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Paper on Design and Analysis of Wheel Set Assembly & Disassembly Hydraulic Press Machine

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Abstract:- The wheels of the train are the part that carries the maximum static load, high axle load, high speeds, shocks and extreme weather conditions which expose them to and wear and tear which ultimately leads to failure.
It is necessary for the railway department to maintain the wheels assembly for the safety and optimum working as defective wheel increases the risk of a train derailment.
The wheels undergo periodic maintenance, and visual inspection is also carried out every day.To test the life and condition of the wheels special not destructive tests are carried out in every 18 months.
This project is an industrial project for AI ENGINEERING ENTERPRISES. It involves the design and analysis of Hydraulic Press Machine which is used to assemble & dissemble the locomotive wheel set.
In this part of paper we studied the different literatures for gaining the deep knowledge and also studying the work which was done related to our project.

Keywords: *HydraulicPress,CAD,Hypermesh.*

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I. Introduction

The hydraulic press is one of the oldest of the basic machine tools. In its modern form, it is well adapted to presswork, ranging from coining jewelry to forging aircraft parts. Modern hydraulic presses are, in some cases, better suited to applications where the mechanical press has been traditionally more popular.
The mechanical press has been the first choice of many press users for years. The training of tool and die makers and manufacturing engineers in North America has been oriented toward applying mechanical presses to sheet-metal press working.
Modern hydraulic presses offer good performance and reliability. Widespread application of other types of hydraulic power equipment in manufacturing requires maintenance technicians who know how to service hydraulic components. New fast acting valves, electrical components, and more efficient hydraulic circuits have enhanced the performance capability of hydraulic presses.
This project is mainly based on the design and analysis of 100tonne hydraulic press which can be used to assemble and dissemble the wheel set assembly. The necessary data will be accumulated from the company.

II. Problem Formulation

In Nagpur railway workshop the maintenance of locomotive performs regularly. Railway wheel sets are dissembled for maintenance and at final stage assembled again. As per the discussion it is found that the assembling and dissembling process is carried out on 100 tons old hydraulic press to mount and unmounts the wheel over the axle. This process requires more labors and time.
Thus this old machine need to be replaced, So we design the hydraulic press machine without changing hydraulic capacity to automate this process, to save time and minimize the human effort by using CAD and FEA techniques.

Existing Press machine

- Wheel set lifting mechanism is manually operated process as shown below.
- During assemble or dissemble wheels are constrained with the vertical members of machine.
- Wheel set either lifted by screw jack or mounted on the vertical member as shown below.

Fig.1: Existing Hydraulic Press

The above shown 100 tons old hydraulic press to mount and un mounts the wheel over the axle Nagpur railway workshop is facing the above stated problem in their workshop premises

III. Literature Review

Mohamad M. Saleh [1]This paper describes the systematic procedure for investigating the performance and the design analysis of the welded structure of a 150-tonne hydraulic press machine. This machine was designed by ENERPAC without any measurement or variable hydraulic system. The investigation discusses the theoretical and experimental model of the machine to establish the accurately optimal design analysis and further development of the present machine at minimum time and lower cost. The applicability of the existing PC based FE package, as a computer aided design tool, was also investigated.

MalachySumaila, AkiiOkonigbonAkaehomenIbhadode[2]A 30-ton hydraulic press was desgined, constructed and tested using locally sourced materials. The principal parameters of the design included the maximum load (300 kN), the distance the load resistance has to move (piston stroke, 150 mm), the system pressure, the cylinder area (piston diameter = 100 mm) and the volume flow rate of the working fluid. The major components of the press designed include the cylinder and piston arrangement, the frame and the hydraulic circuit. The machine was tested for performance with a load of 10 kN provided by two compression springs of constant 9 N/mm each arranged in parallel between the upper and lower platens and was found to be satisfactory.

Priyanka S. Dighade[3]In this project design and analysis of horizontal hydraulic press machine for assembling and dismantling of heavy parts such as couplings, shafts and bearing etc. is to be performed. The primary reason for selecting this project is that it is very inconvenient to perform such operation on regular vertical press machines. Thus there is an urgent need to design a horizontal press machine as a special purpose machine tool. During the visit to for G.S. Industries, It was discussed that the company works on repair, maintenance and overhauling of heavy engineering equipment. There is a regular need of assembling and dismantling of heavy parts such as couplings, shafts and bearing etc. it is very inconvenient to perform such operation on regular vertical press machines. Thus there is an urgent need to design a horizontal press machine as a special purpose machine tool.

