



iJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: IV Month of publication: April 2025

DOI: <https://doi.org/10.22214/ijraset.2025.68343>

www.ijraset.com

Call:  08813907089

E-mail ID: ijraset@gmail.com

Design and Synthesis of Power Press Machine

Dr. S. R. Ikhar¹, Abhishek Pahune², Anuj Bramhankar³, Kushal Kamble⁴, Shubham Waghdhare⁵, Pratik Chaware⁶
¹Associate Professor and Head, ^{2, 3, 4, 5, 6}Students, Department of Mechanical Engineering, K. D. K. College of Engineering, Nagpur, Maharashtra, India

Abstract: Power press machine is essential in metalworking and fabrication, enabling precise cutting, shearing, punching, and notching operations. However, traditional cutting machines often come with high costs and limited portability, making them less accessible for small-scale and flexible manufacturing setups. This study focuses on the design and development of a compact and versatile power press that addresses these limitations.

The power press machine operates using a three-phase motor with an efficient power transmission system utilizing V-belt pulley. It incorporates an automated control mechanism, multiple worktables for diverse operations, and a lubrication system to enhance efficiency and longevity. The reciprocating motion of the slider block ensures precision in cutting and shearing tasks. Designed for ease of maintenance and high operational accuracy, this power press reduces material wastage and labour costs while improving productivity. Its compact form factor makes it suitable for various industrial applications without requiring major modifications. The developed system provides a cost-effective and reliable solution for precision metalworking, contributing to enhanced manufacturing efficiency and process automation.

I. INTRODUCTION

Manufacturing industries rely heavily on metalworking processes such as cutting, shearing, punching, and notching to produce high-precision components.

These operations are essential in various sectors, including automotive, aerospace, construction, and fabrication. To perform these tasks efficiently, power press machines are commonly used due to their ability to apply controlled mechanical force for shaping and cutting metal sheets.

Traditional cutting machines, while effective, present several challenges, including high costs, limited portability, complex maintenance requirements, and energy inefficiency. Many of these machines require skilled operators, leading to increased labor costs and longer production times. Additionally, bulky and expensive industrial cutting machines are often inaccessible to small and medium-sized enterprises (SMEs) that operate on limited budgets.

To address these challenges, this study focuses on the design and development of a compact, cost-effective, and versatile power press machine. The proposed machine incorporates an efficient power transmission system, an automated control mechanism, multiple worktables for different operations, and a lubrication system to enhance efficiency and durability. By integrating these features, the developed power press aims to optimize productivity, improve cutting accuracy, and reduce material wastage, making it a viable alternative for modern industrial applications.

II. OBJECTIVES

The primary objectives of designing a Power Press is to create a versatile and efficient machine that can perform various operation including:

Punching: Create holes of different diameters and shapes in various materials.

Cutting: Cut materials using a reciprocating cutting tool with die.

III. RESEARCH METHODOLOGY

Design calculations play a crucial role in the research methodology of mechanical systems, ensuring that components are optimized for performance, durability, and safety. In this study, the design calculations focus on critical parameters like shear force, energy requirements, and dimensions of key components such as shafts, pulleys, and flywheels.

A. Design Calculation

Punching press with two shafts, one gear pair and one pulley pair. Punching time (t) is 1 sec cam shaft rpm is 60, motor power is 2 hp, stroke length is 30mm.

(1) Shear force required

SF=strength *area

SF=220*350

SF=77000 N

SF=7850 kg or 7.8 ton

(2) Energy for punching

E=force*thickness

E=(77000+0)/2 * 0.005

E=195.5 J

(3) Actual punching time

T= (1*5)/60

T=1/12 sec

(4) Idle punching time

T=1-(1/12)

T=11/12 sec

(5) Change in energy of flywheel (ΔE)

energy extracted from motor in time TR in

ER =1492*(1/11)

