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Engineering Problem

Engineering Design ACHA4001

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1 Introduction

The task set is to produce an alternative design to the current tank for the anodisation process, which, instead of requiring two personnel to lift the cover, would only need one person. The tank can be added with modification, but the material used and dimensions must stay the same. The cover can be changed as the designer sees fit. This assessment provides an insight into the process of carrying out a design project.

2 Key Legislation Considerations

When designing and producing a product for a project, there are legislations that the designer must consider and how they affect the personnel at the workplace. The first one would be the Health and Safety at Work Act. It is the foundation of the safety of the workplace, and everyone has a duty to ensure safety.

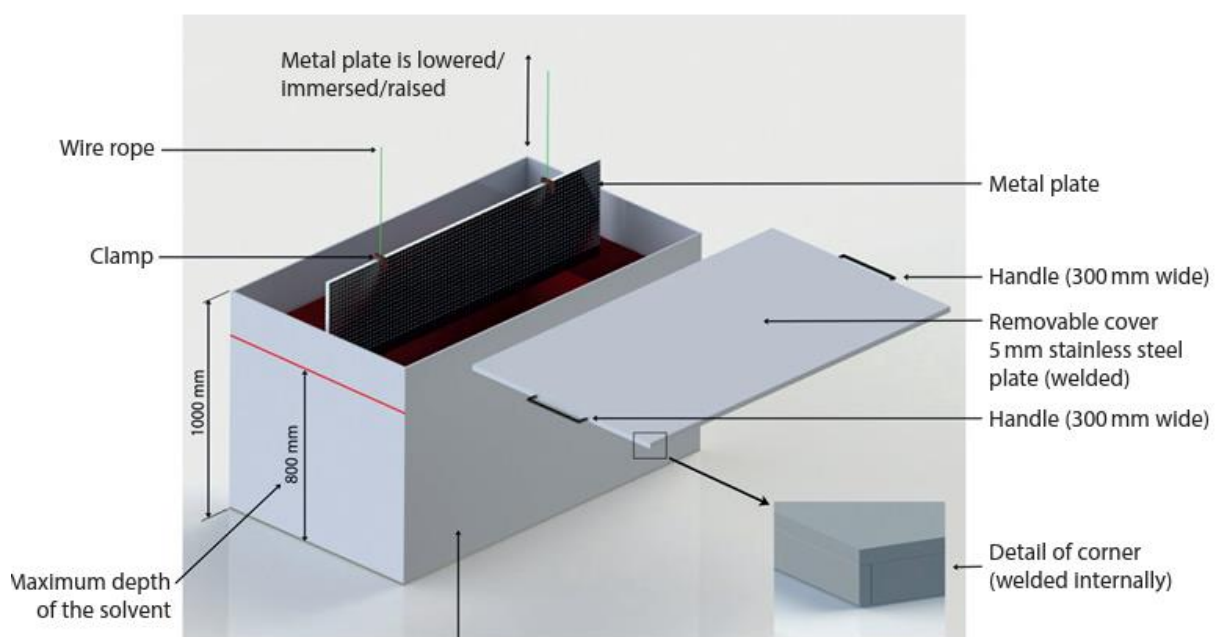
The current design of the tank imposes a risk hazard to the employees. This falls under the Manual Handling Operations Regulations 1992. This is due to the weight of the cover. The cover is 1.77m long, 1.02m wide, with a thickness of 0.005m. This comes to $0.009027m^3$. Factoring in the density of stainless steel, depending on the grade, it is around $8,000kg/m^3$ (thyssenkrupp, 2023). The calculation comes to 72.2kg. There isn't a determined lift weight limit for workers by the HSE, but research suggests that for women, it's 16kg while for men it's 25kg. (H&S Lifting Solutions LTD, 2025). These figures differ for individuals. Without proper training or the use of lifting equipment, this can cause injury risks through repetitive operations and may cause musculoskeletal disorders. (HSE, 2025c).

Another legislation is the Management of Health and Safety at Work Regulations 1999, which involves risk-assessing the workplace to identify what personnel are exposed to and applying control measures to reduce the risks. (Southwell, 2025). Designs can be risk-assessed before any final decision to locate flaws within the design and place alternatives for safer uses. This would also fall into the Provision and Use of Work Equipment Regulations 1998. This regulation ensures that the equipment or design is suitable for the intended use. Ensures that the equipment is installed properly, inspected and safe for use (HSE, 2025b).