IV. DESIGN CALCULATION

Input Data:
Solid Shaft,
diameter = 89 mm
Tolerance limit = 0.01 to 0.03 mm
Wheel,
hub inner diameter = 89 mm
hub outer diameter = 130 mm
width of hub = 190 mm
Tolerance limit = 0 to 0.019 mm

1) Press Fit Force Calculation

$$F_p = P \times \mu \times d \times \pi \times L$$

F_p = Press fit Force (N)
μ = Friction between shaft and hub
d = Nominal Diameter of joint (mm)
L = Length of the joint (mm)
P = pressure of contact (N/mm2)

$$P = \frac{I}{\frac{d}{E_o} \times \left[\frac{{d_o}^2+d^2}{{d_o}^2-d^2} + v_o\right] + \frac{d}{E_i} \times \left[\frac{{d_i}^2+d^2}{d^2-{d_i}^2} - v_i\right]}$$

I = interference between hub and shaft (0.015 mm)
d = Nominal hub diameter (89 mm)
Eo and Ei = Youngs modulus of wheel and shaft (206000 MPa)
do = Hub outer diameter (130 mm)
vo and vi = Poisson's ration of Hub and shaft (0.3)
di = Shaft internal diameter (0 mm)

$$P = \frac{0.015}{\frac{89}{206000} \times \left[\frac{130^2+89^2}{130^2-89^2} + 0.3\right] + \frac{89}{206000} \times \left[\frac{0^2+89^2}{89^2-0^2} - 0.3\right]}$$

$$P = 30.74\ MPa$$

$$F_p = 30.74 \times 0.3 \times 89 \times \pi \times 190$$

$$F_p = 489912.58\ N$$

$$Force = mass \times acceleration$$

Hydraulic cylinder capacity in tons = Total force / acceleration

$$Hydraulic\ capacity = \frac{489912.58}{9810} = 49.9\ ton \cong 50\ ton$$

50 Ton hydraulic force is required for assembling and dismantling wheels from the wheel axle .

4.1 CAD Modelling:

SolidWorks is a solid modeling computer-aided design (CAD) and computer-aided engineering (CAE) computer program that runs on Microsoft Windows. SolidWorks is published by Dassault Systèmes.

