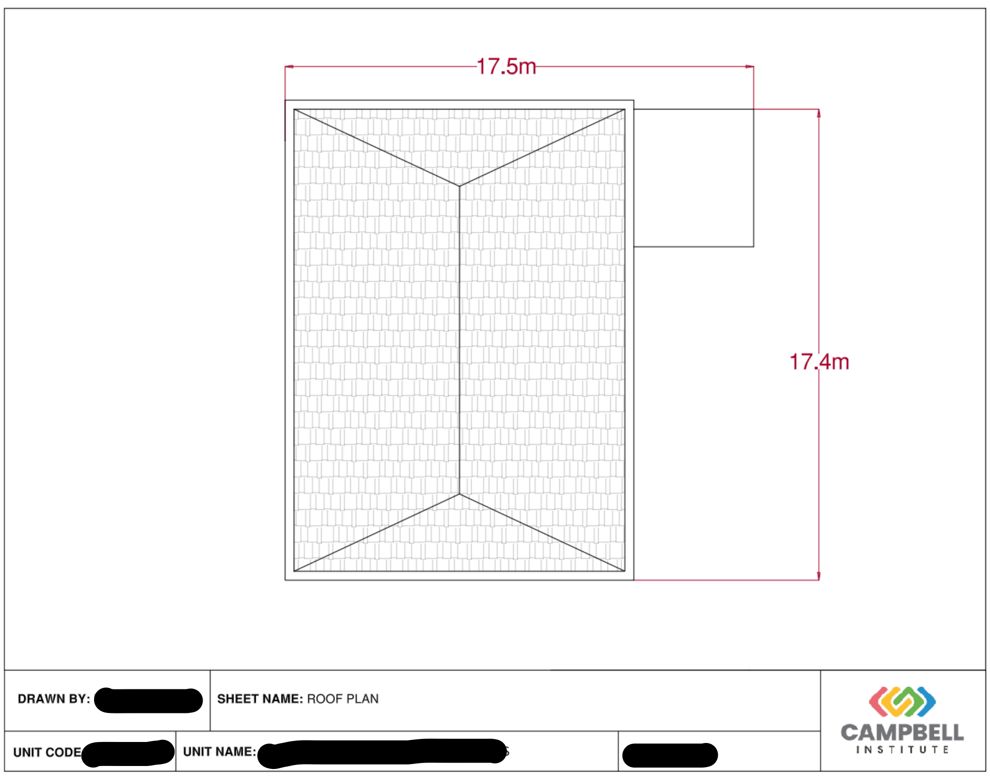
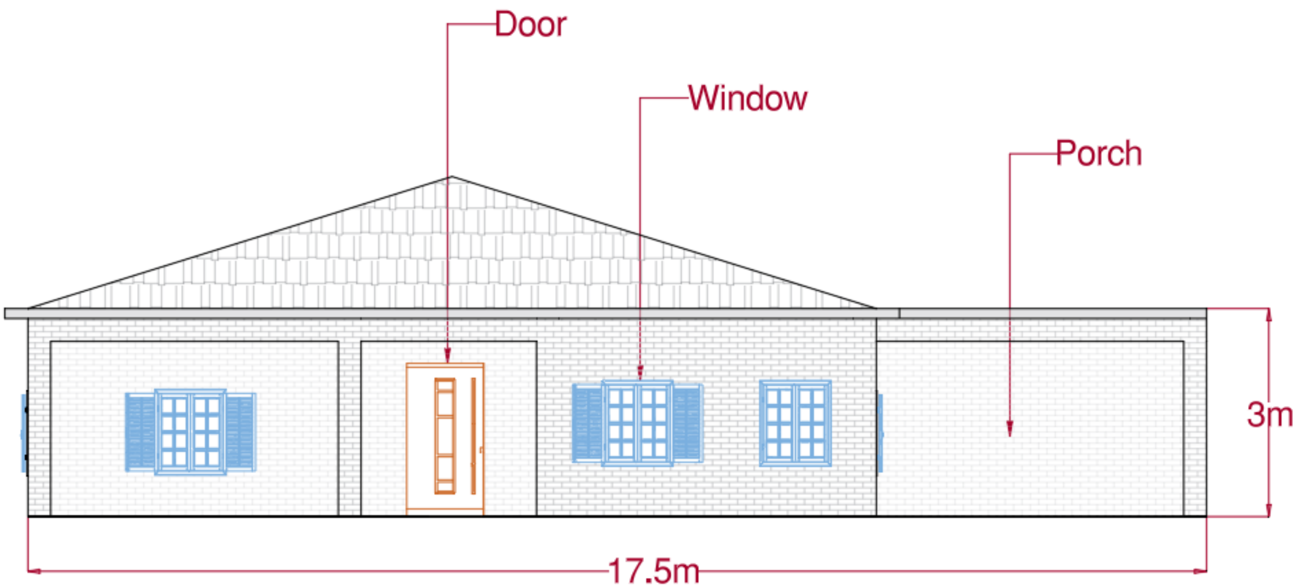
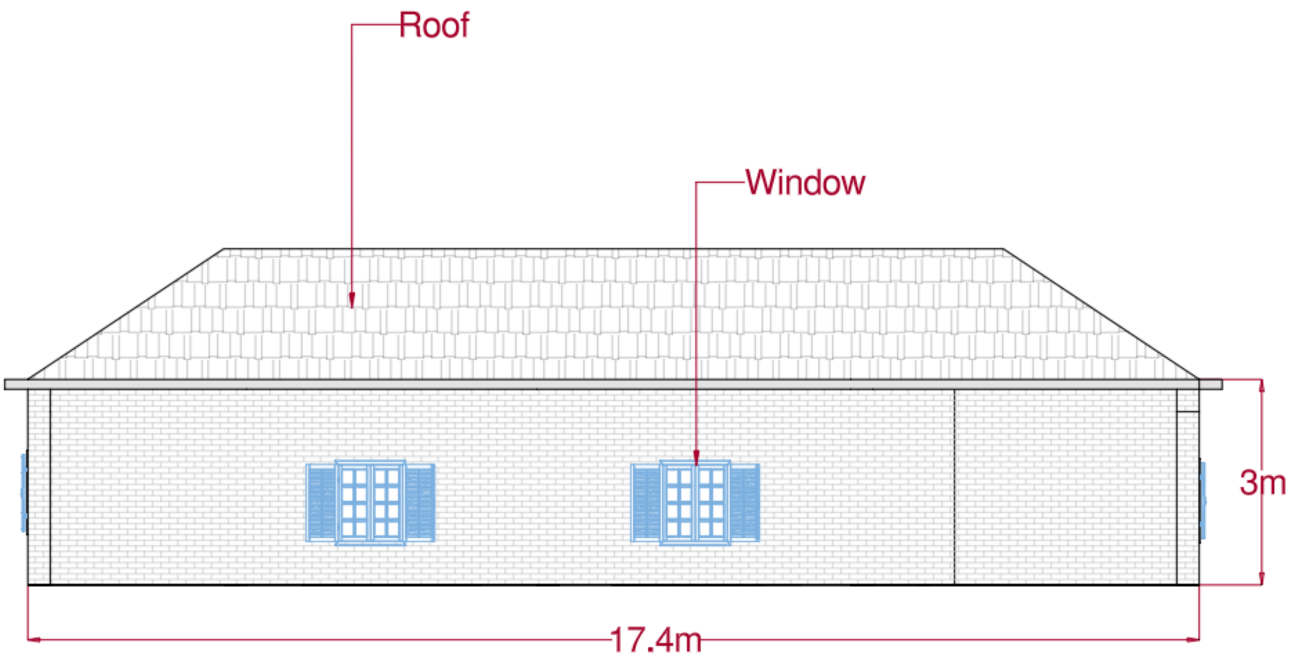


