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Design and Study of Semi-Automatic Battery Operated (SABO) Garbage Cleaning Machine

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ABSTRACT: The problem of collection of garbage and litter especially from roads and streets is increasing day by day. People are forced to absorb dirty air and large amounts of dust particles. To solve this issue, we designed the 'SABO Garbage Cleaning Machine,' which is both financially feasible and socioeconomically advantageous. This machine operates on the simple concept of motion of a cylindrical brush discharging dust particles from the road surface into a container, employs local resources, is less expensive than other machines, and is also more efficient.

KEYWORDS: solidwaste management, street cleaning, dust particles, semi-automatic

I. INTRODUCTION

Street sweeping is one part of a solid waste management system; yet, relatively little information on the many methods of street sweeping is accessible in the literature. Wastes dumped on the streets cause health issues, pollution, and a terrible aesthetic impact, notably on visitors, and so have an indirect influence on the economy of cities and towns. Despite the fact that governments spend huge amounts of their budgets on street cleaning and sweeping, the procedure is not often optimized. For street cleaning, several tools, equipment, and methods (both manual and mechanical) are available. Street cleaning is also a system where savings may be realized by merely enhancing the process's efficiency. The existing mechanical sweeping systems mainly consist of mobile devices that gather garbage using a suction system. In most cases, the suction action is supplemented by one or more revolving brushes for dislodging residues that attach to the road's surface. These systems come in a variety of styles. They range in size from extremely small pedestrian-controlled devices to large systems mounted on a truck chassis. Large mechanical sweepers typically have an auxiliary motor to provide the suction and, in some circumstances, a hose that can be operated by an operator to pick up waste from difficult-to-reach regions.

Existing Mechanical system's usefulness in economically developing countries is limited to just assisting manual sweeping. Also these systems are often seen in only urban centres and metro cities. The difference in cost involved with employing them vs hand sweepers is large. Furthermore, they are notoriously difficult to keep in good working condition; these devices should be supported by well-equipped maintenance facilities that keep a full inventory of replacement components.

The main focus of the conceptual design phase was on determining the general layout and design of the road cleaning system with minimum components involved and having less maintenance cost. Simple in handling such that even layman can operate the machine with mere small training, simple and compact design, and helpful to keep operator away from dust and debris are requirements considered during design of SABO.

II. LITERATURE REVIEW

Currently in India, roads, streets are cleaned by brooms and other hand-held devices which is inefficient and time-consuming process. This process is also not worthy for human health. Pollution due to garbage and litter is considered to be one of the main reasons why human health is poor and also surrounding getting awful.

Automated Garbage collector or waste collectors are the steps to reduce the waste around the society and to keep the environment clean.

In this literature review, the information is related to design such machine which helps us to clean the roads and streets with less human effort, cost friendly and easy to handle to anybody. The research papers and the articles which are related to our projects which helped us to get ideas for SABO are given below.

[1] P. Ramesh I, JabezShiyan Varghese, Akhil Jose Manavalan, Akhil P.R, Adarsh V.V

Design and Fabrication of automatic trash removal machine using in automobile service station

In this project, the mechanism is designed with the help of DC motor, spur gear, and conveyor belt and roller shaft. The total arrangement is such that it collects waste from one place to another with the help of conveyor.

[2]M. Ranjit Kumar, N. Kapilan

Conventional floor cleaning machines

These types of machines are most widely used in airports, railway platforms, hospitals and malls and other commercial places. In this work, modelling and analysis of the floor cleaning machine was done by using the available software from finite element analysis, we observed that the stresses in the manually operated machine are within the safe limit.

[3] Ravi Tandel, Pinkesh Patel, MehulTandel, RonakTandel

Study about mechanical waste collector

In this review paper, this type of system we can use for collecting waste on streets, roads and other places also. The system is designed in such a way that anybody can operate easily and it is mechanically operated.

The system contains teeth which is mounted in front of the frame such that it collects the waste materials by the teeth and stored in the collector. This system is easy to handle, budget friendly.

[4] Sheikh MdShahidMdRafique, Dr. Akash Langde

Design and Fabrication of River Cleaning Machine

The motive of this project is to lift the waste debris from water surface and dispose them in the tray. The collected wastes are thrown on the tray with help of conveyor.

