JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Automatically Operated Double Hacksaw

Amey Dileep More
Mechanical Engineer
Department of Mechanical Engineering
NDMVPS's Karmaveer Adv. Baburao Ganpatrao Thakare College of Engineering, Nashik, India

Abstract: *In any manufacturing industry, increasing productivity is one of the most important goals of production engineering. It is critical for an industry to do this by either reducing operating time or improving the machine's capability to manufacture more components in a shorter amount of time. The Scotch yoke mechanism is used in this project to allow the power hacksaw machine to cut two components at once, increasing productivity. In today's environment, a machine should consume less time. Because the power hacksaw only cut one piece at a time, the output rate was reduced. This time-consuming difficulty is solved with a double-acting power hacksaw. A fine-toothed power hacksaw with a blade held under tension in the frame is known as a power hacksaw. Due to its scotch yoke mechanism, the production rate of a double acting power hacksaw is twice that of a single acting power hacksaw. The scotch yoke mechanism drives the double-acting power hacksaw. The rotating motion is converted to reciprocating motion by the scotch yoke mechanism.*

***Key Words* – Automatic, Production Engineering, Operating Time, Hacksaw, Scotch-Yoke**

1. INTRODUCTION

Many electrically powered power hacksaw machines are currently available for material cutting of bars with various requirements. These machines are precise and good for material cutting, and they have a low material made uptime with a variety of materials, but material cutting is done on a single work piece at a time.

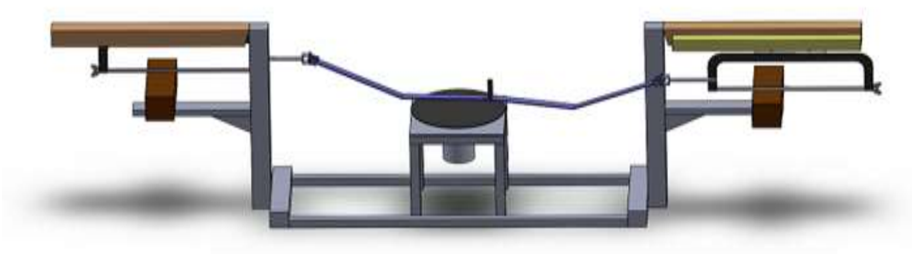


Fig. 1 – Double Way Hacksaw

This will be the most significant disadvantage of a traditional power hacksaw machine with a single hacksaw blade and a single hacksaw frame. To combat this, a suggested four-way power hacksaw machine with the capability of cutting four material pieces simultaneously will be introduced, which will outperform the current one in terms of cutting rates. Four hacksaw frames are positioned in such a way that the angle between the two hacksaws is 90 degrees to create this four-way cutting. The Scotch Yoke is a mechanism that converts a crank's rotational motion into a slider's linear motion. The reciprocating part is connected to the spinning part by a sliding yoke with a slot that engages a pin. This proposed model will be beneficial in overcoming all of the restrictions of standard Power Hacksaw Machines, such as material cutting, subsequent material processing time periods, coolant feeding, and machine idle time and efficiency.

1.1. Problem Statement

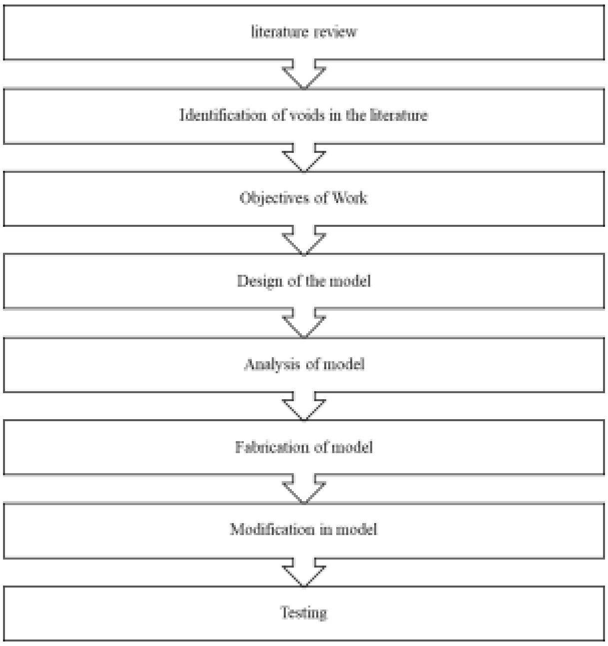
Material cutting with a single hacksaw blade is done in both pneumatic and electrically operated hacksaw machines in current Industrial Processes, resulting in longer cutting time per unit work piece and longer machine time per unit. In modern methods, industries place a greater emphasis on achieving a high rate of material production while using the least amount of available resources. In order to increase output, the four-way power hacksaw machine will improve these parameters by reducing material cutting time per unit. To perform cutting of various materials with a higher rating and increased accuracy by reducing machine idle time.

1.2. Objective of Work

Scotch Yoke Mechanism is the core mechanism of a power driven hacksaw or two-way hacksaw.

- To decrease the amount of human labour required to machine diverse materials.
- In order to attain high production, it is necessary to save manpower and time when cutting materials.
- We can use two hacksaws at the same time by employing a scotch yoke mechanism.
- We use the overall energy of the motor to complete the task in the shortest possible time and at the lowest possible cost.

1.3. Methodology



2. LITERATURE REVIEW

The disadvantages and limitations of a single frame hacksaw machine are overcome by a two-way hacksaw machine. The machine is inexpensive, simple to run, and suitable for all industries. It helps to enhance production by saving time while stopping and restarting it, as well as requiring less human work. In comparison to traditional hacksaw machines, the automatic power hacksaw machine provides high production in a short amount of time. The fundamental advantage of this machine is that it reduces labour intervention to the absolute minimum. The range of workpiece sizes that can be cut with the automatic hacksaw machine can be enlarged by changing the blade size. Because this machine eliminates all of the limitations and flaws of standard hacksaw machines, it is especially advantageous to small-scale businesses due to its ease of use, adaptability, efficiency, and inexpensive cost.