The solvent used for the anodising process contains 30% sulphuric acid, falling under the Control of Substances Hazardous to Health Regulations 2002 (HSE, 2025a). The alternative design of the cover must have a proper seal to prevent exposure to the person operating the equipment.

3 Specification

The specification is what the client requested in the design. The alternative cover has ease of use, making it safer to operate the equipment, and only requiring one person to operate it. The tank's dimensions and materials must stay the same, but modifications can be added to it to provide aid for the alternative cover. The designer has some freedom in the design of the cover, provided that it meets the client's requests. It must also provide clearance above the tank to allow aluminium parts to be lowered into the bath. Since there are dozens of these tanks in the facility and more at the company's different sites, it should be cost-effective to manufacture.



Treatment tank – Insulation, heating elements and electrical fittings removed for clarity

Overall dimensions of the removable cover:
Length 1770 mm, Width 1020 mm, Height 20 mm

Diagram not to scale

4 Time Plan for Producing the Product

When creating a product, the design process takes time and varies depending on its complexity, including the manufacturing and the available resources the company has. The first phase of the time plan is the concept development and design. This provides a foundation for the project to outline the objectives, provide deadlines and other activities. In the development of concept design, sketches and prototypes are generated to create a visual aspect of the design and refined further to meet the requirements. The feasibility of the project is assessed, including production costs and resource requirements, to ensure that it's achievable. (Taylor, 2025).

The next phase is design and development. This involves the concept being finalised and created into a functional product meeting all the technical and quality standards. The product is created in a technical drawing, detailed with dimensions, specifications and materials. It would be tested on a simulation software for structural analysis to predict the product in a real-world environment before creating the very first prototype. Ensure that the product is compliant with safety standards and any relevant industry standards, then optimise the product for efficient manufacturing. (Taylor, 2025).

The final step is testing and validating the product. The functionality of the product is tested to ensure it performs under various conditions and may go through other different tests that are relevant to the application to identify any issues that may have slipped through before it is manufactured for a larger scale. (Taylor, 2025).

From research and my own estimation, a product like this would roughly take 8-12 months to design, refine and manufacture. The second phase of the project will take more time due to creating the specifications, materials, and dimensions of the product, using technical drawings and testing with simulation software, and researching the standards to ensure that it is compliant with the

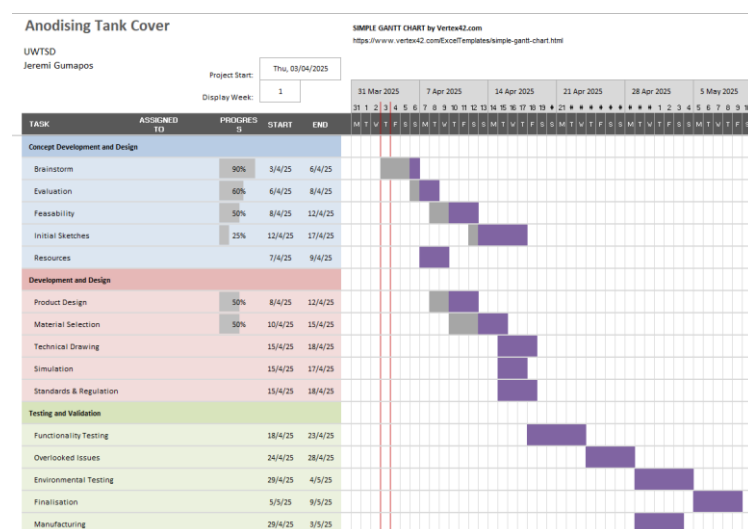


Figure 1 Gantt Chart Example

related appliance. For this example of a time plan, a Gantt chart is used to plan the project.

Figure 1 is a Gantt chart template obtained from Excel, created by Vertex42. (VERTEX42, 2025).

5 Relevant Research

When re-designing a product, research is done to expand and improve ideas. For this project, material research is a key area. The stainless-steel cover is heavy; finding a lighter alternative is recommended. Aluminium may be a cheaper and lighter option, but for its application, it's always exposed to the elements and is known to be not durable. (SANLAKMETALS, 2024). The cover is frequently exposed to 30% sulphuric acid solution at 25°C, a suitable material would be fiberglass reinforced plastic. FRP is much lighter than stainless steel; up to 75% lighter. It is resistant to corrosion and has a low thermal conductivity, making it a perfect material for this application. (Fibergrate, 2024).

