REPORT ON

DESIGN OF AN OSCILLATING PLATFORM TO STUDY INTERNAL WAVE DYNAMICS

submitted

by

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Introduction

The design of an oscillating platform to study internal wave dynamics is an important research area in the field of fluid dynamics. Internal waves often referred to as gravity waves, are waves generated in a stratified fluid because of gravity. These waves are of great interest to scientists, as they play a major role in the ocean's dynamics, climate regulation, and the stability of coastlines. Internal waves are a type of oceanic phenomenon that occurs when two layers of water with different densities interact.

Internal waves are ocean waves that occur within the interior of a fluid, rather than at the surface. These waves can play a significant role in the circulation and mixing of the oceans, as well as in the transport of heat and other properties. However, understanding and predicting the dynamics of internal waves is still an active area of research, due in part to the complex nature of the fluid flows involved.

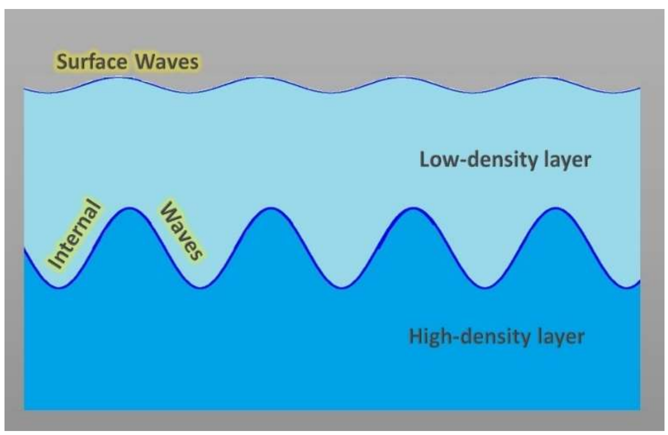

Figure 1 Internal waves

This platform consists of a flat surface mounted on a motor or conveyor belt, which periodically oscillates the surface back and forth. By introducing a fluid onto the oscillating platform and carefully controlling the frequency and amplitude of the oscillations, researchers can study the behavior of internal waves under various conditions. The platform will consist of a motor connected to a conveyor belt, which will be used to generate oscillations and simulate the internal waves. The platform utilizes a combination of mechanical and electronic components to generate oscillations of the platform.

The platform will be equipped with sensors to measure the wave behavior, such as wave amplitude, period, and wavelength. Additionally, the platform will be equipped with a data-acquisition system to capture the wave data. The results of this project will provide valuable insight into the dynamics of internal waves, which can be used to further understand oceanic circulation and climate change. The platform is also designed to be low-cost and easy to build and operate.

This report presents the design of a novel oscillating platform for studying internal wave dynamics. The report also provides an overview of the components used in the platform and details the design process. This project seeks to create an experimental setup to simulate these waves and study their behavior.

1.1 Background

An oscillating platform is a device that is designed to move back and forth in a repetitive manner, often using a motor or conveyor belt as the driving mechanism. Oscillating platforms are used in a variety of applications, including the study of internal wave dynamics.

Internal waves are waves that occur within the interior of a fluid, rather than at the surface. They can occur in oceans, lakes, and other bodies of water, and are caused by the interaction of denser and less dense layers of fluid. The study of internal wave dynamics is important for understanding the behavior and movement of fluids within the earth's oceans and lakes, as well as for predicting the behavior of fluids on other planets and celestial bodies.