3. Design

Different parts have been composed in the concept plan, such as the base table (24x11) inch and material used is gentle steel, the centre arm (23x9x6.5) inch and material used is gentle steel, the shaft (6 inch diameter) is used as an interfacing join for hacksaws and arms and is gentle steel, the dc motor (30 rpm) is attached under the base table, and the upper apron is gentle steel. The following are the steps that make up the project's design phase:

3.1 Selection of Material

The selection of a material is based on the component and the duties that this component performs. Because they perform distinct functions, different sections of the mechanism are subjected to varying loads and stresses. When choosing a material for each section, it's critical to take a unique approach. It has an impact on the overall efficiency and benefit derived from each detail, as well as the best features that various materials may provide. As a result, it's vital to divide apart a design's primary components and describe each one separately. The model's frame is of particular relevance because it bears the brunt of the strain and is a fundamental component of the assembly. It implies that the material from which they are produced must be able to withstand this weight. This part is subjected to a normal force that could produce buckling and a shear force that could cause bending, bending deformation, or even braking. Then you'll need attributes like strength, hardness, and stiffness. Structural steel, namely S355 steel, is an ideal material for these tasks. The hacksaw blade is the second fundamental component of a design. It slices the metal from a technological standpoint. It is subjected to direct compressive force, which causes the rod to bend and buckle. As a result, the blade must possess qualities such as strength, toughness, ductility, and hardness. Mild steel is a suitable material. There are other components, such as the top disc. The top disc bears the load imposed by the motor's weight. The key requirement is for strength, and the chosen material is mild steel.

3.2 Selection of Model

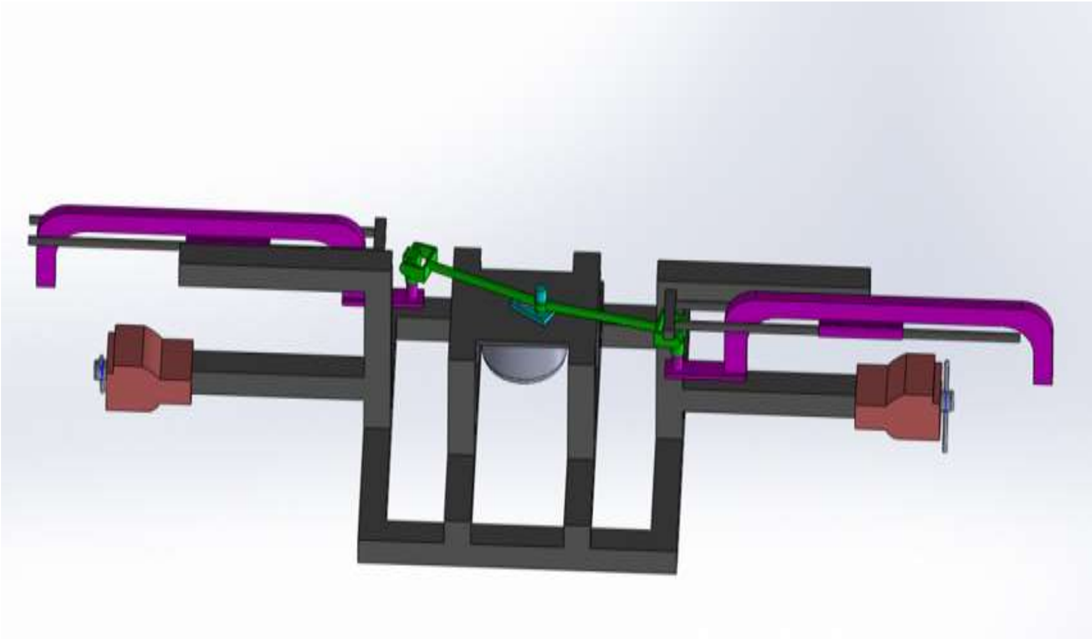


Fig. 2 – Two Way Hacksaw

Frame Work
Length: 24 inches
Breadth: 24 inches
Height: 43 inches

Scotch Yoke Mechanism
Disc: 4 inches (12 mm hole centre for rod)
Stroke Length: 4 inches
Rectangular Frame Length: 2.8 inches
Rectangular Frame Height: 30.8 inches

3.3 Calculation for Scotch Yoke Mechanism

The following are some of the theoretical relationships that were used in the course of carrying out the experimental evaluation for the procedure: Linear Velocity Calculation Using Angular Speed Measurements

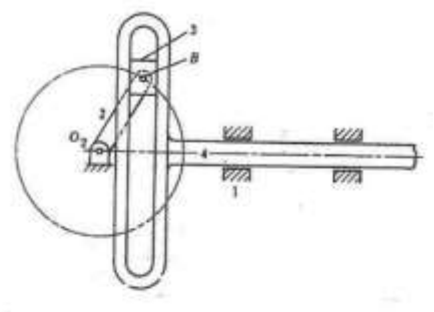


Fig. 3 – Scotch Yoke Mechanism

Angular velocity,

$$w = \frac{2*\pi*rpm}{60}$$

$$= \frac{2*\pi*30}{60}$$

$$= 3.14\ rad/sec$$

Linear velocity,

$$v = r * w$$

$$= 0.0514 * 3.14 \ = 0.161\ m/s$$

The torque rating was established, and the electric motor selection was warranted- the torque rating according to the idealized experimental set up, which must be computed. Motor Torque: For a horizontal travel on a contact surface, the value of torque is given by,

$$\tau = ½\, D * \mu * M * g$$

μ= coefficient of friction (steel on steel = 0.57)

M= mass of blade (0.38 kg)

g = acceleration due to gravity

$= ½ * 0.102 * 0.57 * 0.38 * 9.81$

$= 0.108\ Nm$ ….. (1)

3.4 Selection of Motor

Randomly select one motor which have following specifications,

Voltage	12 v DC, 20watts
Load current	10 A
No load current	2/2.5A
Speed	30 rpm

Table 1 – Motor Specifications

Calculation for DC Motor

From physics

Power = Torque * Angular Velocity

Torque = Power /Angular Velocity

Power =20 $watt$

Angular Velocity = speed in rpm * 2 * π

= 30 * 2 * π

=188.4

Now Torque = $20/188.4$

= 0.106 Nm …... (2)

Form the calculated value of torque 1 and 2 we conclude that the difference between both values is negligible. Therefore we select 12 volt DC motor, 20 watt.