The material and manufacturing cost of FRP is inexpensive compared to stainless steel. The raw materials consist of fibreglass and resin, and for manufacturing, it can either be done with a hand lay-up process or a vacuum infusion process. On the other hand, stainless steel is costly, using a different grade, e.g. 316 stainless steel, for corrosion resistance and manufacturing such as cutting, welding and fabrication.

Another key research area is Health & Safety. Ensure that the design complies with the relevant regulations, such as MHOR 1992, ensuring the new design reduces the risk of injuries and PUWER 1998, that the design is suitable for the intended use. Ergonomic research is also relevant. The design must be operated by one person instead of two to make the process more efficient while factoring in the regulations.

6 Sketches and Design Concepts

6.1 Rolling Shutter Cover

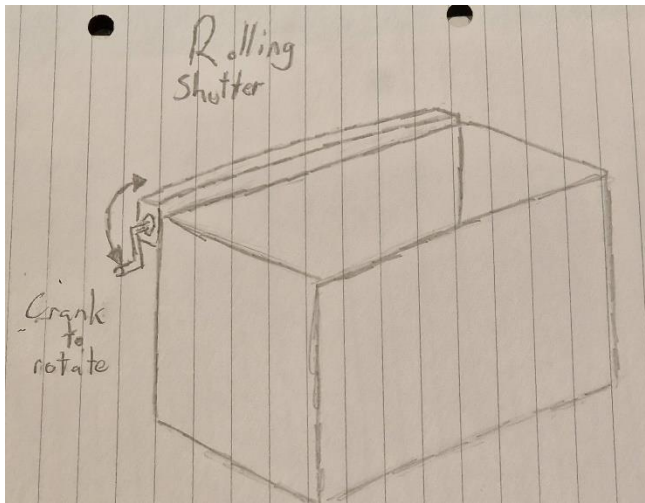


Figure 2 Rolling Shutter Mechanism

My first concept idea for the cover is using a manual rolling shutter mechanism. Since no lifting is required, stainless steel can still be used. A crank is used to operate the mechanism, rotating it clockwise closes the tank and anti-clockwise to open. In this design, wheels are installed at the end of the shutter sitting on the top edge of the tank that acts as a rail. It would also prevent the shutter from rolling all the way in.

Another option was to use guide rails instead of wheels. The guide rails would be installed onto the housing and would have the same length as the tank from the side. A small pedestal is then installed at the end of the guide rails on top of the tank for structural support.