III. METHODOLOGY

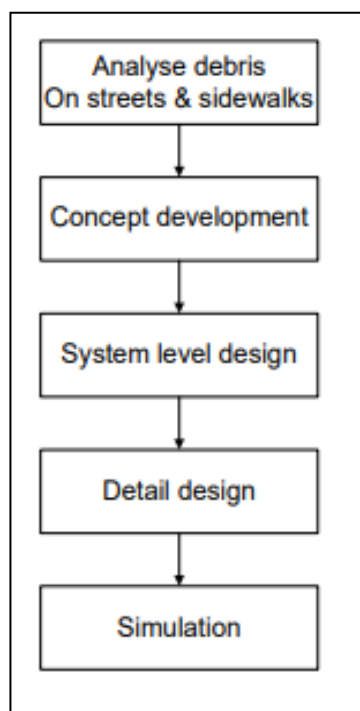


Fig 1. Sequence of work

The selection of the problem statement is done after detailed observation and analysis of existing road sweeping techniques. These included both manual sweepers and huge sweeping machines. The existing sweeping machines are using suction mechanism for waste collection by using electric motor. The main problem in these machine is they are expensive in nature so cannot be used in large scale; also due to involvement of complex mechanism and components they are quite complex for maintenance. Firstly Identification of debris characteristics, types and distributions was studied by taking samples of varieties of litters from roads and sidewalks. There are many types of waste which are thrown in public areas like roads and streets and many of these litters require different collection methods. So the target waste materials selected are all dry litter including wrappers, leaves, dust particles etc. After observation and market research the main shortcomings in existing system are enlisted. Based on our requirements the use of conveyor system was finalised. Basic designing, calculations and analysis using analysis are done simultaneously with respect to standard components. After cross checking with requirements, feasibility and eliminating flaws in design the dimensions of SABO are finalised.

IV. EXPERIMENTAL RESULTS

The following figure shows 3-D sectional representation of the Semi-Automatic Battery Operated (SABO) Garbage Cleaning Mechanism. It has a rotating shaft connected to brush which rotates at very high speed delivered by motor connected to it. That high speed rotating brush helps to collect solid waste which is lifted by the straps connected to the conveyor belt. Conveyor carries the garbage collected by straps and dumps in the collection box which is at the back side of the assembly. A motor of capacity 3kW provides velocity to the rollers connected to the gears. A battery of 40V is connected to the motor which gives 35 minutes of the run-time. The box has capacity of garbage collection is 28.5 liters.