3.5 Selection of Hacksaw Blade

When choosing a hacksaw blade, be sure that at least three teeth are engaged in the workpiece when cutting.

Fig. 4 – Blade Layout

Thin materials, on the other hand, required finer toothing (higher TPI numbers) than thick materials. On the back stroke of the blade, no downward pressure should be applied. One of the most significant factors to consider when choosing a hacksaw blade for a specific material is the tooth per inch (TPI). TPI has an impact on hacksaw blade cutting performance and longevity. TPI blades are divided into two categories: high and low.

TPI (25mm)	Suitable for cutting
14	Large sizes. Aluminum and other soft materials.
18	General workshop cutting.
24	Steel plates up to 5/6 mm
32	For cutting hollow section and tubing

Table 2 – Blade Specifications

- **Cutting Force**

Force required for the cutting

$$Fc = Zc * Kz * A * f$$

Where,
Fc = Cutting force in Kg.
Zc = Nos. of teeth in contact with workpiece. (This no. is maximum when the saw reach the diameter of the circular work piece) = 4
Kz = Specific pressure of cutting = 1.25 Kg/mm^2
A = Width of saw = 25mm
f = Feed per stroke = 0.25mm

$$Fc = 4 * 1.25 * 25 * 0.25$$
$$Fc = 31.25\ Kg$$
$$Fc = 306.56\ N$$

- **Time required for the cutting**

$$T = \frac{L}{(\text{SPM} * \text{FPS})}$$

Where,
T = Time required for Cutting
L = Length of Cut in mm
SPM = Stroke per minute
FPS = Feed per stroke = 0.25 mm

3.6 Design

Allowable Bending Stress for Material

Ultimate tensile stress of cast iron = 200 Mpa
Np = 3
σall = $\frac{Sut}{Nf} = \frac{200}{3}\ Mpa = 66.6\ \frac{N}{mm^2}$

Base Frame Safety Design

$$\frac{M}{I} = \frac{\sigma}{y}$$

Bending Moment,
$M\ = Force *\ perpendicular\ distance$
M = (30 ∗ 9.81)* 609.6
M = 179405.28 Nmm
Moment of Inertia,

$$I = \frac{bh^3}{12}$$
$$I\ =\ 67500$$

Distance of outermost layer from Neutral axis y =
Bending Stress =$\sigma b\ = \frac{My}{I}$

$$\sigma b = 26.57 \frac{N}{mm^2}$$

26.57<66.6 $\frac{N}{mm^2}$
Design is Safe.

Design of Plate

Two forces acting on design of plate i.e. bending and rotational force.
Torque = 6.36 Nm = 6360 Nmm

$$Torque = Force * perpendicular\ distance$$
$$6.36 = Force * (0.0127)$$
$$F = 500.78N = 51.04\ Kg$$

R = Rotational Force i.e. Bending moment = 6.36 Nm
Allowable Bending Stress for Material = 105 N/mm^2

Bending Moment (M),

$$M\ =\ Force *\ perpendicular\ distance$$
$$M\ =\ 318 * 20$$
$$M\ =\ 6360\ Nmm$$

Moment of Inertia (I),

$$I = \frac{bh^3}{12}$$

$$I = (40 * 5^3)/12$$
$$I = 414.66\ mm^4$$
$$Y = 5/2 = 2.5\ mm$$

Bending Stress

$$\sigma b = \frac{M * y}{I}$$
$$\sigma b = \frac{6360 * 2.5}{416.66}$$
$$\sigma b = 38.16 \frac{N}{mm^2}$$
$$i.e. 38.16 < 66.6 \frac{N}{mm^2}$$

Design is Safe.

Design of Hacksaw Handle

The force acting on Hacksaw Handle is equal to the Cutting force.

F = 306.5625 N

Design of Connecting Rod

The cantilever beam is attached to one end of the connecting rod, while the hacksaw handle is attached to the other.

Tensile force F1 acts on the tiny side of the connecting rod (i.e. the cantilever side). This force is equal to the plate's bending force.

F1 = 51.04 Kg = 500.70 N …….. (1)
Force F2 is acting on other end of connecting rod. The force is called longitudinal force. This force is equal to cutting force.
F2 = 31.25 Kg = 306.5625 N …….. (2)
R is the rotational force i.e. bending moment due to rotation of connecting rod.
R = 6360 Nmm ……. (3)
Check safety:

$$\frac{M}{I} = \frac{\sigma}{y}$$

Bending Moment,
$M = Force * perpendicular\ distance$
$M = 306.5625 * 69.425$
$M = 21282.928\ Nmm$

Moment of Inertia,

$$I = \frac{bh^3}{12}$$
$$I = \frac{138.85 * 12.70^3}{12}$$
$$I = 23701.49\ mm^4$$

Distance,

$$y = \frac{138.85}{2}$$
$$y = 69.425\ mm$$

Bending Stress,

$$\sigma b = \frac{M * y}{I}$$
$$\sigma b = \frac{21282.92 * 69.425}{23701.49}$$
$$\sigma b = 62.34 \frac{N}{mm^2}$$
$$i.e. 62.34 < 66.6 \frac{N}{mm^2}$$

Design is Safe.

