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Design and Development of Beach Cleaning Machine

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Abstract: Due to incident of high tide occurred in Mumbai beaches which washed ashore 3 million tons of garbage to the sea shore in June 2018.3 million ton is a big number. How this garbage did come from sea? Its the garbage discarded by man itself and waste of the sea just took those debris into its vicinity and at the moment of high tide, it throws the garbage offshore. So we have decided as we cannot manage the natural phenomenon such as high tide but we can control the outcomes like cleaning the beaches regularly and manual cleaning is not possible. So we are developing a protocol which will clean all this debris. Protocol which we are going to develop consists of an engine which runs through fossil fuel which drives the entire process. The waste is collected through conveyor blades and sand which falls off through perforated conveyor belt to the sand bed, separation of waste material takes place through principle of density difference hopper is attached to it so garbage can be collected in it.

Keywords: Beaches, high tide, cleaning the beaches, conveyor blades

I. INTRODUCTION

The coastal beaches are the main attraction for tourism. To attract tourists, the beach must be kept clean. To clean the beach, some cleaning machine must be used. So we have manufactured a cleaning machine which helps clean the beaches.

The motor is responsible for the driving mechanism of the conveyor. The strainer attached to the conveyor will collect the wastages from the surroundings and transfer it to the storage bucket through the conveying belt. Today's era is moving towards being digitalized and automated. The youth want everything easy and smart. Anywhere you go, you get easy technology availability. So we thought of using this technology and adding more to it for our final year project. Nobody likes to suffer and wait just to get good surroundings. To avoid this and to save the time of our waste management system, we are creating an application called "Smart Cleaning System". For that, we are using the system by which a beach cleaner can do his work smartly using technology. Smart Cleaning System is proposed to overcome real-time problems. With the continued expansion of industries, the problem of water must be urgently resolved due to the increasing sewage problems from industries. The waste produced from the industries is very harmful to human beings and the environment. Through this smart waste management system, workers can maintain all his health and work well through the application. One more useful and important advantage of our system is that the worker can replace the manual work at the beach through this semi-mechanical beach cleaner having easy access. A beach cleaner is a vehicle that drags a raking or sifting device over beach sand to remove rubbish and other foreign matter. They manually pull the vehicles on tracks or wheels. Seaside cities use beach cleaning machines to combat the problems of litter left by beach patrons and other pollution washed up on their shores. The main task in beach cleaning strategies is to find the best way to handle the waste matter, taking into consideration of beach erosion and changing terrain. Beach cleaning machines work by collecting sand by way of a scoop or drag mechanism and then raking or sifting anything large enough to be considered the foreign matter, including sticks, stones, litter, and other items. Similar applications include lake beaches and fields for beach volleyball and kindergarten and playing field sandpits. The word "SANDBONI" is a back-formation referencing the ice-surfacing machine Zamboni.

II. LITERATURE REVIEW

Beach litter collection is a concern for Bang Sane beach, one of the popular tourist attractions of Thailand. In order to solve this problem, a beach cleaning trailer was designed and fabricated with emphasis on the use of local materials and local production**[1]**. The design trailer prototype 3.7x1.6meters was carried out using a three-dimensional solid modeling computer program. This paper explores the economics of the beach-cleaning trailer in terms of payback period, charging rate and working areas. The research provided positive results on economic aspects. The design trailer prototype has been developed and fabricated with emphasis on the use of local materials and local production. The machine has been tested at Bang Saen beach in Thailand. We have explored the economics of the beach-cleaning trailer in terms of payback period, charging rate to customer, working areas. The research provided some positive results on economics aspects. We hope to further design and develop the fully mechanized beach cleaning trailer.

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The basic design principle of a foreign beach cleaning machine was taken into consideration**[2]**. Apart from the tire and hydraulic hoses, all components of the beach cleaning trailer were made from steel. This study focuses on stress analysis in a ball bearing housing the finite element method. This study aims to report the performance of the beach cleaning trailer. Stress in the ball bearing housing is calculated by FEM. A stress analysis made using the forces acting on the ball bearing housing showed the maximum Von Mises stress of the ball bearing housing to be 63.0 MPa. The safety factor was 3.94. It showed that it was very durable to use. For future work, economic analysis should be performed to develop and design a fully mechanized beach cleaning machine. The designed beach-cleaning trailer was quite appropriated to be used due to the utilization of local materials, with the reel of blade enhancement.