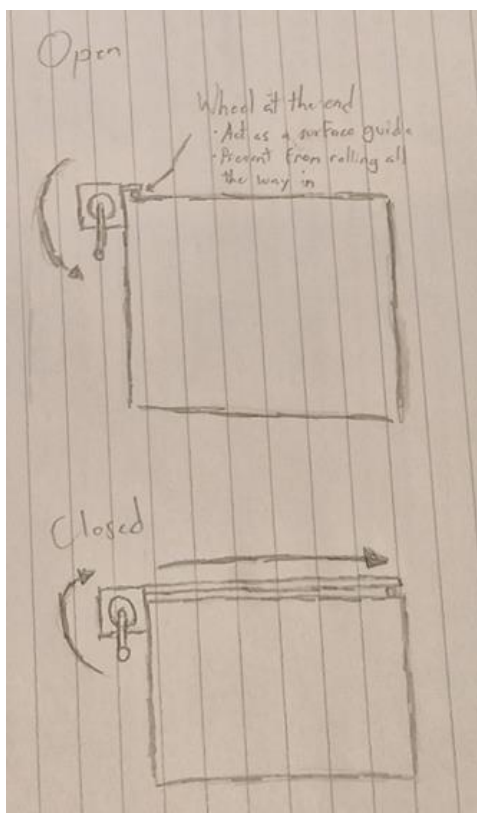
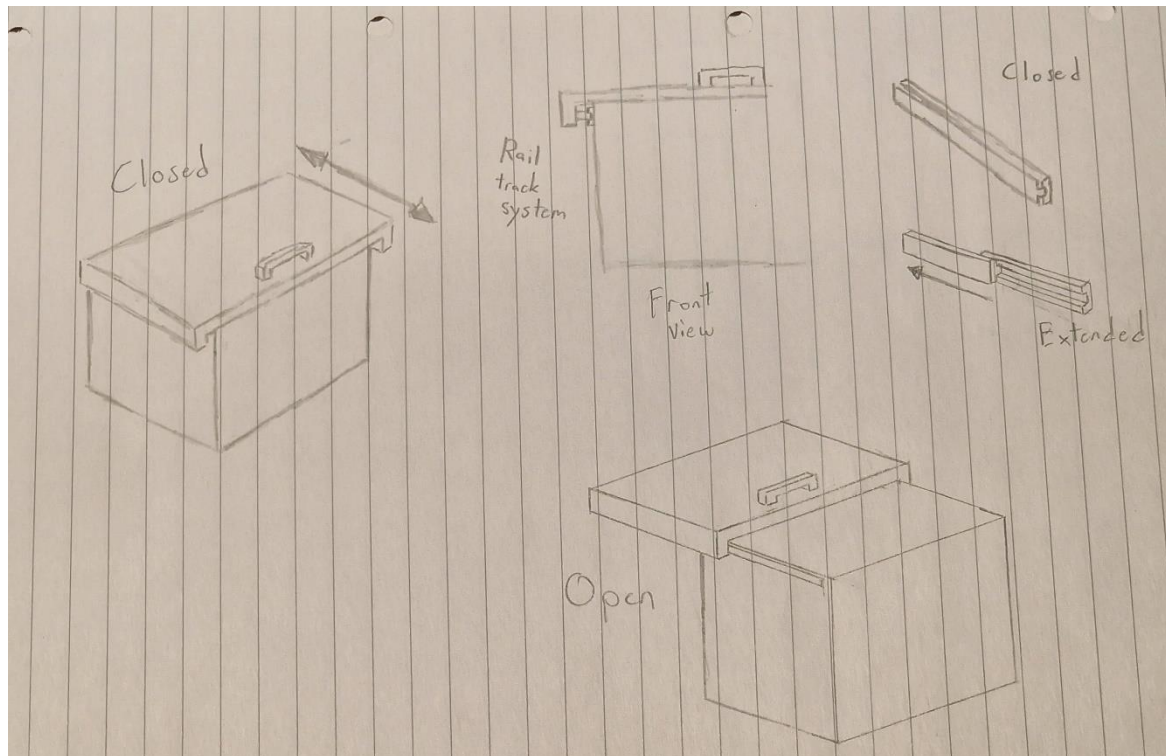


