Career Episode 1

Structural Design and Drafting of a Timber "T" Bridge for Coastal or Riverine Environments

1.1 Introduction

College	[redacted]
Location	[redacted]
Degree	[redacted]
Duration	[redacted]
Subject	[redacted]
Activity Type	[redacted]
Supervisor	[redacted]
Supervisor Email	[redacted]

1.2 Background

1.2.1 Overview of Simulated Activity

This project of timber T bridge was based on a simulated activity provided by academic supervisor and was part of advanced diploma degree and required a complete focus on core responsibilities of civil draftsperson. The activity was executed in professional environment to provide real world conditions like actual projects on site. The project required by Civil Draftsperson to understand Australian Standards, interpret the project design and components of project, assist civil engineers during technical calculations, and cost estimation and providing help by creating detailed technical drawings of timber T bridge project. The scope of work in this simualted activity was development of detailed 2D and 3D drawings of timber T bridge using advanced drafting tools including AutoCAD and SketchUp.

Specifications of Project Design: The timber T bridge was designed to withstand environmental loads, water level fluctuations, and low maintenance requirements in riverine structure. The timber T bridge integrated important structural parts such as dec slabs, girders, columns and T shaped beams to ensure structural reliability, safety and sustainability.

Understanding of Australian Stanadrds and Regulatory Requirements: the project design of timber T was prepared by following AS 5100 for bridge design to determine the loading conditions and adequacy of timber T bridge elements. The sub clause AS 5100.2 was used for calculating the design loads including dead and live loads and load combinations. The sub clause AS 5100.5 was used for selection of timber materials properties using modification factors to optimize the durability requirements. AS/NZS 31000 deals with risk identification, impact of risks, risk analysis, and addressing risks through proper mitigation controls. The AS 1720.1 was also incorporated for timber structures and choosing right materials for construction of timber T bridge. The AS 1100 was used for creating technical drawings of timber T bridge using appropriate commands from AutoCAD and SketchUp tools. The sub clauses AS 1100.101 and AS 1100.105 were used to select appropriate line types, dimension styles, annotation formats, incorporation of title block, and drawings scales for 2D drawings. The code also suggests the preparation of proper layers for each component of project.

Selection of Project design:

1.2.2 Objectives of Simulated Project

The objectives of timber T bridge were written below,

- To create detailed 2D engineering drawings for timber T bridge on AutoCAD tool using correct layers, annotations, technical details and proper dimensioning.
- To create 3D models of timber T bridge by working on SketchUp software to support project design evaluation and communication with engineers and stakholders.
- To assist civil engineers during cost estimation, technical calculations and risk analysis of project.
- To translate timber bridge design to accurate and detailed drawings by working under the Australian Standards.

1.2.3 Work Nature of Simulated Activity

Understanding of Project Design: Being a civil draftsperson, my duty was to interpret the project requirement and comprehend the structural behavior of the Timber "T" Bridge and translate the engineering ideas into precise technical drawings. I started the process of analyzing the design intent by collecting project design from design engineers which comprised bridge geometry, loading condition, environmental impacts, and functional requirements that were given under the Australian Standards, which included AS 5100 on bridge design. I have checked the structural elements of the bridge structure including deck, girders, piles, timber beams and the T-shaped cross-sections, to learn how all aspects played the role of load transfer, stability, and longevity. This knowledge helped me to establish the accurate dimensions, spacing and position of the elements before starting the drafting stage.

Selection of Project Design: The timber T bridge has multiple designs at initial stage and there was a challenge to select an appropriate project design. The final design was selected by conducting meetings and evaluating the multiple aspects of each design including cost, risks, technical details and feasibility by communicating with all stakholders.

Drafting of Timber T Bridge Drawings: I used the systematic drafting workflow based on the AutoCAD to create the 2D documentation. I established the drawing environment, based on relevant technical drawing requirements of AS 1100, by appropriate units' selection, layer management, line types, plotting styles, and annotation settings. This was done by using commands like LINE, OFFSET, TRIM, CIRCLE, ARRAY, HATCH and DIMENSION, which were used to make the plan views, elevations and cross section of the bridge as well as the detail drawing. The structural components, text styles and dimensions were separated using layer management techniques. I used uniform annotation styles, interspersal of dimensions and marking of sections so that the drawings conveyed the design to help civil engineers and other construction team members in the future.

1.2.4 Organizational Chart

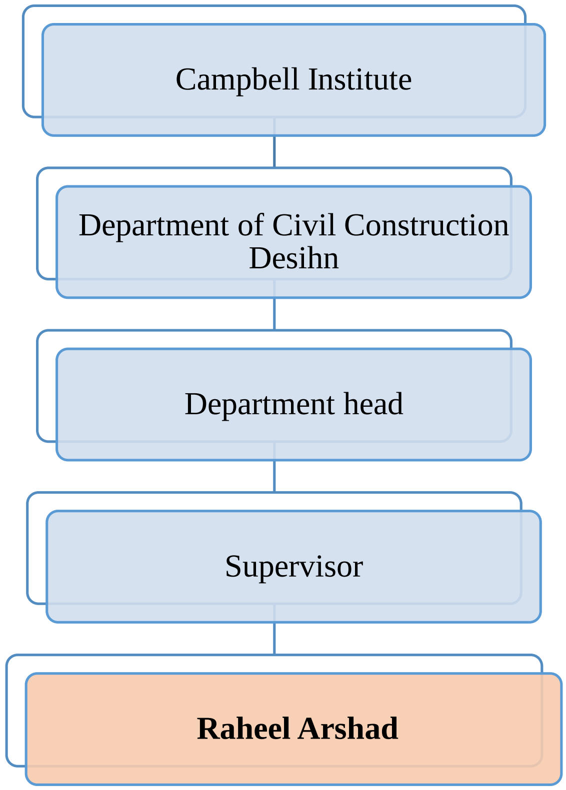


Figure 1: Organogram

1.2.5 Duties of Civil Draftsperson

- To collect and understand the simulated project design and standards used in project design and required for creating technical drawings.
- To select appropriate bridge components based on structural requirements and geometric arrangement mentioned in project design.
- To assist Civil Engineers by performing technical calculations, conducting cost estimation and working on risk analysis of a project.
- To develop accurate 2D technical darwings of the timber bridge in AutoCAD that encompass the various views with elaborate notes.

- To create 3D visualization model of the bridge in SketchUp to have real image representation and full-scale representation of the structure.

1.3 Personal Engineering Activities of Simulated Activity

1.3.1 Helping Engineers

I worked on project being a civil draftsperson, I assisted and helped the civil engineers and technologists by performing several activities on project.