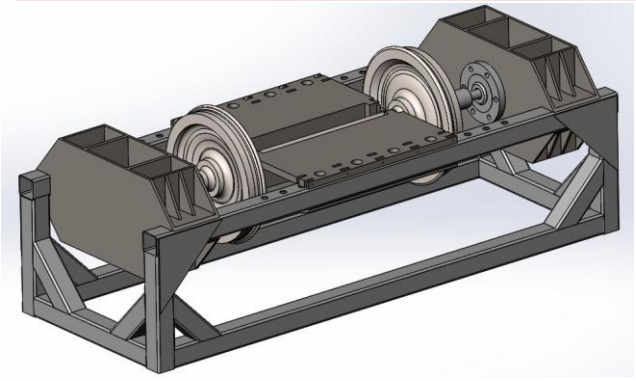


Figure 2 CAD MODEL OF PRESS MACHINE

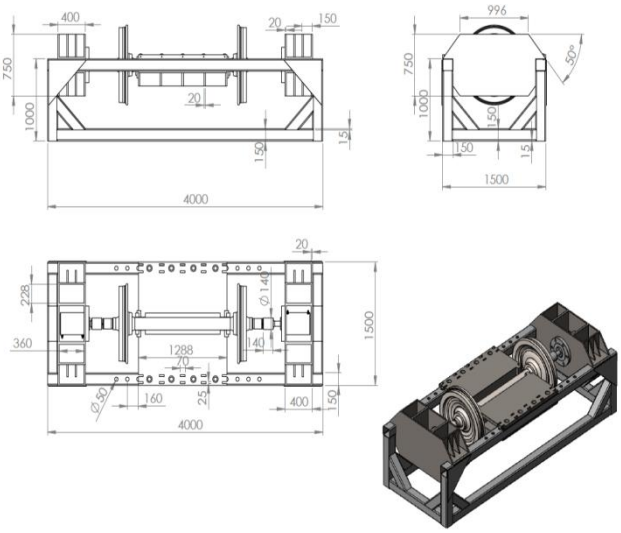


Figure 3 Dimension of CAD Model

4.2 FEA ANALYSIS

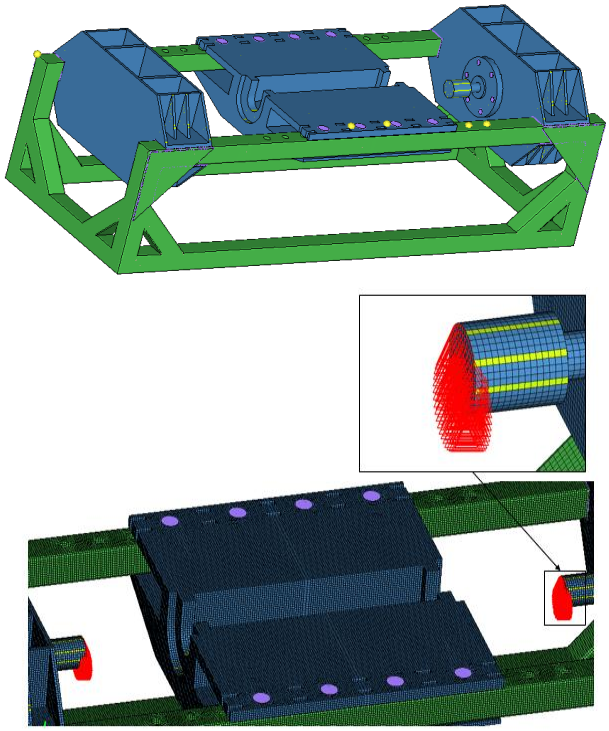


Figure 4 Loading Condition on Press Machine

Forces:

1) Force applied due to load of axle
   2.5 Tonn=2500×9.81= 24525N
2) Force applied due to wheel
   50 Tonn =50000×9.81= 490500N
3) Hydraulic force acting on piston and cylinder
   50 Tonn =50000×9.81= 490500N