Figure 9: Roof Plan



DRAWN BY: [redacted]	**SHEET NAME:** FRONT ELEVATION		[redacted]
UNIT CODE: [redacted]	**UNIT NAME:** MANAGE CIVIL WORKS DESIGN PROCESSES	**ID** [redacted]	

Figure 10: Front elevation



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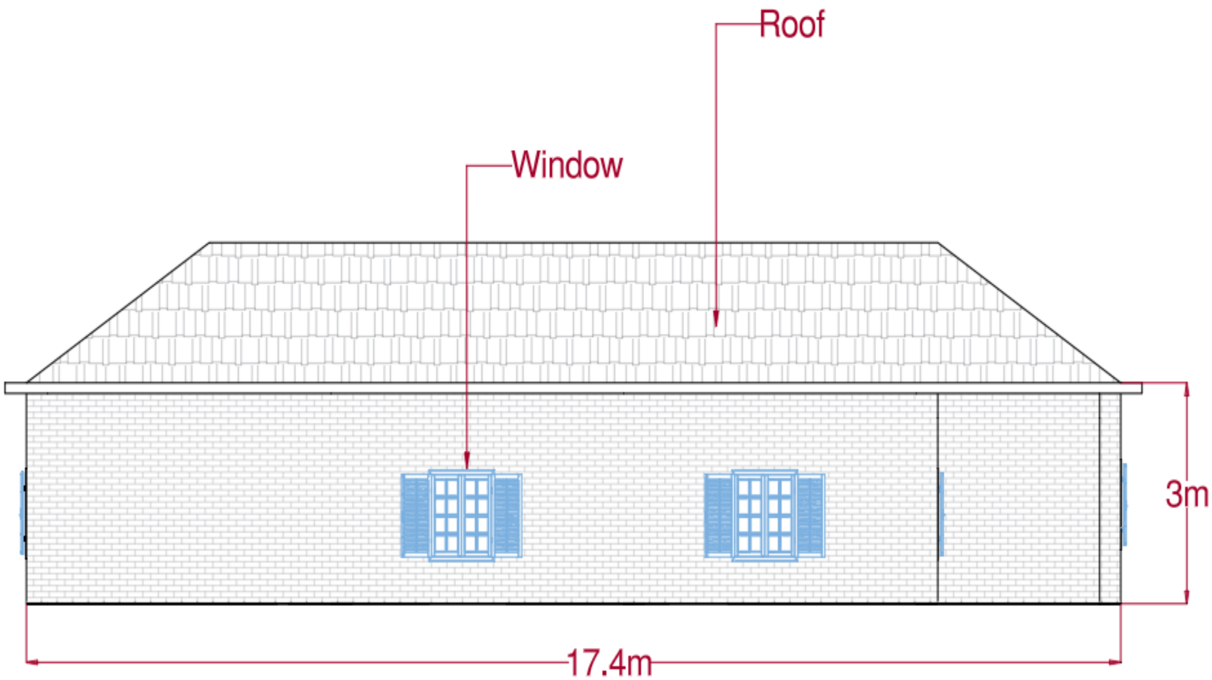
UNIT CODE: [redacted]	**UNIT NAME:** MANAGE CIVIL WORKS DESIGN PROCESSES	**ID** [redacted]	