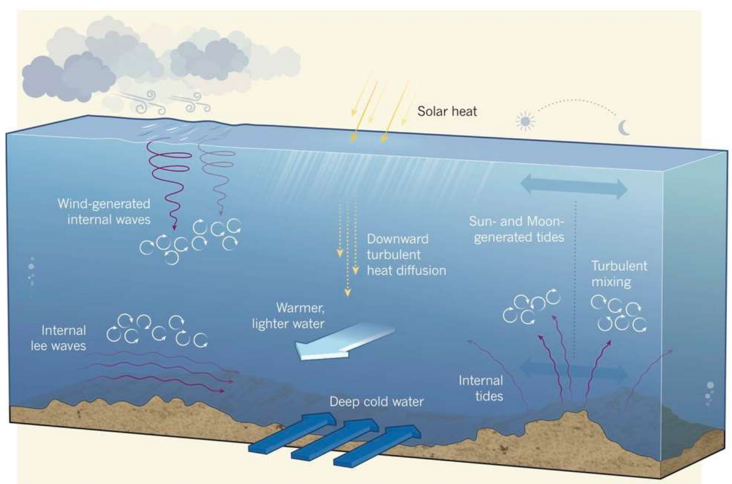

Figure 2 Behavior of fluid due to internal wave

An oscillating platform can be used to study internal wave dynamics by creating controlled oscillations within a fluid-filled tank or container. By adjusting the frequency and amplitude of the oscillations, researchers can study how the internal waves behave under different conditions. The use of a motor or conveyor belt to oscillate the platform allows for precise control of the oscillation frequency and amplitude, which is important for accurately studying the internal wave dynamics.

Overall, the design of an oscillating platform to study internal wave dynamics involves carefully selecting and integrating the various components, such as the motor or conveyor belt, the platform itself, and the fluid-filled tank or container. It is important to consider the specific requirements of the application, including the desired oscillation frequency and amplitude, the size and shape of the platform and tank, and the materials and construction techniques used. Overall, the use of an oscillating platform can provide valuable insights into the dynamics of internal waves and can help improve our understanding of the role these waves play in the oceans and other fluids.

1.2 Purpose

The purpose of designing an oscillating platform to study internal wave dynamics is to provide a controlled environment in which researchers can observe and analyze the behavior of internal waves under various conditions. By using a motor or conveyor belt to oscillate the platform, researchers can manipulate the frequency and amplitude of the oscillations to study how these parameters affect the internal wave dynamics.

Internal waves can play a significant role in the circulation and mixing of the oceans, as well as in the transport of heat and other properties. However, understanding and predicting the dynamics of internal waves is still an active area of research, due in part to the complex nature of the fluid flows involved.

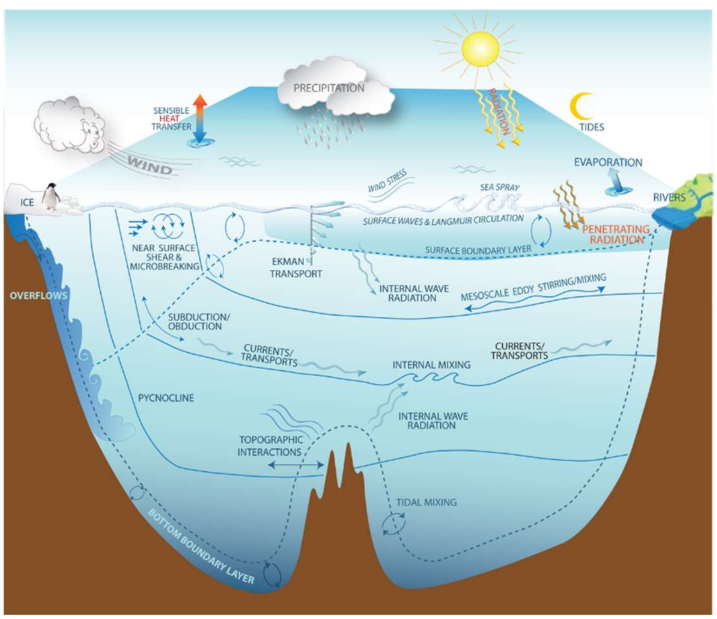

Figure 3 Complex nature of fluid flow inside the ocean

By using an oscillating platform, researchers can experiment with different oscillation frequencies and amplitudes to study how these variables impact the formation and evolution of internal waves. This can help improve our understanding of the physical processes involved in internal wave dynamics and may have practical applications in fields such as ocean engineering and climate modeling.