III. MODEL DESIGN

The power required to drive the conveyor depends on various factors like the amount of load, type of material, mobility, type of conveyor, inclination. By considering the above factors to drive 300 metric tons per hour the power required is 14 kW and to drive 1000 metric tons per hour the power required is 45 kW. A DC motor is a class of electrical machine that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic; to periodically change the direction of current flow. Most types produce rotary motion; a linear motor directly produces force and motion in a straight line.

High torque, heavy duty 12V dc gear motor

1) RPM - 20
2) No load current - 120mA
3) Load torque - 10-19 Kg.cm
4) Load current - 400mA
5) Length of motor - 29mm
6) Diameter of motor - 33mm
7) Spindle length - 15.5mm

Ehrlich supposed that living cells have side-chains in the same way dyes have side-chains that are related to their coloring properties.

These side chains can link with a particular toxin (or any antigen), just as Emil Fischer said enzymes must bind to their receptors "like lock and key." Ehrlich theorized that a cell under threat grew additional side-chains to bind the toxin and that these additional side chains broke off to become the antibodies that are circulated through the body. According to this theory, the surface of white blood cells is covered with many side chains that form chemical links with the antigens. For any given antigen, at least one of these side chains would bind, stimulating the cell to produce more of the same type, which would then be liberated into the bloodstream as antibodies.

According to Ehrlich, an antibody could be considered an irregularly shaped, microscopic, three-dimensional label that would bind to a specific antigen but not to the other cells of the organism. It was these antibodies that Ehrlich first described, agents that specifically target toxins or pathogens without harming the body.

Ehrlich suggested that the interaction between an infectious agent and a cell-bound receptor would induce the cell to produce and release more receptors with the same specificity. According to Ehrlich’s theory, the specificity of the receptor was determined before its exposure to antigen, and the antigen selected the appropriate receptor. Ultimately all aspects of Ehrlich’s theory would be proven correct with the minor exception that the “receptor” exists as both a soluble antibody molecule and as a cell-bound receptor. It is the soluble form that is secreted rather than the bound form released.

A. Functions of the Conveyor System

Conveyors can safely transport materials from one level to another, which when done by human labor would be strenuous and expensive. They can be installed almost anywhere, and are much safer than using a forklift or other machine to move materials. They can move loads of all shapes, sizes, and weights. Also, many have advanced safety features that help prevent accidents. There are a variety of options available for running conveying systems, including the hydraulic, mechanical and fully automated systems, which are equipped to fit individual needs. Conveyors systems are commonly used in many industries, including the automotive, agricultural, computer, electronic processing, aerospace, pharmaceutical, chemical bottling, canning print finishing, and packaging.

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B. Chain design

Selecting standard chain used in cycle as Chain -06 B

Pitch -9.525mm

1) Roller diameter,d1=6.35 mm , Width' b1=5.72 mm , Transverse pitch p_t=54.85 mm, z1= 18, z2= 44

2) Approximate centre distance, a = 40*P ----------nominal

a = 40*9.525

a = 381 mm

3) No of links,

$L_n=2(a/p) + (\frac{z1+z2}{2}) + \left(\frac{z2-z1)}{2\pi}\right) * (\frac{p}{a}) = 2(381/9.525) + (\frac{18+44}{2}) + \left(\frac{44-18}{2\pi}\right) * \left(\frac{9.525}{381}\right) = 111.10 = 111$

C. Design of Sprocket 1

Used chain no.06B, For Z=18,Pitch, P = 9.525 mm,Width between inner plates, b1= 5.72 mm

Roller diameter, d1= 6.35 mm ,Transverse pitch p_t =10.24 mm

1) Pitch circle diameter

$D = \frac{p}{\sin(180/z)} = \frac{9.525}{\sin(180/18)} = 54.85$ mm

2) Top diameter (D_a)

$(D_{a)max}$ =D+1.25p-d1 =54.85+1.25*9.525-6.35 =60.4 mm

3) Root diameter , Df =D-2r1

But roller seating radius (r1), $(r1)_{max}=0.505d1+0.069\sqrt[3]{d1} = 0.505*6.35+0.069\sqrt[3]{6.35} = 3.33$ mm

D_f=D-2r1 = 54.85-2*3.33 = 48.19 mm

4) Tooth flank radius ,$(r_e)_{max}$ = 0.008d1(Z^2+180), = 0.008*6.35 (18^2+180) = 25.6 mm