ER=373/3

ER =124.33 J

$\Delta E =192.5-124.33$

$\Delta E =68.1667 J$

(6) Mean speed of flywheel

Speed reduces from 1440 rpm to 60 rpm

SR= 1440/60 SR= 24

as machine has two shafts, so speed are reduces into steps,

24→6*4 SR1=6. AND SR2=4. & N=1450 RPM

∴ pulley/flywheel speed (N1) = N/SR1=1440/6

N1=240 RPM =N_{max}

Let coefficient of speed cs=0.12for punching press

&Cs=ΔN/Nm

N_{min}= 212 83 rpm

&Nm=226.415rpm

& ωm=23.710 r/s

(7) Inertia of mass of flywheel

I=E/w²cs =68.1667/23.710²*0.12

I=1.0104 kg-m²

D1=90 mm

D2=D1*SR1=90*6

D2=540mm

R2=270mm. K2=R2/√2.for disk type flywheel

K2=190.279 mm

Parallelly, for ring type flywheel

K2=R2=270 mm

$$M=I/ki^2 = 1.0104/0.190279^2.$$

$$M=27.90\text{kg} \ \&$$

$$M=I/ki^2=1.0104/0.27^2$$

$$M=13.86 \text{ kg}$$

(8) Diameter of pulley & gears

$$D1=90 \text{ mm. } D2=500\text{mm. Pulley}$$

$$D3=100\text{mm. } D4=432\text{mm. Gear}$$

(9) Energy required to lift mass to 30mm

$$E'=mgh=10*9.81*0.03$$

$$E'=2.943 \text{ J}$$

(10) Forces on plates of structures

$$S_{uc} = 240 \text{ Mpa, } S_{uc}= 220 \text{ Mpa, } S_{yt}=440 \text{ Mpa}$$

$$\text{let Fos} = 2$$

$$(\sigma_{ac})_{\text{allow}} = 240/2 = 120 \text{ Mpa}$$

$$\tau_{\text{allow}} \ 220/2 = 110\text{mpa.}$$

$$(\sigma_t)_{\text{allow}}=220 \text{ MPa}$$

$$\text{Forces acting on each plate} = 77000/2=38500 \text{ N}$$

$$P= 38500 \text{ N}$$

(11) Dimensions of plate structure

$$\text{min area (A)} = F/ \sigma_{ac} = 38500/120$$

$$A= 320.833 \text{ mm}$$

let thickness of plate (t') be

$$t'= 18\text{mm} \ \& \ L= A/t' = 320.833/18$$

$$L= 17.82 \text{ mm}^2$$

(12). vertical position (h1) of bearing in structure plate Shear area in structure plate

$$a1=RA/ \tau_{\text{allow}} = 38500/110$$

$$a1= 350 \text{ mm}$$

$$a1=2(h1)*t$$

$$h1=a1/2t=350/(2*18)$$

$$h>10 \text{ mm}$$

(13) Diameter of shaft (Tool Carrying Shaft)

$$(SF)=77000 \text{ N}$$

$$1.(SF)_{\text{max}}=38.5 \text{ kN}$$

$$2.BM = Rb(1/2+x) - Fx \ \&$$

$$(BM)_{\text{max}} = Rbl /2= (33500 \times 76) / 2$$

$$(BM)_{\text{max}}=1463000 \text{ Nmm}$$

3.Mt Torque or twisting moment

$$Mt = 77000 \times \text{radius}$$

$$\text{radius} = 15\text{mm}$$

$$Mt=77000*15$$

$$Mt=115000 \text{ Nmm}$$

$$\text{Now, } \tau_{\text{allow}} = 16/3.14*d^3$$

$$d2 \geq 44.1915\text{mm} \ d2 \geq 5 \ \text{or} \ d2=50\text{mm}$$

$$\ \& \ (\sigma_t)_{\text{allow}} = 16/3.14*d^3$$

$$D2=42.54\dots\dots \text{ (Less Than Required)}$$

(14) Cam diameter (Dc)

Dc = stroke length + shaft diameter

Dc = 30 + 50

Dc = 80 mm

(15) Diameter of shaft

as $F_4 = F_3 \implies T_4/T_3 = T_3/R_3$

$T_3 = T_4 \cdot R_3/R_4 = M_t \cdot D_3/D_4$

$T_3 = 288750 \text{ Nmm}$ torque transmitted by shaft (1)