Assisting Civil Engineers: Being a civil draftsperson, I contributed significantly to the project as a support activity through the provision of technical, analytical, and documentation-related assistance to the civil engineers. I also played a role in the decision-making process of the engineers by conducting some initial technical calculations including deck loads, the pile capacities, the volume of timber, and the weights of the materials in line with AS 5100. These estimations made the engineers verify the soundness of the intended Timber "T" Bridge. I was also actively involved in supporting the team by coming up with a comprehensive cost estimate, whereby I would quantify the material requirements, the rate of installation and construction allowances that would allow the engineers to examine financial feasibility and optimize material usage. Based on AS/NZS ISO 31000, I have first performed a risk analysis by identifying construction risks, calculating the probability and impacts, and suggesting risk control mechanisms- details that would help engineers to establish safer construction methods.

Providing Help to Engineers Through Delivering Detailed Technical Drawings: My technical drawings were important in conveying technical details of project design and stakeholder’s requirements. I have created correct 2D plans, elevations, sections, and layout drawings in Auto CAD and a 3D model in Sketch up, I have facilitated the engineers to understand project geometry, structural components and their dimensions in compliance with Australian Standards. These drawings are used for design consultation with engineers and other stakeholders such as supervisors, safety officers and project planners.

Collaboration with Engineers and Stakholders: I had frequent meetings with Civil Engineers and Stakholders to discuss technical challenges like alignment of the structural components, thickness of the deck, component’s spacing and material specifications. I dicussed the progress of drafting tasks and identifed the problems that I faced during drafting process and solved them with the help of civil engineers and stakholders.

1.3.2 Risk Analysis

I assisted engineers by providing a detailed risk analysis and consulted with engineers and stakholders to mitigate these risks proactively to avoid their damage to timber bridge project by adhering to Australian code AS/ NZS 31000. I have identifed risks related to drafting tasks, construction activities, design related risks and environmental conditions.

Sr#	Risk Description	Probability of Risk	Risk impact	Risk Mitigation Controls
1	Inaccurate Technical Caluclations	Medium	High	Rechecking technical calculations, verifying loads and conducting peer reviews from professional engineers.
2	Construction Safety Risks	Medium	High	Hire Professional safety supervisor, provide proper PPEs and follow safety protocols.
3	Environmental Risks	High	High	Select high durability timber materails to withstand extreme environments and provide proper timber treatment.
4	Communication Gaps	High	High	Conduct regular meetings and discuss project related issues to solve them on time.
5	Drafting Errors	Low	Medium	Regularly review drafted drawings, identify and solve drafting errors before final submission.

1.3.3 Contributing to Technical Calculations

I assisted the civil engineers by collecting and providing technical data and provided some basic calculatiosn by following the methods they have told me. I calculated the area of the deck plan by multiplying width and height to get 196.0 m^2 hence sufficient area was covered to ensure sufficient surface. I computed the deck volume as the product of the plan area and deck thickness of 0.15 m and the result was 29.40 m^3 of timber. I determined cross-sectional area of the pile based on the diameter given of 0.5 m which gave value of 0.1963 m^2. To determine the volume of one pile I multiplied cross-sectional area by length it was embedded in which is 2.0 m, thus the volume of a single pile is 0.3927 m^3 per pile. I then multiplied this by 19 piles and got the total volume of piles: 7.461 m^3. I summed up deck and pile volumes to get total timber volume of 36.861 m^3. This gave a weight of 40.55 tons when timber density of 1100 kg/m^3 was multiplied to it.

- **Deck plan area**

$A_{deck}=14.0\times14.0=196.0\ m^2$

- **Deck volume**

$V_{deck}=A_{deck}\times t=196\times0.15=29.40\ m^3$

- **Pile cross-section area**

$A_{pile}=\pi\ (0.5/2)^2=0.19635\ m^2$

- **Volume per pile (Lp = 2.00 m)**

$V_{p1}=0.19635\times2.00=0.3927\ m^3$

- **Total piles volume (19 piles)**

$V_{piles}=0.3927\times 19=7.461\ m^3$

- **Total timber volume**

V_{total}=29.40+7.461=36.861 m^3

- **Total timber mass**

M=V_{total}×1100 = 40,547 kg = 40.55 tons

- **Simple structural checks**

Deck bending (short check, 2 m span)

Self-weight of deck (kN/m^2):

W_{self} =ρtg/1000=1100×0.15×9.81/1000=1.62 kN/m^2

Adopted live load = 5.00 kN/m^2 total uniform load w = 6.62 kN/m^2.

1.3.4 Drafting Process for 2D Detailed Drawings

Workplace Management and AutoCAD Setup: I established a professional setup before starting the drafting process of 2D AutoCAD drawings to ensure accuracy, efficiency, and compliance with AS 1100. I selected drawings units to Meters from UNIT tool and set appropriate precision level for drafted drawings to ensure consistency with project requirements. I created a proper drafting template and standard title block for details of drawings and draftsperson.

Layer Management and Annotations: I created layers for different structural components of timber T bridge and differentiated with color coding.

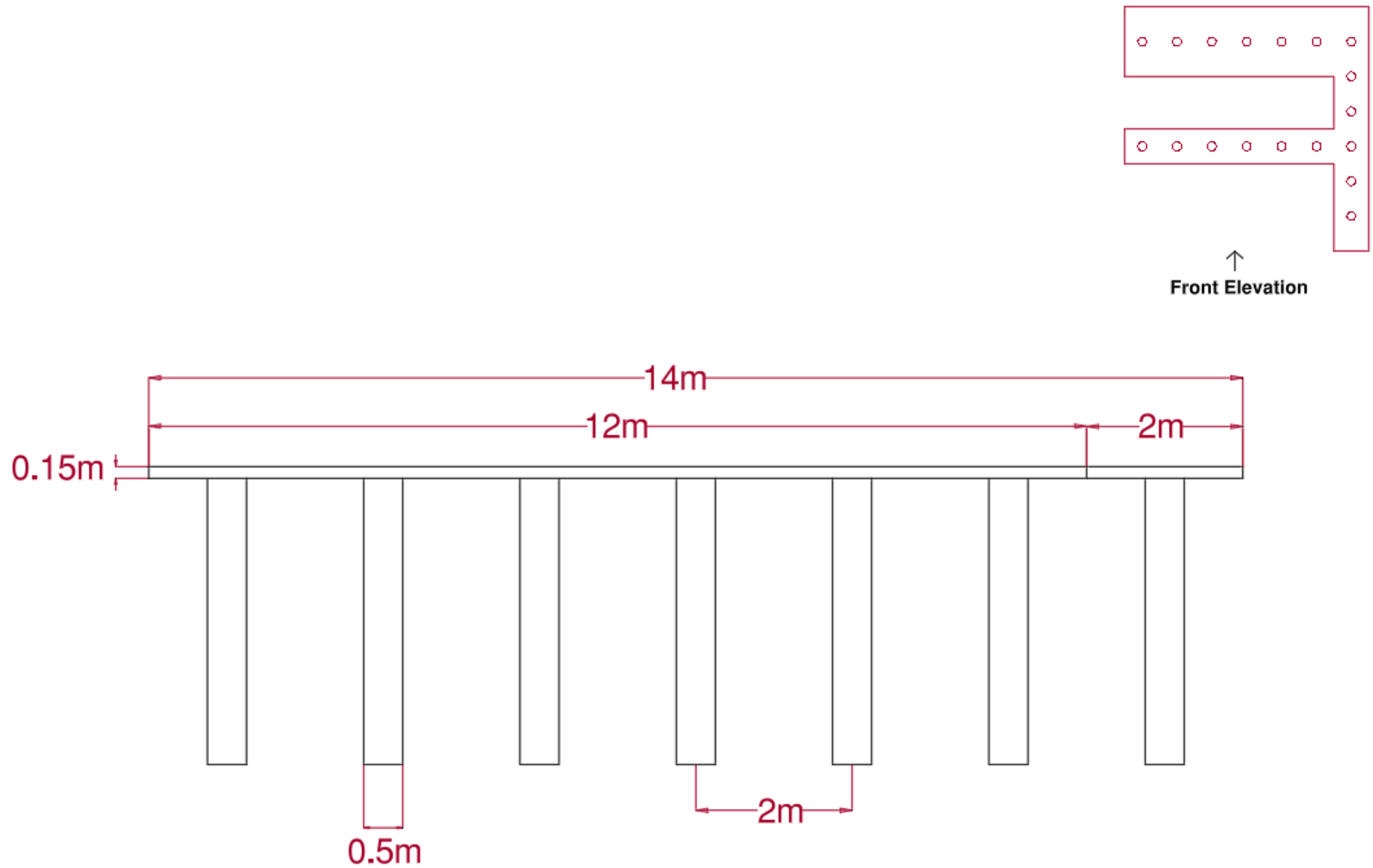
Layer-1: This layer was created for piles and provided white color to this layer and annotation of circular piles was provided.

