GNG<1103/2101>

Design Project User and Product Manual

Dream Team
User manual Deliverable
Group 8
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Submitted by:

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List of Acronyms and Glossary

None used

Table 1. Acronyms

Acronym	Definition
3-D	3 dimensional
N/A	
N/A	
N/A	
N/A	

Table 2. Glossary

Term	Acronym	Definition
Erosion	N/A	"The process of eroding or being eroded by wind, water, or other natural agents."

Revs per minute	RPM	“ It is a calculation of the rotation frequency, the number of revolutions or turns an object takes per minute. It puts in the image how many times in one minute an involuntary component spins around its axis.”
Fidelity	N/A	“the degree of exactness with which something is copied or reproduced.”
N/A	N/A	N/A
N/A	N/A	N/A

1 Introduction

This lab manual will explain the context of the basis of our design and the assumptions made throughout the various stages in chronological order of design. Open to all users who are interested in the thought process in which this accelerated erosion tester is made as well as any potential clients or for the free view of anyone interested.

This lab manual is the result of a group effort to create a solution to design create and test an accelerated erosion tester. Combining the efforts of our 3 group members Ibrahim, Semilore, and Ramtin, and the help of a 4th member who unfortunately due to complications was not able to finish this project with us, Jacob Roberge. There will be 3 prototype designs included in this lab manual which will have a low-fidelity prototype model, a medium-fidelity prototype model, and a final finished prototype which was all created within 3 months due to time constraints. As this project continued various concerns such as safety, budget, interpersonal, and time constraints played a big role in developing this project thus for these reasons a very simple prototype was the ideal this group had in mind. The purpose of this document will be to explain every step of the way to recreate this or to learn from using our failures, thought processes, and problems as well as results along the way

This User and Product Manual (UPM) provides the information necessary for <types of users> to effectively use the <System Name (Acronym)> and for prototype documentation.

