



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 9, Issue 9, September 2020

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.512

9940 572 462

6381 907 438

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www.ijirset.com

Design and Manufacturing of Portable Drilling Machine

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ABSTRACT: Conventionally, we use a drilling machine to make holes which is operated manually. But the height to which holes will be drilled is normal to human height. And for higher levels we generally use ladders or cranes. This project describes the design and fabrication of scissor lift which will be operated on DC motors for drilling application. In the present market the fix drilling machine are available and in most of the industries the drilling is done manually. It requires man power and more skilled workers. For drilling at different position we need either a manual process or more drilling machine. The former one consumes lot of time and is costlier. For portable drilling we need to move the spindle in all three directions. Thus based on the functional and economical aspects we have fabricated a unique machine.

KEYWORDS: Portable drilling machine, spindle, scissor mechanism.

I. INTRODUCTION

Our research survey revealed that in manufacturing or production companies, mostly some difficult methods were adopted for drilling holes in column for building structure which are above human height. For this we have fabricated model which has focused on this difficulty and hence a suitable design is created for drilling a hole at height without any human accident or human errors. The design and fabrication have been done by keeping simplicity and economy in mind such that this can be used by small, large and medium scale industry. A scissor lift or mechanism is a device used to extend or position a platform by mechanical means. The term "scissor" comes from the mechanic which has folding supports in criss cross "X" pattern, which is known as Pantograph. The drilling machine is one of the most important machine tools. In a drilling machine holes may be drilled quickly. The holes are generated by the rotating edge of a cutting tool known as the drill which exerts large force on the work clamped on the table. Industries at present are using scissor lifts operated on hydraulic and pneumatic. These kinds of lifts are highly efficient and offer you with ease of application. But as far as Cost and Safety is concerned, the Hydraulic as well as Pneumatic Lifts lack in them. Thus, we use an automated motorized scissor lift that has been designed in such a way that operation has become so simple that even unskilled labour can also use it. The D.C motor is coupled with the lead screw by gear arrangement. The lead screw rotation depends on the rotation of the D.C motor. This is an era of automation where it is defined as replacement of manual effort by mechanical power in all degree of automation. The operation remains to be an essential part of system although with changing demands on physical inputs, the degree of mechanisation is increased.

II. PROBLEM STATEMENT

In many industries, columns having larger size can't be drilled with the help of small drilling machine. At a higher height it becomes difficult to make holes manually or by using equipment. And in such case accuracy is an important phenomenon. Also, many fatal accidents can occur while drilling holes manually at a higher height with the help of a ladder. Balancing the self-weight of worker on ladder with maintaining stability of ladder and working with heavy

drilling machine made a very tricky situation for the worker, which engaged another worker for balancing of ladder. So, to overcome above problems we developed a portable drilling machine.

III. LITERATURE SURVEY

[1] Bhavin.H.Mehta in their paper concluded that with increasing employee and industry pressures there is need to implement ergonomic solution for labour intensive tasks that are to elevate at precise range with high speed, without drifting at specified height for extended period of time, the Screw Operated Lifting Equipment operating by a Lead Screw at precise range with high speed, at specified elevation for extended period of time is good alternative. [2] Anupam Chaturvedi's paper is a brief explanation about design procedure of the mechanically operated scissor lift working on the principle of lead screw. Also, they explained the importance of some useful accessories such as Self Storing Maintenance Stand, Blocking Mechanism, Self Locking Pair, Loading by Saddle Plate, Stability Conditions as well as Controller Mechanism. [3] Balkeshwar Singh introduced a method of lifting loads with the help of electrically operated screw jack with a DC motor. The need has long existed for an improved portable jack for automotive vehicles. It is highly desirable that a jack become available that can be operated alternatively from inside the vehicle or from a location of safety off the road on which the vehicle is located. Such a jack should desirably be light enough and be compact enough so that it can be stored in an automobile trunk, can be lifted up and carried by most adults to its position of use, and yet be capable of lifting a wheel of a 4-5 ton vehicle off the ground. Further, it should be stable and easily controllable by a switch so that jacking can be done from a position of safety. It should be easily movable either to a position underneath the axle of the vehicle or some other reinforced support surface designed to be engaged by a jack. Thus, they developed a product considering all the above requirements. This particular design of the motorized screw jack will prove to be beneficial in lifting and lowering of loads. [4] Ivan.Sunit.Rout worked in order to address about importance of use of power screws to lift load with minimum efforts. The efforts required in achieving the desired output can be effectively and economically be decreased by the implementation of better designs. Power screws are used to convert rotary motion into reciprocating motion. An object lifting jack is an example of a power screw in which a small force applied in a horizontal plane is used to raise or lower a large load. In this fabricated model, an electric motor will be integrated with the object lifting jack and the electricity needed for the operation will be taken from the DC battery and thereby the mechanical advantage will be increased. [5] R.A.Tatara has predicted use of simple, all-electric, cart-mounted scissor lift with a capacity of 185 kg (408 lbm) which has been designed and constructed using steel. It is optimized in terms of mobility, stability, rigidity, safety, and versatility. An 8897-N (2000-lbf) actuator translates its purely horizontal force into a vertical lift. [6] Divyesh.Prafulla.Ubale focused on various aspects related to lifting mechanism and its design. The dimensional, dynamic and strength analysis reflects that the selected mechanism is functional and most likely reliable for its purpose. The portable work platform is operated by hydraulic cylinder which is operated by a motor. Also, whole device is motorized and with help of control panel allows user to travel from one place to other. The scissor lift can be designed for high load also if a suitable high capacity hydraulic cylinder is used. The hydraulic scissor lift is simple in use and does not require routine maintenance. In this paper we carried out detailed analysis of scissor mechanism members against bending and buckling failure and also focused on various design aspects and working of scissor mechanism.