Figure 3 Open and Closed State

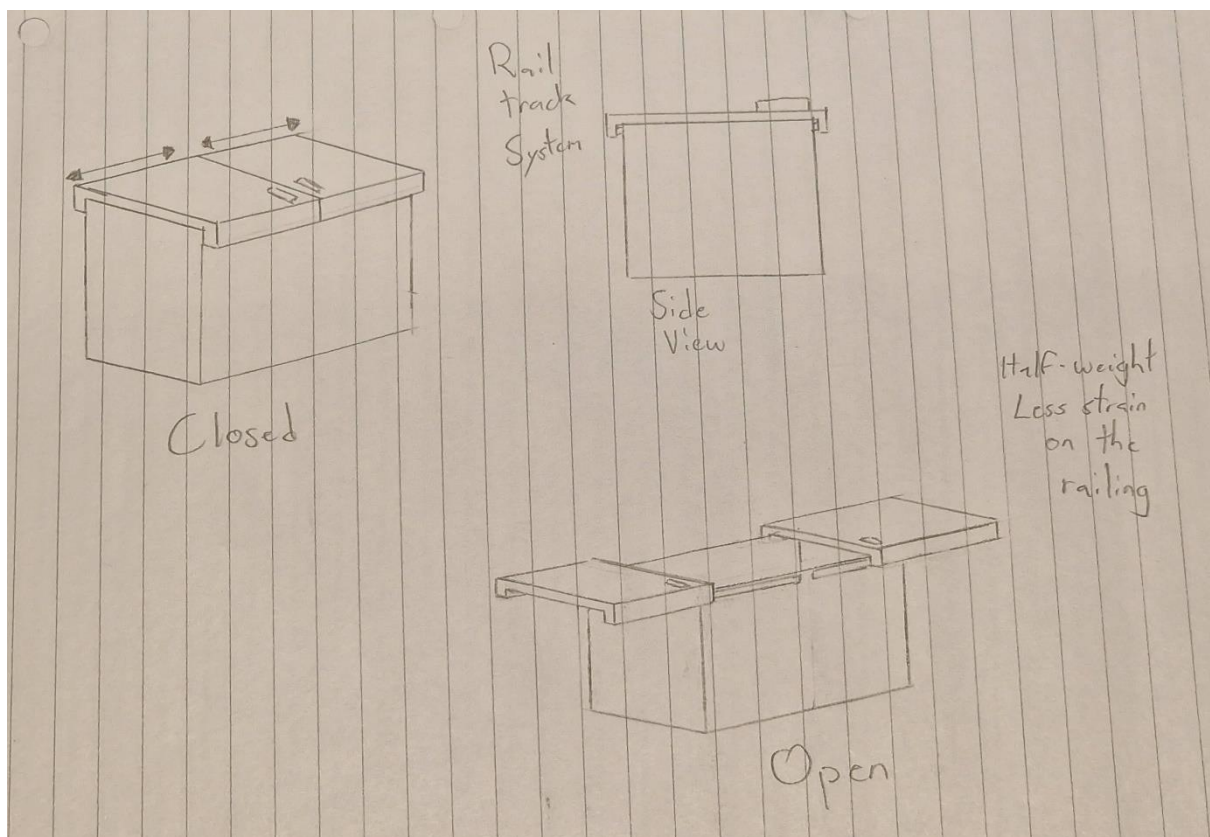
Figure 3 shows how the mechanism would look as it closes and opens, with arrows as an indication.

6.2 Ball Bearing Slide/ Rail Track System Longitudinal



Another concept is using a ball bearing slide or rail track system. It is installed longitudinally on the tank and the cover. No lifting is required, but due to the cover hanging over when opened, it will cause strain on the telescopic slides. Therefore, the material used here is FRP. It is much lighter than stainless steel, so there is less stress on the slides, and it is corrosion-resistant. The problem with this design is that the person has to reach over to grab the cover to close it, which may be a health and safety hazard.

6.3 Ball Bearing Slide/ Rail Track System Transverse



This last design is the same as the second concept design, but instead of installing the telescopic slides longitudinally, they are instead installed transversely. The cover is cut in half to allow this installation. This also reduces the weight of the cover for each pair of slides, therefore less strain while it is open. Compared to the second design, this eliminates the need for the person to reach over the tank, which is beneficial for health and safety. Therefore, this will be the chosen design for this project.

7 CAD Model of the Selected Design.

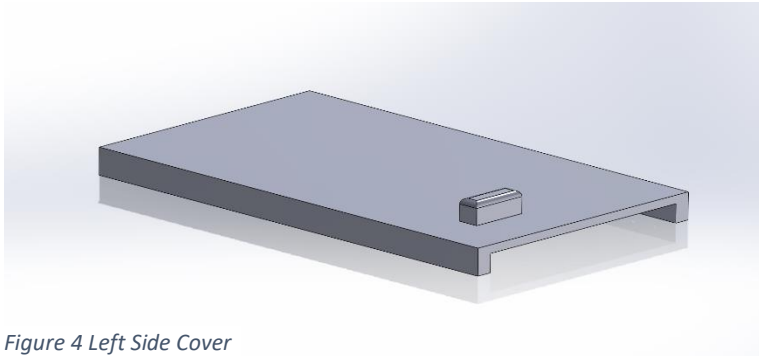


Figure 4 Left Side Cover

Figure 4 is a CAD drawing of the left side cover.