Figure 11: Right elevation



DRAWN BY: [redacted]	**SHEET NAME:** LEFT ELEVATION		[redacted]
UNIT CODE: [redacted]	**UNIT NAME:** MANAGE CIVIL WORKS DESIGN PROCESSES	**ID:** [redacted]	

Figure 12: Left side elevation

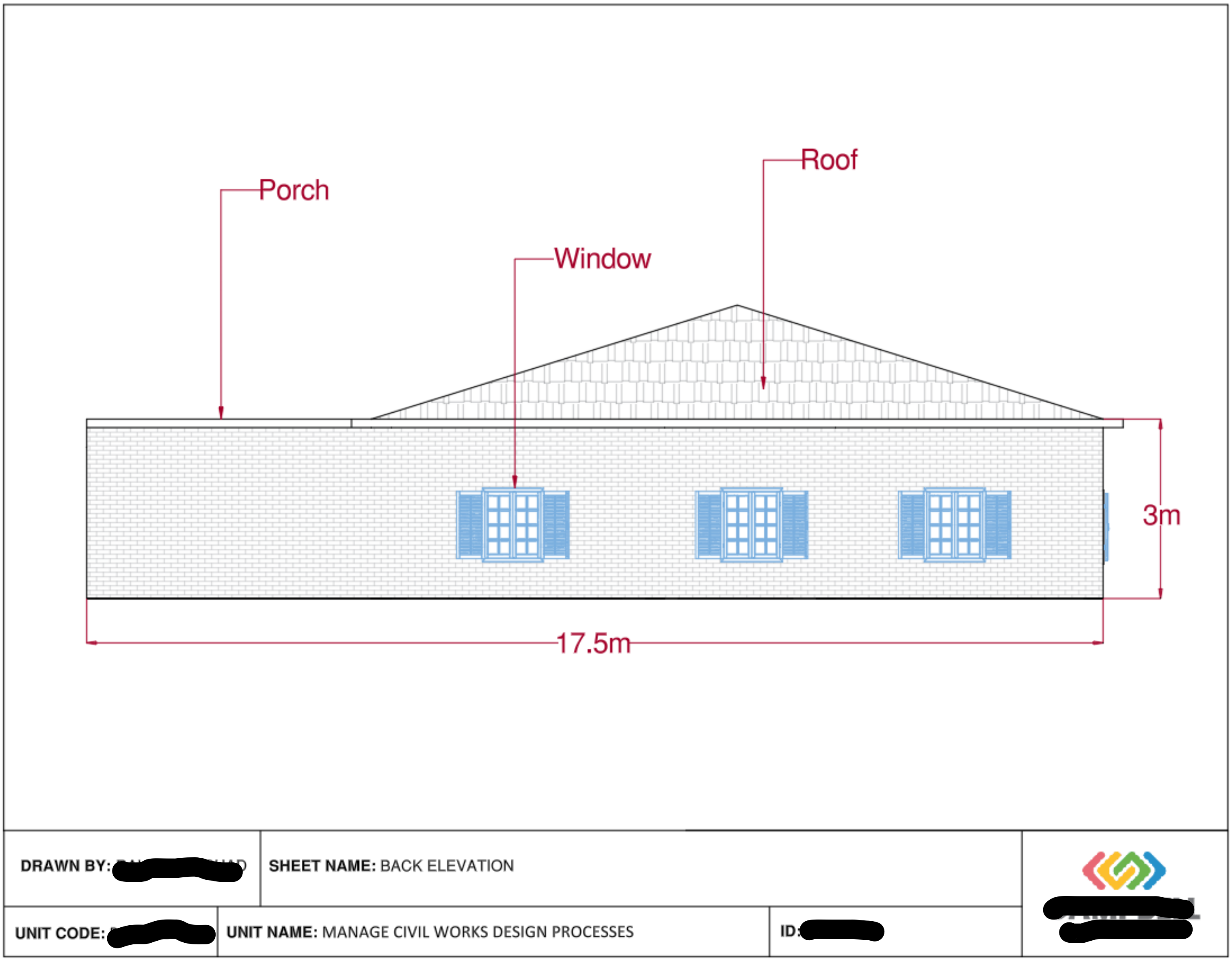
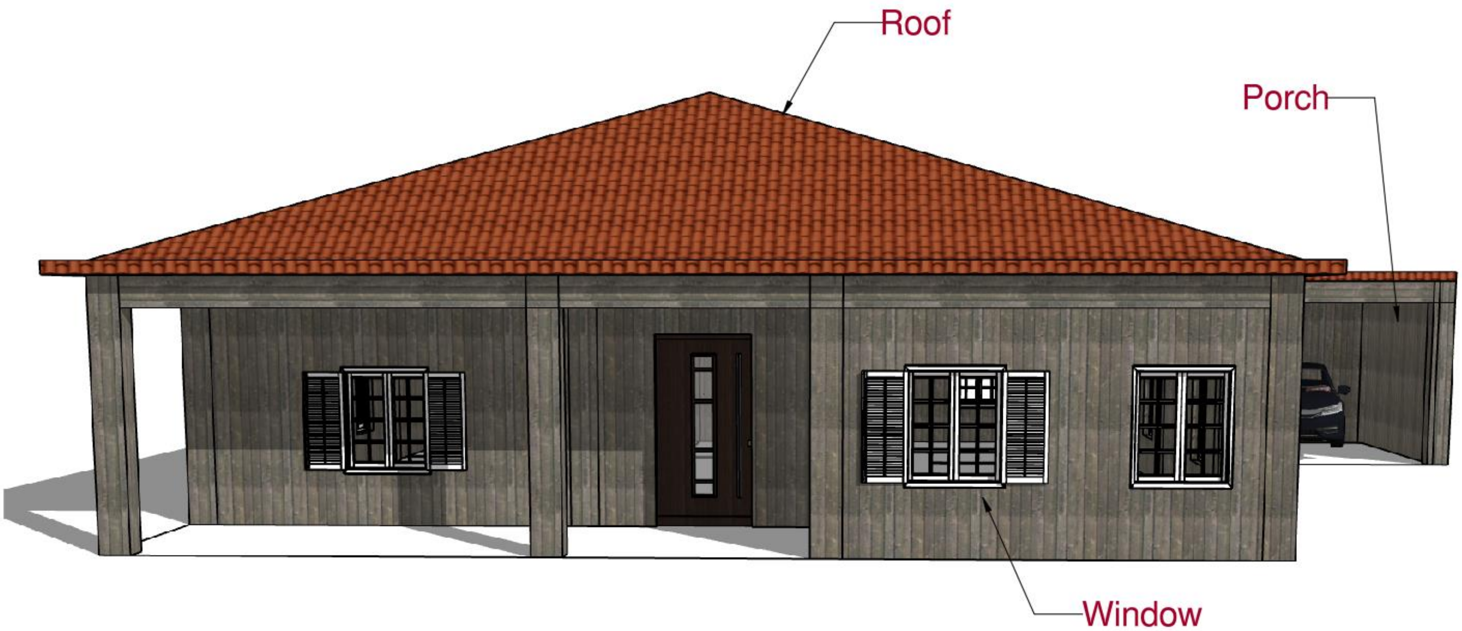


