Design and fabrication of beach cleaning machine

C Balasuthagar¹, Dinesh Shanmugam¹ and K Vigneshwaran²
¹Department of Mechanical Engineering, SRM Institute of Science and Technology, Kattankulathur, Chennai, India
²Department of Mechanical Engineering, Rajalakshmi Engineering College, Chennai, India.

E.mail: balasutc@srmist.edu.in

Abstract-Beaches are one of the main tourist attractions in the coastal parts of India. They are also the most polluted. Most government neglected cleaning of beaches. The main reason being the difficult nature of cleaning it. It takes up lot of resources and time. The workers need to manually pick the waste. The waste when thrown in the sand gets covered with the sand by the heavy coastal winds. This makes the spotting of waste difficult. It is difficult for the workers to clean as they have to dig each cubic feet to collect the waste. The heat and humid climate of the beaches makes the working conditions worse. Many organisations and government bodies are taking several steps to get rid of the waste accumulated in beaches more effectively. India has a long stretch of coastline of about 7517 Km with nearly 170 famous beaches both on eastern and western coasts. Our aim of work is to design and fabricate the beach cleaning machine. We have created a simple economical design so that it will be easy for maintenance and use. The parts have been sourced locally so replacement parts will be easier to get. The machine is environment friendly and can run in any conditions offered by the beach. We have designed and manufactured a beach cleaning machine which is both cheap and easy to use. It does not have a huge learning curve. The machine runs on human power or electric motor. The electric motor is powered by solar panels. This gives an advantage over the current models available in the market which runs in fuel motors. The entire machine is able to fit in the rear of a car.

1. Introduction
Beaches are one of the main tourist attractions in the coastal parts of India. They are also the most polluted. Most government neglected cleaning of beaches. The main reason being the difficult nature of cleaning it. It takes up lot of resources and time. The workers need to manually pick the waste. The waste when thrown in the sand gets covered with the sand by the heavy coastal winds. This makes the spotting of waste difficult. It is difficult for the workers to clean as they have to dig each cubic feet to collect the waste. The heat and humid climate of the beaches makes the working conditions worse. Some governments have invested in beach cleaning machines[1,2]. The main drawback being they are quite expensive and there are not many who can operate it. Those machines get broken way too often and the spare parts need to be imported. This makes the government to abandon such machines. These machines while cleaning the beaches create pollution due to their heavy fuel based motors. Thus the whole point of reducing pollution is nullified. The pollution is being changed from one form to another. We have designed and manufactured a beach cleaning machine in a pragmatic way, which is both cheap and easy to use. It does not have a huge learning curve. As all the parts for the machine been sourced locally, there will not be much difficulty in obtaining spare parts. The machine runs on human power or electric
motor. The electric motor is powered by solar panels. This gives an advantage over the current models available in the market which runs on fuel motors.

Waves bring a lot of waste from deep sea. These plastic waste slashes into the beaches and gets mixed with the sand. This wet waste easily gets soiled with sand and will be difficult for human eyes to notice. The machine is capable of clearing such waste with utmost ease. Tides too play a major role in putting the waste from deep sea into the beaches. Many animals like tortoise get stuck in this waste when they come to lay eggs in the beach. This causes a lot of deaths, thus tipping the balance of the environment. One of the other problems faced by the shore areas is the advent and constant cyclones that affect the areas. These cyclones once settle damages a lot of property thus creating a lot of waste. It takes a lot of time to remove such waste and to clear the sand of it. If the waste left to rot in the beaches it gets into smaller pieces ultimately ending up getting eaten by aquatic animals[3].

The main aim of the study to design and fabricate the beach cleaning machine with simple economical design so that it will be easy for maintenance and use. The machine is environment friendly and can run in any conditions offered by the beach. The machine does not have a huge learning curve. As all the parts for the machine been sourced locally, there will not be much difficulty in obtaining spare parts. The machine runs on human power or electric motor. The electric motor is powered by solar panels. This gives an advantage over the current models available in the market which runs in fuel motors. The entire machine is able to fit in the rear of a car.

2. Methodology

The essential objective of the beach cleaning machine is to clean the beaches at a depth as fast and efficient. To reduce the cost of machine and to be able to transport it to most remote beaches. To procure spare parts locally and should be able to fix by any person who knows basic mechanics.

Figure 1 represents the of working methodology of the machine

![Working Methodology](image)

**Figure 1. Working Methodology.**
When the machine is pushed in forward direction the motion of the machine helps the conveyor to move. This is because the shaft which is connected to the wheel has a sprocket in it. This sprocket is then connected to the shaft of the conveyor with the help of a chain drive. It has a special projection on the chain on which the plates were bolted. This was made so that the motion of the chain is not obstruction and is not affected by the movement of plates and spokes. The rotational motion at the top of the conveyor system disposes the waste into the waste box situated behind. The waste can then be removed by the worker when its full. The bin act as a waste disposal site. If needed the segregation of the waste can be done at the waste bin. The whole model was designed in the SolidWorks (Figure 2) and the analysis was carried out using the same software. Components were made individually and at the end the entire components were assembled accordingly.

