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Design and Fabrication of Seabin Project for Efficient Collection of Water Waste Using Solar Energy

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Abstract: **Water bodies across the world are facing existential crises. The human settlements are regularly dumping off the garbage and refuse to clean the water bodies. This is a major environmental hazard and causes a degradation of water bodies and affects the overall food chain. This work is emphasized on the design and fabrication of a floating debris interception device i.e. Seabin to curb this problem. The idea is simple if we can have garbage bins on land, why not have them in the ocean as well. The Seabin works in such a way that the water is pumped out of the catch bucket that is already submerged in the water. Through this suction, the water with all its floating litter collects in the bucket. The catch bag accumulates litter, separating it from the water. The water is again pumped out of the bucket. This whole process takes place simultaneously and fresh batches of litter settle down in the catch bag until the limits get exhausted.**

Index Terms: **Seabin, Environmental hazard, Plastic waste, Debris**

I. INTRODUCTION

Plastic products are commonly utilized by the maritime industry. For example, fishing nets and strapping bands used to secure cargo are typically composed of plastic. Plastic materials are also used to package food products and other items consumed by the crew members on commercial vessels. Disposal at sea has been the normal procedure that commercial vessels have followed to discard packaging materials and other waste products.

The discarding of waste products in sea is not new. What has changed in recent decades is that lot of products are now made of plastic. Another form of plastic litter is the raw material used by the plastic industry to manufacture their products. Raw plastic usually is fabricated into tiny pellets, or spherules, then shipped to factories where it is transformed into consumer products. Plastic pellets are also used for packing and insulating material for cargo transportation. In both instances, these pellets can enter rivers and seas by accidental or deliberate discharge.

Plastic materials threaten the marine environment for the same reasons they are a commercial success: durability and economic affordability. Because of its low cost, plastic is readily and ubiquitously utilized as a source of disposable material. It is the durable properties of plastic, however, that pose the greatest threat; plastic materials persist in the marine environment long after they have been thrown away.

Plastic pollution is the most widespread problem affecting the marine environment. It also threatens ocean health, food safety, and quality, human health, coastal tourism, and contributes to climate change.

The most visible and disturbing impacts of marine plastics are the ingestion, suffocation, and entanglement of hundreds of marine species. Marine wildlife such as seabirds, whales, fishes, and turtles, mistake plastic waste for prey, and most die of starvation as their stomachs are filled with plastic debris.

Wang et al. [1] presented the distribution of atmospheric microplastic (MP) abundance over the ocean based on a survey conducted in Pearl River, South China Sea and East Indian Ocean. They revealed that MP undergoes a long-range distance, more than thousand kms away, through the atmosphere becomes the main source of oceanic MP. Winton et al. [2] identified the prevalent MP items in freshwater of Europe, specifically plastic, that could be possibly reduced by creating awareness among the (actions of the) public, industry, and the government. Their investigation addressed the variation of reported MP in freshwater and oceanic atmospheres. Gallo et al. [3] studied the impending impacts of macro and MP waste on marine biodiversity and human life. They suggested analytical method on production and consumption of plastics and waste management and tough plan actions to control unnecessary plastic packet, ban on single-use plastic bags, intensification of the collection rate of plastic waste, deposit-refund arrangements for plastic beverage bottles that have a proven a high rate of victory in many countries. Krishnakumar et al. [4] found white irregular shaped polyethylene and polypropylene debris in their research in the Andaman and Nicobar Islands beach sediments in 2018. The main cause of plastic litter was due to tourists, shipment and improper handling of solid wastes disposed in the marine environment carried by tides, circulates around the island, and finally reaches the coastal areas and cause threat to the marine life.

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Zhu et al. [5] investigated the presence of plastic debris on 1 seabird species and 2 shorebird species from Yongxing Island of South China Sea and found a 56 items of plastic debris in 4 of 9 birds, with size ranging from 0.67 to 8.64 mm. Maximum portion (92.9%) of the total items of MP found with size < 5 mm and predominated by polypropylene-polyethylene copolymer 83.9%. The main color of collected MP debris was blue 91.1% and shape was thread 89.2%, sheet 8.9%. This work concluded that marine birds could mistake plastic debris as food items. Sonam et al. [6] analyzed the impact of the marine pollution and utilized oceanographic model of coasting trash dispersal by rectifying for wind-driven vertical blending, gauged at least 5.25 trillion particles weighing 268,940 tons. They marked a huge loss of micro plastics from the ocean surface contrasted with anticipated paces of discontinuity, that recommends systems at play that expel <4.75 mm plastic particles from the sea surface. Xu et al. [7] developed a simple, fast and low-cost method to treat oily wastewater by synthesizing corn straw fiber via conventional impregnation. By using chemical coupling agent, they could increase absorption capacity and absorption efficiency, that has great potential for treatment of oily water.