Layer-2: This layer was created for columns 2D top view and provided with blue color and a circular annotation was provided for differentiating from rest of components.

Layer-3: This layer was created for text and provided a red color to prominent the written details on structural parts.

Layer-4: This layer was created for 3D drawings and provided a brown color to this layer for providing a real time picture to stakholders and engineers.

Drafting Process using AutoCAD: After setting up the workplace and creating layers and selecting annotations the drafting process for 2D drawings was started. I fisrt created bridge outline using LINE command and have drawn a line of 14m length, taken offset from OFFSET command to draw inner spacing of 2m center to center for each grid. I have created timber piles having diameter of 0.5m using CIRCLE command and used ARRAY command to replicate on each grid at 2m center to center distance. The rectangular shaped arms and decs were created using RECTANGLE command. I used ORTHOGRAPHIC PROJECTION to create different views such as top view, front view, and back view. I used MIRROR tool to duplicate the symmetrical features and ensured the precise alignment of bridge components. I added text and dimensions by employing the TEXT and DIMLINEAR commands. I used MLEADER command for labels to adress timber type, pile diameter, and structural information. I used HATCH command to show materails texture where required. After verification and reviewing of drawings I set up layout for plotting and printing of final drawings in PDF format.



DRAWN BY: [redacted]	**SHEET NAME:** FRONT ELEVATION OF BRIDGE	[redacted]
UNIT CODE: [redacted]	**UNIT NAME:** APPLY SAFE DESIGN PRINCIPALS TO CONTROL WHS RISKS	**ID:** [redacted]