IV. OBJECTIVES

- ❖ Design of a versatile portable machine for drilling.
- ❖ To increase productivity.
- ❖ To reduce man power.
- ❖ Reduce the time required for drilling huge parts.
- ❖ Reduce number of fatal accidents.
- ❖ To drill precise holes with maximum accuracy.

V. METHODOLOGY

As our project is based on industrial problem, we started our project by introducing a problem statement on which we started working. So **"First Things First"**, we started searching research papers published by various authors, due to which we can understand and find a solution which will give us a direction, idea and method to work. Now based on selected research papers we collected basic information required for the project. This collected information gave us an option to select appropriate and precise mechanism required for the project. On the basis of selected mechanism, we started selecting various components required for assembly of the project. Now comes the major part of the project that is design and calculations of various components used. Calculations are done by taking help from the research papers and design of all components and assembly is completed in **Solid works 2016**. All the activities done till now are going

to come true, that is fabrication part. According to the design we completed the fabrication step by step and assembled all the components to get a final product.

VI. COMPONENTS USED

1.1 Lead Screw:

A lead screw, also known as a power screw or translation screw, is a screw used as a linkage in a machine, to translate turning motion into linear motion. Because of the large area of sliding contact between their male and female members, screw threads have larger frictional energy losses compared to other linkages. They are not typically used to carry high power, but more for intermittent use in low power actuator and positioned mechanisms.

1.2 Drill chuck assembly:

Drill chuck assembly is used to hold a drill on a spindle where actually drilling operation takes place. We used Jacob's drill chuck which is generally used all over the world, which can be loosened and tightened with the help of a key for the adjustments of the drill.

6.3 DC Motor:

A DC motor is any of a class of rotary electrical motor that converts direct current electrical energy into mechanical energy. 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 in part of the motor. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings.

6.4 Arduino UNO:

The Arduino UNO is an open source micro-controller board based on the micro-chip ATmega328p micro-controller and developed by Arduino.cc. The board is equipped with sets of digital and analogue input/output (I/O) pins that may be interfaced to various expansion boards and other circuits. The board has 14 digital input pins; six capable of PWM output, six analogue input pins and is programmable with the Arduino IDE, through a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

6.5 L298N Motor Driver:

This dual bidirectional motor driver is based on the very popular L298 Dual H-Bridge Motor Driver Integrated Circuit. The circuit will allow you to easily and independently control two motors of up to 2A each in both directions. It is ideal for robotic applications and well suited for connection to a microcontroller requiring just a couple of control lines per motor. It can also be interfaced with simple manual switches, TTL logic gates, relays, etc. This board equipped with power LED indicators, on-board +5V regulator and protection diodes.

6.6 Bluetooth Module:

HC-05 Bluetooth Module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Its communication is via serial communication which makes an easy way to interface with controller or PC. HC-05 Bluetooth module provides switching mode between master and slave mode which means it able to use neither receiving nor transmitting data.

VII. CALCULATIONS

❖ Cutting parameter calculations:

We know

$$V_{\max} = \frac{\pi \times D \times N_{\max}}{1000}$$

$D = 4\text{mm}$ (4×10^{-3}), $V_{\max} = 20\text{m/min}$, N_{\max} = speed of the motor.