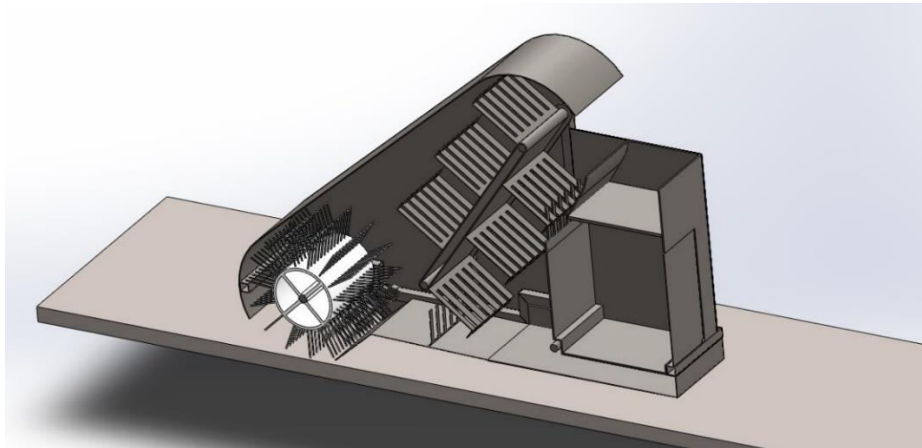


Fig 2. Sectional View of the SABO Assembly

ANALYSIS

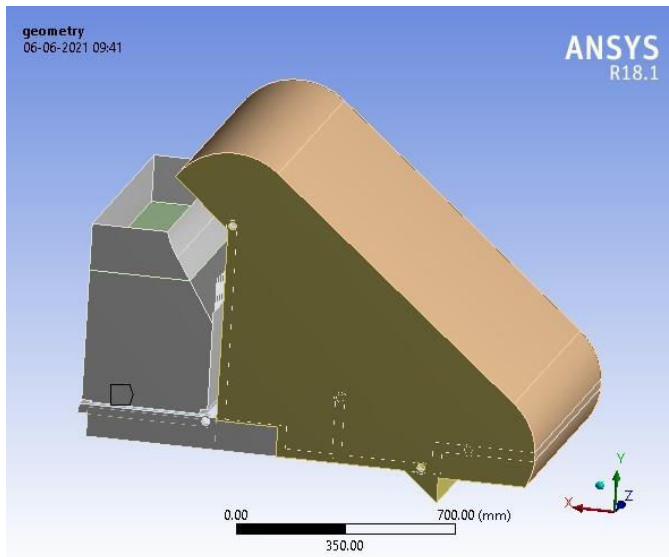
The static structural analysis is done on the ANSYS Workbench version 18.1. Material used for frame and the chassis of the body is stainless steel. A static structural analysis is used to determine the deformation, stresses and force reactions caused by the forces applied on it during pulling or pushing and also weight of components placed on it. The meshing size is 18.870mm which is default mesh size.

ANSYS REPORT:-

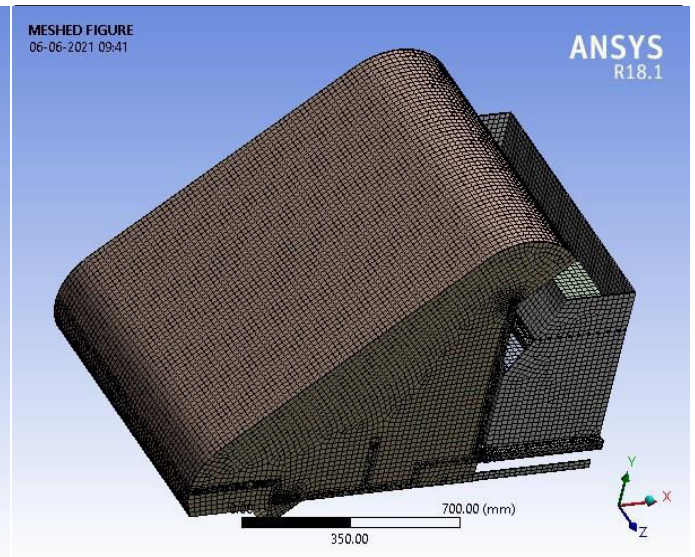
Structural analysis is done using ANSYS Workbench 18.1. The force applied on the frame is pushing force which is considered as 200N at each handle ends which is very high but taken at extreme conditions. The weight of garbage is also considered. The meshing given was coarse meshing. The end results are safe under the given conditions. The deformation seen on frame is 0.19mm, which is very negligible which is at the corner where maximum forces are considered.

The 3D model of SABO Garbage cleaning machine with actual dimensions is subjected to actual load in Static structural analysis in Ansys workbench stated that the design is safe with factor of safety 2.5 and the maximum principal stresses generated are around 1.5 MPa which are within safety limit.

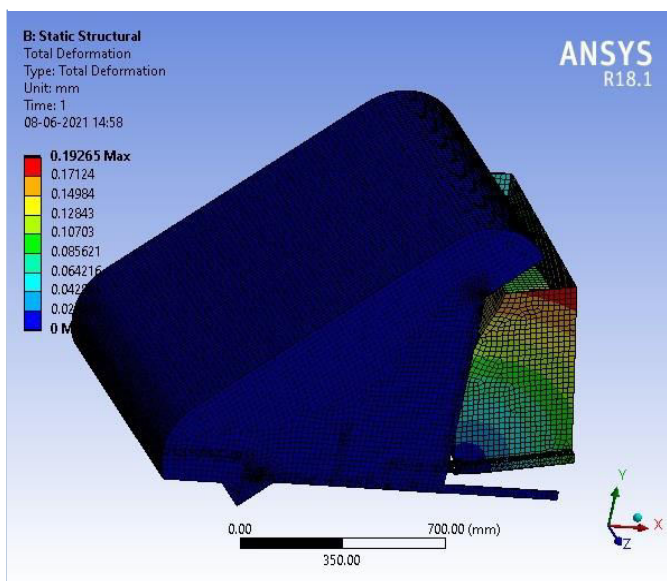
The following attached images shows the ANSYS results,-