Figure 13: Left side elevation

2.3.5 Helping Civil Engineers by Providing 3D Visualizations using SketchUp

I created a new worksheet in SketchUp and adjusted the units to meters. I selected this setting to maintain accuracy in scale and be consistent throughout the modeling process. To determine the main footprint dimensions, I used the TAPE MEASURE tool and set the guidelines that were used to determine the main footprint dimensions that were 17.5m×17.4m so that I could locate every structural and architectural component. I used the RECTANGLE tool to draw up the foundation contour and used the PUSH/PULL tool to extrude the base slab to a thickness of 0.124m, which is representative of the actual RCC slab design. I used the LINE tool to divide the internal layout into functional spaces which include bedrooms, living room, dining area, kitchen, toilet and bath and parking area. I created each wall vertically up to a height of 3m to depict the ground floor structure correctly using PUSH/ PULL tool. To make the roof, I picked the upper wall edges and used the MOVE tool to raise and bring the slope to a total height of the building of about 5.1 meters. I added window and door opening with the help of the RECTANGLE and PUSH/PULL tools based on the structural plan to be correct in the dimensions and location. I moved around various visions, front, back, left, and right, to ensure that there were alignment and uniformity of the wall thickness. I was able to change to the Top view using the CAMERA option and used the DIMENSION tool to check every grid spacing. To make the object look more like a real one, I used the PAINT BUCKET tool to give the object the right material appearance and color. I completed the model by storing different scenes of 3D, top, front, back, right, left, shaded, monochrome and hidden line views to clearly depict every aspect of the structure.