Tan et al. [8] proposed a distinctive eco-friendly corn straw material with preferable super hydrophobicity and superoleophobicity for separating oil from liquid mixtures. The modified corn straw found to have preferable chemical durability and environmental continuance, allowing it to both selectively adsorb oils and completely repel water. The designed corn straw provides an eco-friendly alternative for the cleanup of oil spills, as well as a means to relieve the environmental problem of agricultural waste disposal. Jian Dai et al. [9] presented the various features in the progress of the floating modular photovoltaic system. They designed a system encompasses several standardized floating modules prepared by high density polyethylene that serve as either photovoltaic panel floaters or maintenance walkways. They also presented details of the launching of the proposed floating photovoltaic system at the testbed and assesses the power generation of the system.

II. Methodology

This project aims to create a debris collector (SEABIN) to collect floating debris or waste materials from water. The idea proposed here is very similar to the existing SEABIN PROJECT with a few changes in its performance parameters. We have studied keenly the different types of cleanup programs and have taken inspiration from all of them. Our version of Seabin is estimated to catch 1.5 Kg of floating debris per day (depending on weather and debris volumes) including microplastics up to 2 mm small. The project works in such a way that the water is pumped out of the catch bucket that is already submerged in the water. Through this suction, the water with all its floating litter collects in the bucket. The nylon catch bag accumulates litter, separating it from the water. The water is again pumped out of the bucket. This whole process takes place simultaneously and fresh batches of litter settle down in nylon catch bag until the limits get exhausted.

A design of the component has been prepared and shown in Figure 1.

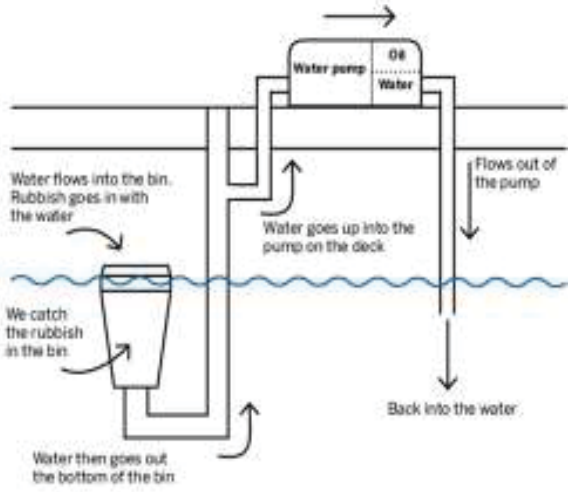

Figure 1. Design of the component

III. Experimentation

The following components have been used to prepare the designed seabin model.

A. L-shaped Aluminum Vertical Post

This component is the primary one as it forms the base of the project. This vertical post is hollow for weight reduction and is made of aluminum. Aluminum is a material having less density and is non-corrosive in nature. These properties of aluminum are ideally suitable for the component as it has to remain in contact with water most of the time. Figure 2 shows the dimensions of the vertical post

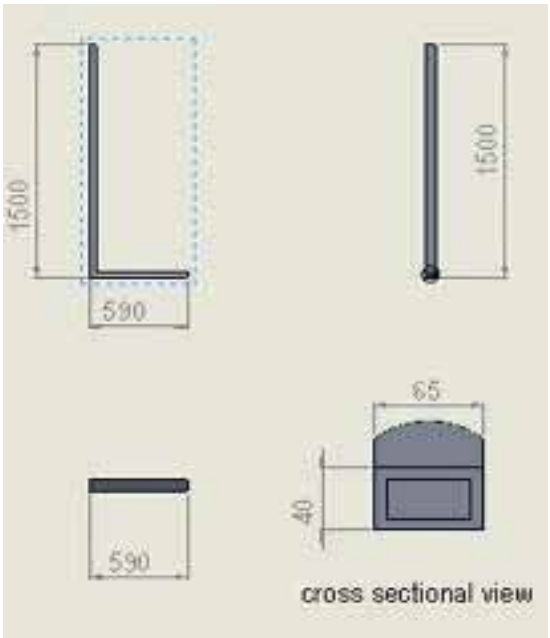

Figure 2. The dimensions of the vertical post

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B. Debris Collector

This component is a cylindrical collector with a varying cross-section holding the main filter that collects all the floating trash in it as the suction is created and acts as a basin interacting with the whole structure. Apart from this, because of the decreasing cross-section, a pressure difference in the pump is created that helps in the suction of water under unusual cases of water head. The capacity of this bucket is 5 liters and collects up to 2 Kg of trash when submerged in the water. Design of the debris collector has been given in Figure 3.