Figure 2: Detailed layout- Front Elevation View

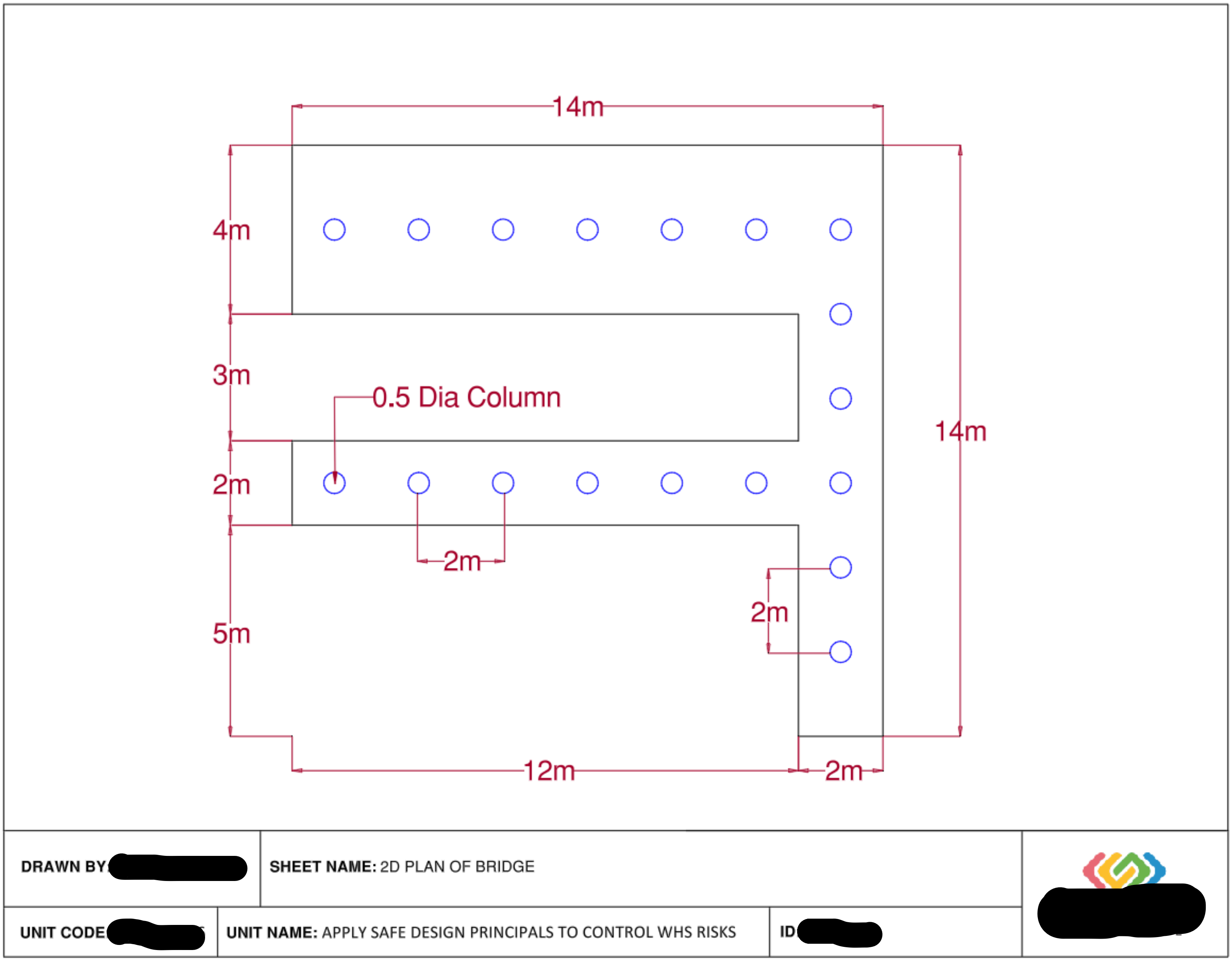


Figure 3: 2D Plan View of Timber Bridge

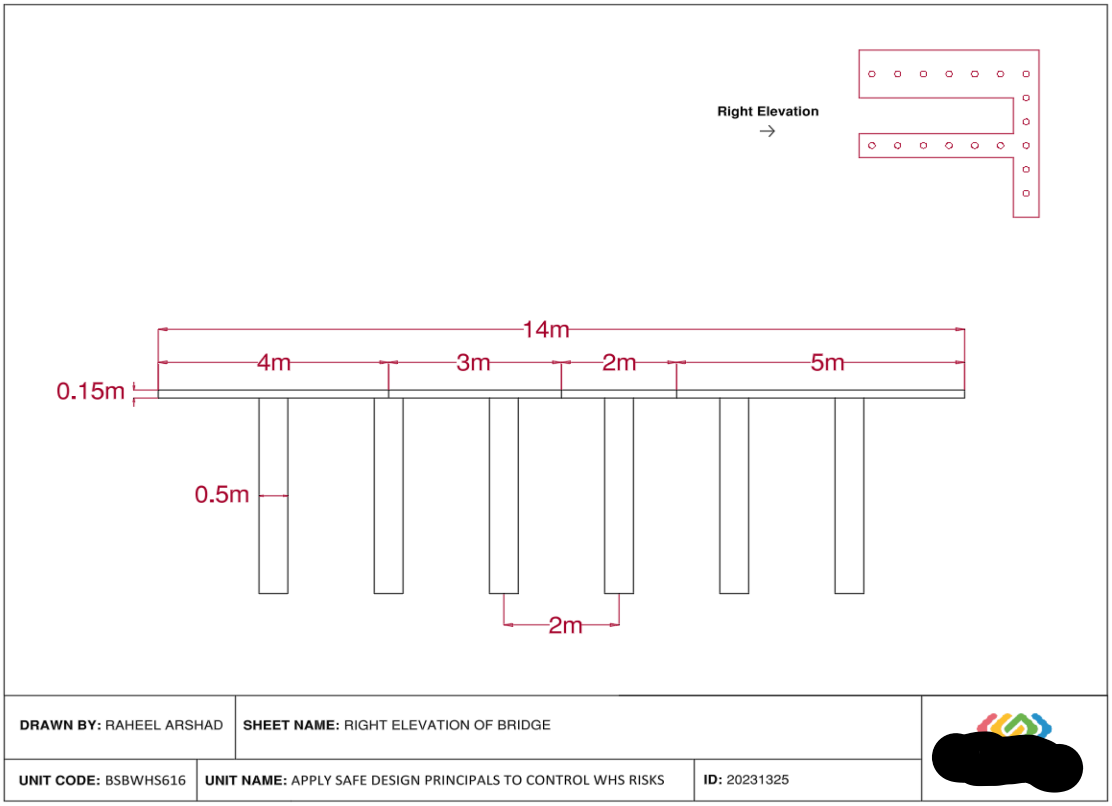


Figure 4: Right Elevation View

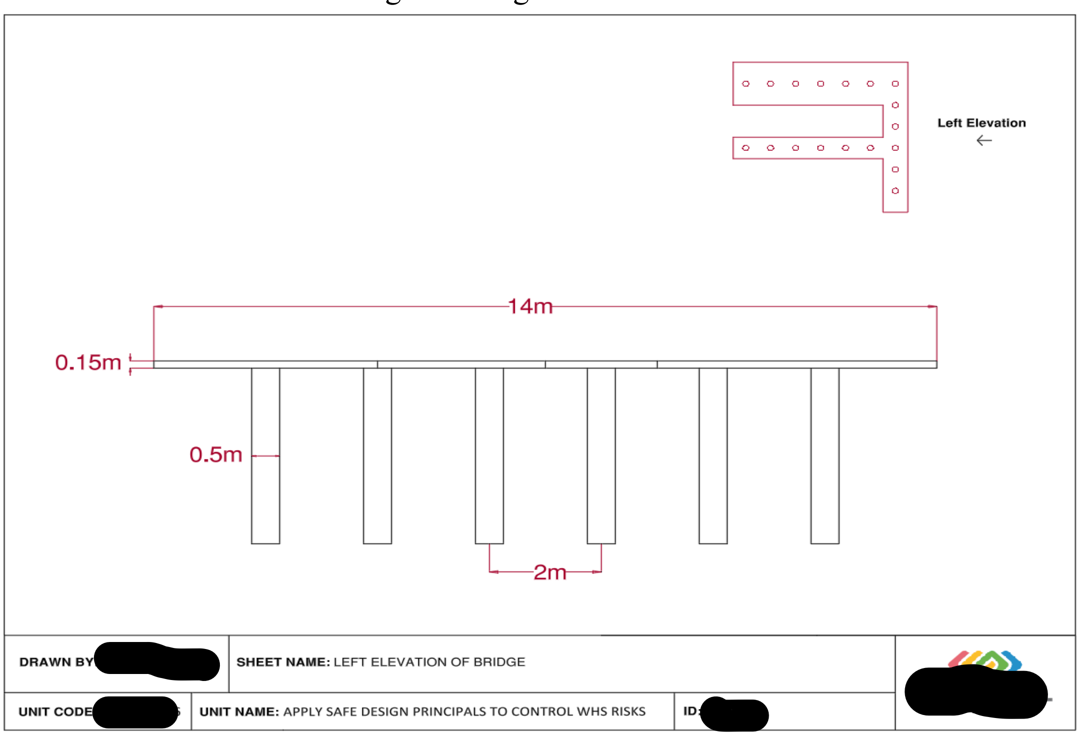
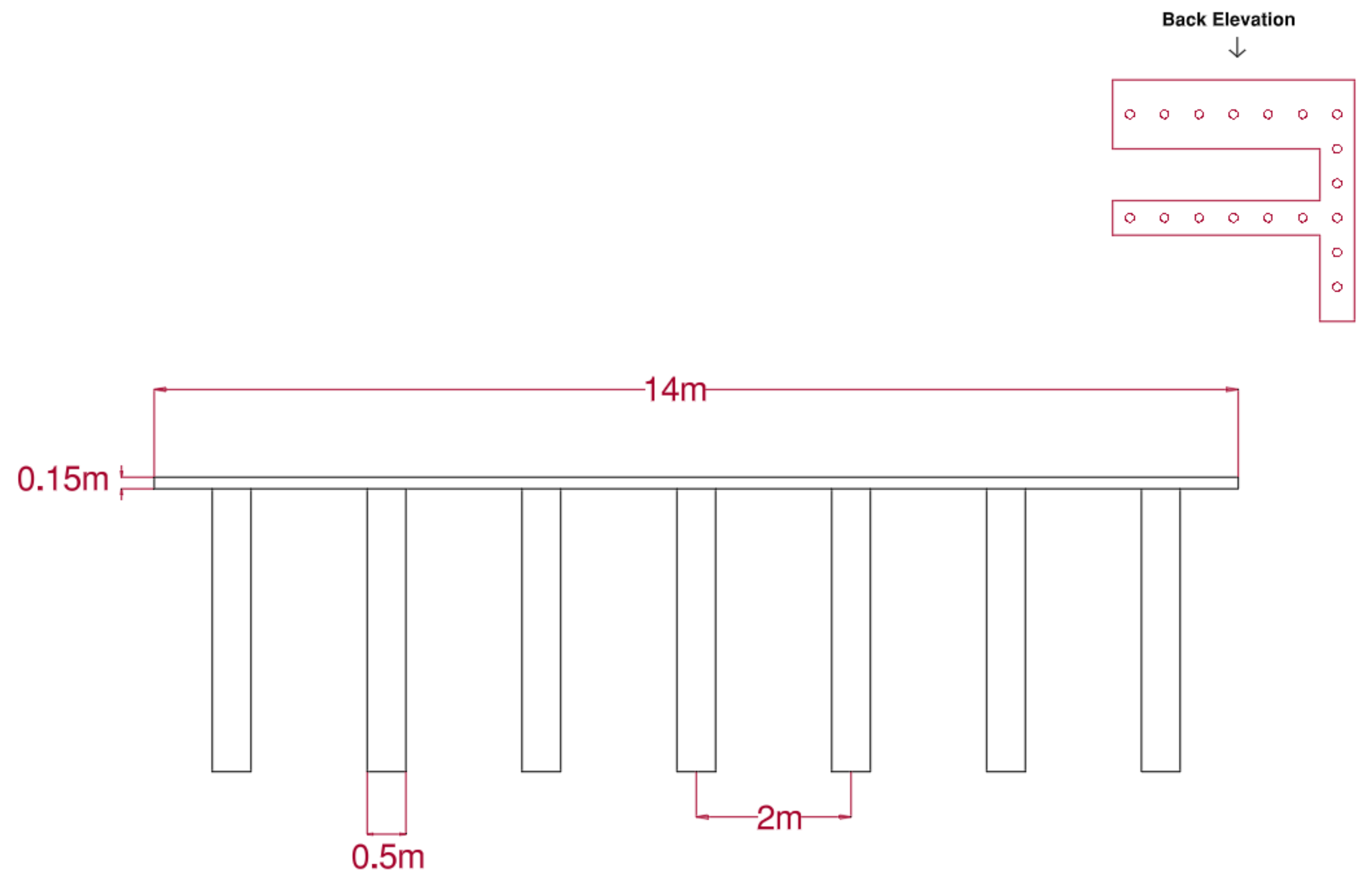