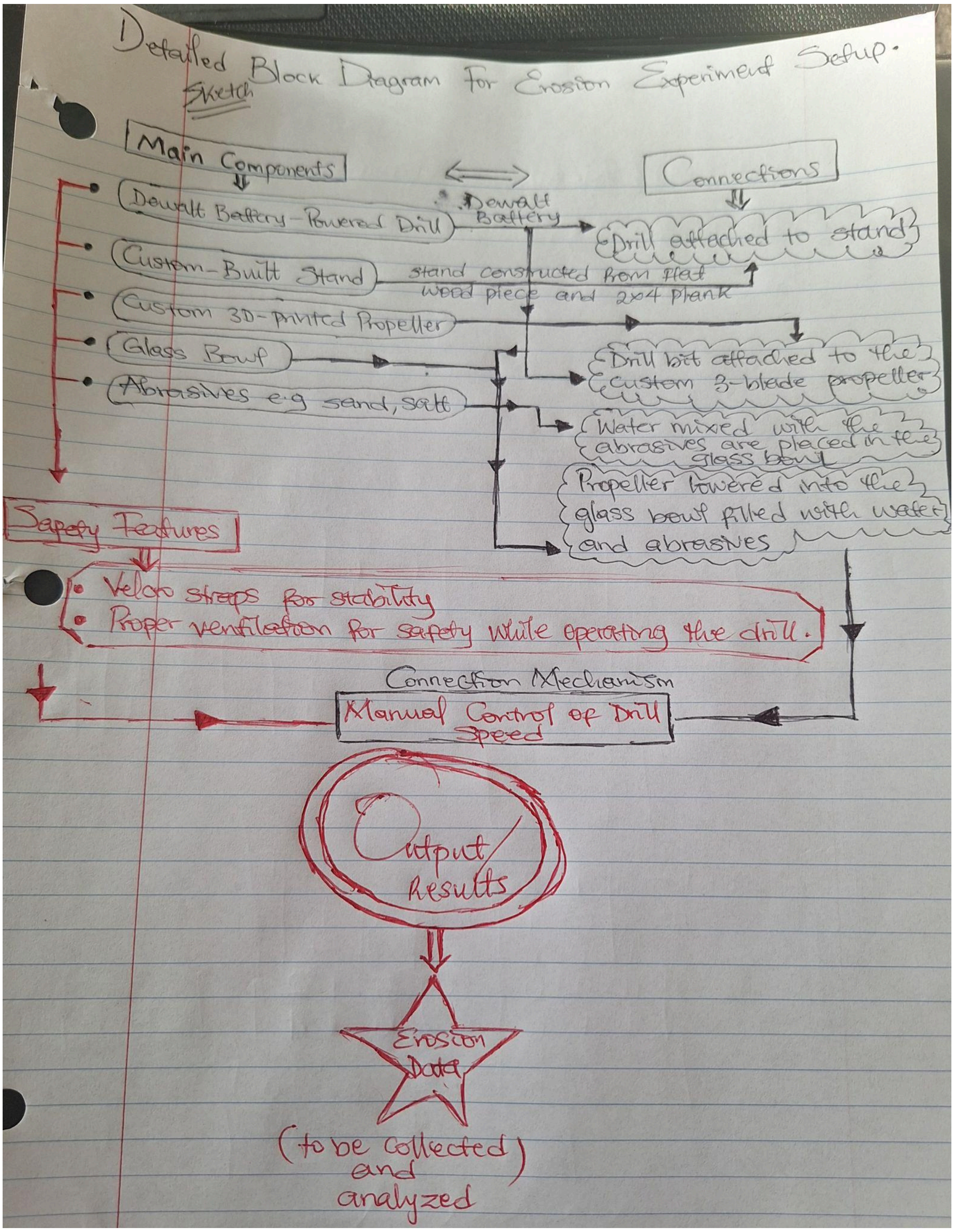
2 Overview

Problem To design create and test an accelerated erosion tester.
The fundamental need of user: To innovate and design a way of accelerating erosion on given proponents with given data to aid in research.
The main differentiation of our product against the competition is our efficiency and simplicity. While other groups used an Arduino motor we've decided to use a drill to save time and get faster results with the increased rpm potential. While also keeping our design without wires and essentially bare bones to get results.

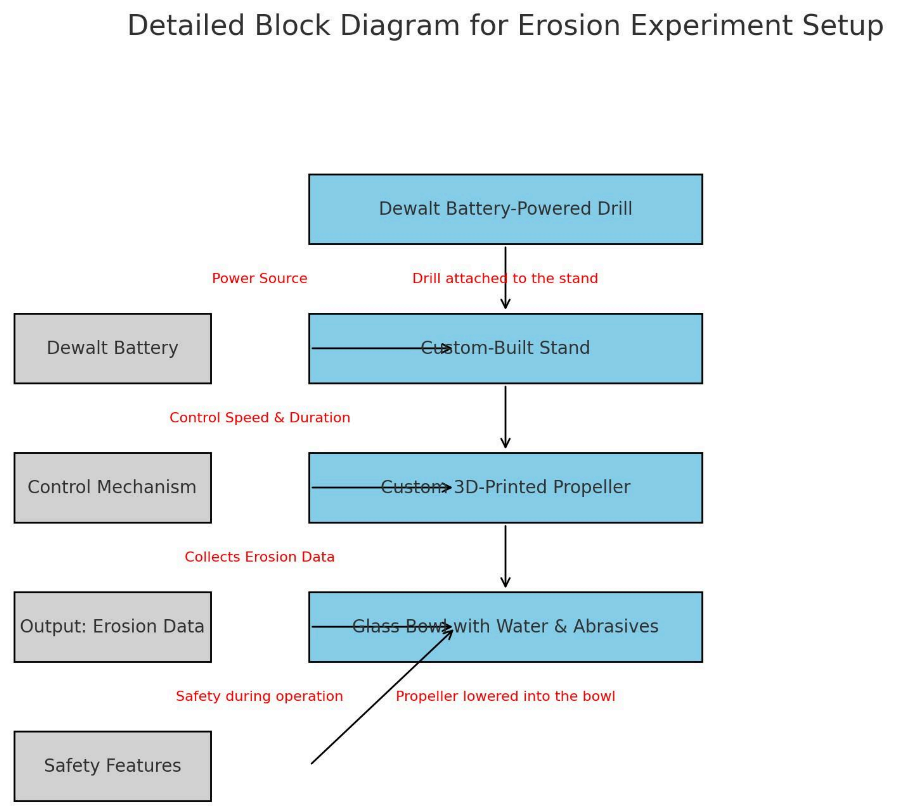
This prototype simply uses a Dewalt battery-powered drill held down by a custom-built stand to test a custom 3-D printed propeller in various conditions to test erosion.