$N_{\max} = 1591549.431\text{rpm}$ (not possible)

$N_{\max} = V_{\max} \times 1000$

Take $D = 4\text{mm}$

$$N_{\max} = \frac{V_{\max} \times 1000}{\frac{\pi \times D}{20 \times 1000}} = \frac{\pi \times 4}{20 \times 1000}$$

$N_{\max} = 1591.5494\text{rpm}$ (possible)



$N_{max} = 1600\text{rpm}$

Therefore, motor speed is 1600rpm for drilling the hole.

❖ **Feed for Drilling Operation:**

For Diameter = 4 mm

$S = 0.2$ mm/revolution (CMIT handbook table no.272 page no.651)

Material factor (From table no.272-page no.651)

For medium carbon steel

$K = 1.15$

Power Requirement at

$$P_T = \frac{1.25 \times d^2 \times K \times N \times (0.056 + 1.5S)}{10^5}$$

$$P_T = \frac{1.25 \times 4^2 \times 1.15 \times 1600 \times (0.056 + 1.5 \times 0.2)}{10^5}$$

$$P_T = 0.1310 \text{ watt}$$

$$P_T = 0.000131\text{kw}$$

Assume efficiency is 90%

Power of motor is given by,

$$\eta_{\text{motor}} = \frac{P_T}{P_M}$$

$$P_M = \frac{P_T}{\eta_{\text{motor}}}$$

$$= \frac{0.0001310}{0.9}$$

Motor = 0.000145556kw

Motor = 0.145556watt

Motor power in horse power (HP)

We know that

1HP = 746 watt

$$\text{Power} = \frac{0.145556}{746}$$

Power = 0.0001951HP

Hence standard motor of 0.1 HP Power is selected.