Figure 5: Left view



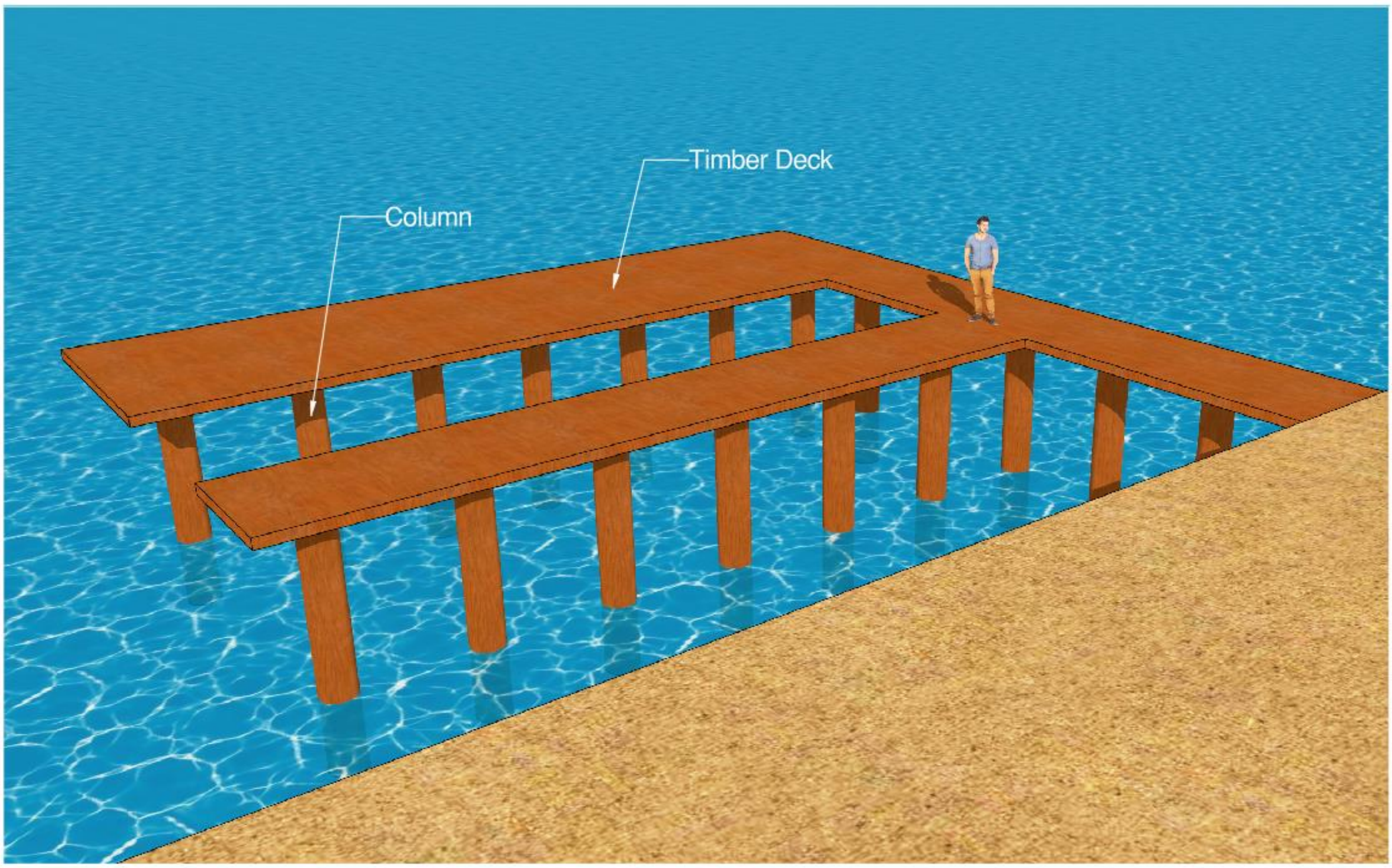
DRAWN BY: [redacted]	**SHEET NAME:** BACK ELEVATION OF BRIDGE	[redacted]
UNIT CODE: [redacted]	**UNIT NAME:** APPLY SAFE DESIGN PRINCIPALS TO CONTROL WHS RISKS	**ID:** [redacted]

Figure 6: Back Elevation View

1.3.5 Drafting Process for 3D Detailed Drawings

Setting up The SketchUp Workspace: While creating the 3D draft of the Timber "T" Bridge I opened the SketchUp workspace and set meters as the drawing unit, allow snap settings, and created layers and the Outliner desk to handle the part of the bridge, including piles, deck, and T-arms.