The construction of this stand is built from a flat piece of wood from Home Depot paired with a 2x4 wood plank as the stand as the base. Attached to the 2x4 is a stand for the Dewalt power drill which is all tied in with screws to keep stability. 3 velcro straps are used to ensure further stability of the motor and keep it firmly mounted. Below the drill is an attached drill bit to a 3-D printed custom 3-blade propeller lowered into a glass bowl filled with water and abrasives such as sand and salt.

<u>Sketch</u>



Detailed Diagram



2.1 Conventions

N/A

2.2 Cautions & Warnings

Cautions include a 3-D printing certificate to ensure safety within creating the propellor blades. Understanding of simple use of drills and screws and simple wood cutting. Safety goggles throughout these processes are strongly advised with close-toe boots. If the prototype is recreated simply ensure all open electronics are clear from the bowl when operating.

3 Getting started

Overview

This section provides a step-by-step guide to set up, operate, and exit the Accelerated Erosion Testing Device. The instructions are designed to be easily understandable, even for users without engineering backgrounds. Visual aids, such as pictures and screenshots, accompany each step for clarity.

Setup

1. Assemble the Stand

   - Attach the 2x4 wood plank to the flat wood piece using screws (Figure 1).

   - Ensure stability by tightening the screws securely (Figure 2).

   [Figure 1: Attaching 2x4 wood plank to flat wood piece](attachment1.jpg)

   [Figure 2: Securing the screws for stability](attachment2.jpg)

2. Mount the Dewalt Drill

   - Place the Dewalt drill on the stand's mount.

   - Secure the drill in place using velcro straps (Figure 3).

   [Figure 3: Mounting the Dewalt drill on the stand](attachment3.jpg)

3. Attach the Propeller

   - Connect the custom 3-blade propeller to the drill bit.

   - Lower the propeller into the glass bowl filled with water and abrasives (Figure 4).

[Figure 4: Attaching the propeller and placing it into the glass bowl](attachment4.jpg)

Operation

1. Power On the Drill

   - Press the power button on the Dewalt drill.

   - Adjust the speed as needed using the control (Figure 5).

   [Figure 5: Powering on the Dewalt drill and adjusting the speed](attachment5.jpg)

2. Monitor Erosion Process

   - Observe the propeller's erosion in the water and abrasive mixture.

   - Record data as necessary for research purposes.

Exit

1. Power Off the Drill

   - Press the power button again to turn off the Dewalt drill.

   - Wait for the drill to stop completely before proceeding.

2. Remove the Propeller

   - Lift the propeller out of the glass bowl carefully.

   - Ensure no water or abrasives spill during removal.

3. Disassemble the Setup

   - Remove the velcro straps from the drill.

   - Dismantle the stand by unscrewing the components.

Special Steps for Clients

1. Provide Detailed Instructions

- Include a printed manual with clear steps and visual aids.

- Highlight safety precautions and emphasise the importance of following guidelines.

2. Offer Technical Support

- Provide contact information for technical assistance.

- Offer additional training or guidance if necessary for clients unfamiliar with the device.

Conclusion

Following these steps will allow users to set up, operate, and exit the Accelerated Erosion Testing Device safely and efficiently. For clients receiving the prototype, providing detailed instructions and offering ongoing support ensures successful usage of the device.

3d printing the propeller

3.1 Configuration Considerations

The configuration is simply made of a blade capable of rotating inside a tank of liquid(water in this case) to see parts of the blade deteriorate over time.

3.2 User Access Considerations

Various users could benefit from this accelerated erosion tester such as research institutions, environmental agencies, nuclear laboratories, engineering firms, mining and energy companies, etc. This design could be used by anyone if see fit

3.3 Accessing/setting up the System

To set up the system it is necessary to have safety equipment goggles and closed-toe shoes/boots. As well as a platform wide enough to be able to assemble all parts of this prototype. The specific materials required that were previously mentioned above in the document will also be needed (2-4 wooden planks, custom drill of choice, etc...).In case of safety, a noncautious environment should be used for example no electrical wires hanging around and or fire safety hazards to minimise the risk of injuries.

3.4 System Organization & Navigation

3.5 Exiting the System

This prototype is not built to be portable or put away this keep in one location if forced to relocate then simply firmly hold by the base of the board and if see fit remove the drill and re-attach at the new location.

4 Using the System

There are a couple of features to be noted on the prototype, one of them being the modulation of the motor as velcro straps are the only thing holding it in place, the propeller being able to spin backwards and forwards. The entire prototype was also focused on reduced weight but still rigid. The reason for these features was to make the prototype as flexible and portable as possible as the dimensions and location of where the prototype will be set up were not provided by the client.