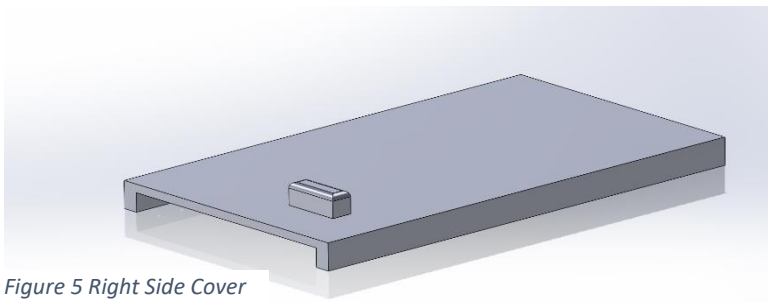
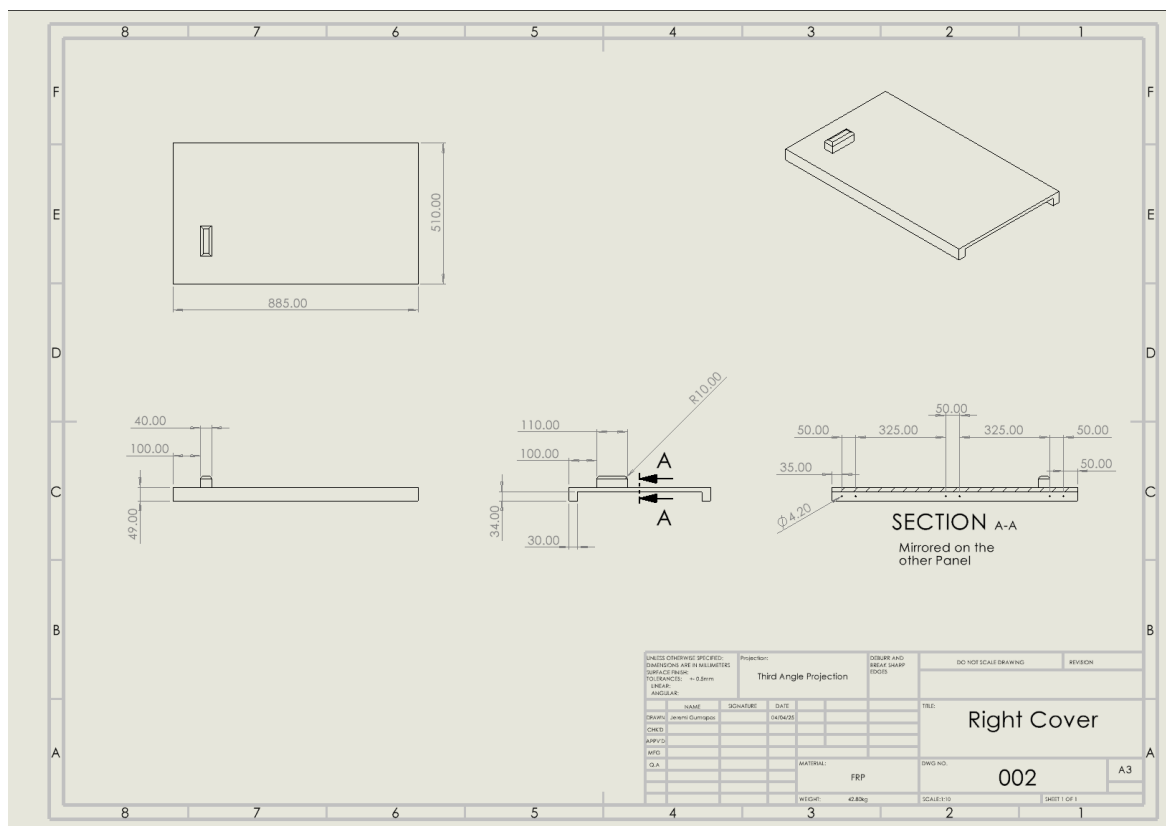
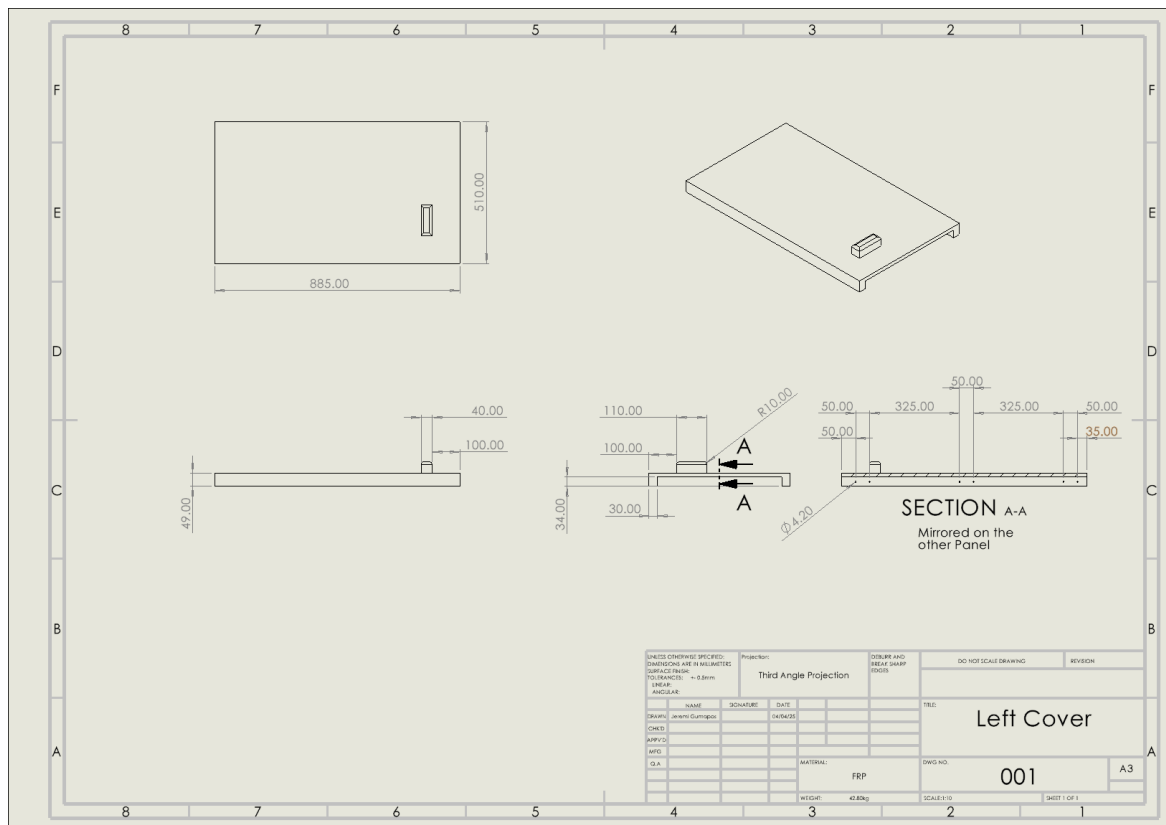