$(r_{e)min}$ = 0.12d1(Z+2) = 0.12*6.35 (18+2) =15.24 mm

5) Roller seating angle , (ά)max=(120-90/Z =(120-90/18) =1150

$(ά)_{min}$=(140-90/Z)=140-90/18 =135^0

6) Tooth height above the pitch polygon, (h_a)max=0.625 p-0.5d1+0.8p/Z

=0.625*9.525-0.5*6.35+0.8*9.525/18 =3.2 mm

(h_a)min=0.5(p-d1) = 0.5(9.525-6.35) =1.58 mm

7) Tooth side radius (r_x)=p

8) Tooth width bf1=0.95b1 =0.95*5.72 = 5.434 mm

9) Tooth side relief (ba) =0.1p = 0.1*9.525 = 0.9525 mm

D. Design of Sprocket 2

Used chain no.06B, For Z= 44 ,Pitch, P = 9.525 mm ,Width between inner plates, b1=5.72 mm

Roller diameter, d1= 6.35 mm, Transverse pitch pt =10.24 mm

1) Pitch circle diameter, $D=\frac{p}{\sin(180/z)} = \frac{9.525}{\sin(180/44)} = 133.51$ mm

2) Top diameter (D_a), $(D_{a)max}$ =D+1.25p-d1, = 133.51+ 1.25*9.525-6.35= 139.06 mm

3) Root diameter , D_f =D-2r_1 But roller seating radius (r1) $(r1)_{max}=0.505*d1 + 0.069\sqrt[3]{d1}$

= 0.505*6.35 + $0.069\sqrt[3]{6.35}$ = 3.33 mm D_f = D-2r1 = 54.85 - 2*3.33 = 48.19 mm

4) Tooth flank radius , $(r_e)_{max}$ = 0.008*d1(Z^2+180) = 0.008*6.35 (44^2+180) = 107.49 mm

$(r_{e)min}$ = 0.12d1(Z+2) = 0.12*6.35 (44+2) = 35.052 mm

5) Roller seating angle , (ά)max=(120-90/Z) = (120-90/44) =117.950

$(ά)_{min}$=(140-90/Z)=140-90/44 = 137.95^0

6) Tooth height above the pitch polygon, (h_a)max = 0.625 p-0.5d1 + 0.8p/Z

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=0.625*9.525-0.5*6.35 + 0.8*9.525/44 = 2.95 mm

(h_a)min=0.5(p-d1) = 0.5(9.525-6.35) =1.58 mm

7) Tooth side radius (r_x)=p

8) Tooth width bf1=0.95b1 V = 0.95*5.72 = 5.434 mm

9) Tooth side relief (ba) =0.1p = 0.1*9.525 = 0.9525 mm

These are the optimum values from which we can design our beach cleaning machine. As per our observation the machine will work efficiently on dry sand other than the wet sand and these optimum calculations are only applicable for dry sand beaches of India.

IV. WORKING

The device is placed across a beach and sea so that only sand can get through the lower basement. Floating waste like bottles, plastic cans, other waste, etc is lifted to the conveyor. The chain revolves with the sprocket wheel which is driven by the motor. The energy provided to the motor is electrical energy. When the motor runs the chain starts to circulate making the machine to lift. The wastage material is stored in the collecting box. Once the collecting box is full, the waste materials are removed from the box. There is a 45 to 50-degree bend plate which is assembled at the bottom of the box. It is mainly used to leveling the beach surface. The material which we are going to use is M/S Mid Grade which is easily available in the market with less cost compared to others.

V. EXPERIMENTAL METHODS

Raking Technology can be used on the dry or wet sand. When using this method, a rotating conveyor belt containing hundreds of fine combs through the sand and removes surface and buried debris while leaving the sand on the beach. Raking machines can remove materials ranging in size from small pebbles, shards of glass, and cigarette butts to larger debris, like seaweed and driftwood. By keeping the sand on the beach and only lifting the debris, raking machines can travel at high speeds.

Sifting Technology is practiced on dry sand and soft surfaces. The sand and waste are collected via the pick-up blade of the vehicle onto a vibrating screening belt, which leaves the sand behind. The waste is gathered in a collecting tray which is often situated at the back of the vehicle. Because sand and waste are lifted onto the screening belt, sifters must allow time for the sand to sift through the screen and back onto the beach. The size of the materials removed is governed by the size of the holes in the installed screen.

