

# Compressive Force Analysis on Piston of Automatic Screw Jack Compression Dustbin

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**Abstract** - The spread of urbanization has happened very rapidly in a developing country like India. And the same amount of waste production has also increased. Efficiently managing waste is a huge problem and challenge for us. This paper outline efficient and effective approach to handling waste production. In this paper, Automatic screw jack compression dustbin is built on screw jack mechanism which operated by low torque motor using very high torque ratio belt and pulley linkage by which a very high compressive force achieved on the piston of screw jack and the motor is connected to an Arduino Uno board which consist of a microcontroller and the microcontroller circuited with the Ultrasonic sensor. The location of Ultrasonic sensor little lower from the topmost portion and opposite side of opening of dustbin. The microcontroller Arduino will be programmed such as when the dustbin full, the motor will start and it rotate the screw jack which compress the trash with high compressive force so there are again space available for store more waste and again dustbin full this process repeat until the waste are compacted efficiently.

**Index Terms** - Compressive Force, Mechanical Advantage, Screw jack compression, Torque ratio.

## I. INTRODUCTION

In current developing India, there are various urban areas all around the country, with this development of urban areas, the population growth of the area is also increasing. Thus, with the increase in population, there is an increase in amount of garbage and many waste products. So, handling of these type of waste product we need dustbins at various location in urban areas. It is found that waste is usually stacked due to improper removal of garbage from the dustbin. This compression dustbin designed to compress the garbage time to time, so the unwanted space occupied by the sponge type garbage being prevented and make space to accumulate more and more waste. The sensor is located opposite from opening and lower than the

top portion of dustbin which detect the level of waste and send signal to microcontroller which present on Arduino Uno, this Arduino Uno programmed in such a way that when the garbage full at dustbin the motor starts rotating the screw jack compression mechanism done and the garbage compressed by a heavy compressive force.

## II. LITERATURE WORK

L Gogoi [1] Solid Waste Disposal and its Health Implications in Guwahati City 2012 This project based on Improper management of waste causes air pollution which affects our environment leading to many adverse effects on human health. In a paper published by in this paper he also discusses that 41% of air pollution is due to garbage collection. In this letter he also tells that what kind of diseases are caused by bad waste like malaria, dengue, chikungunya etc.

N Sharma [2] Smart bin implementation for smart cities 2015, He worked on an ultra-sonic based smart dustbin for smart cities. In this project they divide the dustbin into three sections and use ultrasonic sensors to measure the filled level of the dustbin for each segment of the dustbin and also use a GSM module to send the data of each level to the garbage analyzer. We do Municipal solid waste is a potential resource of organic matter, which can be converted into compost or biogas or bio-fertilizer and some part of MSW can also be recycled and reused.

Somade Kolavole David, Jitendra Narayan Biswal, Kamalakant Muduli, Oyekola Peter, John Pumva[3] The design and analysis of a hydraulic trash compactor 2020 In this project They design, analyze and manufacture a garbage compactor that effectively will deal with this issue. Large amount of waste accumulation. Waste generation is one of the major environmental issues affecting the world today. Traditional waste disposal methods are relatively

expensive and unhygienic in many developing countries around the world. This explains the need to provide a more hygienic and cost-effective appliance that reduces the amount of these household wastes. Thus, the objective of this work is to design and manufacture a motorized waste compactor using locally procured materials. The machine uses a hydraulic system that is connected to a motor to provide compressive force. Both software analysis and performance evaluation of the machine was carried out to ensure that the design was reliable and efficient.

Suman Kirtaniya, Sumegh Moon, Atul Rajak, Suyog Khadilkar, Suraj Patil [4] Design and Manufacturing of Automatic Screw Jack Stepney for Automobiles Car 2020 They worked on in which several automobile garages, revealed the facts that mostly some difficult methods were adopted in lifting the vehicles for repair and maintenance. This fabricated model has mainly concentrated on this difficulty. There are mainly two types of jacks-Hydraulic jacks and Mechanical jacks. A Hydraulic jack consists of a cylinder and piston mechanism. The movement of the piston rod is used to raise or lower the load. Mechanical jacks are tilizr hand operated or power driven. The main parts of mechanical screw jack (cylindrical) jack are Body, Screw, Nut and Thrust Bearings. In this type of a jack, the nut remains stationary while the screw rotates and helps in lifting or lowering the load. A screw jack is a portable device consisting of a screw mechanism used to raise or lower the load. The principle on which the screw jack works is similar to that of an inclined plane. Jacks are used frequently in raising cars so that a tire can be changed. A screw jack is commonly used with cars but is also used in many other ways, including industrial machinery and even airplanes. They can be short, tall, fat, or thin depending on the amount of pressure they will be under and the space that they need to fit into. The jack is made out of various types of metal, but the screw itself is generally made out of lead. Some screw jacks are built with anti-backlash. The antibacklash device moderates the axial backlash in the lifting screw and nut assembly to a regulated minimum