& $\tau_{\text{allow}} = 16 T_3/3.14 \cdot d^3$

$d^3 = 16T/3.14 \cdot \tau_{\text{allow}}$

$d \geq 23.733 \text{ mm}$

Let, $d_1 = 30 \text{ mm}$

(16) Force acting on bearing of shaft (1)

$F_3 = T_3/R_3 = 288750/45$

$F_3 = 6.416 \text{ KN}$(force acting on bearing & T_3 is torque transmitted through pulley)

1) Pulley 90 mm diameter

2) Pulley 500 mm diameter

3) Gear 100 mm pitch circle diameter

4) Gear 432 mm pitch circle diameter

(17) Bending moment on shaft (1)

$M_{B1} = F_3 \times x$

$x = 130 \text{ mm}$ from diagram

$M_{B1} = 6.416 \times 130 \times 1000$

$M_{B1} = 844080 \text{ Nmm}$

$\tau_{\text{allow}} = 16/\pi d^3 \sqrt{(M_{B1})^2 + (M_t)^2}$

$110 = 16/\pi d^3 \sqrt{(844080)^2 + (288750)^2}$

$D_1 = 34.56 \text{ mm} \therefore$ For safety purpose let $d_1 = 40 \text{ mm}$

(18) Belt calculation

1) belt length (L) = 1970 mm as B- 1970 mm as B- 80 inch

2) Distance of circle between Pulleys = 478 mm

3) Power transmitted through belt = 2HP = 1492 W

Max torque 250 mm Radius Pulley get from motor = 54.9144 N, $T_{\text{max}} = 54194.43 \text{ Nm}$

Force on belt (FB) = $T_{\text{max}}/R = 54914.43/250$

FB = 219.65 N Or FB = 23 kg

Force on belt (FB) $\geq 70 \text{ kg}$ or 680.173 N

$D = T_{\text{mn}}/\cos \alpha$

$T = D \cos \alpha / \text{mn} = 432 \cos 15/6 = 65.8$

$D_4 = 66 \times 6 / \cos \alpha$

$D_4 = 435.937 \approx 437 \text{ mm}$

$D_3 = 15 \times 6 / \cos 25 = 99.30 \text{ mm}$

$b = \pi \text{mn} / \sin \alpha = 44.6$

Motor -----> 2HP, 1440 rpm, 3-phase

$D_1 = 90 \text{ mm}$; $N = 1440 \text{ rpm}$

$D_2 = 500 \text{ mm}$; mass of flywheel = 27 kg

$SR_1 = D_2/D_1 = 5.55$

Speed of flywheel (N_1) = 1440/5.55

$N1 = 259.459 \text{ rpm}$

Shaft (1) dia. = $d1 = 40\text{mm}$, $L1 = 360 \text{ mm}$

$D3 = 100\text{mm}$, module (m) = 6mm, width (b) = 50mm

$N2 = N1 = 259.459 \text{ rpm.}$

$SR2 = 259.459/60SR2 = 4.324$

Therefore $D4 = D3 \times SR2$

$D4 = 100 \times 4.324$

$D4 = 432 \text{ mm}$, module (m) = 6mm, width (b) = 50 mm Helix angle (\emptyset) = 15°

$d2 = 50\text{mm}$; $L2 = 250 \text{ mm}$

- cam diameter = 80 mm
- structure plate thickness = 18 mm
- torque carrying capacity of clutch = 1155000 Nmm
- tool plate thickness = 20 mm Belt B-80 3 no.s

cam shaft or shaft (2) bearing ----->NU 1010 ECP single row cylindrical roller bearing

B. CAD Model of Various Components

The components are design in SOLIDWORK software. The different types components which are used in the power press machine are given below:

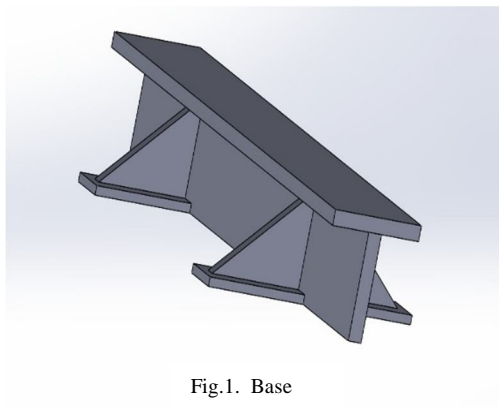


Fig.1. Base

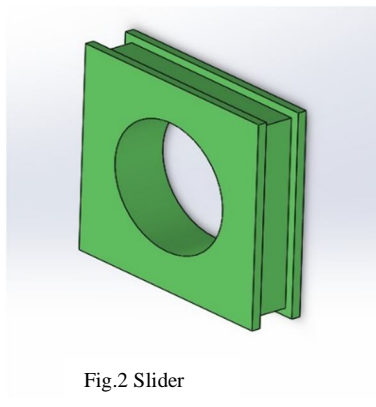


Fig.2 Slider

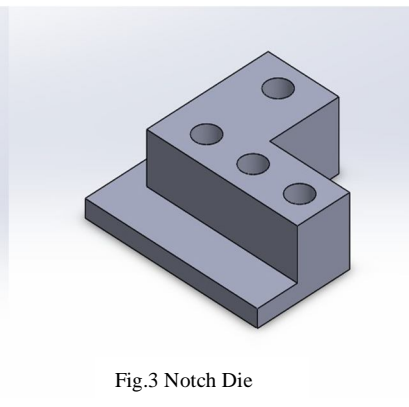


Fig.3 Notch Die

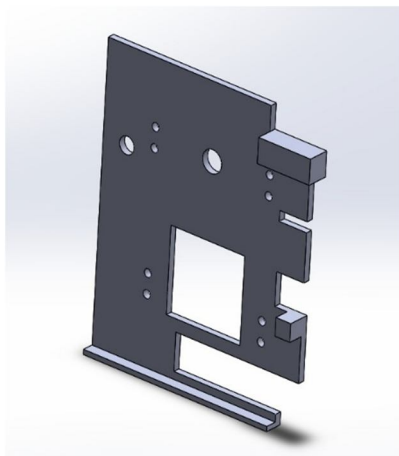


Fig.4 Structure plate left

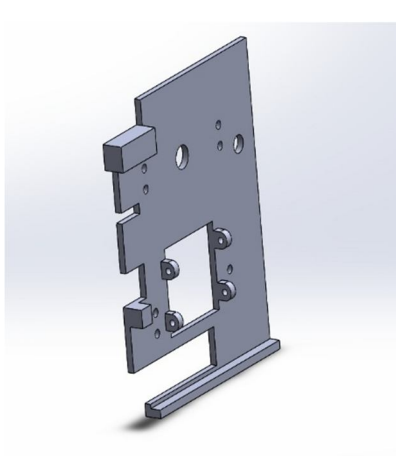


Fig.5 Structure plate right

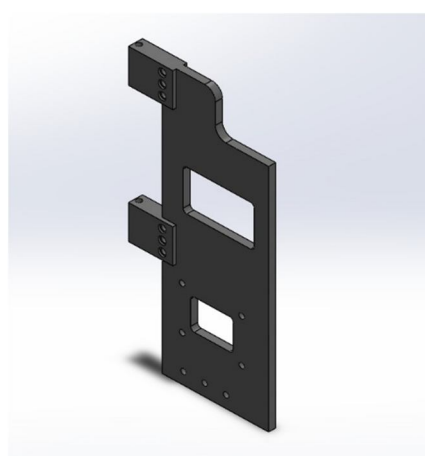


Fig.6 Tool plate

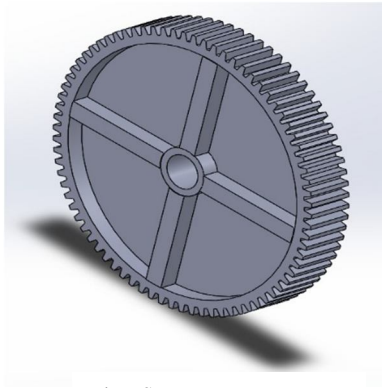


Fig.7 Spur gear

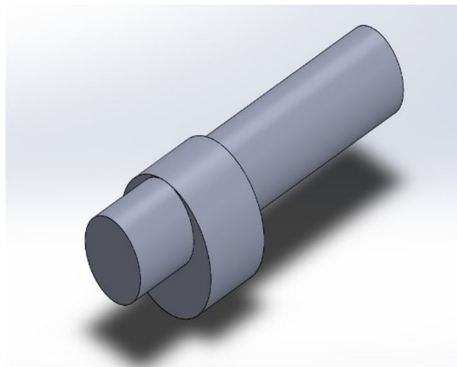