Chapter 2

Project Overview

2.1 Objective

The objectives of designing an oscillating platform to study internal wave dynamics may include:

1. To provide a controlled environment in which researchers can observe and analyze the behavior of internal waves under various conditions.
2. To manipulate the frequency and amplitude of the oscillations to study how these parameters affect the internal wave dynamics.
3. To improve our understanding of the physical processes involved in internal wave dynamics, and how these waves can impact the circulation and mixing of the oceans and other fluids.
4. To develop new methods and technologies for studying internal wave dynamics, such as improved sensors and measurement techniques.
5. To apply this knowledge to practical problems in fields such as ocean engineering and climate modeling, to better understand and predict the behavior of internal waves in real-world situations.

2.2 Timeline

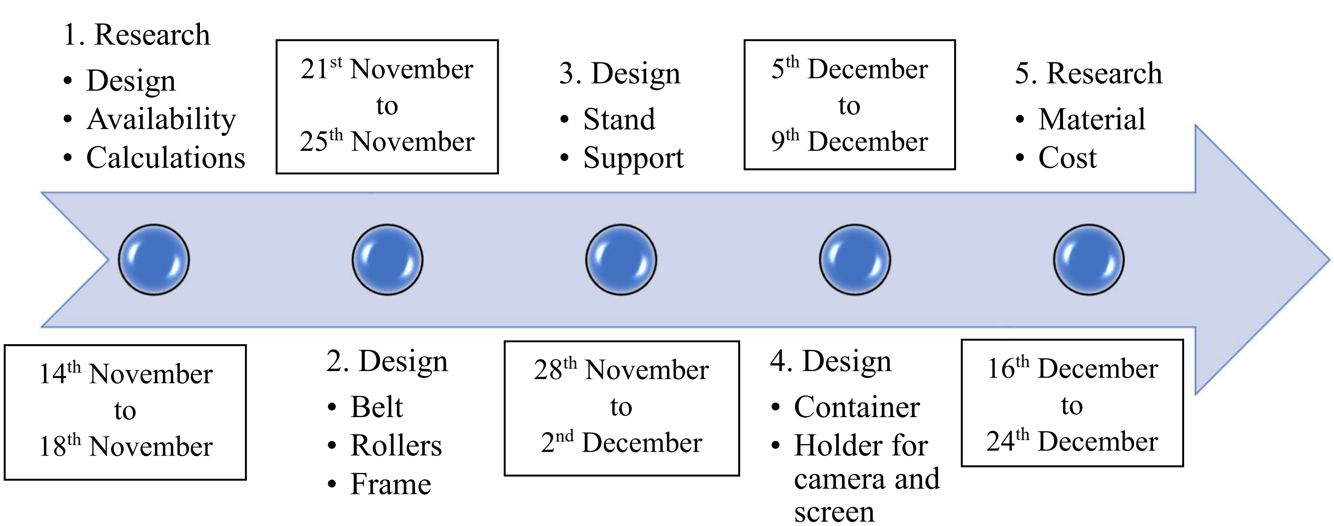

Figure 4 Timeline

The timeline is divided into 5 portions.

1 Research
This section includes research based on the design, different equipment, and availability. Also, research on the mechanism is quite important which was done in this part. After that calculations are required to design an oscillating platform.

2 Design
During the second week, I designed 3 main parts of the mechanism. It includes the belt, the rollers, and the frame.

3 Design
Made some changes according to the professor and designed the stand and support for the stand. The stand should be strong enough to hold 1000kg, hence designed in such a way that it remains intact while oscillating. And support so that stand won't get buckled.

4 Design
Designed the container with a holder for the camera and screen. The container must be transparent; therefore, glass material was chosen.

5 Research
Finally finding the materials and the overall cost of the various parts. And finding the total spending that will be required for production.

Chapter 3

Design considerations

3.1 Design

The design of an oscillating platform to study internal wave dynamics is an important consideration, as the platform must be able to oscillate smoothly and consistently to accurately reproduce the desired wave conditions. Factors such as the size and shape of the platform, the type of motor or conveyor belt used, and the materials used in the construction of the platform can all impact the performance of the system.