The catch bag we have used here is made up of nylon material added with corn straw fiber in powder form, which helps to separate oil from water as well. The metal sheet is sewed into a bag corresponding to the size and shape of the bucket.

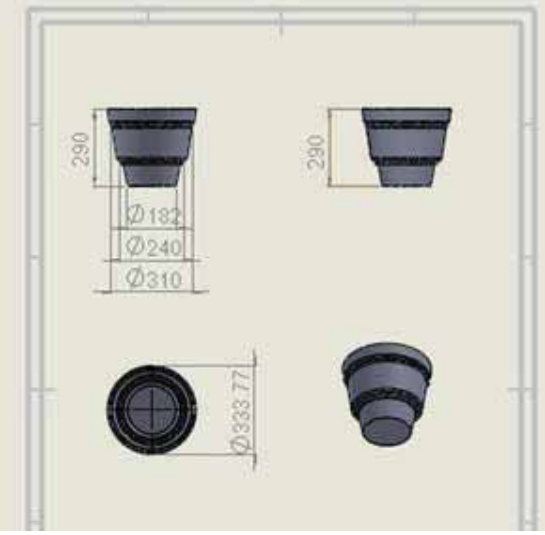

Figure 3. Design of the Debris Collector

C. Water Pump

The water pump used here is mainly for the suction force through which the water with the floating litter enters into the bucket. The trash gets trapped in the bucket while the water is pumped again into the tank.

Specifications:

1. Single-phase Water Pump
2. In-built Thermal Over Load Protector
3. Power Rating: 0.37 kW
4. Power Supply: 180 V - 240 V
5. Motor Power: 0.5 hp
6. Capacity: 6 lpm
7. Head: 6 - 26 m.

D. Solar Panels

The use of non-conventional energy sources is the major highlight of this project. This reduces the burden on conventional electrical sources and reduces largely the operational price of the setup, particularly in remote places.

We have incorporated the use of the installed solar panels in the present organisation for power generation that will be supplied to the pump for suction. We can store solar energy in a battery for constant use throughout the day. This makes the project run with 100% renewable energy.

E. Corn Straw Fiber

Unlike many other water cleaning projects, this project focuses on additional problems such as removing oil from the water. Oil spills and oil contamination also pose a similar threat to marine life. This gives rise to a necessity for the separation of oil from water. Therefore, this project incorporates the use of corn straw fiber (in powder form) as an oil absorbent. Figure 4 shows the corn straw fiber in powder form.

Figure 4. Corn Straw Fiber

F. Final assembly and Working

The final setup and testing have been performed on the water storage tank at the gate 2 of the present organization. The clamps used to hold the vertical post and bucket assembly in place for jerk free operation. We have attached 4 clamps in sets of 2 on a brick combination. Figure 5 shows the final assembly and working of the designed seabin model.

IV. Result and Discussion

This version of Seabin is estimated to catch 1.5 Kg of floating debris per day (depending on weather and debris volumes) including microplastics up to 2 mm small. This project works in such a way that the water is pumped out of the catch bucket that is already submerged in the water. Through this suction, the water with all its floating litter collects in the bucket. The nylon catch bag accumulates litter, separating it from the water. The water is again pumped out of the bucket. This whole process takes place simultaneously and fresh batches of litter settle down in nylon catch bag until the limits get exhausted.

V. Conclusions

- The cost of the model is estimated to be around Rs.3000/- which is quite cheap, to be used in general purpose.
- This work shows a very effective method to remove solid waste even if oil material from the water bodies.
- The materials used in this model are durable and environmentally acceptable.
- The installation of the model is an easy and feasible task with a touch of little technical knowledge.

- This model more efficient than a manual worker skimming the floating debris as it is semi-automatic.
- This model can operate on any type of weather and will be helpful in important cleaning programs taken up by the government of India.
- This model shows an efficient and cost-effective way to clean water bodies as well as environment.
- Presently working on energy from solar panels to make it pure renewable. Depending on the situation other from renewable energy like ocean energy, wind energy, etc. can also be used. The size of the project is enough to catch 2 to 3 kg of litter every day and can be increased depending upon the usage. Certain eco-friendly chemicals can be used to separate oil from water and kill bacteria. This type of project can be used country-wide to clean small water bodies, rivers, ponds, etc.,

Figure 5. Final assembly and working of seabin model

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