Fig.8 Driver gear pulley

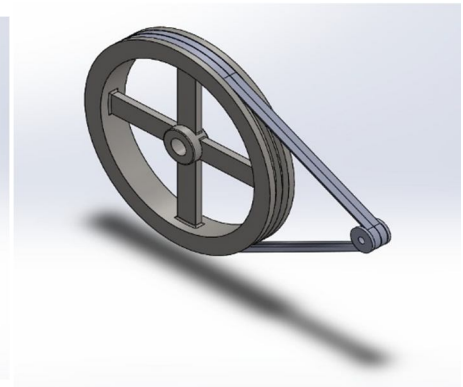


Fig.9 Flywheel and pulley

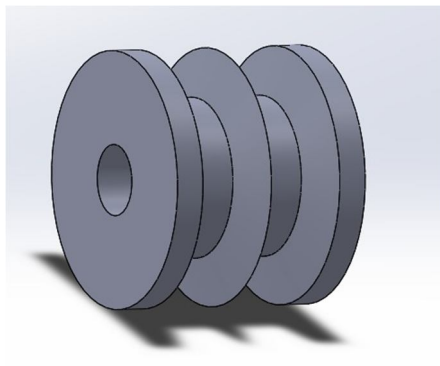
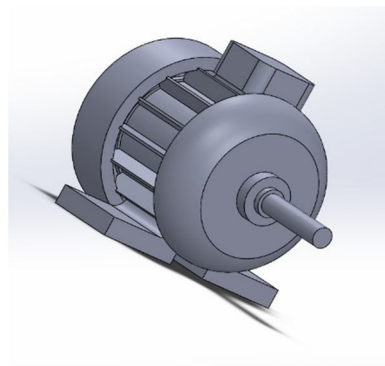


Fig.10 Cam shaft



ZFig.11 Motor pulley

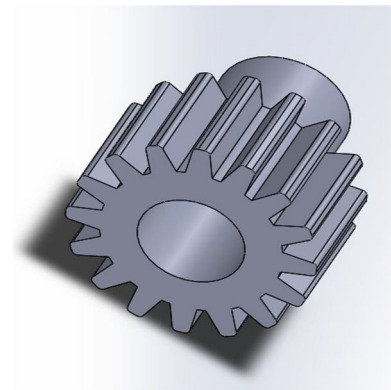


Fig.12 Motor

Fig.13 Hole punch

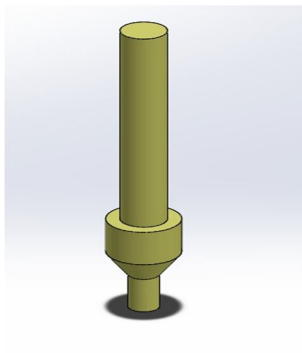


Fig.14 Notch punch

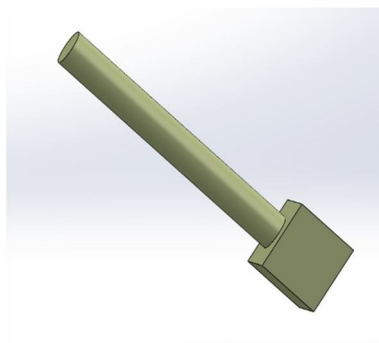
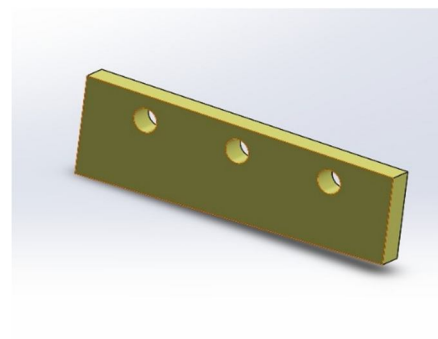