4. MODELLING AND DISCRIPTION

4.1 Hacksaw Handle

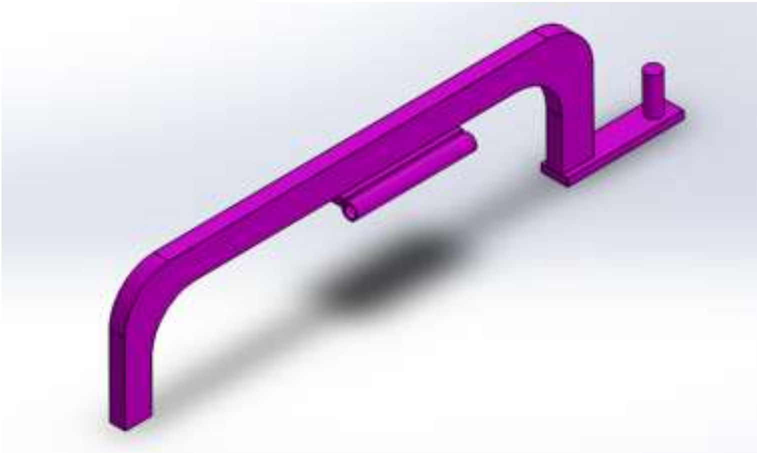


Fig. 5 – Hacksaw Handle

A hacksaw is a fine-toothed saw that was originally and primarily used to cut metal. They can cut a variety of materials, including plastic and wood; plumbers and electricians, for example, frequently use them to cut plastic tubing and conduit. There are two types of saws: hand saws and powered saws. The majority of hacksaws are made by hand and have a C-shaped frame that keeps the blade under tension. Such hacksaws contain pins for attaching a narrow disposable blade to the handle, which is usually a piston grip. The frames might also be adjusted to accommodate different blade diameters. The thin blade is tensioned using a screw or equivalent device.

4.2 Connecting Rod

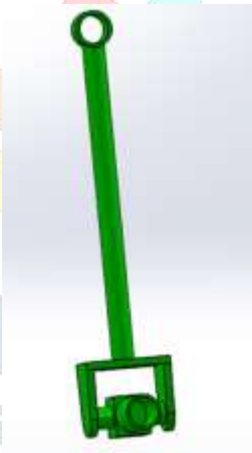


Fig. 6 – Connecting Rod

This rod has a hole on the end for joints and link connections. Two of these shafts were used in two side hack saws. It builds a simple mechanism with the crank that transfers reciprocating motion into rotting motion.

4.3 Frame

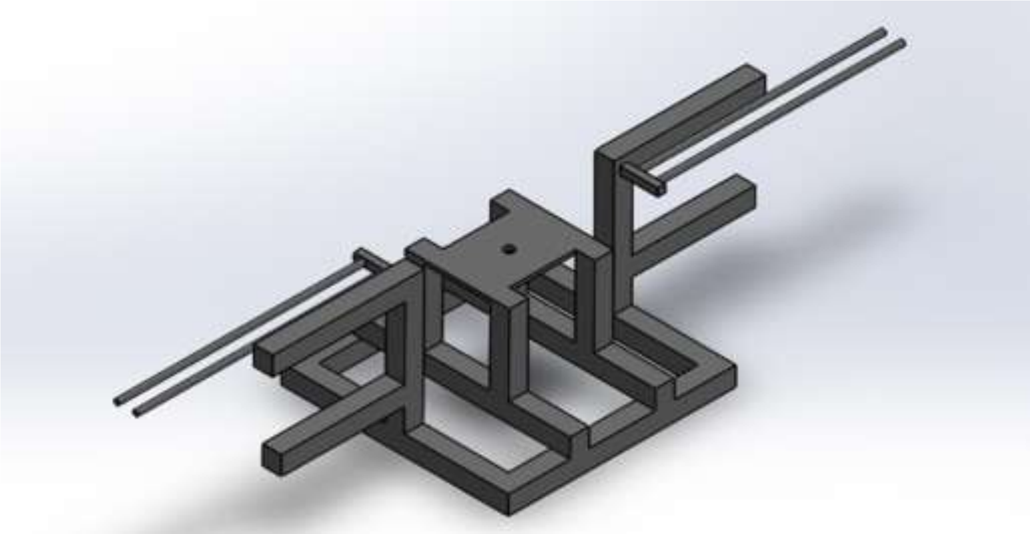


Fig. 7 – Frame

We use a square steel frame that is 24*24 inches in size. It's a platform on which all of the components, such as the dc motor and shaft, are attached. The motor is balanced by the middle arm of the frame, which is coupled to the shaft.

4.4 DC Motor

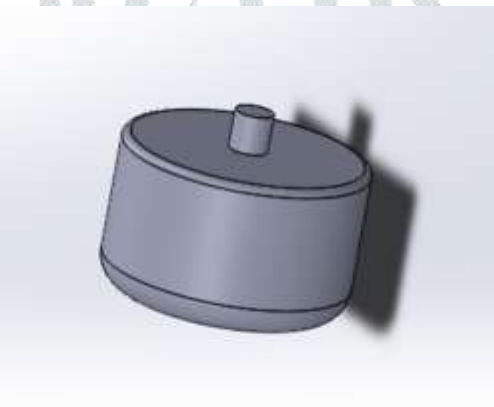


Fig. 8 - Motor

A DC motor is an electric motor that is powered by direct current (DC). The cutting operation is carried out by the responding movement of the Hacksaw sharp edge, which is provided by a DC motor that is controlled by a basic wrench component that converts the rotating movement of the wrench into the responding movement of the Hacksaw edge.