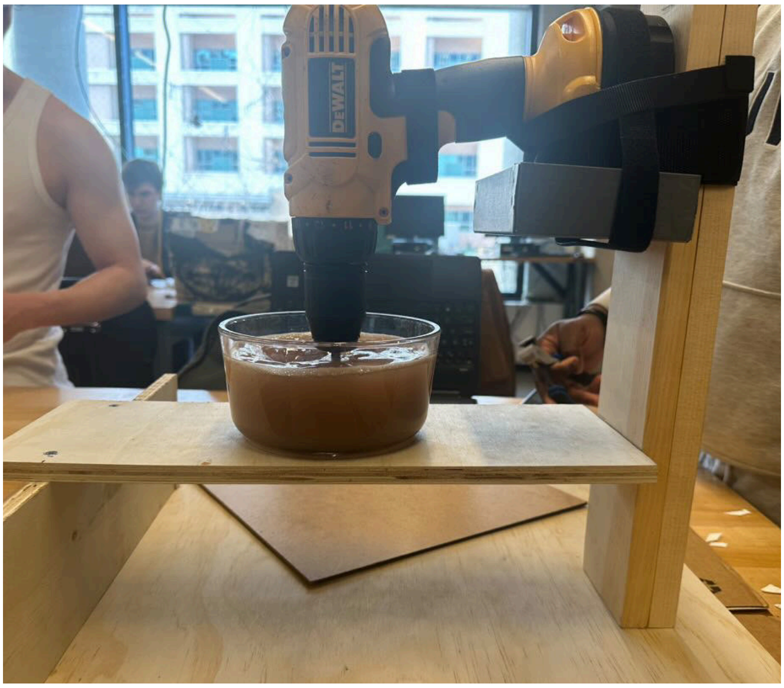
4.1 <Given Function/Feature>

4.1.1 <Hand Drill>

One of the subsections is the drill itself. The drill is a DeWalt hand drill and is rated to spin at 2200 rpm allowing for results to show really quickly. The drill also can spin clockwise or counterclockwise which allows for good circulation of abrasives depending on the chosen rpm.

4.1.2 <Stand>

The other subsystem is the stand itself. The stand was designed to be modular and lightweight. This was to allow for easy maintenance fixes, portability, ease of manufacturing, cost, and much more. The modularity also allows it to be able to run both a hand drill or an Arduino motor depending on the budget and circumstance. The use of wood also makes it sturdy, resulting in little to no vibrations when the system is under load. It can also support a lot of weight due to the structural design and water spillage should have no effect on the electronics as the bowl is raised above. The bowl can also be mounted on top of the plywood plank or through it with a few modifications, allowing for the container size to be modular as well.



5 Troubleshooting & Support

Measurements: Slight problems were encountered along the way due to a lack of initially measuring every piece of equipment and using it for other parts of the prototype with rigorous sketching. Thus ensure to include all measurements in sketches.

Battery: Ensure you have a sufficient battery with the drill or a constant supply of power attached to ensure the propellor does not come to a halt deviating results.

5.1 Error Messages or Behaviors

No part is prone to breaking, however the drill battery will eventually run out. The measured time that it took before the drill battery ran out was around one hour but this time may vary depending on how fast or slow the rpm is set to. The battery can easily be recharged by taking the velcro straps off, allowing easy access to the drill and for the battery to be removed from the drill.

5.2 Special Considerations

There are no real special circumstances that should be considered for troubleshooting as the prototype itself is really reliable and sturdy, resulting in no issues while running. A part that is not breaking, but rather due to wear are the velcro straps as if not tightened properly, will slowly become more loose causing the drill to fall. This however is really rare as the drill is supported by 3 velcro straps instead of just one.

5.3 Maintenance

The only regular maintenance that shall take place is recharging of drill battery and monthly tests on the stability of the bowl and ensuring that the velcro straps stay at 100% capacity.