Fig.15 Shear punch



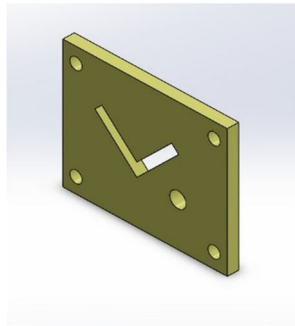


Fig.16 Angle punch

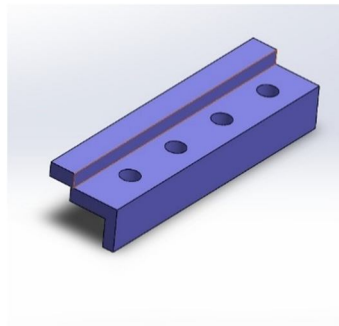


Fig.17 Shear die

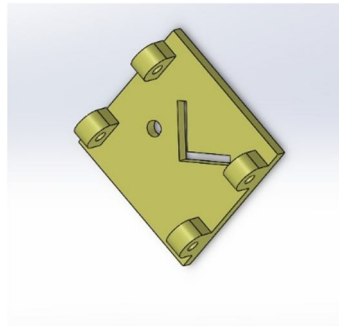


Fig.18 Angle die

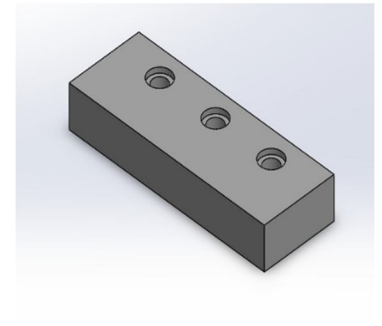


Fig.19 Hole die

C. Final CAD Design

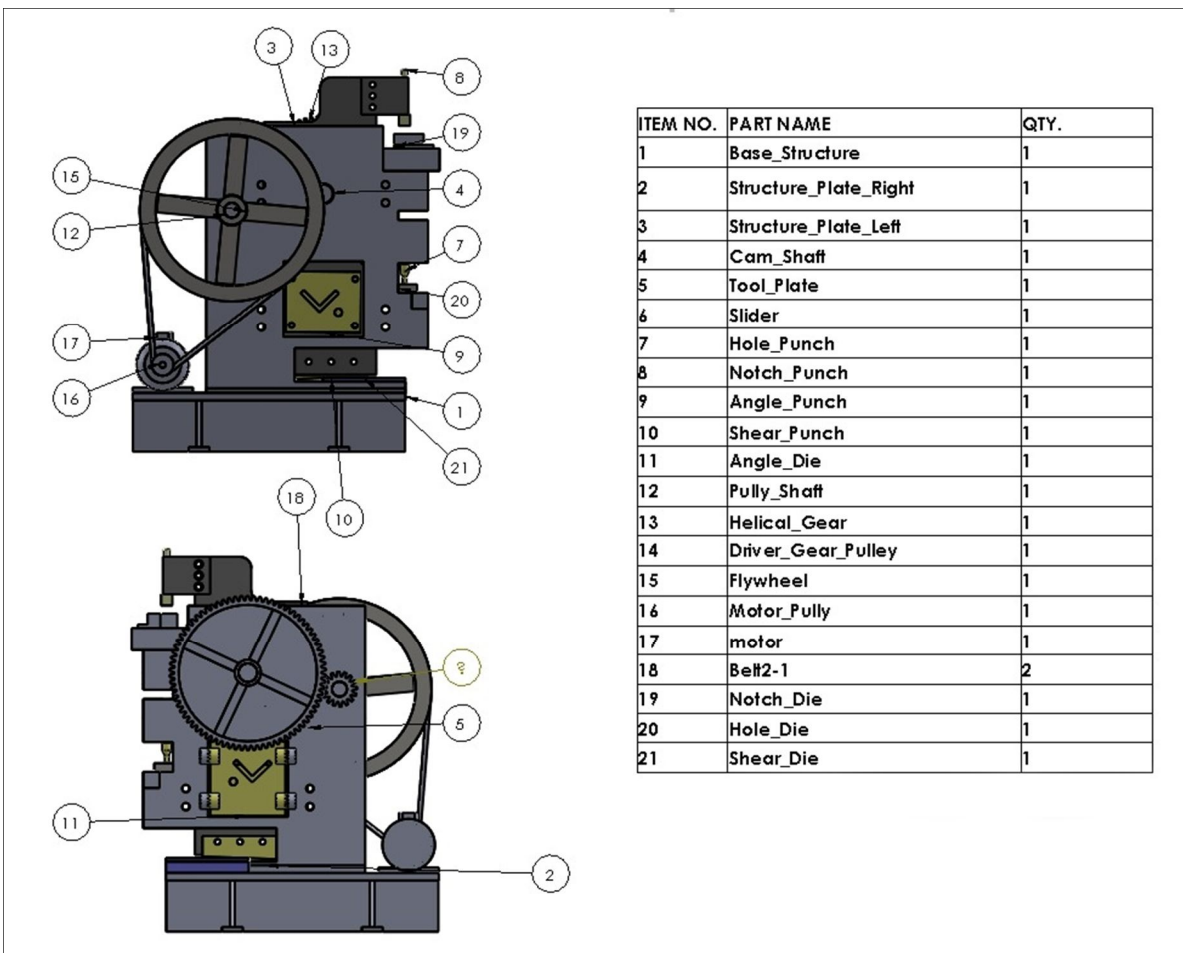


Fig.20 Final CAD Design

IV. SCOTCH YOKE MECHANISM

The power press machine operates using a scotch yoke mechanism coupled with a V-belt pulley system to achieve efficient power transmission and precise metalworking operations. The machine converts rotary motion from the flywheel into reciprocating motion of the slider block, enabling punching, shearing, and cutting processes with high accuracy

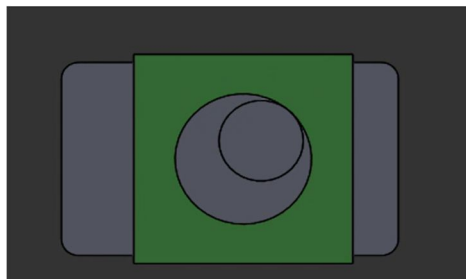


Fig.21 Scotch yoke mechanism

V. RESULTS

The following data provides the design of power press machine. The result are given below:

- 1) Shear Force Capability: Handles a shear force of 77,000 N.
- 2) Flywheel Design: Operates at a mean speed of 226.415 RPM with an inertia of 1.0104 kg-m².
- 3) Energy Efficiency: Requires 195.5 J for punching operations.
- 4) Compact and Portable Design: Plate thickness: 18 mm; Lightweight and portable.
- 5) Component Dimensions: Shaft diameter: 50 mm; Cam diameter: 80 mm.
- 6) Speed and Power Transmission: Utilizes a scotch yoke mechanism and V-belt pulleys for power transmission.
- 7) Reduction in Setup Time: Minimizes material alignment and holding setup times.
- 8) Versatility: Performs punching, cutting, and shearing operations.
