Design and Analysis of Mechanism for Pressing of Fiber Discs in Idle Roller in Hot Rolling Machine

Ms. Naz Ansari[1] Dr.C.C.Handa[2] Prof.V.N.Mujbaile[3]
[1] M.Tech Student [2]Professor & Head of Dept. [3]Assistant Professor
[1,2,3]Department of Mechanical Engineering
[1,2,3]KDK College of Engineering Nagpur, Maharashtra, India

Abstract— This project involves the designing and analysing of mechanism for mounting of fiber discs in idle roller in hot rolling machine. The objective of the project is design special purpose hydraulic press machine, design machine that can be used for the pressing the fiber discs, to reduce the process time and performed the analysis of the tower by using finite element technique. This involved gathering of functional and structural requirements of fiber discs in idle roller in hot rolling machine from the client, making General arrangement drawings, Hand Calculations, CAD model generation, Finite element analysis, The result is explained on the basis of a comparative analysis of probable designs.
Key words: Fiber Discs, Idle Roller, Hot Rolling Machine

I. INTRODUCTION

The development of engineering over the years has been the study of finding ever more efficient and convenient means of pushing and pulling, rotating, thrusting and controlling load, ranging from a few kilograms to thousands of tons. Presses are widely used to achieve this. Presses, as defined by Lange are pressure exerting machine tools.

In hydraulic press, the force generation, transmission and amplification are achieved by using fluid under pressure. The liquid system exhibits the characteristics of a solid and provides a very positive and rigid medium of power transmission and amplification. In a simple application, a smaller piston transfers fluid under high pressure to a cylinder having a larger piston area, thus amplifying the force. There is easy transmissibility of large amount of energy with practically unlimited force amplification. It has also a very low inertia effect.

A typical hydraulic press consists of a pump which provides the motive power for the fluid, the fluid itself which is the medium of power transmission through hydraulic pipes and connectors, control devices and the hydraulic motor which converts the hydraulic energy into useful work at the point of load resistance. Bending is a metal forming process in which a force is applied to a piece of sheet metal causing bending of it to an angle and forming the desired shape. Bending is typically performed on a machine called a press brake which can be manually or automatically operated. A press brake contains an upper tool called the punch and a lower tool called the die. The sheet metal is located between them. In automatic press brake the punch is forced into the sheet under the power of a hydraulic ram. The bend angle is determined by the depth which the punch forces the sheet into the die. Precisely, this depth is controlled to achieve the desired bend angle.

II. PROJECT OBJECTIVE

- To design special purpose hydraulic press machine.
- To design machine that can be used for the pressing the fiber discs.
- To increase the efficiency.
- To reduce the process time.
- To analyze the machine by using Finite element technique.

III. DATA ACCUMULATION:

Shaft diameter = 150 mm
Disc inner dia = 150mm
Disc Outer dia = 250mm
Disc thickness = 50mm
Length of shaft = 2000 mm
Weight of shaft approx = 320 kg
Weight of composite shaft = 400 kg maximum
Maximum 5 ton force required to press Fiber disc tightly

FIT TYPE		
Parameter	Value	Unit
Designation	150 H7/h6	---
Fit Type	Clearance fit	---
Maximum Clearance	65	µm(0.001mm)
Minimum Clearance	0	µm(0.001mm)