Detailed Drafting Process: I created a deck on the 14 m x 14 m rectangle with the PUSH/PULL Tool and then extruding it to a 0.15 m thickness and grouped it to avoid unwanted geometry merging. I then used the T-shaped arms of the bridge by drawing the top, middle and bottom profile using the LINE and RECTANGLE Tools after which I extruded them to their full length and placed the arms in the proper place using the TAPE MEASURE Tool to ensure that the correct spacing and alignment occurs. The arms have been grouped to a layer to improve control. A CIRCLE Tool was used to create the circular profile of timber piles with a radius of 0.25 m, then PUSH / PULL to extrude to the full height and one paddle component was made subsequently matched by the MOVE + COPY Array option to have the same width distance of 2 m across in both directions of the deck footprint. More beams and connectors were placed under the deck using the RECTANGLE, OFFSET and MOVE tools to add more technical details and represent the structural support system. Once the geometry was done, I used the PAINT BUCKET Tool to add timber material to the object and to provide a visual distinction between parts of the object, changed shadows to make the object clearer, and the Camera Standard Views and Section Plane tools to create a front, top, side and section view of the bridge. All these steps of 3D drafting enabled me to check the structural design, detect alignment or spacing problems, communicate the design efficiently to the engineers and provide that the 3D representation corresponded correctly to the 2D AutoCAD drawings and project specifications.



DRAWN BY: [redacted]	**SHEET NAME:** 3D ISOMETRIC VIEW OF BRIDGE	[redacted]
UNIT CODE: [redacted]	**UNIT NAME:** APPLY SAFE DESIGN PRINCIPALS TO CONTROL WHS RISKS	**ID:** [redacted]