- 9) Cost Savings: Reduces dependency on hydraulic mechanisms and minimizes material waste.
- 10) Improved Safety: Includes robust components and safety features.
- 11) Idle and Punching Time: Punching time is 1/12 seconds; idle time is 11/12 seconds.
- 12) Pulley and Gear Dimensions: Pulley diameters: D1 = 90 mm, D2 = 500 mm; Gear diameters: D3 = 100 mm, D4 = 432 mm.

VI. DISCUSSION

The results and calculations provide valuable insights into the design and performance of the multifunctional power press machine. Below is a detailed discussion in simple language:

- 1) Shear Force Capability: The machine can handle a shear force of 77,000 N, showing its ability to cut or punch strong materials like square bars, round bars, and angle bars. The energy required for punching is calculated as 195.5 J, which is relatively low for such operations.
- 2) Component Dimensions: The shaft diameter (50 mm) and cam diameter (80 mm) are optimized to handle operational stresses. These dimensions ensure the durability and reliability of the components during continuous use.
- 3) Speed and Power Transmission: The scotch yoke mechanism and V-belt pulleys ensure smooth and efficient power transmission. This reduces dependency on hydraulic systems, making the machine simpler and less expensive to maintain.
- 4) Compact and Portable Design: The machine is designed with compact dimensions and a lightweight structure (plate thickness of 18 mm). This makes it easy to move and suitable for industries with limited workspace.