4.5 Bench Vise

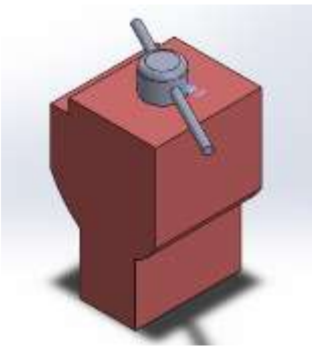


Fig. 9 – Bench Vise

A Bench Vice is a holding device that is used to hold a specimen or work piece between two jaws. One jaw is permanent while the other is moveable out of the two. Bench vices (also known as workbench vices or vises) attach directly to a workbench and hold the work piece in place during operations like sawing, planing, and drilling. This page examines the various varieties of vices, as well as how they work and the materials used to construct them. It is made up of a cast steel body, a moveable jaw, a fixed jaw, a handle, a square threaded screw, and a nut, all of which are constructed of mild steel.

4.6 Rotor Plate

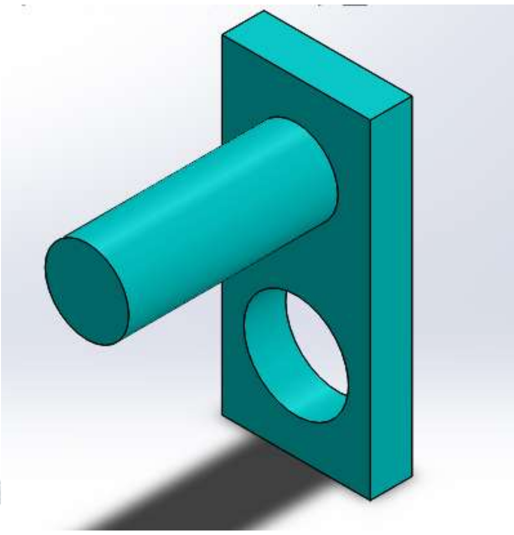


Fig. 10 – Rotor Plate

5. ANALYSIS

1) Static frame

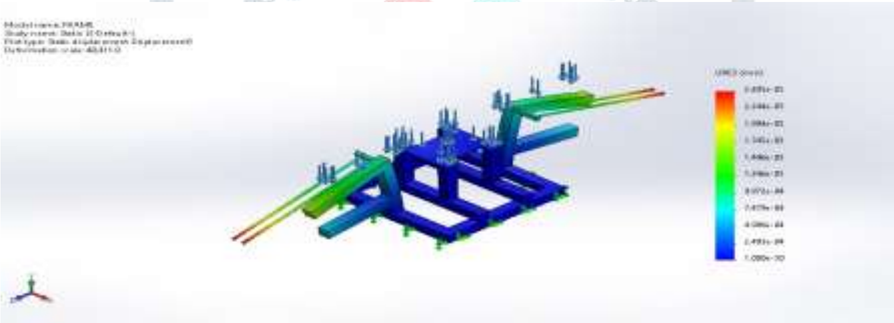


Fig. 11 - Total Deformation

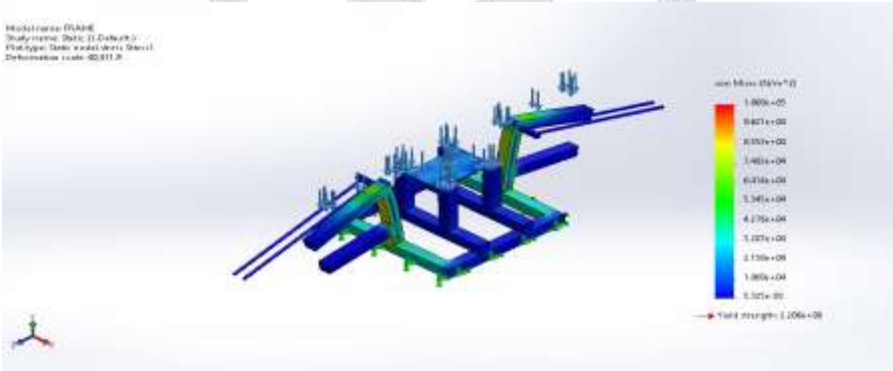


Fig. 12 - Equivalent Stress

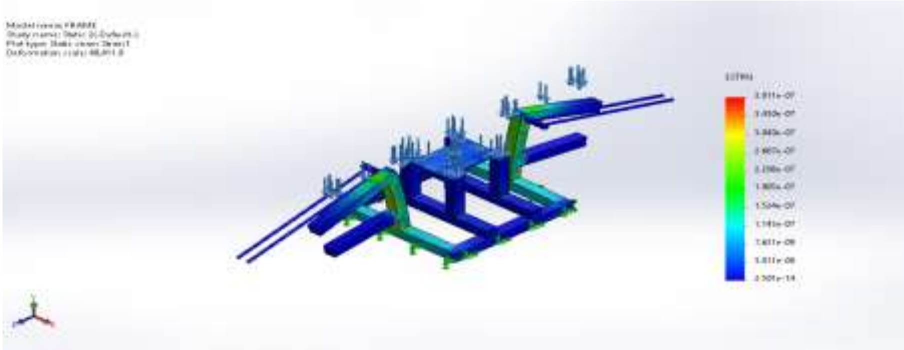


Fig. 13 - Equivalent Strain

2) Rotor plate

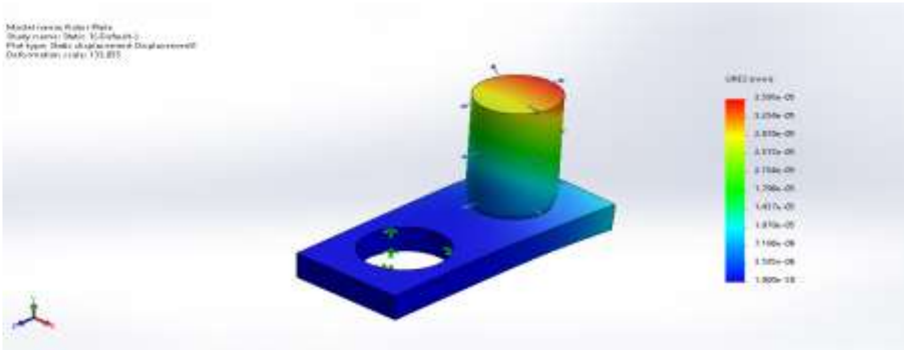


Fig. 14 - Total Deformation

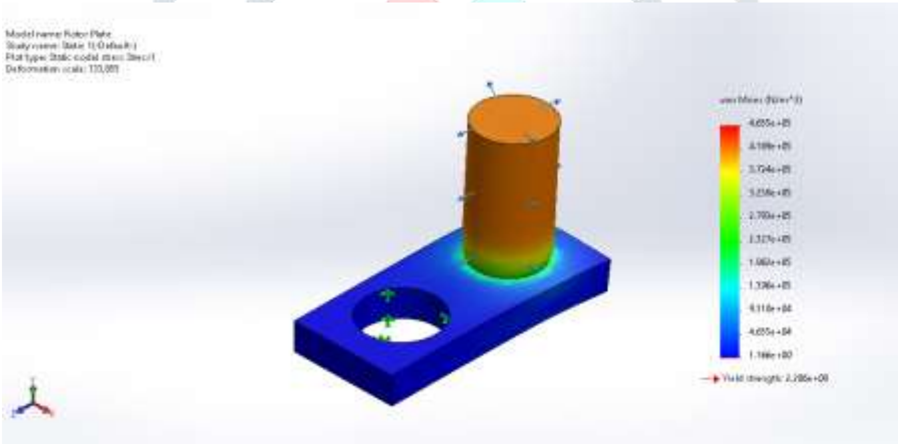


Fig. 15 - Equivalent Stress

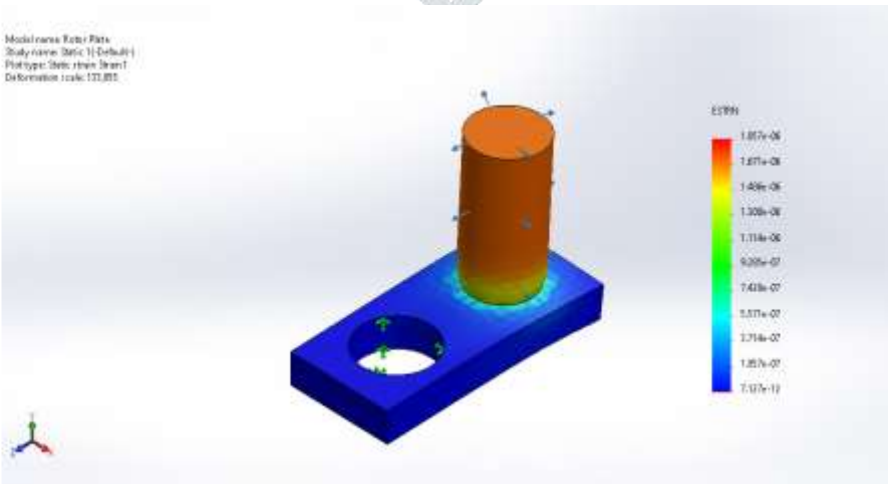