Kamalakkannan.A, Kalaiselvan.Pk Isaac.Raj, Vijay.Vis [5] Automatic Motorized Scerw Jack To Redused Man Power 2016 In this project they survey in the regard in several automobile garages, revealed the facts that mostly some difficult methods were adopted in lifting the vehicles for reconditioning. Now

the research paper has mainly concentrated on this difficulty, and hence a suitable device has been designed, such that the vehicle can be lifted from the floor land without application of any impact force. The fabrication part of it has been considered with almost case for its simplicity and economy, such that this can be accommodated as one of the essential tools on automobile garages. The motorized screw jack has been developed to cater to the needs of small and medium automobile garages, which are normally man powered with minimum skilled labour. In most of the garages the vehicles are lifted by using screw jack. This needs high man power and skilled labour. In order to avoid all such disadvantages, the motorized jack has been designed in such a way that it can be used to lift the vehicle very smoothly without any impact force. The operation is made simple so that even unskilled labour can use it with ease. The D.C. motor is coupled with the screw jack by gear arrangement The screw jack shaft's rotation depends upon the rotation of D.C motor. This is a simple type of automation project. This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains to be an essential part of the system although with changing demands on physical input, the degree of mechanization is increased.

Mohammed Yousuf, Shaik Ashraf, Yaaseen Shahid Iqbal, Tasleen Ansari [6] Motorized Screw Jack 2016 This paper manages the outline and manufacturer of mecha-nized screw jack which is utilized for lifting overwhelming cars, utilizing the power from a dc motor. The project helps in reducing the exertion and additionally, time is taken to lift the heap in contrast with the standard screw jack. It compris-es of a D.C motor, battery, worm gear and a screw jack. A screw jack's compressive drive is acquired through the pressure compel connected by its lead screw. A square string is regularly utilized, as this string is extremely solid and can oppose the substantial burdens imposed. These sorts are self-locking, which makes them more naturally safe than other jack innovations. This sort of screw jack will be useful for ladies and physically challenged people to lift the vehicle. Electrical incitation is picked here in light of the fact that the power acquired through this is relatively high. The bearing of the turn of the motor is acquired by the beat tweak from the control hand-off. Therefore it is thought to be the most profi-cient and simple strategy

to activate. A scissor lift (jack) or instrument is a gadget used to amplify or position a plate framed by mechanical means. The expression “scissor” is utilized since the collapsing backings are in bundle “X” de-sign. The augmentation or removal movement is accom-plished by applying power to one of the backings and in this way, the lengthening of the crossed example happens. The constraint connected to broaden the scissor instrument might be hydraulic, pneumatic or mechanical means. Our goal is to impel through electric mean.

### III. DESIGN AND METHODOLOGY

#### Design

The design of Automatic screw jack compression dustbin consists three main parts:

- a) Dustbin box
- b) Screw jack compression mechanism
- c) Servo motor controlled with Arduino Uno

#### Dustbin Box

The shape of dustbin is rectangular. There is ultrasonic sensor attached to the dustbin box opposite of the opening. The opening of dustbin placed little higher than the position of sensor. A rectangular guide also provided for the vertical opening for easily intake of garbage.

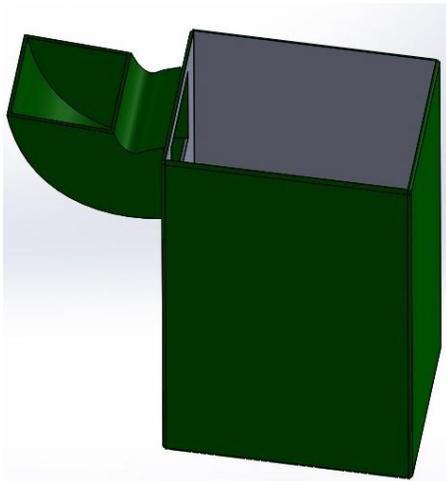


Fig. 1 Dustbin box

#### Screw jack compression mechanism

This is the main component of this project design of this part consist piston attached with the long screw rod. Screw rod inside the nut fixed with the frame. The handle of the screw rod rotated by the high torque

pulley this high torque pulley connected with the pulley of the motor by belt mechanism.