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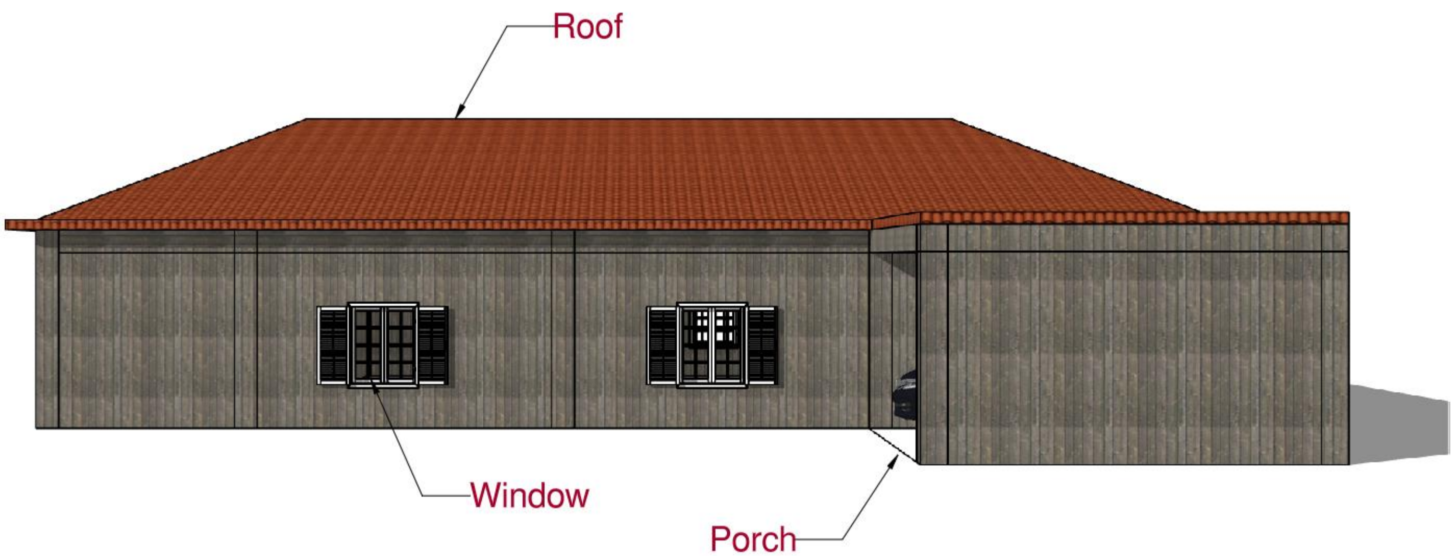
UNIT CODE: [redacted]	**UNIT NAME:** MANAGE CIVIL WORKS DESIGN PROCESSES	**ID:** [redacted]	

Figure 14: 3D Front View



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UNIT CODE: [redacted]	**UNIT NAME:** MANAGE CIVIL WORKS DESIGN PROCESSES	**ID** [redacted]	