Combined Raking And Sifting Technology differ from pure sifters in that it uses rotating tines to scoop sand and debris onto a vibrating screen instead of relying simply on the pick-up blade. The tines position can be adjusted to more effectively guide different-sized materials onto the screen. Once on the screen, combined raking and sifting machines use the same technology as normal sifters to remove unwanted debris from the sand. Sand Sifting By Hand is used for smaller areas or sensitive habitat. Sand and debris are collected into a window or pile and manually shoveled onto screened sifting trays to separate the debris from the sand. While it is effective, it requires the movement of sand to the site of the tray, and the redistribution of the sand after sifting. A more efficient method is the use of a screened fork at the place where the debris is located. The effort to manually agitate the sand can become tiresome; however, the recent development of a battery-powered sand rake combines the spot cleaning effectiveness of manual screening with the ease of an auto-sifting hand tool. Combined rake and sand sifting by hand this is the combined method which we used in our project, which contains rake technology where the raking system will scoop out the debris from the sand and lift that with the help of belt conveyor and top of that we have also added the feature of the screening method.

We have made meshes on the conveyor so the sand can be easily sifted and dropped back on the ground and after that, the sand on the ground will be leveled up with the help of a 45degree angled plate as the cleaning process continues and the lifted debris will be dumped into a separate can. Once the CAN have been filled it could be emptied manually and could be attached for another round so this way we have combined the raking method and sand sifting by hand and that's all our project is going to be about.

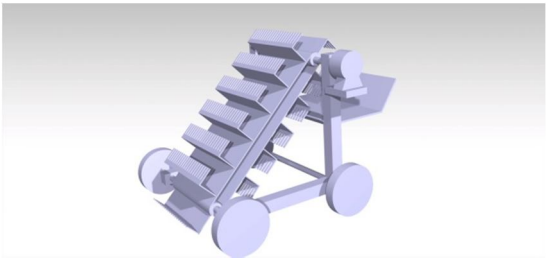

Fig.1. Beach cleaning machine.

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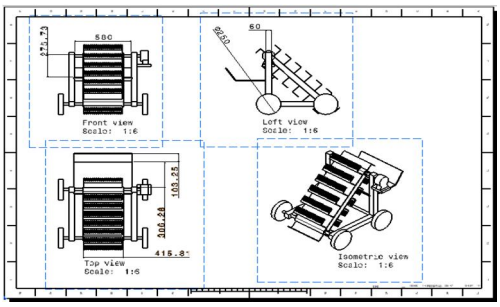

Fig.2. Drafted view of beach cleaning machine

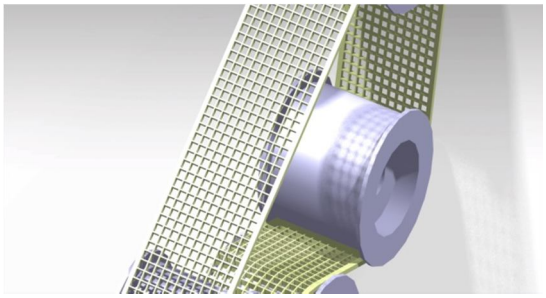
Fig.3 Conveyor with meshing system

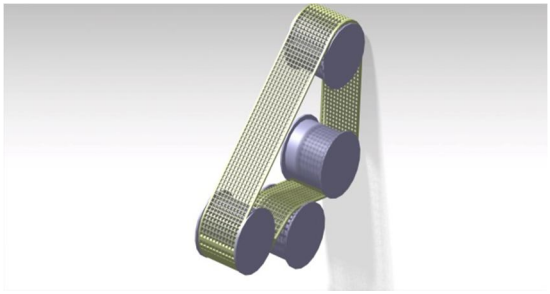
Fig.4 Conveyor and pulley assembly

VI. RESULT

From the above experimental setup, we obtained a reliable, efficient and desired beach cleaning machine design suitable for humid beaches of India. Various parts of the machine dimension are calculated above. The waste is collected through the conveyor blade along with the sand which falls off through the perforations on the conveyor back to the sand bed; separation of waste material takes place through the principle of density difference. Also with the help of the calculation of the chain and sprocket, we have got the optimum value for which the work of our beach cleaning machine will be efficient and work under the environments of Indian beaches.