Fig. 16 - Equivalent Strain

3) Motion part

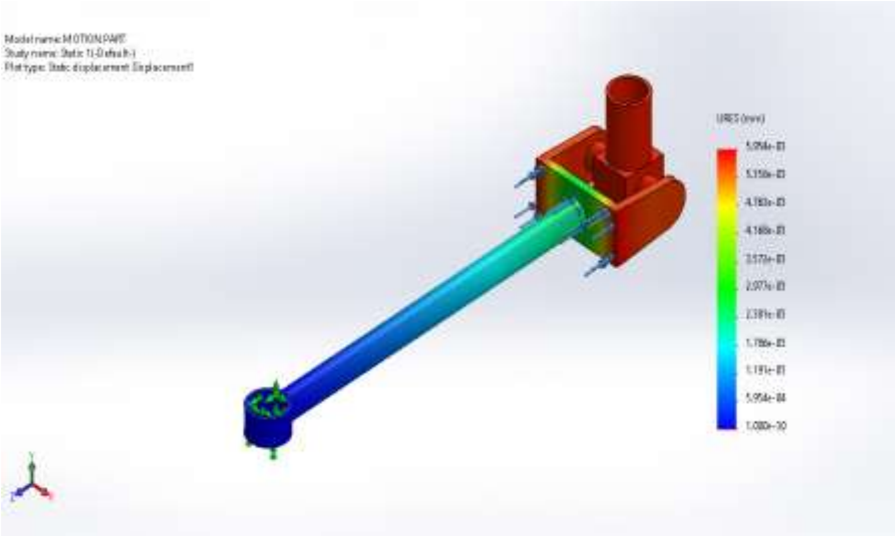


Fig. 17 - Total Deformation

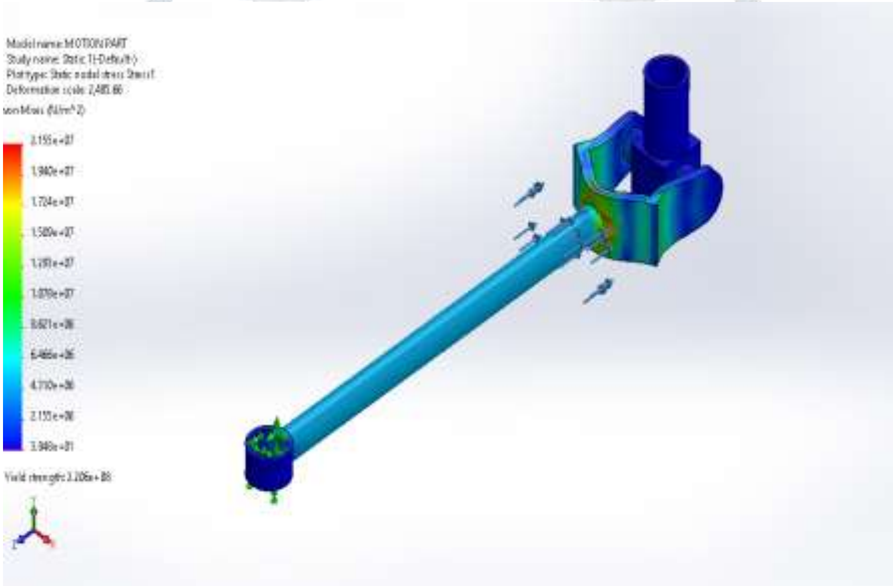


Fig. 18 - Equivalent Stress

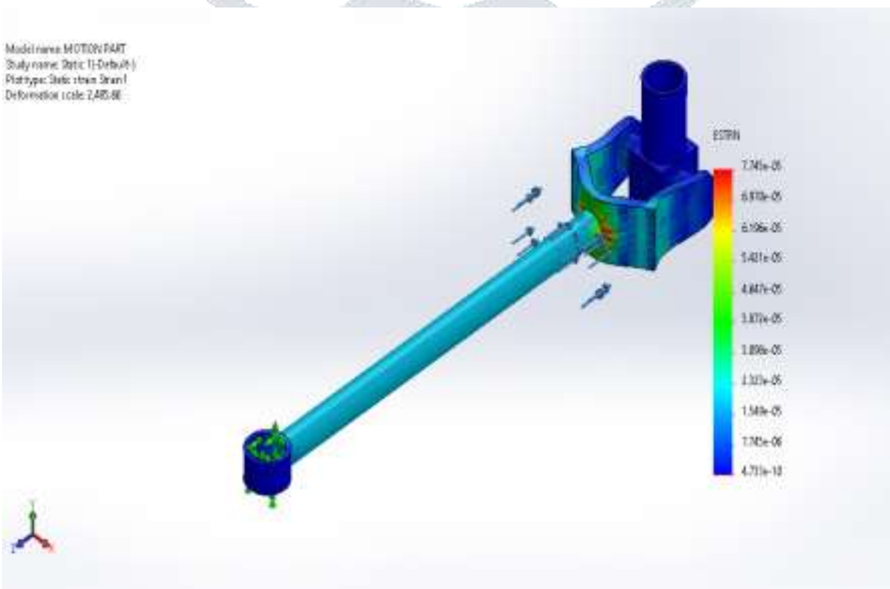


Fig. 19 - Equivalent Strain

4) Hacksaw Handle

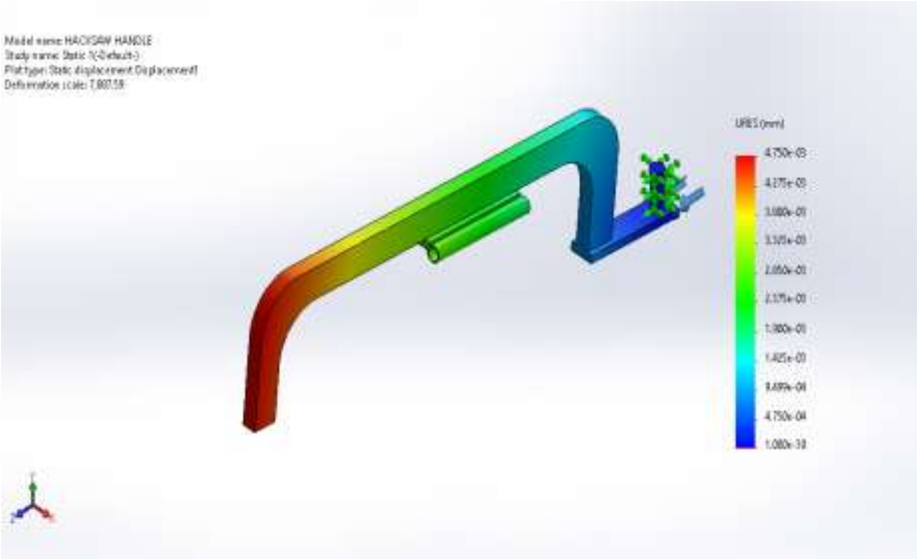


Fig. 20 - Total Deformation

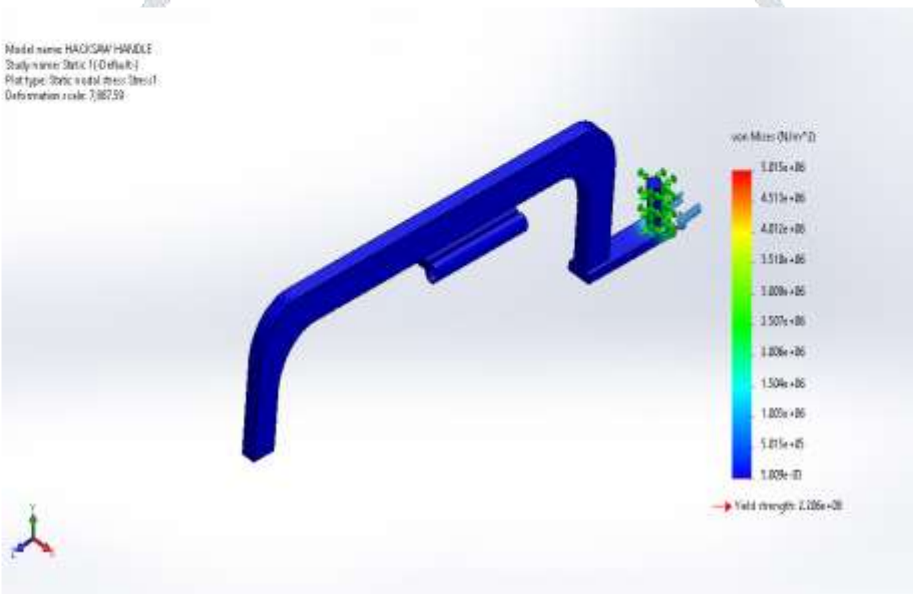


Fig. 21 - Equivalent Stress

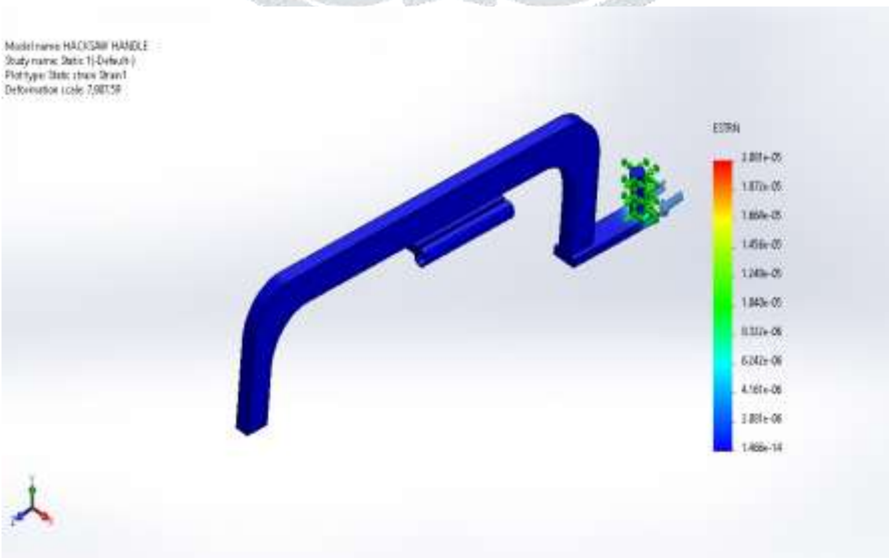


Fig. 22 - Equivalent Strain

6. COSTING

The cost estimation is detailedly described in the table mentioned. The real price of the prototype may differ in practice; the goal of this estimation is to gain a general notion of the prototype's overall cost.

Sr. No.	Part Name	Quantity	Quantity Ref.	Unit Price	Total
1	MS 1.5” Hacksaw	2	NOS	250	500
2	Bench Vice	2	NOS	350	700
3	12V/1.5A DC Motor	1	NOS	3200	3200
4	12V Battery	1	NOS	1800	1800
5	30*30 Square Pipe	12	Kg	80	960
6	Bush	4	NOS	100	400
7	MS 6mm dia. Metal rod	5	Kg	150	750
8	MS U joined	1	NOS	280	280
9	Nut/Bolt	20	NOS	40	800
10	Washer	20	NOS	20	400
11	2sp mm wire	2	Miter	30	60
				Total=>	9850

Table 3 – Costing

7. CONCLUSION