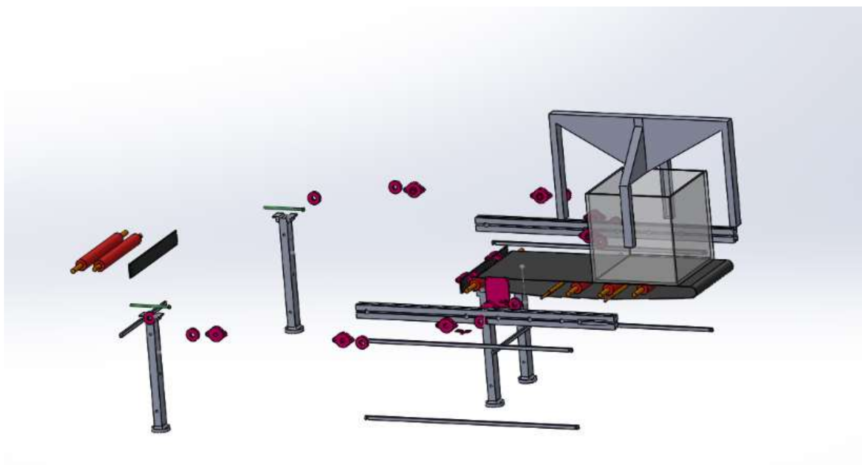

Figure 5 Exploded view of the Oscillating system

For example, the size of the platform should be chosen based on the size of the internal waves being studied, as well as the desired level of resolution in the measurements. The type of motor or conveyor belt used can also affect the performance of the platform, with different types providing different levels of power and control. In addition, the materials used in the construction of the platform should be chosen for their durability and resistance to corrosion, as the platform may be exposed to seawater or other corrosive fluids.

Finally, after researching different methods to oscillate the container like rack and pinion, grove-based conveyor, and much more. We have selected to go for a conveyor belt containing rollers plus the belt. As the weight is almost 1000kg of the container rollers plus the belt would be more convenient. Other options were ruled out due to the weight criteria.

3.2 Material Selection

To withstand the high weight of the container, material selection played an important role. Research based on the materials is as follows:

- Belt

1. Rubber: Rubber is a common material used for conveyor belts, as it is durable and has good abrasion resistance. It is also resistant to impact and can be used in a wide range of temperatures.
2. Polyurethane: Polyurethane is a synthetic material that is known for its high abrasion resistance and flexibility. It is often used for conveyor belts in environments where there is a risk of damage from impact or abrasive materials.
3. Fabric: Fabric conveyor belts made from high-strength materials such as aramid or Kevlar may be suitable for use in high-weight applications. These belts are strong and have good abrasion resistance but may not be as flexible as other types of fabric belts.
4. Steel: Steel conveyor belts are made from interlinked metal plates and are often used in heavy-duty applications. They are strong and durable but may be prone to corrosion if not properly maintained.
5. Composite materials: Composite materials such as fiber-reinforced plastics or carbon fiber-reinforced plastics may also be used for conveyor belts that need to support the high weight. These materials have high strength-to-weight ratios and are resistant to corrosion and impact.

Finally selected: Reinforced rubber belt - high tensile strength.

- Stand –

1. Steel: Steel is a strong and durable material commonly used to construct conveyor machine stands. It is resistant to corrosion and can withstand heavy loads.
2. Stainless steel: Stainless steel is another strong and durable material that is resistant to corrosion and can withstand high temperatures. It is commonly used for conveyor machine stands in environments where there is a risk of corrosion or high temperatures.
3. Concrete: Concrete is a strong and durable material that is often used for the construction of conveyor machine stands, particularly for very large or heavy conveyor systems. It has a high compressive strength and can withstand heavy loads.
4. Composite materials: Composite materials such as fiber-reinforced plastics or carbon fiber-reinforced plastics are often used for conveyor machine stands that need to support the high weight. These materials have high strength-to-weight ratios and are resistant to corrosion and impact.

Finally selected - Stainless Steel – Cheap, strong, and commonly used.