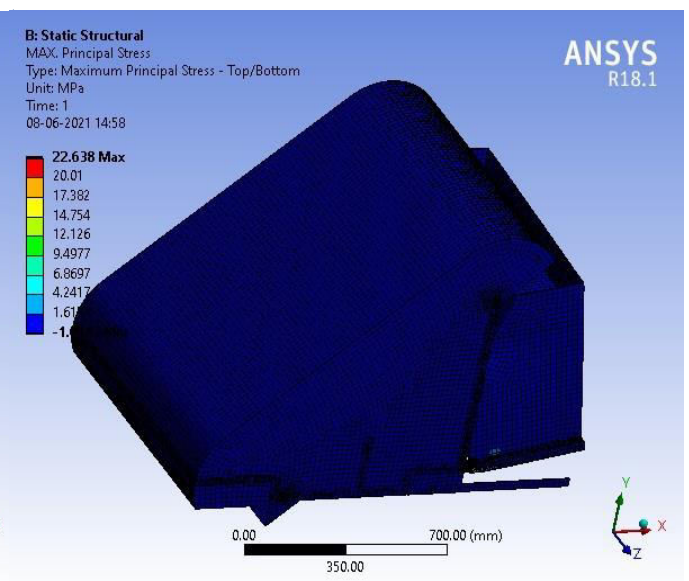
Model(B4)>Geometry> Geometry
Fig 3.Geometry of SABO



Model(B4)>Mesh>MESHED
fig 4. Meshed figure



Model (B4) > Static Structural (B5) > Solution (B6) Model (B4) > Static Structural (B5) > Solution (B6) > Total Deformation > Total Deformation
Fig 6. Deformation



Model (B4) > Static Structural (B5) > Solution (B6) > MAX. Principal Stress
fig 7. Maximum principle stress

V. RESULT AND DISCUSSION

The design body of the SABO prototype is very compact and user friendly. It is designed on the bases of actual requirements concluded from various municipal workers who need such kind of things for their safety as well as improvised work efficiency. ANALYSIS report and simulation proved that the design is safe for the operating conditions. Selection of the components as per the requirement and finding out the actual forces acting on it, is the main task to determine reliability of the mechanism. The production cost is about 35000 – 40000Rs. The maintenance cost is very low. Charged pair of batteries needs to keep together and its maintenance is the only matter. The available

cleaning mechanisms available in market are very expensive and also they are either non-automatic or have very low capacity. This mechanism is cost efficient as well as have more capacity, so we can say that target is achieved.

VI. SCOPE FOR FUTURE DEVELOPMENT

- In the above system the input used is electrical energy by means of batteries. After further research the solar energy can be used after installing solar panel.
- This system can be converted from semi-automatic to fully automatic by enhancing it further. GPS system enabled machine with artificial intelligence can clean roads itself without need of operator.

VII. CONCLUSION

The problems faced during operating and maintaining conventional cleaning machines are eliminated by using SABO garbage cleaning machine. The operator has to handle SABO only to give it direction and further process of cleaning, transferring and collection of garbage in bags is done by machine itself. Also during manual sweeping process, the person gets exposed to too much dust and harmful substance and particles which are eliminated by our system. Hence SABO garbage cleaning machine is low cost and operator friendly alternative to current conventional cleaning machine and manual sweepers.

VIII. ACKNOWLEDGEMENT

The SABO garbage cleaning machine is the part of our final year project study for Bachelor of Engineering. We are thankful to Prof. Dr. S. V. Gawali, Head of Mechanical Engineering Dept., PVG's College of Engineering and Technology, Pune for his encouragement and constant support throughout the study.

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