Figure 15: 3D Right View

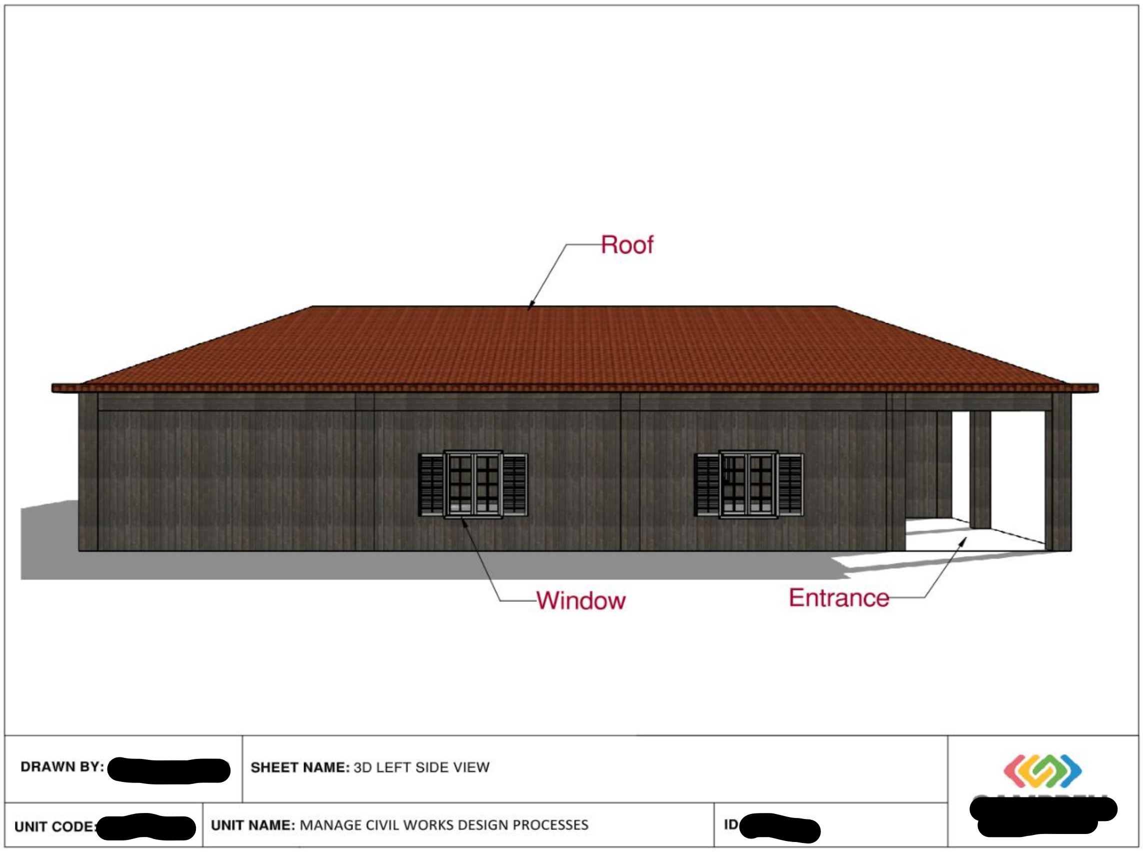


Figure 16: 3D Left View

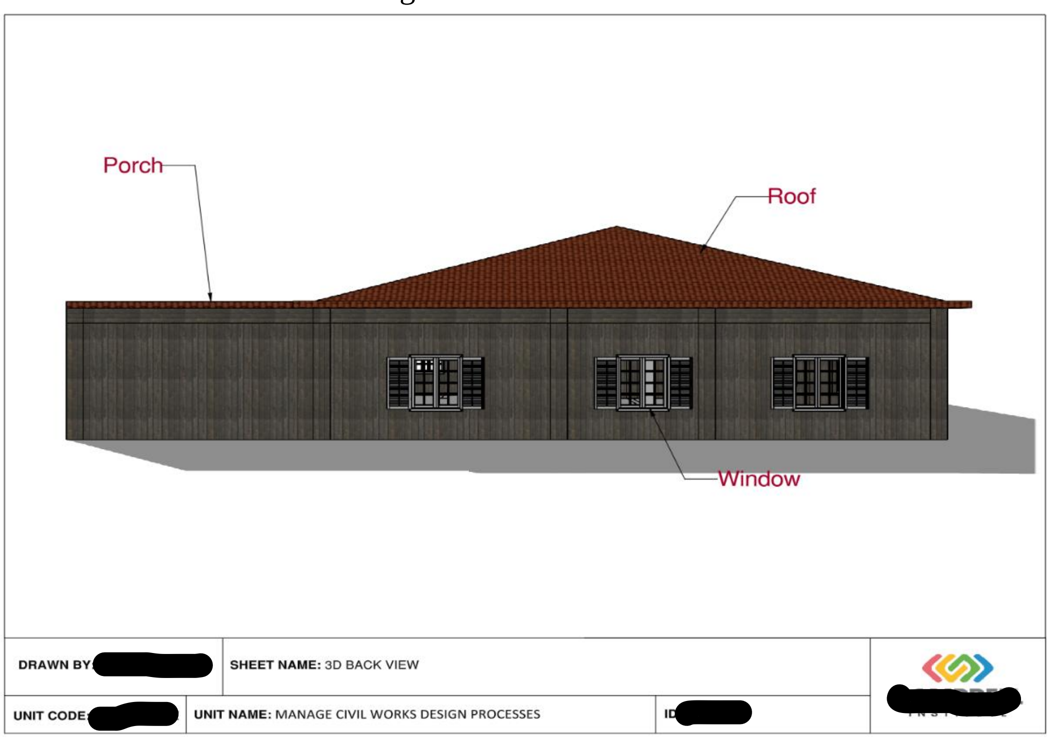
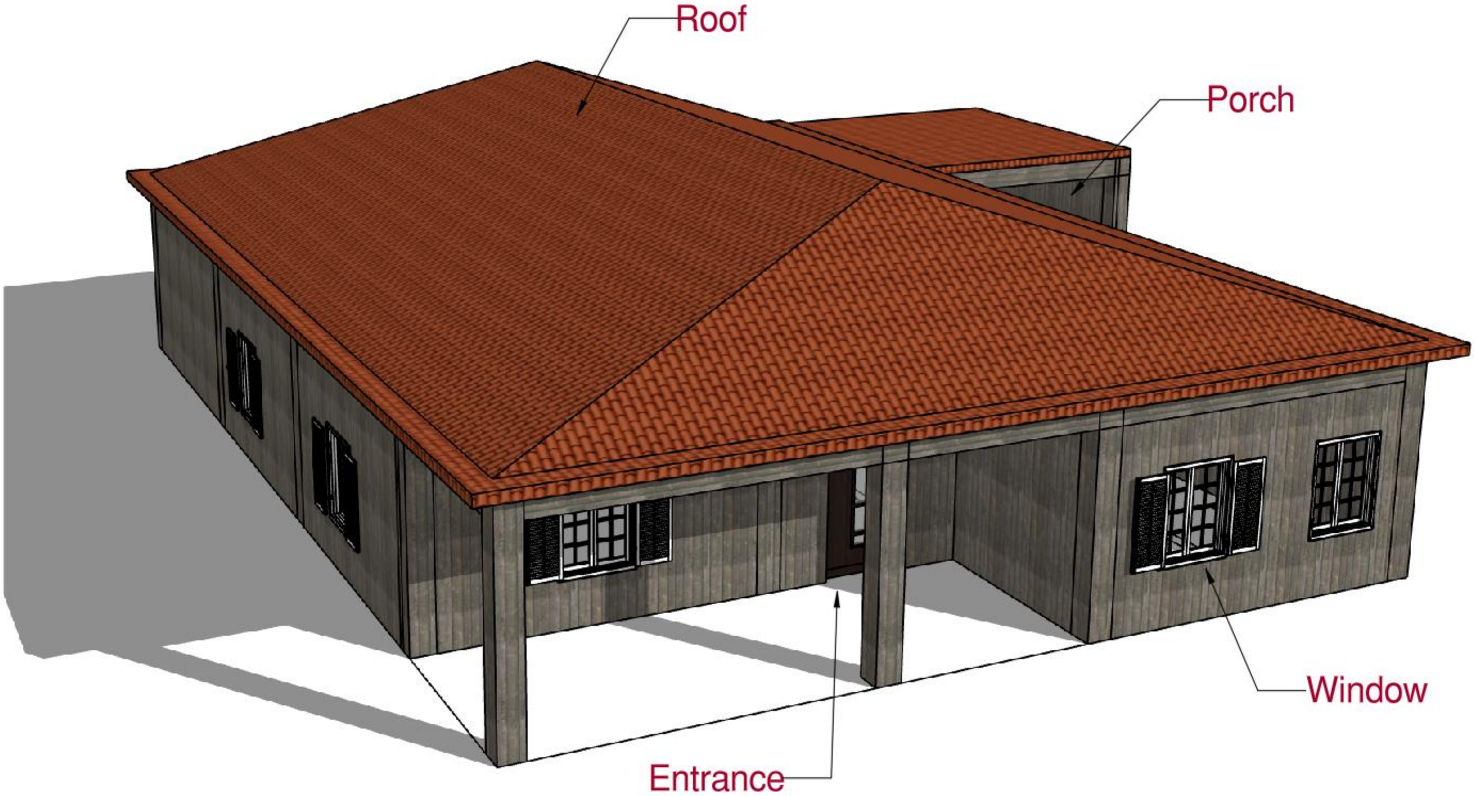