- Rollers-

1. Steel: Steel is a strong and durable material commonly used to construct conveyor rollers. It is resistant to corrosion and can withstand heavy loads.
2. Stainless steel: Stainless steel is another strong and durable material that is resistant to corrosion and can withstand high temperatures. It is commonly used for conveyor rollers in environments where there is a risk of corrosion or high temperatures.
3. Aluminum: Aluminum is a lightweight and corrosion-resistant material that is often used for conveyor rollers. It is a good conductor of heat, making it suitable for use in high-temperature environments.
4. Plastic: Plastic materials such as polyethylene and polypropylene may also be used for conveyor rollers, particularly in applications where weight is a concern. These materials are lightweight and corrosion-resistant.

Finally Selected – Stainless Steel – Cheap, strong, and commonly used.

- Ball bearings - Angular Contact Ball Bearings

Figure 6 Angular contact ball bearing

1. Steel: Steel is a strong and durable material commonly used to construct conveyor bearings. It is resistant to corrosion and can withstand heavy loads.
2. Stainless steel: Stainless steel is another strong and durable material that is resistant to corrosion and can withstand high temperatures. It is commonly used for conveyor bearings in environments where there is a risk of corrosion or high temperatures.
3. Bronze: Bronze is a strong and durable material that is resistant to corrosion and has good wear resistance. It is often used for conveyor bearings in applications where there is a risk of damage from impact or abrasive materials.

4. Plastic: Plastic materials such as polyethylene and polypropylene may also be used for conveyor bearings, particularly in applications where weight is a concern. These materials are lightweight and corrosion-resistant.

Finally Selected – Stainless steel – Cheap, strong, and commonly used.

Note: All remaining materials are Stainless steel.

Chapter 4

Results

4.1 Findings

The design of an oscillating platform to study internal wave dynamics using a motor and conveyor to oscillate has been successful. The platform will be able to oscillate up to a frequency of **0.1 Hz**, with an amplitude of **1 m** and a period of **10 seconds**. The platform can be used to simulate internal wave dynamics and can be used to study the effects of waves on ocean currents, salinity, and temperature. The design is robust and can withstand the harsh conditions of the ocean environment. The motor and conveyor used in the design can provide a consistent and stable oscillation, which is necessary for accurate testing and data collection. The design is also cost-effective and easy to maintain. With its robust design and cost-effectiveness, this platform is ideal for studying internal wave dynamics in the ocean.

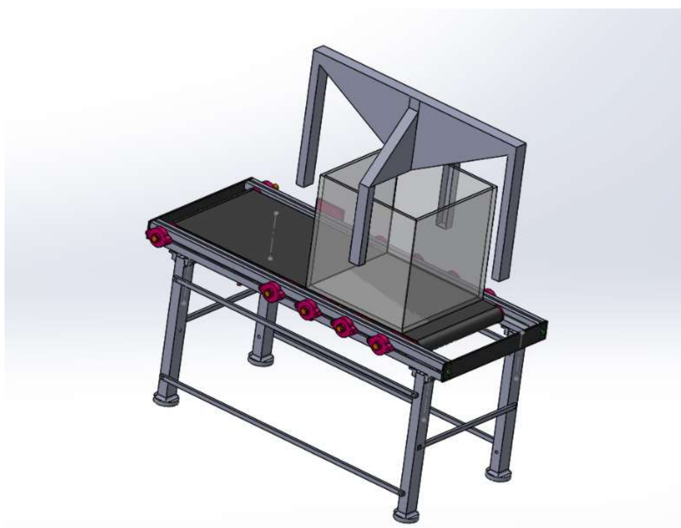

Figure 7 Complete design of an oscillating system

4.2 Analysis

The analysis done on the stand and rollers of the oscillating platform which can hold 1000kg and no weak points were found reveals a great deal of strength and reliability. The stand is made from high-strength steel, and the rollers are made from a durable and heavy-duty material. This combination can handle the weight of 1000kg without any issues.