Due to its high efficiency, ease of operation, and low cost, the suggested model of two-way power hacksaw machine is useful in overcoming problems with conventional hacksaw machines and meets all of the expectations needed in the micro industries. It can endure vibrations, has no jerk dangers, and requires no special training to operate. Other hacksaw machines can only cut one piece at a time, but this one can cut two. In comparison to other hacksaw machines, this one is lighter. The machine is inexpensive, simple to run, and suitable for all industries. Ordinary hacksaw machines can be replaced with programmed twofold hacksaw machines, it has been discovered. In comparison to normal hacksaw machines, a programmed twofold hacksaw machine provides exceptional efficiency in a short period of time. The true advantage of this machine is that work interference is minimized to the greatest extent possible.

8. REFERENCES

[1] Tanuj Joshi Department of Mechanical Engineering Noida International University Greater Noida, India. “Automated double hacksaw cutter”, International Journal of Engineering and Technology, vol.7 Issue 07, July-2018.

[2] Sathyanathan.M, Chandru.S, Lingesh.K. “Automated double way hacksaw”, International Journal of Advanced Research in basic engineering sciences and Technology, vol.4, Issue.8, August-2018.

[3] Mr. Naveen virmani, Ravindra Gupta Mukesh Verma, “Automatic Hacksaw”, International Journal of Engineering science and Technology Letters, vol.I, IssueII, June-2018.

[4] Raj Ruturaj, Rathod Nayan, Thakar Vrajesh, “Automated Four way Hacksaw Machine”, International Research Journal of Engineering and Technology, vol.04 Issue 04, April-2017.

[5] Avi Rana, Deepak Bailwal, Gagan Bansal, “Designing and Fabrication of Double acting Hacksaw Machine”, International conference on Mechanical Industrial system Engineering, June-2018.

[6] Amjad Al-Hamood, Hazim U. Jamali, Oday I. Abdullah, “Dynamics and lubrication analyses of scotch yoke mechanism”, International Journal of Tool Design and Research, vol.16, Issue, 2001.

[7] Junzhi Yu, Yonghui Hu,Jiyan Huo, Long Wang, “An adjustable scotch yoke mechanism for robotic dolphin”, IEEE International conference on Robotics and Biomimetic, December-2007.

[8] P.J. Thompson, R.W. Taylor, “An analysis of the lateral displacement of a power hacksaw blade and its influence on the quality of the cut”, Vol. 16. pp. 51-70, October-1976.

[9] P. J. Thompson, M. Sarwar, “Power Hacksawing”, International Machine Tool Design and Research Conference, August 2015.