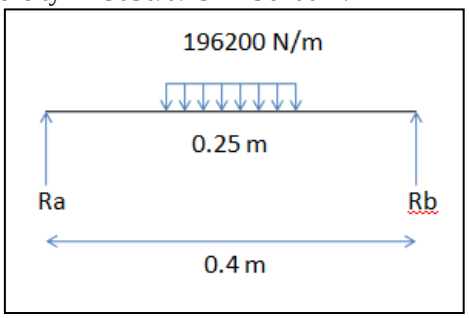
IV. DESIGN CALCULATIONS

5 Tonne maximum load
Single hydraulic operated piston
Force from hydraulic power pack,

$$5 \times 1000 \times 9.81 = 49050\ N$$

A. Bending of support for fiber disc

Load intensity = 49050/0.25 = 196200 N/m

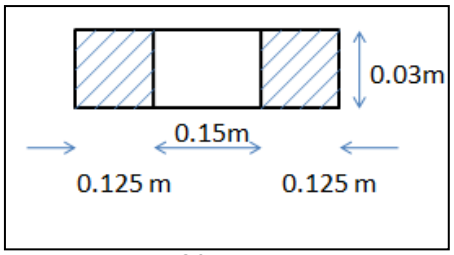


Ra + Rb = 49050 N
Ra = Rb = 24525 N
Max. Bending moment,

$$M = 24525 \times 0.2 - (196200 \times 0.125 \times 0.0625)$$

$$M = 3372187.5\ \text{N.mm}$$

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



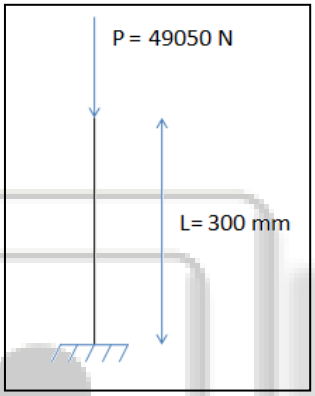
$$y = \frac{30}{2} = 15\ mm$$

$$I = \frac{BD^3}{12} = \frac{250 \times 30^3}{12} = 562500\ mm^4$$

$$\sigma = \frac{3372187.5}{562500} \times 15 = 89.925\ MPa$$

B. Buckling of piston rod

Diameter = 100 mm
P = 5000 x 9.81 = 49050 N
l = 300 mm
E = 210000 MPa



$$Pcr = \frac{\pi^2 EI}{Le^2}$$

One end fixed and other is free,
Le = 2L = 600 mm

$$I = \frac{\pi D^4}{64} = \frac{\pi \times 100^4}{64} = 4906250\ mm^4$$

$$Pcr = \frac{\pi^2 \times 210000 \times 4906250}{600^2} = 28217969.8\ N$$

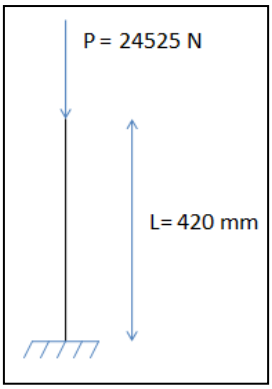
$$Pcr > P\ , safe$$

Compression,

$$\sigma = \frac{F}{A} = \frac{49050}{\frac{\pi}{4} \times 100^2} = 6.25\ MPa$$

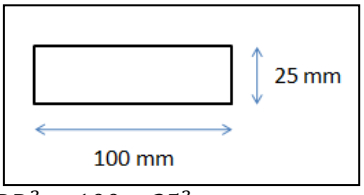
C. Buckling of pressing arm

P = 24525 N
l = 420 mm
E = 210000 MPa



$$Pcr = \frac{\pi^2 EI}{Le^2}$$

One end fixed and other is free,
Le = 2L = 840 mm

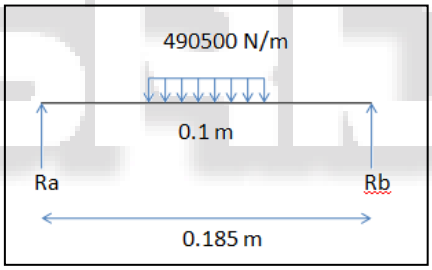


$$I = \frac{BD^3}{12} = \frac{100 \times 25^3}{12} = 130208.34\ mm^4$$

$$Pcr = \frac{\pi^2 \times 210000 \times 130208.34}{840^2} = 382083.97\ N$$

$$Pcr > P\ , safe$$

D. Bending of pressing arm

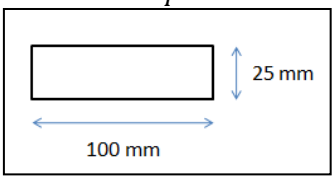


Ra + Rb = 49050 N
Ra = Rb = 24525 N
Max. Bending moment,

$$M = 24525 \times 0.0925 - (490500 \times 0.05 \times 0.025)$$

$$M = 1655437.5\ N.mm$$

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



$$y = \frac{25}{2} = 12.5\ mm$$

$$I = \frac{BD^3}{12} = \frac{100 \times 25^3}{12} = 130208.34\ mm^4$$

$$\sigma = \frac{1655437.5}{130208.34} \times 12.5 = 158.9\ MPa$$

E. Results comparison

Member	Material	Calculated parameter	Comparing parameter	
Bending of support for fiber disc	Steel grade S275	89.9 MPa (stress)	265 MPa (Yield stress)	Actual stress < yield stress
Bucking of piston rod	MS 146:1988 (Grade 250)	49.05 KN (actual load)	4906.25 KN (Cripling load)	Pactual<Pcr
Buckling of pressing arm	Steel grade S275	24.525 KN (actual load)	382.08 KN (cripling load)	Pactual<Pcr
Bending of pressing arm	Steel grade S275	158.9 Mpa (stress)	265 MPa (Yield stress)	Actual stress < yield stress