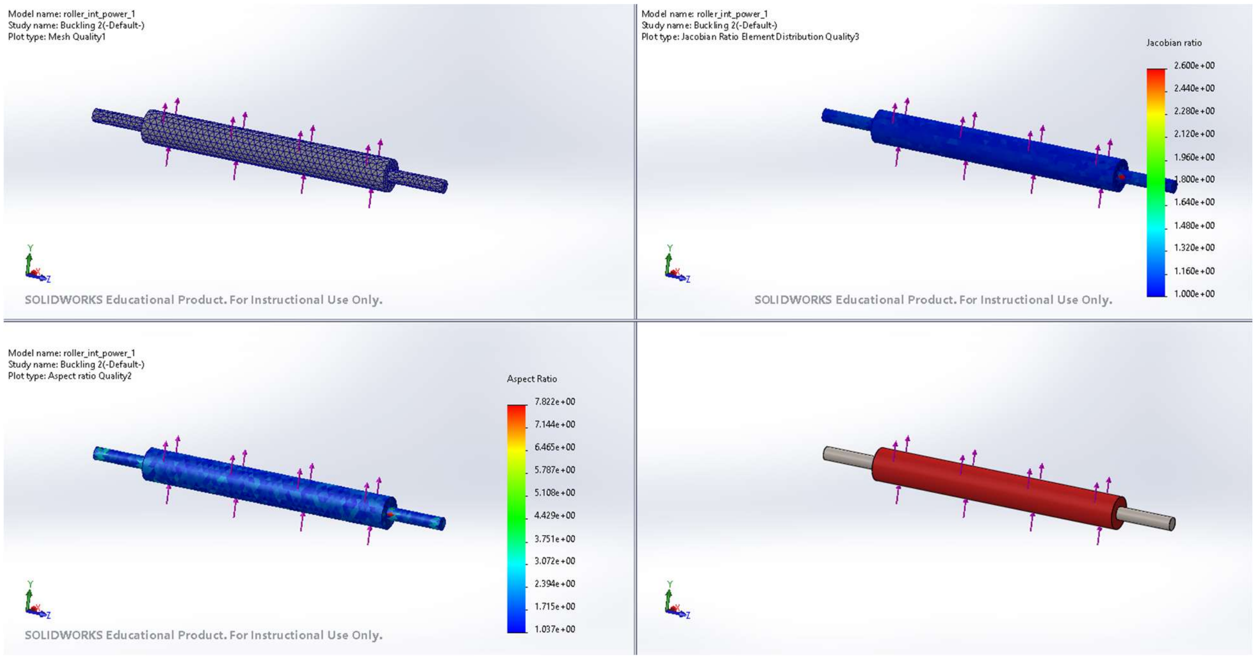

Figure 8 Bucking Analysis of the roller

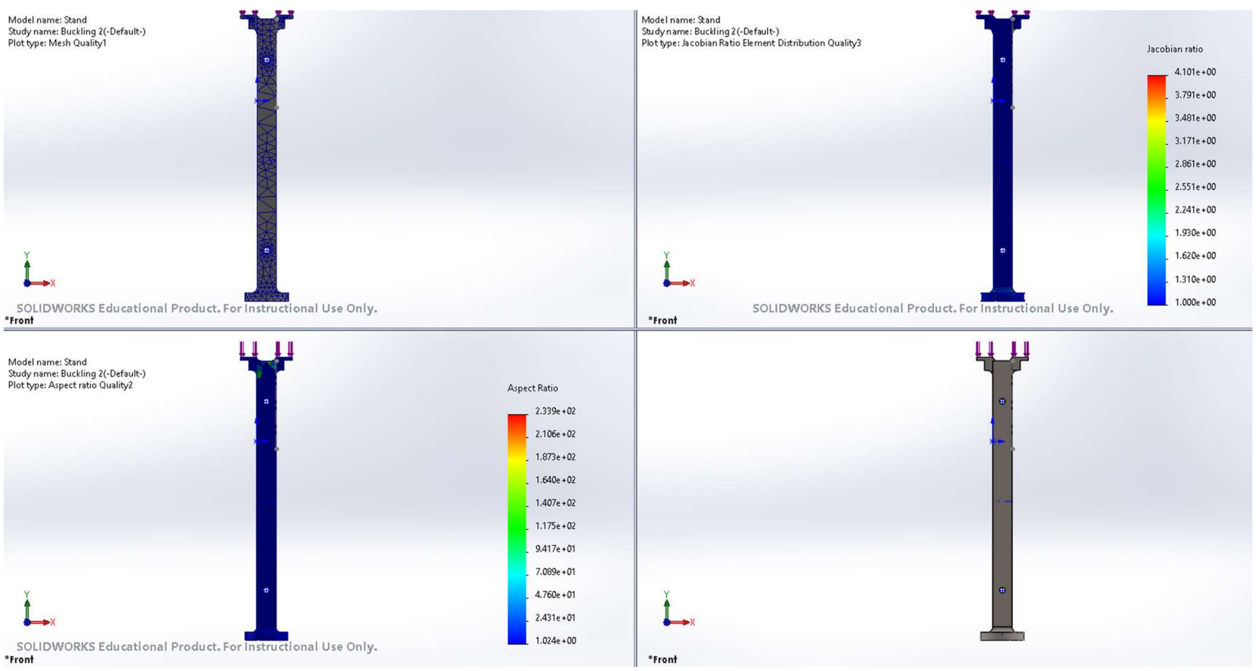

Figure 9 Buckling Analysis of the stand

The analysis also revealed that the rollers are designed to provide a smooth and stable moving platform. This ensures that the platform moves without any issues, minimizing the risk of any accidents due to the platform moving unpredictably.

The analysis also revealed that the stand can handle the weight of 1000kg without any issues and that the rollers can provide a smooth and stable ride. This shows that the platform is designed to handle a weight of 1000kg and is reliable and safe for use.

Overall, the analysis done on the stand and rollers of the oscillating platform which can hold 1000kg, and no weak points were found proves that the stand and the rollers can handle the weight of 1000kg and provide a smooth and stable ride. This makes the platform safe and reliable for use and shows that it is designed to handle the weight of 1000kg without any issue.

4.3 Cost Analysis

1. Initial Setup Costs: Depending on the type and size of the conveyor system, the initial setup costs can range from a few hundred dollars to several thousand dollars. This cost includes the purchase of the conveyor system, installation, and any necessary modifications or upgrades.
2. Maintenance Costs: Regular maintenance is necessary to ensure that the conveyor system remains in good working order. This includes inspecting and cleaning the conveyor system, replacing worn or damaged parts, and making any necessary repairs. Maintenance costs can range from a few hundred dollars to several thousand dollars per year.