5.4 Support

In case of emergency service, our group members can aid in such situation via our company telephone number and head operator:

Ramtin Tizfahm: 613-465-3874

Email : Dreamteamorg,inc@gmail.com

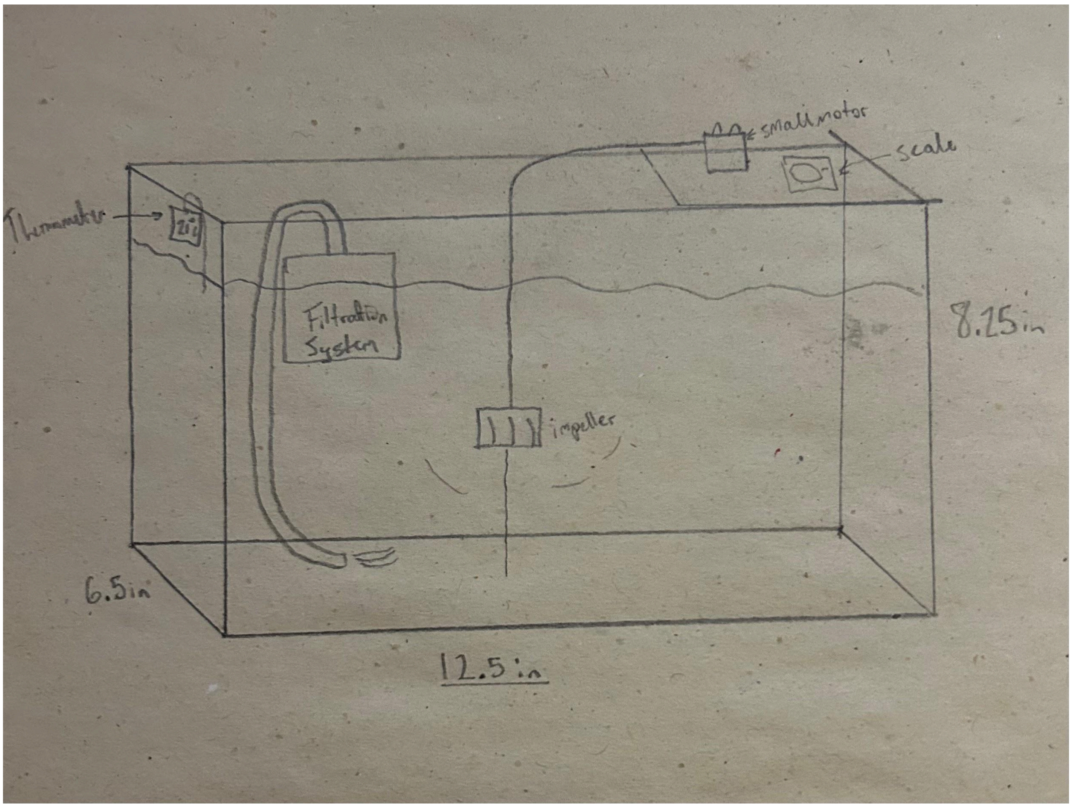
6 Product Documentation

The final prototype was heavily changed due to parts not working with no replacements. This could be tracked as prototype 1 reflected the original sketch but prototype 2 was a lot closer to the final prototype. This also led to the prototype being constructed out of wood and not out of metal and acrylic as originally planned. This can also be seen as the original sketch and concept had an acrylic fish tank as the container and a metal rod to attach the sample.

The original concept used an arduino UNO board with a stepper motor attached to it to spin the sample, however due to the motor not working, this resulted in the use of the drill from the second prototype to spin the sample. With this major change, the entire prototype had to be revised.

With the new concept, the build cost would be too high causing us to go over budget which meant that the materials needed to be changed. The criteria for the materials to meet was for it to be cheap, sustainable, durable, light weight, and waterproof. Even though wood is not waterproof, the water resistance in wood is enough for it to run several trials and get the results desired as well as it meeting or exceeding other criterias. Steel was a close second however cost using steel would have been too high as well as manufacturing time and tools being a lot more as well.

Original Sketch:



Thermometer
21°
Filtration System
small motor
scale
impeller
8.25in
6.5in
12.5in

Prototype 1:

Prototype 2:

Prototype 3:

6.1 <Subsystem 1 of prototype>

6.1.1 BOM (Bill of Materials)

[Bill of Materials (1).xlsx]

6.1.2 Equipment list

Equipment needed:

- Hand Drill
- Clamps
- Saw
- Drill Press
- Glue Gun
- Ruler
- Pen

6.1.3 Instructions

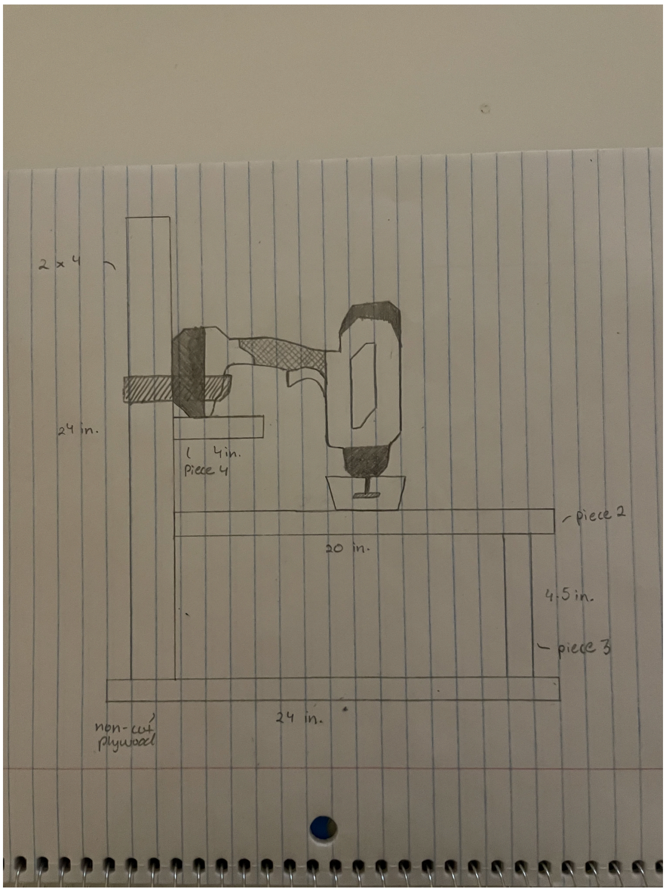
Assembling the Prototype:

1) Take the 2x4 and attach to the non-cut plywood sheet. (offset the 2x4 inwards on the plywood sheet to provide more structural stability)
2) Take the 8x1(½) screws and attach the 2x4 with the plywood sheet
3) Align piece 3 at the end of the non-cut plywood sheet (opposite to the 2x4) and screw in using the 8x1(½) screws
4) Take piece 2 and mount on top of piece 3 and against the 2x4
5) Screw in piece 2 and piece 3 together using 8x1(½) screws
6) Screw in piece 2 and the 2x4 using the 12x3 screws
7) Mount piece 4 against the 2x4 and above piece 2 using the 12x3 screws. (make sure to test and see if the drill reaches the bowl and goes low enough to submerge the sample)
8) Place the bowl where the drill aligns to the centre and add markers
9) Use the glue to add a few drops in each corner and to the centre of the marked area and place the bowl on top
10) Use the velcro straps to secure the drill in place
11) Add water

Reference pictures:


DEWALT


DEWALT


2 x 4
24 in.
4 in.
Piece 4
piece 2
20 in.
4.5 in.
piece 3
24 in.
non-cut plywood

6.2 Testing & Validation

The prototype ran for 15 minutes with just water and with a 50/50 salt and sand mix as abrasives. Though there were no actual graphs and tables made due to time constraints, tiny pieces of the PLA filament were noted floating at the top with the 50/50 mix. No results were seen with the use of water by itself.

7 Conclusions and Recommendations for Future Work

A couple of lessons were learned while making the prototype, the main one being that having a modular design is really helpful in case something goes wrong. It is also useful as it is inevitable when something goes wrong and breaks the entire prototype. It is also important that parts are pre-planned and bought early on with backups as well as the development of the prototype starting at the beginning to middle of the semester as well to ensure that even with many failed attempts, a prototype is successfully completed before Design Day. This would also be something that I would implement if I had a few more months as parts like the servo motor and acrylic container with a thermometer and scale were either broken or not available and replacements would have taken too long to arrive causing our group to change almost the entire design last minute.

8 Bibliography

https://languages.oup.com/google-dictionary-en/

https://en.wikipedia.org/wiki/Main_Page

https://www.e3s-conferences.org/articles/e3sconf/abs/2023/19/e3sconf_unsat2023_05002/e3sconf_unsat2023_05002.html#:~:text=The%20test%20 measures%20the%20 depth,a%20nozzle%20of%20 controlled%20 geometry.

APPENDICES

9 APPENDIX I: Design Files

Table 3. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Makerepo File	https://makerepo.com/IbrahimUsman/1994.dream-team-accelerated-erosion-test-system	N/A
2023-2024 GNG 1103 In class slides	Uottawa Brightspace(not public)	N/A
N/A		
N/A		
N/A		