VII. CONCLUSION

As compared to the previous beach cleaning machine developed this prototype is efficient and cheap and is user-friendly. This is the combined method that we used in our project, which contains rake technology where the raking system will scoop out the debris from the sand and lift with the help of belt conveyor.

We have also added the feature of screening method which we have made meshes on the conveyor so the sand can be easily sifted and dropped back on the ground and after that the sand on the ground will be leveled up with the help of a 45degree angled plate as the cleaning process continues and the lifted debris will be dumped into a separate can and once it has been filled it, could be emptied manually and could be attached for another round.

This way we have combined the raking method and sand sifting by hand and that's all our project is going to be about.

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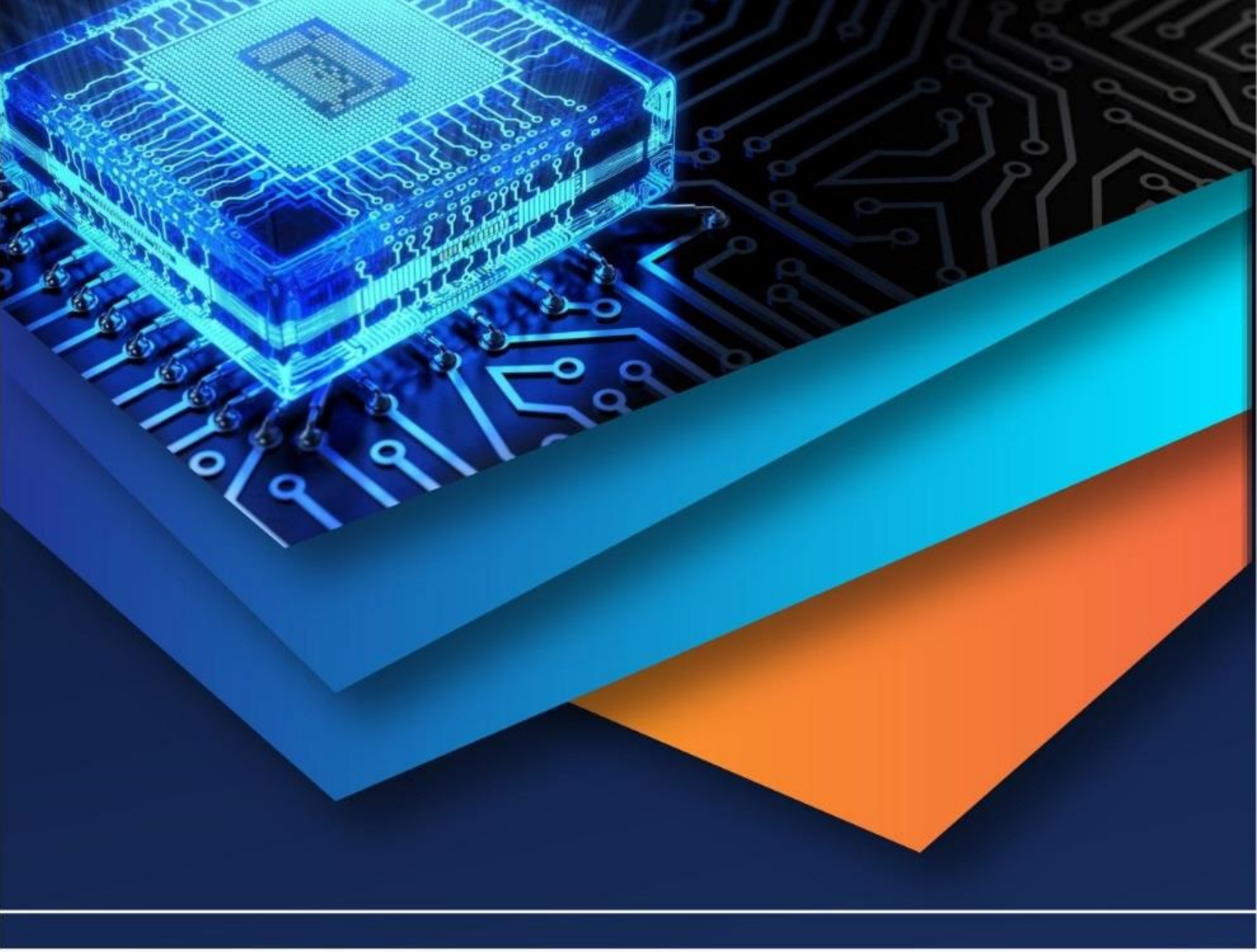

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