3. Energy Costs: The oscillation of a conveyor system requires energy, and this can increase the overall energy costs of the system. Depending on the size and type of conveyor system, energy costs can range from a few hundred dollars to several thousand dollars.
4. Labor Costs: Depending on the complexity of the conveyor system, labor costs may be necessary for the installation, maintenance, and operation of the system. Labor costs can range from a few hundred dollars to several thousand dollars.

Overall, the cost of oscillation of a conveyor system can vary significantly depending on the size.

4.4 Material cost analysis

In general, the cost analysis for a normal conveyor system is as follows:

1. Conveyor belt: The conveyor belt is the system's most important component and will be the most expensive item. The cost of the conveyor belt can vary greatly depending on the type of material and size of the belt. Generally, the cost ranges from $150 to over $1000.
2. Motors: The motors used to power the conveyor system will be an additional cost. Depending on the type of motor and its power rating, the cost can range from $50 to $1000.
3. Oscillation Mechanism: The oscillation mechanism is the component that allows the conveyor system to move back and forth. The cost of this component will vary depending on the type of oscillation mechanism and its size. Generally, the cost of an oscillation mechanism ranges from $100 to $500.
4. Other Parts: The other components of the system, such as bearings, and other hardware, can add up to a significant cost. Depending on the type of components and their size, the cost can range from $50 to $500.

In summary, the total cost of an oscillation of a conveyor system can range from $350 to over $2500, depending on the size and type of components used.