❖ **Torque at Spindle:**

$$T_s = 975 \times \frac{P_T}{N}$$

$$= 975 \times \frac{0.0001310}{1600}$$

$$T_s = 0.000798 \text{ kgm}$$

$$T_s = 0.007831 \text{ Nm}$$

❖ **Thrust at spindle:**

$$T_H = 1.16 \times K \times d \times (100 \times s)^{0.84}$$

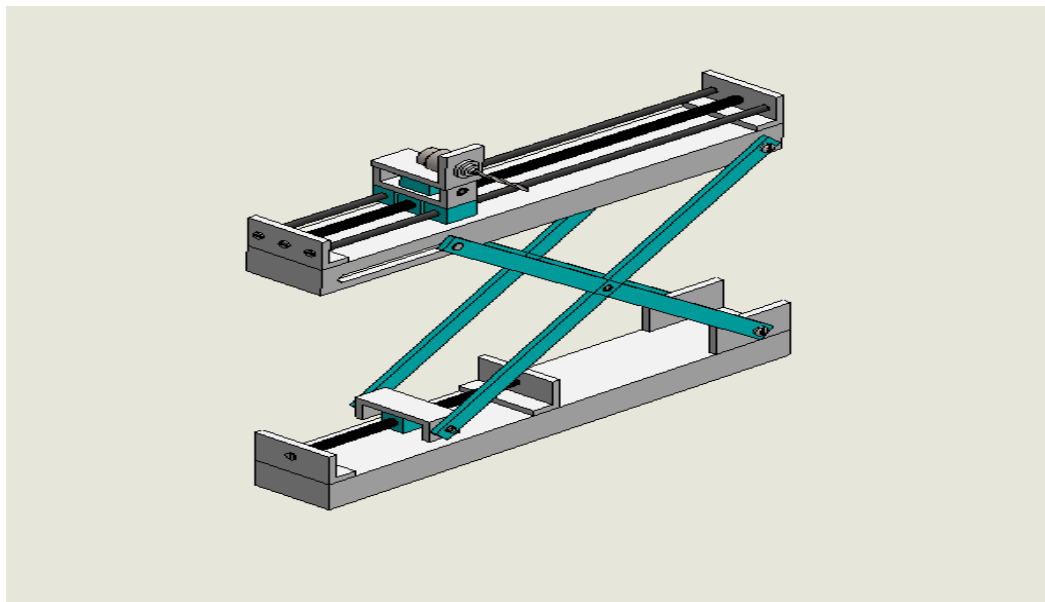
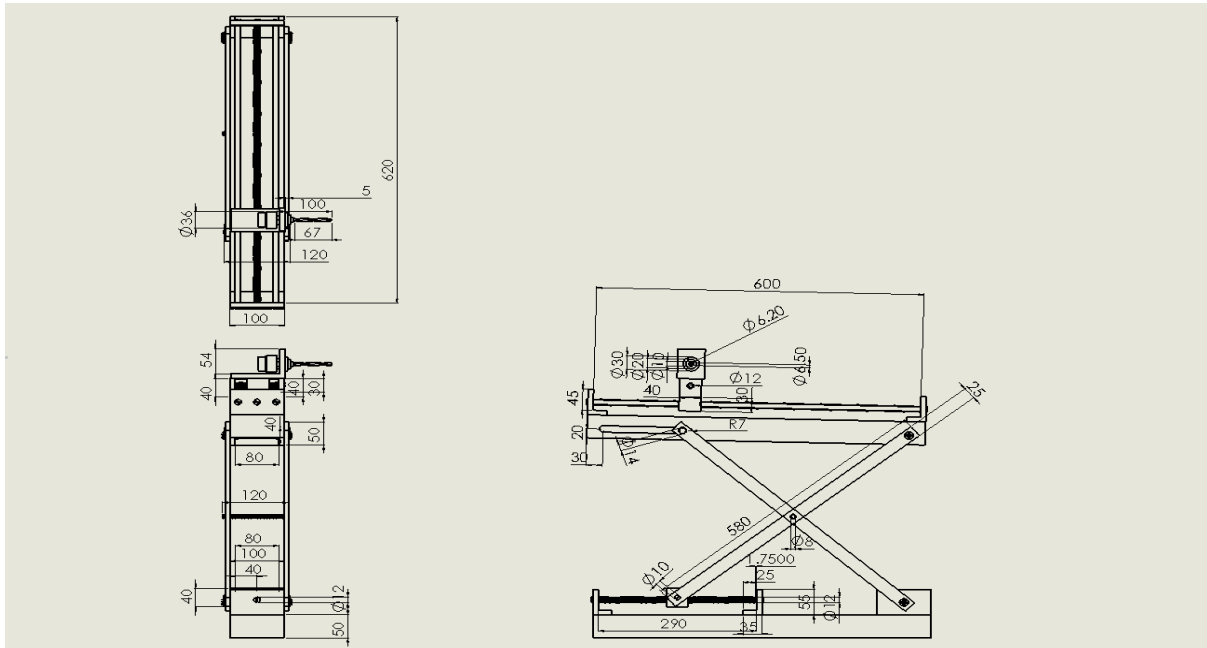
$$T_H = 1.16 \times 1.15 \times 4 \times (100 \times 0.2)^{0.84}$$

$$T_H = 66.08167 \text{ Kg}$$

$$T_H = 66.08167 \times 9.81 \text{ N}$$

$$T_H = 648.26 \text{ N}$$

VIII. DESIGN OF CAD MODEL



IX. WORKING METHODOLOGY

Working of the model takes place in 3 axis:

- ❖ The whole model is connected to Arduino circuit which controls the DC Motors attached with each lead screw which creates a movement X, Y and Z direction respectively.
- ❖ The circuit sends signal to the DC Motor connected to Y axis which makes UP and DOWN movement due to which required height is achieved. It takes place because of the scissor mechanism which is also called as the pantograph.

- ❖ Then it turns on the motor attached to the X axis which creates a horizontal sideways movement.
- ❖ At last Z axis motor is turned on which makes drill chuck attend the required position along with turning on the drill spindle motor.
- ❖ All the controls are handled by the operator using a remote Bluetooth control which gives all the instructions to the motor and the drill bit reaches it desired position.

X. FUTURE SCOPE

- ❖ Industrial Portable Drilling Machine is designed according to industry needs and considering all the parameters while performing operations. Current machine is operated with help of servo motors controlled by electric switches. It can be upgraded in future for ease of operation.
- ❖ Mass optimization of machine using light weight material that has high strength to weight ratio.
- ❖ Control panel can be upgraded by using PLC's system.
- ❖ Computerized Numerical version of this machine could be possible in future.

XI. CONCLUSION

- ❖ With this design of an Industrial Portable Drilling Machine, the complexities in the design are reduced and also with such design parameters, the time required for drilling is reduced to carry operation of drilling.
- ❖ Only one person is sufficient to carry out the drilling operation on column. He can have control on machine by using remote or switch panel, there is drive (motor) for each motion and operation.
- ❖ Also there will be reduction in accidents occurred due to manual handling of drilling machines which was a major problem.

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