Figure 7: 3D Isometric View

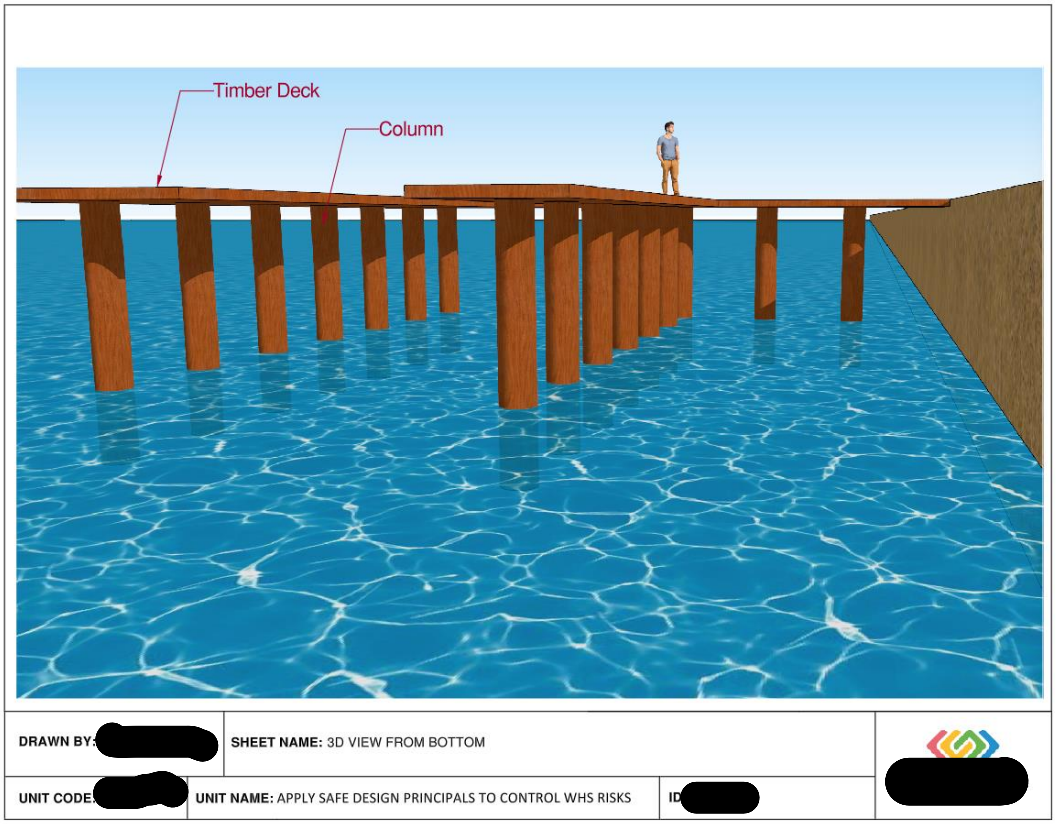


Figure 8: 3D Bottom View

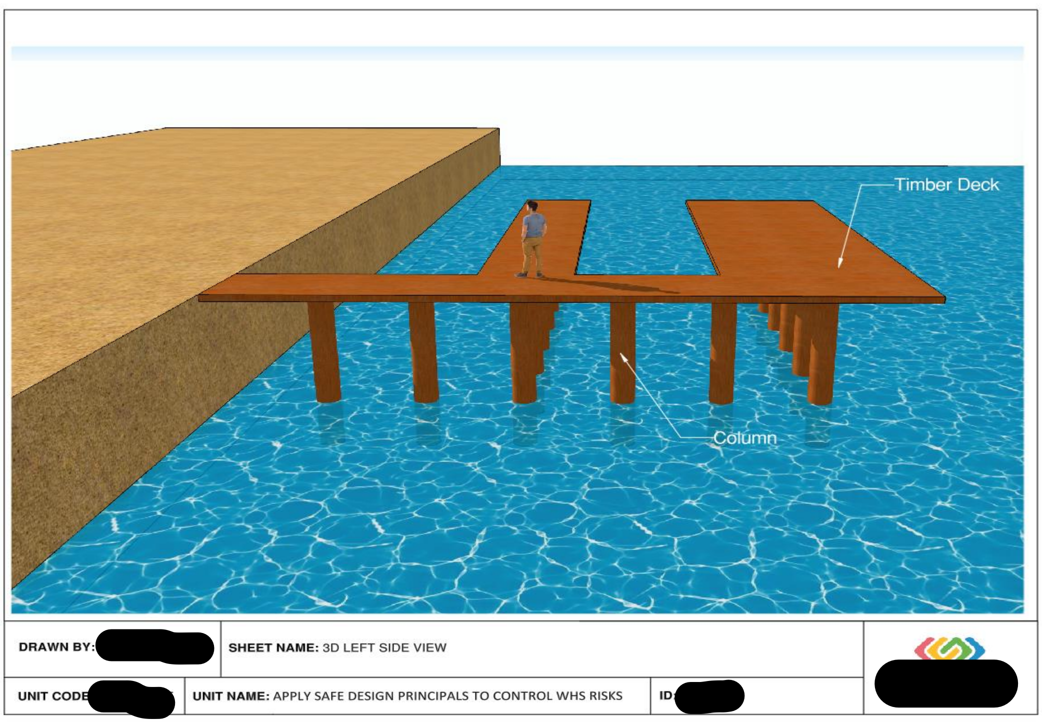
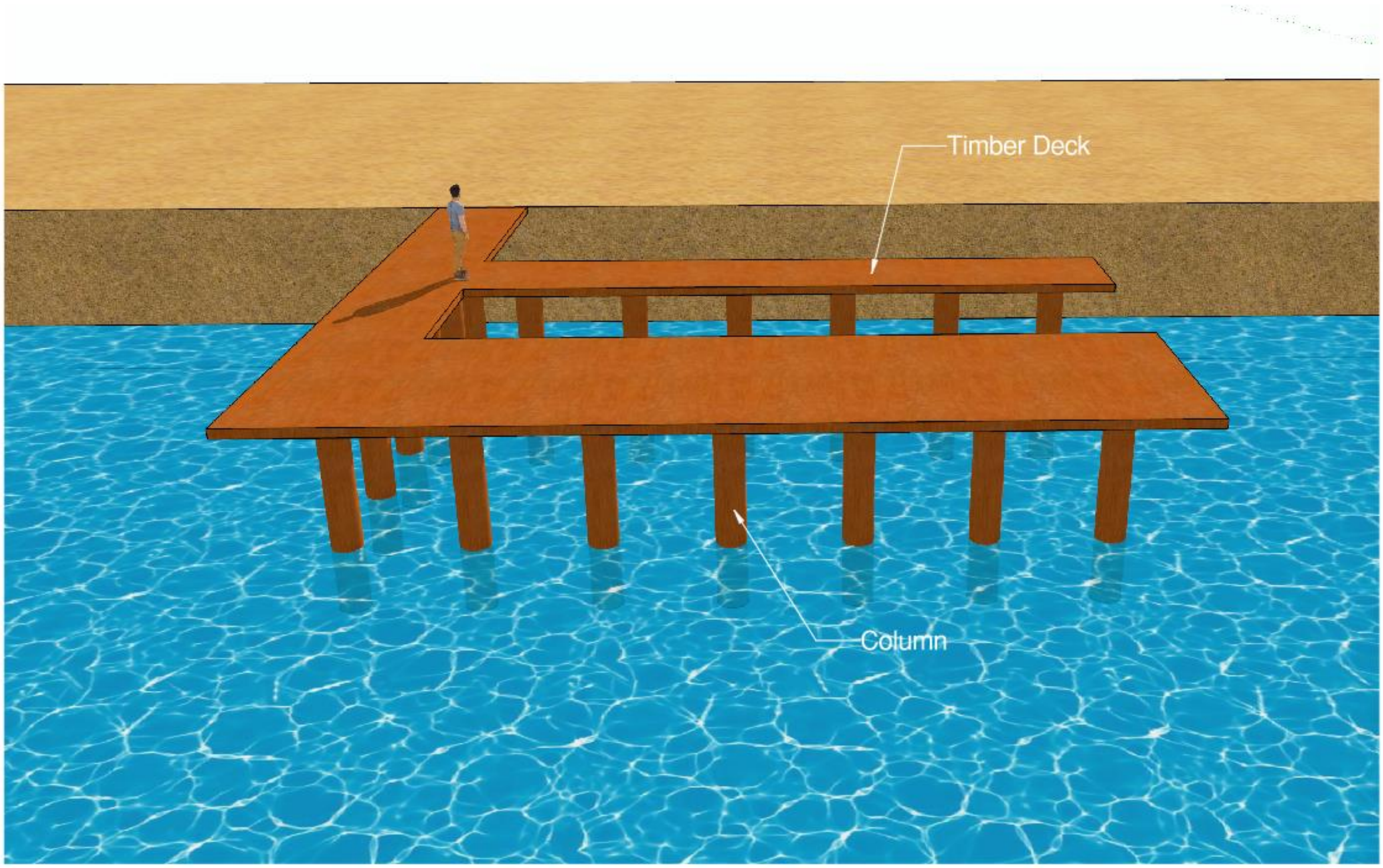
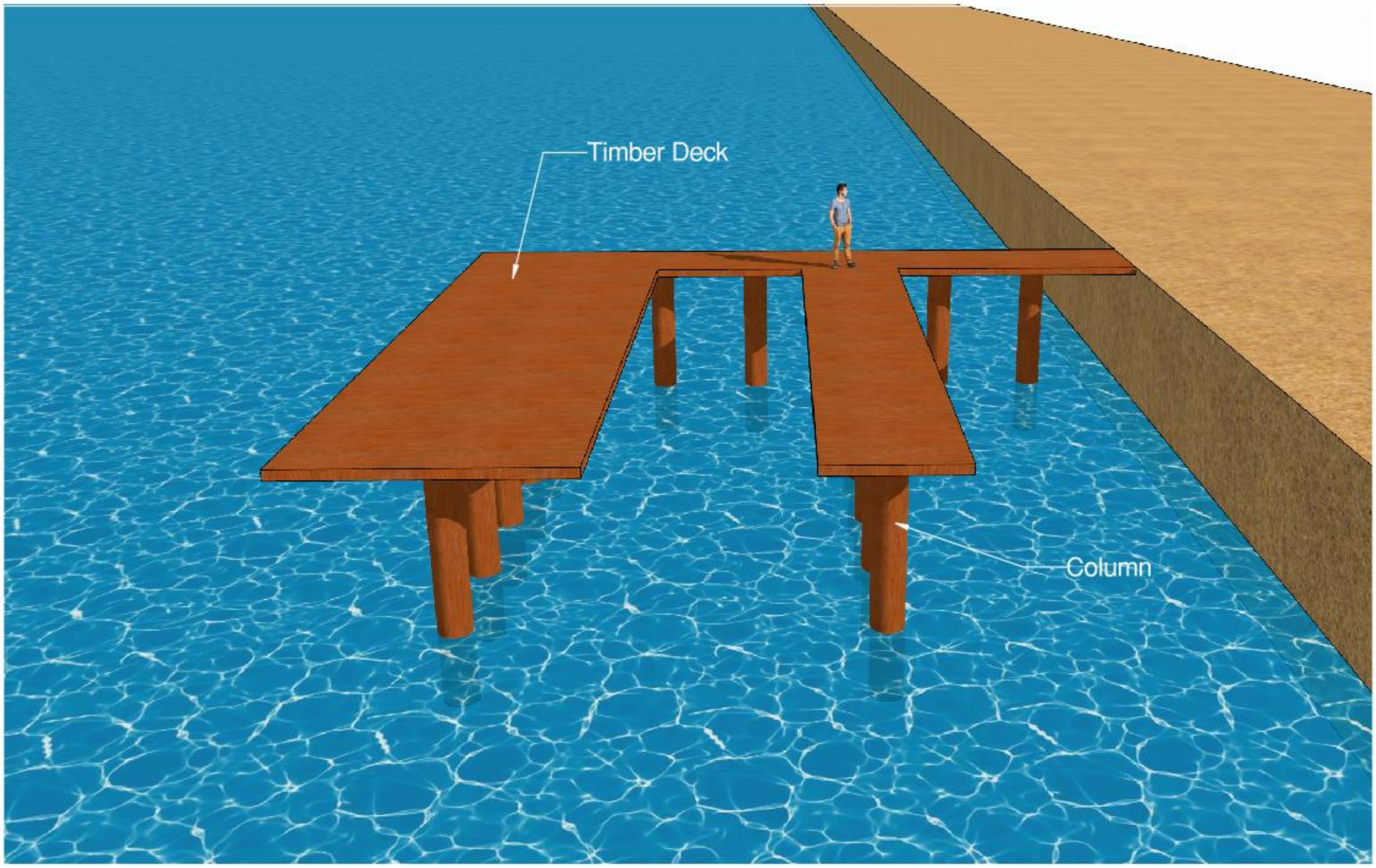