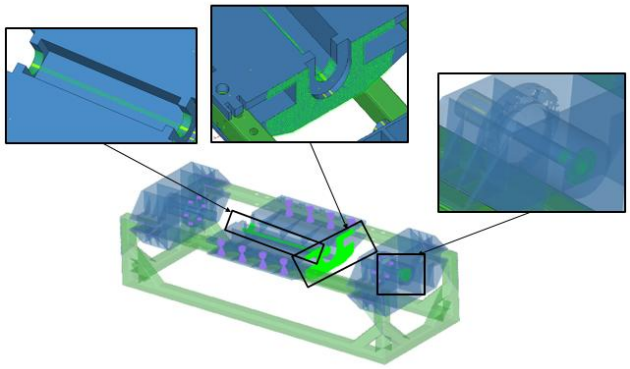


Figure 5 ANALYSIS AERA

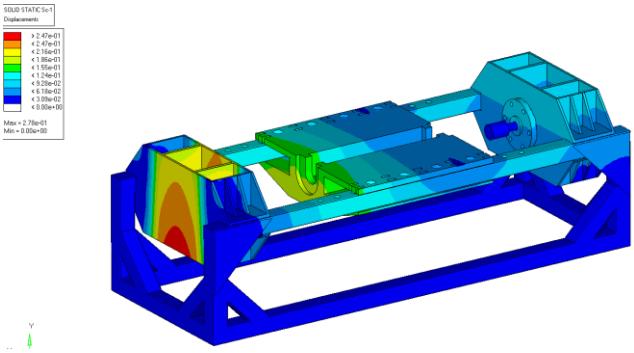


Figure 6 Deformation Counter of Machine

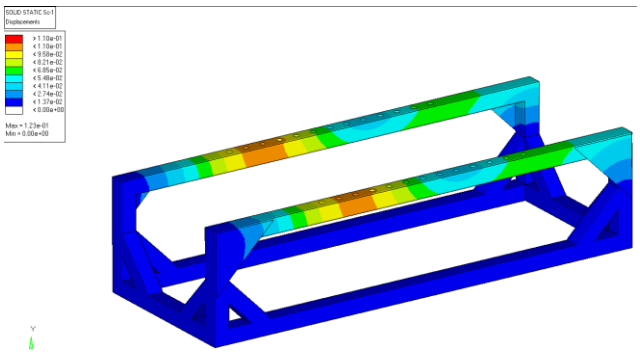


Figure 7 Deformation Counter of Frame

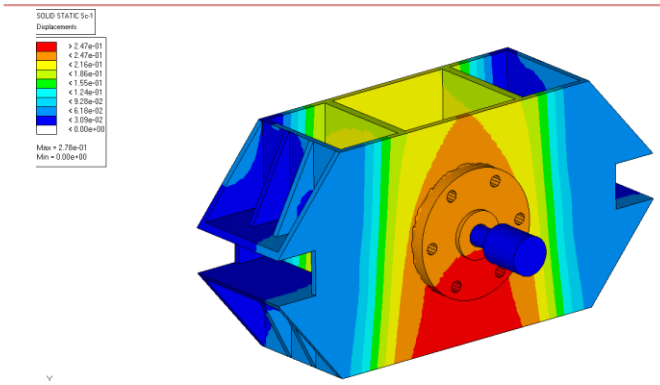


Figure 8 Deformation Counter of Press machine

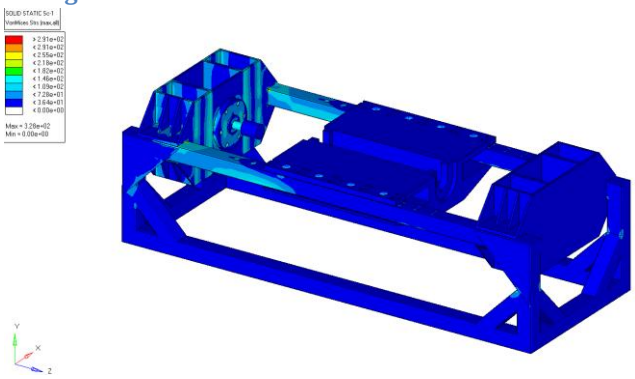
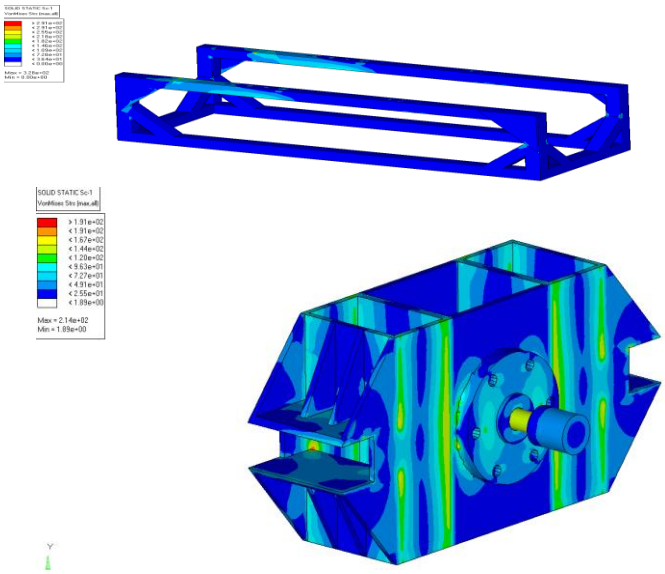


Figure 9 Stress counter of machine



V. Conclusion

Force applied due to load of axle is 24525N. Hydraulic force acting on piston and cylinder is 490500N. To check the effects of maximum forces on the designed structure a Linear static Analysis is carried out by using Finite Element Analysis Technique.

From the Results of FE analysis it is observed that structure is deformed by 0.27mm, the Base is deformed by 0.123mm, the side support is deformed by 0.278mm, the press machine bed is deformed by 0.183mm and maximum stresses developed in structure is 328 Mpa, maximum stress developed in base is 328MPa, maximum stress developed in side support is 214MPa and maximum stress developed in press machine bed is 64.3MPa.

Yield stress of structure material is 360.5 MPa.

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