Figure 17: 3D Back View



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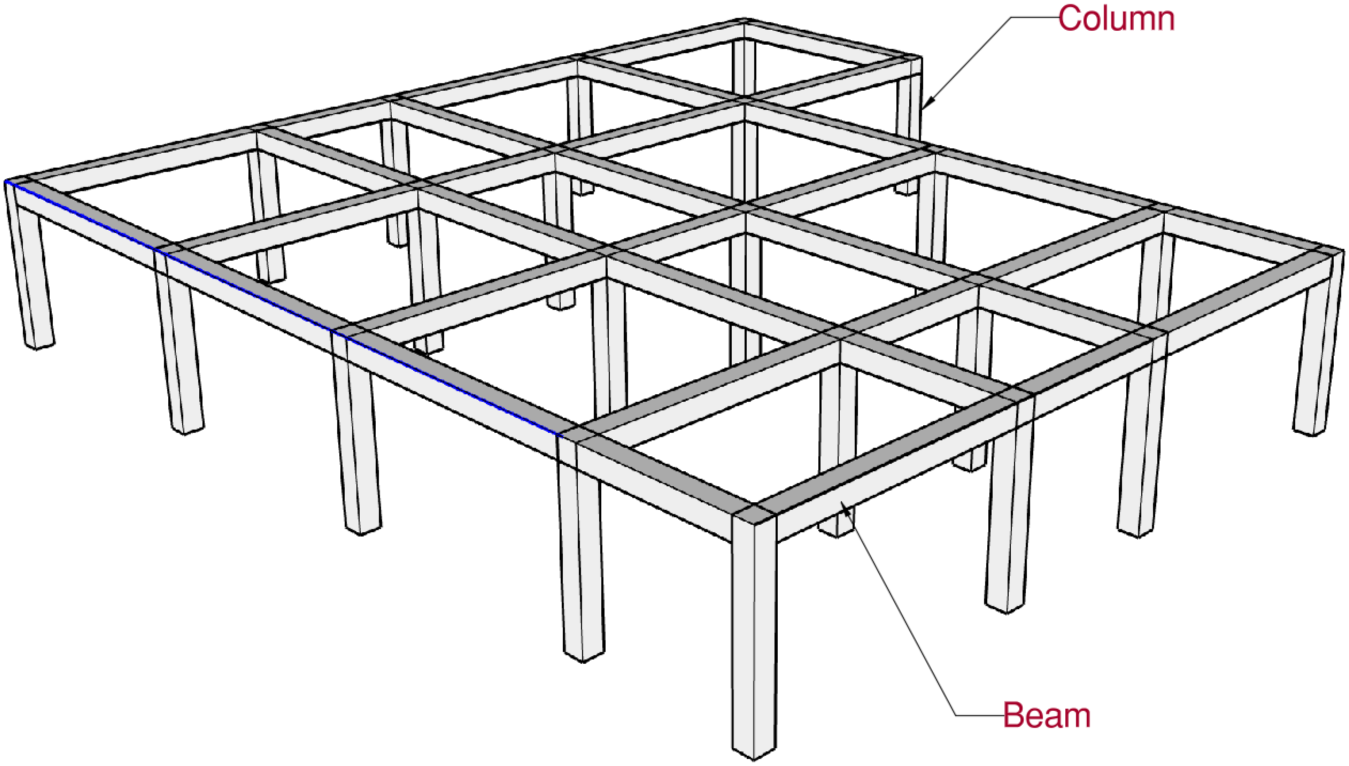
UNIT CODE: [redacted]	**UNIT NAME:** MANAGE CIVIL WORKS DESIGN PROCESSES	**ID:** [redacted]	

Figure 18: 3D Isometric View



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UNIT CODE [redacted]	**UNIT NAME:** MANAGE CIVIL WORKS DESIGN PROCESSES	**ID:** [redacted]	

Figure 19: 3D Frame Structural View

2.3.6 Assisting Civil Engineers by Conducting Cost Analysis

I prepared a cost analysis proposal by assembling an elaborate quantity schedule of all construction process and unit of measurements. Earthwork excavation was estimated to 46 m^3 at 50 AUD/m^3 so that the total amount was 2,300 AUD. I worked for plain cement concrete footing volume, and it was calculated at 7 m^3 at 198 AUD/m^3 and reinforced cement concrete footing at 7 m^3 at 297 AUD/m^3 which comprised the total costs of 1386 AUD and 2079 AUD respectively. The columns volume of RCC up to the plinth level were measured 2 m^3 with unit rate 347 AUD/m^3, which gave a cost of 694 AUD. I estimated the cost of backfilling to 104m^3 at 40 AUD/m^3 to AUD 4160. Lastly, plumbing, electrical works, contingency, and contractor profit were added, and this made the total of the estimated project cost to be 111,447 AUD.