Table 3.1: Result Comparison

V. CAD MODELING

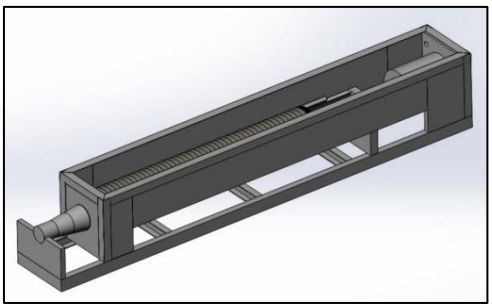


Fig. 4.1: Isometric view of CAD model of Fiber disc press machine

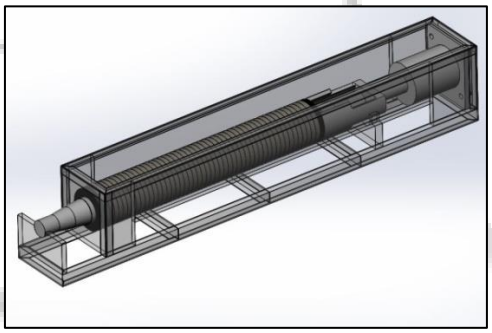


Fig. 4.2: Isometric view (Visible) of CAD model of Fiber disc press machine

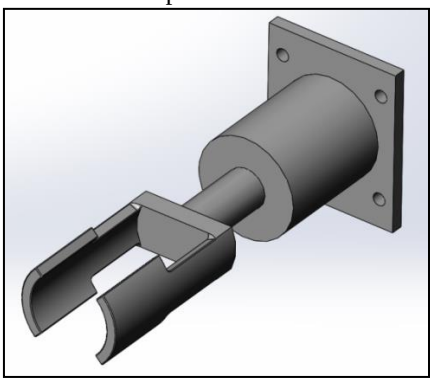


Fig. 4.4: Isometric view of CAD model of Press arm

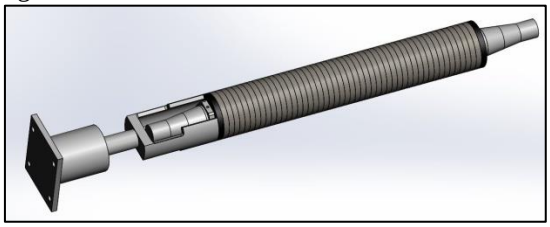


Fig. 4.7: CAD Model of composite shaft with Pressing arm

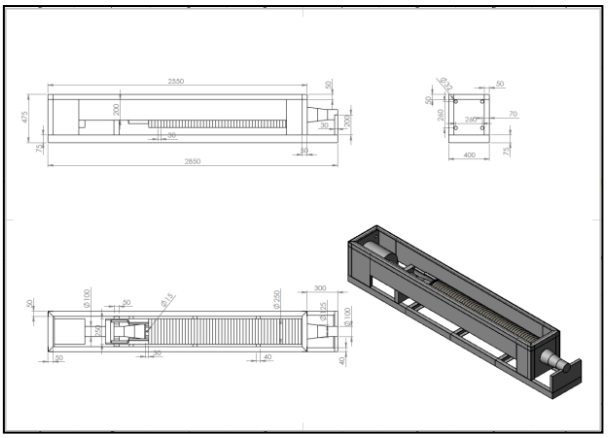


Fig. 4.9: Detail drawing of Fiber disc press machine

VI. FINITE ELEMENT ANALYSIS:

A. Linear Static analysis:

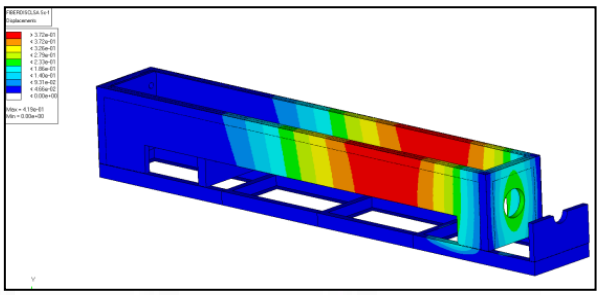


Fig. 5.1: Maximum Displacement obtained is 0.419 mm

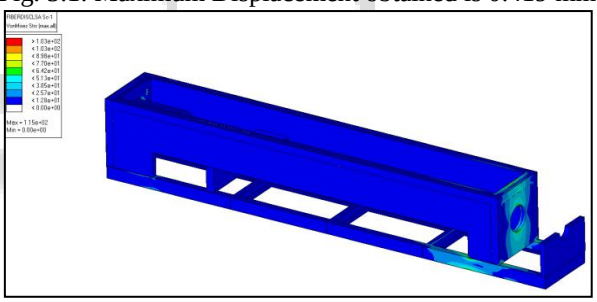


Fig. 5.2: Maximum Stress obtained is 115 MPa Press arm

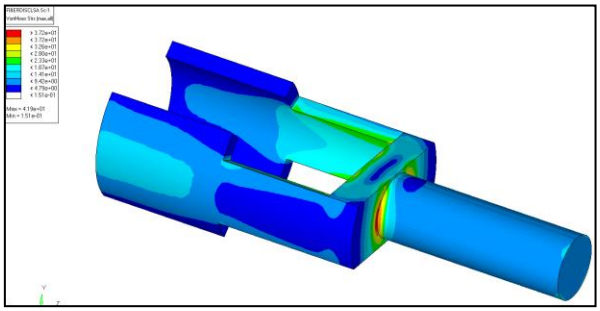


Fig. 5.3: Maximum Stress obtained is 41.9 MPa

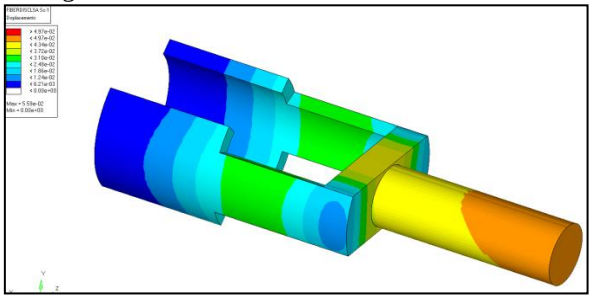