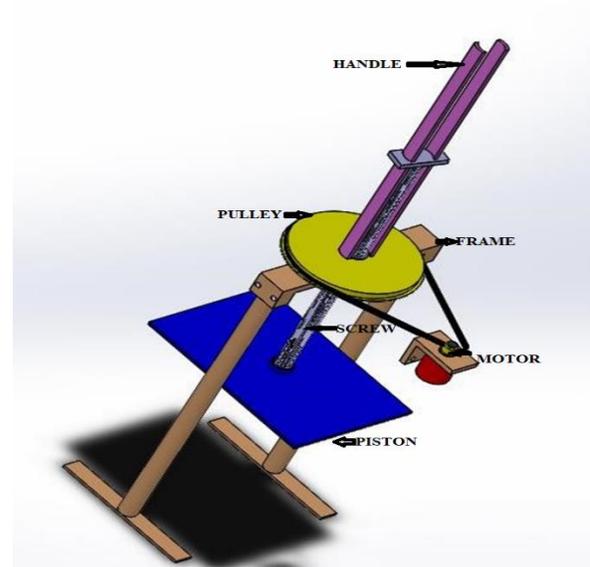


Fig.2 Screw jack compression mechanism

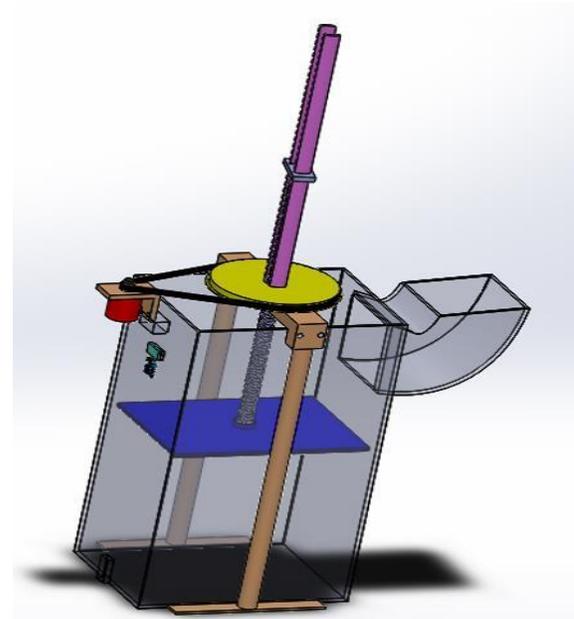


Fig 3. Complete design of dustbin

#### Methodology

When dustbin is filled with garbage the light weight, puffy and compressible garbage occupied more space as per its weight to density ratio for resolving this problem there is compression of garbage is needed and this compression done by various methods here the compression of waste done by screw jack mechanism for achieving high mechanical advantage. In this mechanism the compressor piston is attached by the

screw rod which is held to the frame with the help of nut and for the rotation of the screw rod a bigger pulley attached to the handle of the screw. Bigger pulley is attached to a smaller pulley of motor for getting high torque ratio. By the help of mechanical advantage and high torque ratio we achieve high compressive force on the compressor piston at very low torque input therefore with the help of low torque motor we compress the garbage very compactly.

#### IV. COMPRESSIVE FORCE ANALYSIS

To eliminate all these problems, we have to do some calculations and analysis.

Relation between motor torque and compressive force produce by the piston:

$$M.A. = 1/\tan(\theta+\phi)$$

$$F_c = 2T_m D/d \cdot ds \cdot \tan(\theta+\phi)$$

$F_c$  = Force exerted by piston on the garbage

M.A. = Mechanical advantage of screw

$\Theta$  = Screw helix angle

$\Phi$  = Angle of friction

$T_m$  = Torque of motor

$d$  = Dia. of smaller pulley

$D$  = Dia. of bigger pulley

$ds$  = Diameter of screw

For calculation of Compression Force ( $F_c$ ) the data of this compression dustbin is given below:

$\Theta$  = Screw helix angle =  $4^\circ$

$\Phi$  = Angle of friction =  $9^\circ$

$T_m$  = Torque of motor = 1N-m

$d$  = Dia. of smaller pulley = 40mm

$D$  = Dia. of bigger pulley = 400mm

$ds$  = Diameter of screw = 50mm

Compression Force ( $F_c$ ) = 1735 N (Theoretical)

This much of force based on theoretical based but in real case analysis included all the mechanical losses and the frictional losses in the screw jack the actual compressive force available for the trash compression equal to 1447 N.

Compressive force ( $F_c$ ) = 1547 N (Actual)

#### V. CONCLUSION

For a given screw the thread angle 4 degree and friction angle 9 degree. Diameter of screw 50 mm, diameter of smaller pulley 70 mm and diameter of bigger pulley 400mm, applying a low torque motor of 1 N-m the compressive force of 1447 N achieved. The

working of automatic compression is done successfully with the help of Arduino Uno and ultrasonic sensor. During the designing of dustbin, all the standards are kept in mind like its user friendly, durable, convenience and prevention against damage.

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