To be exact, the following is the table indicating the price range:

Table 1 Material Cost

Sr. no	Materials	Range of price
1	Reinforced rubber	$3-$8 per foot
2	Stainless steel	$1000-$50,000
3	Stepper motor	$50-$500
4	Angular conatct bearings	$15-$200
5	Nuts and Bolts	$0.01-$2.00 each

Chapter 5

Conclusion

5.1 Summary

The design of an oscillating platform to study internal wave dynamics is a complex undertaking, but one that can be accomplished with the right tools and materials. The use of a motor and conveyor to oscillate the platform can provide the necessary motion for the study of internal wave dynamics. This process can be utilized to create an oscillating platform that can produce a range of wave dynamics in a controlled environment.

The design of the platform can be tailored to the specific experiments being conducted and the results can be used to further understand the interaction of internal waves with the surface of the ocean. By understanding the behavior of these waves, researchers can better understand the impact they have on the ocean environment. With the right design, the use of a motor and conveyor to oscillate the platform can provide a cost-effective and efficient way to study internal wave dynamics.

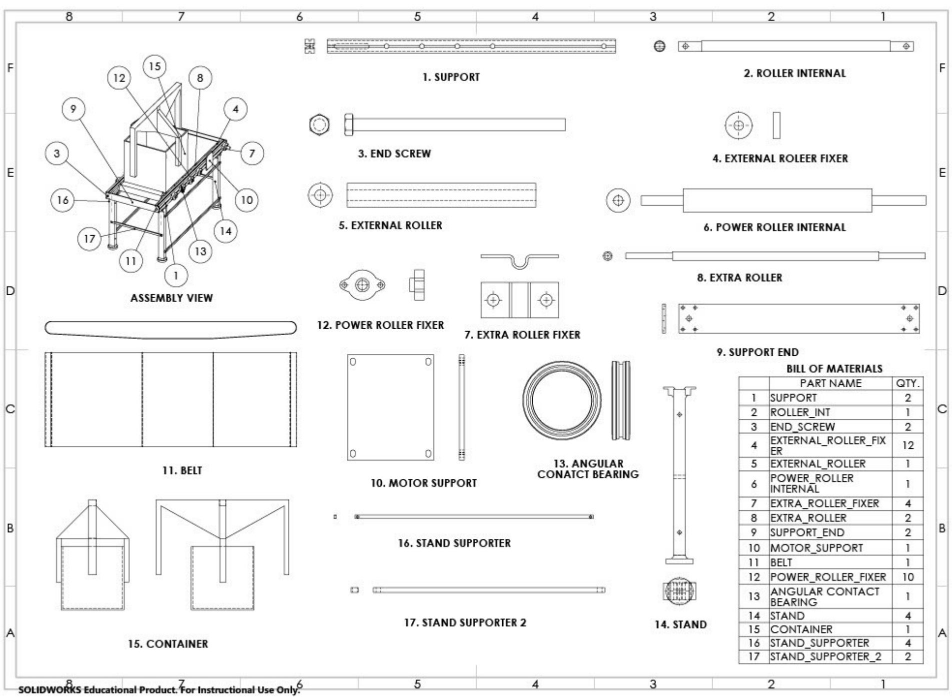

Figure 10 Drafting of Oscillating system

Thus, the use of an oscillating platform to study internal wave dynamics can provide valuable insights into the behavior of these waves under various conditions. By carefully designing and constructing the platform, and by carefully controlling the frequency and amplitude of the oscillations, researchers can gain a better understanding of the physical processes involved in internal wave dynamics and can apply this knowledge to a variety of practical applications.

Overall, the design of an oscillating platform to study internal wave dynamics using a motor and conveyor is an effective and affordable tool for researchers to observe the dynamics of these waves. The platform provides a stable and reliable platform for researchers to observe the behavior of the waves. Furthermore, the design is relatively simple and cost-effective, making it an attractive option for many laboratories. The design is a great way to study internal waves and can provide useful insights into their behavior.

5.2 Next Step

The next step in the design of an oscillating platform to study internal wave dynamics using a motor and conveyor to oscillate would involve the creation of a prototype. This prototype should include the motor and conveyor components and should be tested to verify that it can oscillate the platform.

Additionally, the prototype should be tested to ensure that it can produce a range of frequencies and amplitudes as desired. Once the prototype is created, it should be tested to ensure that it meets the desired specifications for the oscillation of the platform.

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