Fig. 5.4: Maximum Displacement obtained is 0.05 mm

Frame

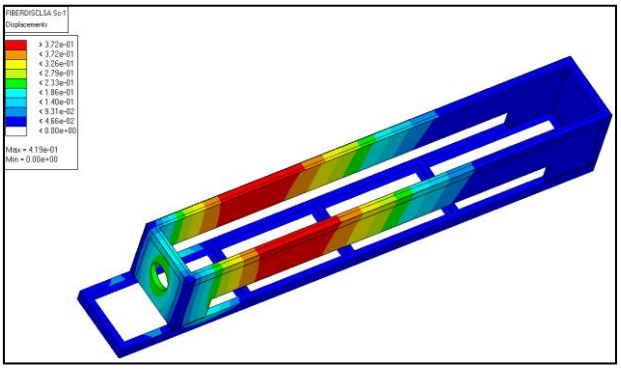


Fig 5.5: Maximum Displacement obtained is 0.419 mm

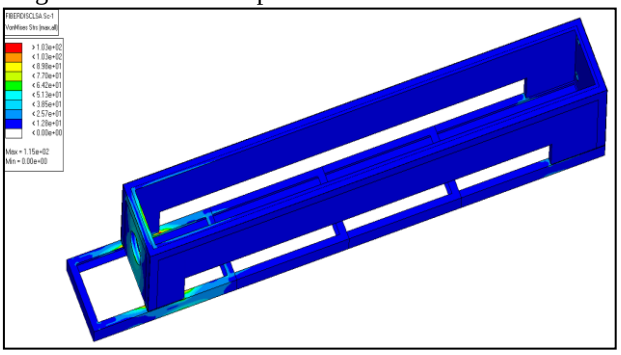


Fig 5.6: Maximum Stress obtained is 115 MPa

VII. Result Discussion

By performing Finite Element analysis with Linear static conditions with 5 ton hydraulic pressure, maximum displacement of 0.42mm and maximum stress of 115 MPa obtained in Design of mechanism for mounting of fiber discs.

This maximum stress is observed in frame structure where structure material(S 275) has yield stress of 265Mpa. In the piston arm stresses developed are 41.9 Mpa, less than the frame stresses.

As the displacement obtained in the assembly are very less, maximum stresses should be considered for the result comparison.

From the results of Finite element analysis it is seen that maximum stress 115 MPa present in the structure are concentrated to very small region. And allowable yield stress for material is 265 MPa.