2.4 Technical Problem and Solution

I identifed a technical issue during the drafting process that was the various grid lines had been misaligned inside the AutoCAD document, and the grid did not reflect precisely the building dimensions needed, that was 17.5 m x 17.4 m. This problem was caused by wrong OSNAP settings that led to minor undesired displacements to the entire OFFSET command and consequently the entire grid lines being displaced and hence the order of columns, beams, and elevations. Secondly, duplicate reference lines in the layer structure were a source of confusion in dimensioning and did not help solve the inconsistency in the layout. I resolved these issues by checking the layer property, deleting any duplicate reference lines that were not needed, and going back to default in OSNAP settings so that snapping would be very accurate. After that, I asked my supervisor about file set-up and snap tolerances, and I then redrafted the critical lines in the grid and cleaned up all the misaligned objects. With the TRIM tool, I have cleansed the overlapping wall areas and checked the whole grid system again, and made sure that structural components are correctly aligned, and bring back to the design requirement and drafting standards.

2.5 Creative Works

The innovative tasks of the project were to convert the technical design requirements into specific and visually understandable drawings utilizing the tool of AutoCAD as well as SketchUp in an original and systemic way. I created an organized beam layout by linking the columns with the

POLYLINE tool strategically and using OFFSET tool to make beams in uniform dimensions to ensure the accuracy of the structure. To make the drafting clearer, I relied on the external wall perimeter as a reference and used the TRIM feature to the creative effect of removing the repetitive or overlapping objects to make the layout look clean and professional. I added the inside walls according to the room disposition, and all the intersections were polished to fit the structural scheme and make a smooth and consistent finish. I improved the model in 3D environment by creating various visual representations of the model in terms of shaded, monochrome, hidden line, and multi-angle rendered views, to help the engineers and other stakeholders to get more insight into the space arrangement, roof geometry, structure proportions of the building. These creative works did not only enhance the aesthetic appeal of the design, but also ensured that the project drawings were detailed, realistic, and complied with professional requirements of drafting.

2.6 Project Management

To complete the drafting work in the best manner, project management needed to be organized, well-planned, and in constant communication with the civil engineers and the stakeholders to avoid any misinterpretation of any of the technical specifications and their delivery. To oversee the drafting process, I had set the priorities, made the drawing phases planned, and did not miss the order in recording the progress made, revisions, and approvals. I worked closely with civil engineers throughout the project to clarify structural dimensions, reinforced details, and specifications that were related to loads to ensure that all the drawings were in accordance with the AS 1100 drafting guidelines and AS 3600 design rules. I conducted meetings with meetings and consultation with stakeholders regularly to review grid layouts, sectional details, 3D views and quantity of material they would need, to identify technical problems early and address them as and when. I also showed refined drawings, clarified the design assumptions and used the feedback of the engineers, supervisors and members of my team to ensure that the project objectives were followed.

Project Management -[redacted]							
Serial Number	Name of Activity	Project Duration					
		Duration of Activity	Week-1	Week-2	Week-3	Week-4	Week-5
1	Data Collection	One Week					
2	Technical Calculations	Two Weeks					
3	Risk Analysis	Two Weeks					
4	Drafting process	Three Weeks					
5	Cost Estimation	Two Weeks					
6	Review of Drafting task	Two Weeks					
7	Risk Analysis	Two Weeks					
8	Project Submission	One Week					
9	Quality Control of Activities	Throughout Project					
10	Stakeholders Coordination	Throughout Project					

Figure 20: Project Planning and Management

2.7 Codes

I worked on this project by following the Australian stanadrds including AS 1100 for drafting work for creating 2D and 3D models using AutoCAD and SketchUp tools and AS 3600 for concrete structure of RCC single storey building.

2.8 Summary

In this project, planning, drafting, modelling and estimation of single storey reinforced concrete building was performed in compliance with the Australian Standard AS1100 and AS3600. I had to create correct 2D technical drawings in AutoCAD, create detailed 3D models in SketchUp, be able to perform the calculations associated with structure, and assist engineers with a quantity take-off and estimate costs as a civil draftsperson. The task involved creating grid patterns, column and beam layouts, wall patterns, elevations, and sectional viewpoints, and several standpoints (3D) of visualization to check the spatial accuracy and building alignment. I worked together with civil engineers and stakeholders to solve technical problems, refine drawing specifications and that all the documents followed the safety, quality, and design requirements. The project has entailed a full set of construction documents and a detailed cost analysis through systematic coordination, standard compliance and timely communication.

This is a project that has helped me as a civil draftsman in terms of developing professional skills. My technical drafting became more precise, I enhanced my knowledge of the structural behavior of concrete construction, and I got an opportunity to comprehend better the application to dimensions and reinforcement considerations of structural construction. I have been trained to ensure that I control the drafting workflow effectively, focus on important activities and use quality-control incidences to create the drawing using AutoCAD and SketchUp.