VII. CONCLUSION

The development of a compact, efficient, and cost-effective power press machine successfully addresses the challenges of traditional metalworking systems.

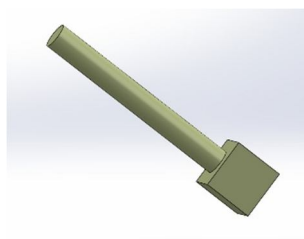
The designed machine demonstrates high shear force capability (77,000 N), precise power transmission using a scotch yoke mechanism and V-belt pulleys, and improved energy efficiency (195.5 J for punching operations). With a mean flywheel speed of 226.415 RPM and optimized component dimensions, the system ensures stable performance and durability. Its compact and portable design, along with multiple functionalities such as punching, cutting, and shearing, enhances versatility while reducing operational costs and material waste.

Additionally, the incorporation of robust safety features, minimized setup time, and an efficient idle-to-punching cycle (11/12s idle, 1/12s punching) further improves productivity and operator safety. The machine's reduced reliance on hydraulic mechanisms makes it an energy-efficient and cost-saving solution for modern industrial applications.

Overall, the results validate the effectiveness of the proposed power press in enhancing precision, reducing costs, and improving operational efficiency. Future work may focus on further optimizing the design through advanced automation, improved material selection, and enhanced safety mechanisms to expand its industrial applicability.

REFERENCES

- [1] Amit Kumar Jhardade and Prof. Gajendra Das Kori , summarizes research on the design and analysis of mechanical press tools. The importance of using advanced modeling and analysis techniques to enhance the design and performance of mechanical press tools Vol. 4, no 9, pp 1889- 1891, Sep 2023.
- [2] Harit M. Trivedi, Chitrag D. Rana, etc carried out on a study on shearing operation for MS Bar Cutting by Cutting Machine. Now world requires speed on each and every field. Hence quick work is most important new machine and techniques are being developed continuously to manufacture various product at cheaper rates and high quality. Volume 8, Issue 11, Year November-2020.
- [3] Amey S. Shirodkar, Chinmay Vishnu Jambhavadekar, etc April 4, 2020 analyzing on a punching Machine is one of the principle machines in paper cutting and sheet metal industry. Press or machine punch is a tool used to work metal by changing its shape and internal structure.
- [4] M. L. Jadhav, S. K. Khot, etc October 8, 2017 conducted the study presents a versatile machine designed for tender coconut punching, mango slicing, and sugarcane bud chipping. Utilizing a second-kind lever mechanism and made from readily available materials, the machine is compact (150 × 60 × 45cm) and portable (20 kg).
- [5] Mr. Jayant Khade1, "Design and Fabrication of Automated Punching Machine", IEJRD – International Multidisciplinary Journal, vol. 2, no. 5, p. 7, Sep. 2016.
- [6] Dayanand A. Ghatge 1, Charudatta Birje 2, Priyanka S. Yadav 3 Dept of Mechanical Engineering, Karmaveer Bhaurao Patil College of Engineering, Satara, Maharashtra, India International Advanced Research Journal in Science, Engineering and Technology Vol. 4, Special Issue 1, January 2017
- [7] Amey S. Shirodkar Professor in Department of Mechanical Engineering, S.S.J.C.O.E. Dombivli E, Maharashtra, India. Volume: 07 Issue: 04 | Apr 2020
- [8] Design and Fabrication of Auto Roll Punching Machine, [U.g. Scholar Department of Mechanical Engineering PR CET, Vallam, Thanjavur, India.] Vol. 5, Special Issue 8, May 2016.
- [9] Ioan DAN, Romeo CIOARA, "Pre-tensioned c-frame for the crank mechanical press", Proceeding in manufacturing System, Volume 7 Issue:4, 2012.





10.22214/IJRASET



45.98



IMPACT FACTOR:
7.129



IMPACT FACTOR:
7.429



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089  (24*7 Support on Whatsapp)