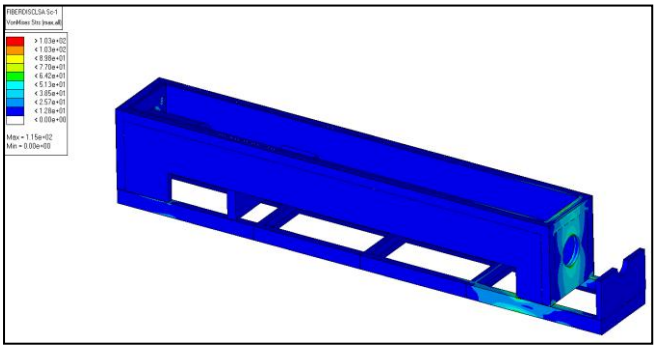


Fig. 6.1: Finite Element Analysis Results

VIII. Conclusion

The purpose of this research is to obtain optimal design for fiber discs in idle roller in hot rolling machine through material selection and design criteria of fiber disc, environmental conditions for placement, economy and commissioning. A typical hydraulic press consists of a pump which provides the motive power for the fluid, the fluid itself which is the medium of power transmission through hydraulic pipes and connectors, control devices and the hydraulic motor which converts the hydraulic energy into useful work at the point of load resistance.

On the basis of objective, data accumulated and design calculations the CAD model of the fiber discs in idle roller in hot rolling machine was design using Solidworks. After CAD modelling the Finite Element Modelling and Finite Element Analysis was carried out by using HYPERMESH and Nastran to validate the Designed CAD model. The linear static analysis results shows that the stresses are well within the safe limit, hence the design is safe.

It can be concluded that a linear static analysis of Fiber disc press machine is performed with the following boundary conditions. Base of the machine is constrained and the hydraulic force of 49050 N is applied on piston and cylinder.

References

[1] Design and Analysis of Hydraulic Press Machine: A Review by Naz Ansari, C.C.Handa and V.N.Mujbaile,Mechanical Engineering Department, KDK College of Engineering,Nagpur
[2] Review on Design Of Mechanism for Pressing of Fiber Discs in Idle Roller in Hot Rolling Machine by Naz Ansari, C.C.Handa and V.N.Mujbaile, Mechanical Engineering Department, KDK College of Engineering, Nagpur
[3] Finite Element Analysis of Mechanism for Pressing of Fiber Discs in Idle Roller in Hot Rolling Machine using F.E.A by Naz Ansari, C.C.Handa and V.N.Mujbaile, Mechanical Engineering Department, KDK College of Engineering, Nagpur
[4] Design and Manufacture of a 30-ton Hydraulic Press by Malachy Sumaila and Akii Okonigbon Akaehomen Ibhadode, Mechanical Engineering Department, Federal University of Technology Yola, Adamawa State, Nigeria
[5] Design and Development of Hydraulic Press with Die by Tejas Patel , Vikas Panchal , SaurinSheth , Purvi Chauhan , BVM Engineering College, Vallabh Vidyanagar
[6] "Design Optimization of Hydraulic Press Plate using Finite Element Analysis" by Akshay Vaishnu, Path Lathiya, Mohit Sarvaiya ,Department of Mechanical Engineering, Sanjaybhai Rajguru College of Engineering, Gujarat Technological University, Gujarat, India.
[7] International Journal of Innovative Research in Science, Engineering and Technology, "Stress Analysis of a Frame of a Bush Pressing Machine for Pumps" by Amith Kalekar , S. B. Tuljapure , Department of Mechanical Engineering, Walchand Institute of Technology, Solapur, India.
[8] IJMEER, "DESIGN, MANUFACTURE AND SIMULATE A HYDRAULIC BENDING PRESS" by Manar Abd Elhakim Eltantawie.

[9] INTERNATIONAL JOURNAL FOR RESEARCH IN APPLIED ScIENCE AND ENGINEERING TECHNOLOGY "Design and Optimization of a 30 Ton Hydraulic Forming Press Machine" S. M. Bapat and Dessaiyusufali.
[10] Design & Analysis of Frame of 63 Ton Power Press Machine by Using Finite Element Method by H.N. Chauhan M.P. Bambhania ,B.H. Gardi College of Engineering & Technology, Gujarat Technological University.
[11] IJISET - International Journal of Innovative Science 'ANALYSIS AND STRUCTURAL OPTIMIZATION OF 5 TON H-FRAME HYDRAULIC PRESS" by Santoshkumar S. Malipatil, Prof. Yogita N. Potdar, Prof. A. C. Mattikalli, Department of Mechanical Engineering, M.M.Engineering College, Visvesvaraya Technological University, Belgaum, Karnataka, India .
[12] DESIGN STUDY OF A HEAVY DUTY HYDRAULIC MACHINE USINGFINITE ELEMENT TECHNIQUES MOHAMAD M. SALEH, B.Eng., M.Eng. Sponsoring Establishment: Scientific Studies and Research Center, Damascus, Syria. August 1992.