Figure 9: 3D Left Side View



DRAWN BY:[redacted]	**SHEET NAME:** 3D BACK SIDE VIEW	[redacted]
UNIT CODE:[redacted]	**UNIT NAME:** APPLY SAFE DESIGN PRINCIPALS TO CONTROL WHS RISKS	**ID:**[redacted]

Figure 10: 3D Back View



DRAWN BY: [redacted]	**SHEET NAME:** 3D RIGHT SIDE VIEW	[redacted]
UNIT CODE: [redacted]	**UNIT NAME:** APPLY SAFE DESIGN PRINCIPALS TO CONTROL WHS RISKS	**ID:** [redacted]

Figure 11: 3D Right Side View

1.3.6 Assisting Civil Engineers by Cost Estimation

I assisted Professional Civil Engineers by providing them with a detailed cost estimate to ensure the financial stability of project using accurate quantities and competitive market rates. I estimated cost of Timber "T" bridge following a calculation of amount of material and installation demand. I calculated total quantity of timber materails to 36.861m^3 and multiplied it by the unit price of AUD 2,000/m^3 to determine total cost of timber to AUD 73,722.00. I added 10% of the timber cost amounting to AUD 7,372.20 allocating to fasteners and preservative treatment. I added cost of the pile installation of 19 piles at a rate of AUD 700/ pile with a total of AUD 13,300.00. I calculated cost of installing the deck using deck area of 196.0m^2 at AUD 150/m^2 which equals AUD 29,400.00. I added a lump amount of AUD 5,000.00 as a mobilization and miscellaneous expense. I added all costs to get subtotal of AUD 128,794.20 and then added a 10% GST, which made it to total to AUD 141,673.62. I carried out critical examination of the possible WHS risks related to the activities in the project. I discovered the necessity of implementation of control measures and safety precautions to reduce hazards.

Table 1: Cost estimation

Item	Quantity	Unit rate (AUD)	Amount (AUD)
Timber supply (Greenheart)	36.861 m^3	2,000 /m^3	73,722.00
Fasteners & preservative (10% of timber)	—	—	7,372.20
Pile installation	19 nos	700 /pile	13,300.00
Deck installation (carpentry & fixings)	196.0 m^2	150 /m^2	29,400.00
Mobilisation & miscellaneous	lump sum	—	5,000.00
Subtotal (excl. GST)			128,794.20
GST (10%)			12,879.42
Total (incl. GST)			141,673.62

1.4 Problem and Solution

During the drafting and modelling process, I encountered several technical and drafting challenges that required systematic problem-solving. One major issue occurred in AutoCAD when the piles were not aligning correctly due to an incorrect base point selection while using the ARRAY command, which caused uneven spacing and disrupted the structural symmetry of the bridge layout. I resolved this by re-establishing the correct reference coordinates, recalibrating the spacing values, and reapplying the Rectangular Array using precise grid snapping, which restored uniform pile distribution. Another drafting problem arose when dimensions and annotations appeared inconsistent across drawing sheets because the annotation scale was not uniformly applied. I corrected this by standardising text and dimension styles in accordance with AS 1100, applying a consistent annotation scale across all viewports, and locking annotation layers to maintain stability.

1.5 Creative Works

I used advanced darfting tools for creating detailed 2D and 3D drawings of timber T bridge including AutoCAD and SketchUp software. I used ARRAY command & fined references to assure smooth and appropriate alignment of the piles. I employed OFFSET and TRIM commands to be used creatively to have an accurate arm spacing and shape definition. I successfully used HATCH command to indicate material areas and enhance the graphics of the 2D bridge plan.

1.6 Project Planning and Management

I managed the drafting tasks using a well-designed and methodical flow of work which was accurate, consistent, and completed all project deliverables in time. I have started with the sequencing of drafting, templates, standardized layers, annotation styles, and plotting formats throughout the drawings process. I had planned drafting activities in stages, like first layout development, developing component draft, quality test, and finishing verification, to ensure that the drafting process was in control and the process could be tracked. I ensured that there were continuous coordination and communication with the civil engineers and other stakeholders throughout the project in order to address issues that are encountered during the design, clarify technical requirements and resolve problems like alignment issues, dimensional conflicts, and material specifications.

Project Management -Raheel Arshad-20231325							
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 12: Project Management

1.7 Codes

I followed Austrlian Standards including AS 5100, AS 1720.1:2010 (R2016), and AS 1100 duirng working on project and used AutoCAD and SketchUp as drafting tools.

1.8 Summary

In this project, the Planner carried out a timber bridge known as T bridge structural design and drafting project in the coastal or river settings as part of an Advanced Diploma in Civil Construction Design. Working in professional setting that is simulated within Australian environment, the draftsperson used the Australian Standards (AS 5100, AS 1720.1, AS 1100, AS/NZS 31000) to summarize the engineering requirements, provide a personal aid to a civil engineer in terms of technical calculations, estimation of costs and analysis of risks and create accurate 2D and 3D drawings used in the process of engineering with the help of AutoCAD and SketchUp. To complete this project, it was necessary to consider numerous design alternatives, to make up conformable drafting practices, elaborate structural models and to assure technical correctness, safety, durability and efficient communication among the stakeholders. The overall project deliverables were detailed 2D plans, elevations, sections, full 3D model, and cost estimate, which presented a complete and realistic exercise of designing, and which was in line with the industry standards.

I enhanced my knowledge on the Australian Standards relating to bridge design, structural draft and risk management. I also learned to develop professional level 2D and 3D engineering drawings in AutoCAD and SketchUp. I optimized my understanding of engineering designs, simple structural calculations and assisting the engineers in their decision making.