![Figure 2. Assembled machine.](image)

3. **Design and Specifications**

3.1 **CONVEYOR DESIGN [4,5]:**

TRANSMISSION RATIO \( i = 1 \)

\[
Z_1 = 14
\]

\[
Z_2 = i \times Z_1 = 14 \quad (Asi = Z_2/Z_1)
\]

Assume centre distance = 650mm

Minimum pitch = 650/50 = 13

Maximum pitch = 650/30 = 21

From design data book we take standard value, i.e. pitch = 15mm

Centre distance in multiple of pitches, \( a_p = \frac{650}{p} \)

\[
= 650/15
\]

\[
= 43
\]

Length of the chain \( L_p = \frac{2a_p + (Z_1 + Z_2)}{2a_p + (Z_2 - Z_1)/2D\pi} \)

\[
= (2 \times 43 + 14 + 14)/2 = 100
\]

Length of chain \( L = 100 \times 15 = 1500mm \)

Diameter of sprocket = \( p/\sin(180/z_1) = 15/\sin(180/14) = 67.403 \)

Radius of sprocket = 33.5mm

3.2 **MOTOR**
Assumed weight =10kg
Torque, T=f*r
=10*9.81*33.5 = 3286.35Nmm = 3.28Nm
P=2NT/60 = 2*3.14*1500*3.28/60
= 514.96watt
= 0.69hp

After completing calculations and compared with the standard dimensions using the design data book. We have meticulously arrived the specifications as per the table 1.

| Sl No. | Parameter                  | Specification |
|--------|---------------------------|---------------|
| 1      | Speed of Motor            | 1500 RPM      |
| 2      | Pitch length of chain     | 15 mm         |
| 3      | Type of chain             | Simplex       |
| 4      | Length of chain           | 1500 mm       |
| 5      | Diameter of sprocket      | 68 mm         |
| 6      | Diameter of spoke         | 6 mm          |
| 7      | Length of spoke           | 7 inch        |
| 8      | Diameter of holes plate   | 6 mm          |
| 9      | Length of the plate       | 11 inch       |
| 10     | Breadth of the plate      | 20 m          |

4. Fabrication
The beach cleaning machine is fabricated with mild steel rectangular tube section frame. The main factor in choosing the rectangular tubing section is to reduce the weight of the entire machine. As weight reduction enable the machine to be carried very easily. The spokes were made by cutting long steel rods and bending it by placing it on a vice. The steel rods were selected because they can resist huge loads. The spokes are welded on the steel plates which in turn are welded on the special provision provided on the chain. Long plates are cut into 11"x 3" size for placing the spokes. Small holes are cut into the plate inorder to have additional weight reduction. Chains and sprocket were selected based on the calculation. Pedestal bearing is used to hold the rotation shaft on which sprockets were mounted. Motor is mounted on the upper sprocket shaft. The below diagram (Figure 3) shows the final assembly of the beach cleaning machine.
5. Conclusion

This machine helps in cleaning the beach with the state of the art technology which would be earlier cleaned by manual workers and they are being affected by the hazardous garbage, and thereby saves the ocean life from pollution. Since the cost of this system is less due to local procurement the machine can be widely used for all the beaches. As the system works on a basic chain and sprocket system maintenance will be very low and it does not require fossil fuel so it can be used in a remote location. This machine works with wide range of operation like removing seaweed, dead fish, shells, wood, and virtually any unwanted debris. It can work on both wet and dry sand. As the plates are screwed to the chain, we can remove the plate and fix the screen so that very fine debris can be removed. When this system is powered by the solar power it has the advantage of harnessing the natural resources thereby the machine becomes environmental friendly.

References

[1] Amit Kumar Yadav, Animesh Singh, M. A. Murtaza and Ajendra Kumar Singh 2018 *International Journal of Energy and Management Research* **8** 1-4
[2] Vivek Dhole, Omkar Doke, Ajitkumar Kakade, Shrishail Teradale and Rohit Patil 2019 *International Research Journal of Engg& Technology* **6** 796 – 800
[3] Sahil bharti, S.R.Sadhave, H.Ramkumar, S.Ishwarya Lakshmi and G.Muralidharan *International Journal of Soft Computing and Artificial Intelligence*, ISSN: 2321-404X
[4] James C. Conwell, G. E. Johnson 1996 *Mechanism and Machine Theory* **31** 533-544
[5] Niels Fuglede and Jon Juel Thomsen 2016 *Mechanism and Machine Theory* **100** 17-32
[6] Youn Ju Lee and Won ByongYoon 2015 *Journal of Food Engineering* **144** 10-19
[7] TorleifMalma, SabineFell and PerCarlsson 2004 *Coastal and Shelf Science* **60** 339-347
[8] A.Nagadeepan, J. Hersha himlan, J. Guruyogeshwaran and S. Balaji *International Journal of Engineering, Science and Mathematics* **7**
[9] Tejpal Parshiwani, Maitreya Fulmali and Pritam Banabakode 2019 *Journal of Emerging Technologies and Innovative Research* **6**
[10] M.Bhavani, S.Kalaiselvan, S.Jagan and S.Gopinath 2019 *International Journal of Recent Technology and Engineering* **8** Issue-1S2 ISSN: 2277-3878
[11] D. Smith and Harris Pearson 1955 Farm machinery and equipment. Tata McGraw-Hill, India, 519
[12] Hunt, D 2002) Farm Power and Machinery Management, Laboratory Manual and Workbook, 7th Ed., Iowa State University: AMES IOWA
[13] Emaad Mohamed H. Zahugi, Mohamed M. Shanta and T. V. Prasad 2012 *IJAIT* **2** 4