Figure 5 Right Side Cover

Figure 5 is the CAD drawing of the right side cover.

8 Technical Drawing



9 Manufacturing Process

The chosen material for the cover is FRP. Therefore, the manufacturing process for this material is pultrusion. The pultrusion process provides a good strength-to-weight ratio and corrosion resistance. It is also cost-effective compared to prepreg hand lay-up. (Addcomposites, 2024)

The chosen screw is a countersunk M5 20mm DIN 7991 High tensile steel. (ACCU, 2025a) These will be used to install the slider on the tank. While M6 20mm joint connector bolts are used to install the other side of the slider on the covers. (ACCU, 2025b).

The slider used for this design is the telescopic ball bearing slide produced by CHAMBRELAN. (CHAMBRELAN, 2025).

10 Justification for Design Choices

Firstly, the material chosen for the design is FRP. This is due to the material being much lighter than stainless steel therefore, less strain is placed on the sliders while it is open. This is also why the sliders are installed transversely rather than longitudinally, because each pair of sliders carries half the weight of the cover. It also has high corrosion resistance, perfect for this application since it will always be exposed to the elements. It is also cost-effective than stainless steel.

The slider design is chosen over the rolling shutter mechanism because of its ergonomics. It is a lot easier to operate, therefore, not having to move as much around the tank and is more efficient. It is installed transversely because of less strain, but also removes the need to reach over the tank when installed longitudinally, which offers health and safety benefits.

11 Further Work

Research more about the company that produces the ball bearing sliders. See if they can produce custom sliders since there isn't a suitable slider that fits with the tank. The cut cover is 885mm long, and the closest to that value is their 900mm sliders. If these are installed, the sliders protrude out by 15mm on each side. Could have researched the integrity of the ball bearing slider through a simulation software such as SOLIDWORKS

More research could have been done on the material FRP. As there are different types of fibres which provide different properties, such as their strength and stiffness. There are also different types of resins which can provide other benefits to FRP such as increased flexibility, corrosion resistance and thermal properties. There may be more materials that are suitable for this application that have better properties or are more cost-effective in manufacturing.

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