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Design and Analysis of Hydraulic Jack for Hydraulic Cylinder Assembly

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Abstract: Hydraulic jack is a most effective material handling equipment used in industries. This paper has provided the design and analysis of hydraulic jack to overcome the problem of center matching during hydraulic cylinder assembly at Bajaj steel industries ltd. The paper has given a brief description about drive system, design specification and 3D modeling of system. The structural analysis is carried using ANSYS and fatigue life is calculated.
Keywords: Hydraulic jack, scissor lift, design, FEA.

I. INTRODUCTION

Hydraulic jack is a material handling equipment used in industry for variety of applications. It is driven by mechanical, hydraulic and pneumatic power. For heavy duty application hydraulic drive is preferred to achieve desired result. Some of material handling equipment used in industries are scissor lifts, scissor jack and hoisting machinery. These equipment are used according to system requirement for a particular process in industry.

Scissor lift is used as a lifting platform for heavy load application. It consist of system of levers and hydraulic cylinders on which the metal platform is able to move in the vertical plane. The movement is achieved by crisscross links, folding support called scissor mechanism. It is widely used to lift building objects, maintenance and construction, stacking process etc. Some of the applications of hydraulic jack are pallet handling, vehicle loading and work positioning, automatic production lines, distribution lines and so on.

II. PROBLEM STATEMENT

During internship at Bajaj steel industries ltd. Nagpur, a case study is done in hydraulic cylinder assembly section. It is found that they were using a mechanical fixture to hold the hydraulic cylinder and making adjustment with the help of overhead crane according to positional requirements.

Every time they need to adjust the height of barrel and piston rod according their different sizes. It takes a lot more time to complete the assembly. Also the manpower required was more. Therefore hydraulic jack is provided as solution to maintain the height of barrel and piston rod.

III. OBJECTIVES

A. To provide hydraulic power to conventional mechanical fixture.
B. To provide the solution for center matching problem during assembly.
C. Aimed to be user friendly.
D. To provide solution for easy loading and unloading of components during assembly.
E. To minimize actual assembly time.
F. To minimize labor's efforts (mechanical efforts).
G. To improve the production rate of the cylinder assembly.

IV. MATERIAL SELECTION

Material selection plays key role while designing any system as it determines the strength and fatigue life. Scissor links undergoes bending and buckling stress. Therefore to provide strength, stiffness, plasticity and hardness mild steel is recommended. Also top platform and bottom platform subjected to weight of fixture and cylinder and connecting pins undergoes direct shear stress. Hence recommended material is mild steel.

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V. DESIGN SPECIFICATION

Sr.No.	Requirement	Quantity
1	Capacity	6.5 ton
2	Raised height	914mm
3	length	3600mm
4	Closing height	150mm

VI. MODELING

A. Design Of Base Frame And Top Frame

1) The base frame in hydraulic jack provides a proper balance to the structure.
2) The top plate in hydraulic jack provides a Platform for material loading. It is designed to bear a load of 6.5 ton.
3) The dimensions of base frame and top frame are 3600 mm*600mm*150mm.

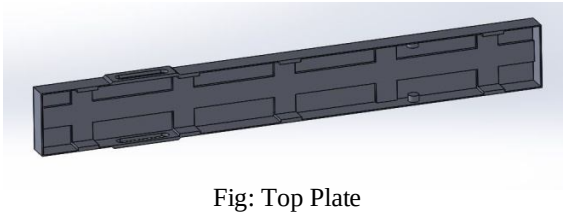

Fig: Top Plate

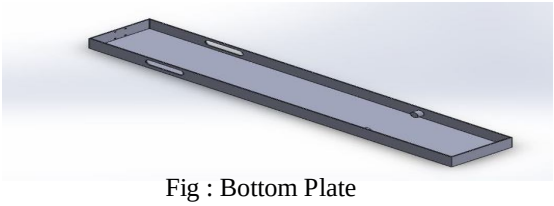

Fig : Bottom Plate

B. Design of Pin

1) Pin is main factor in hydraulic jack since it is used as supporting member.
2) Pin is component which can undergo direct shear stress.
3) Hence proper design of pin strengthen the system.

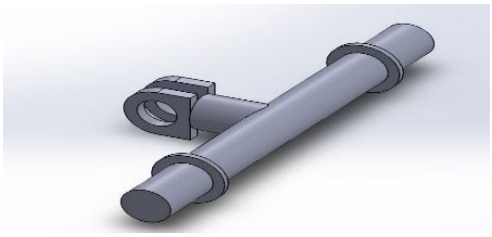

Fig: Bottom slider pin

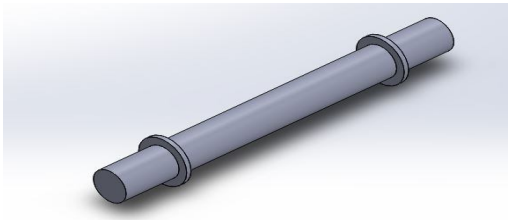

Fig: Top slider pin

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C. Design of Scissor Links

1) Scissor link is the main component that support the whole system and it is responsible for the movement of hydraulic jack.
2) Scissor links undergoes maximum load and stress, also it may be subjected to bending and buckling.
3) Hence to strengthen the link reinforced members are provided to it.
4) Dimension are 2080mm*130mm*36mm.

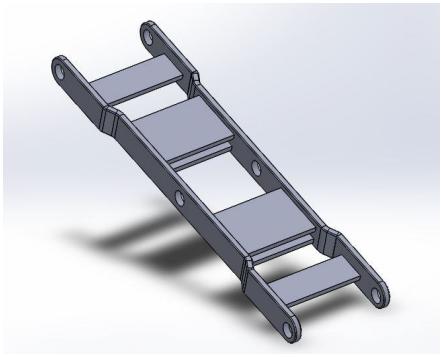

Fig: scissor link

D. Design of Hydraulic cylinder

1) Hydraulic cylinder is used to raise or lower the scissor platform using hydraulic power.
2) The barrel diameter and piston rod diameter are 100mm and 70mm resp.
3) Stroke length is 609.6mm

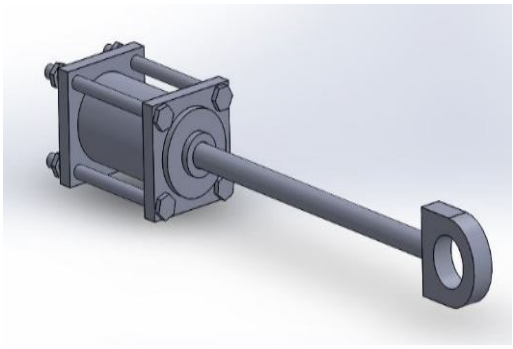

Fig: Hydraulic Cylinder

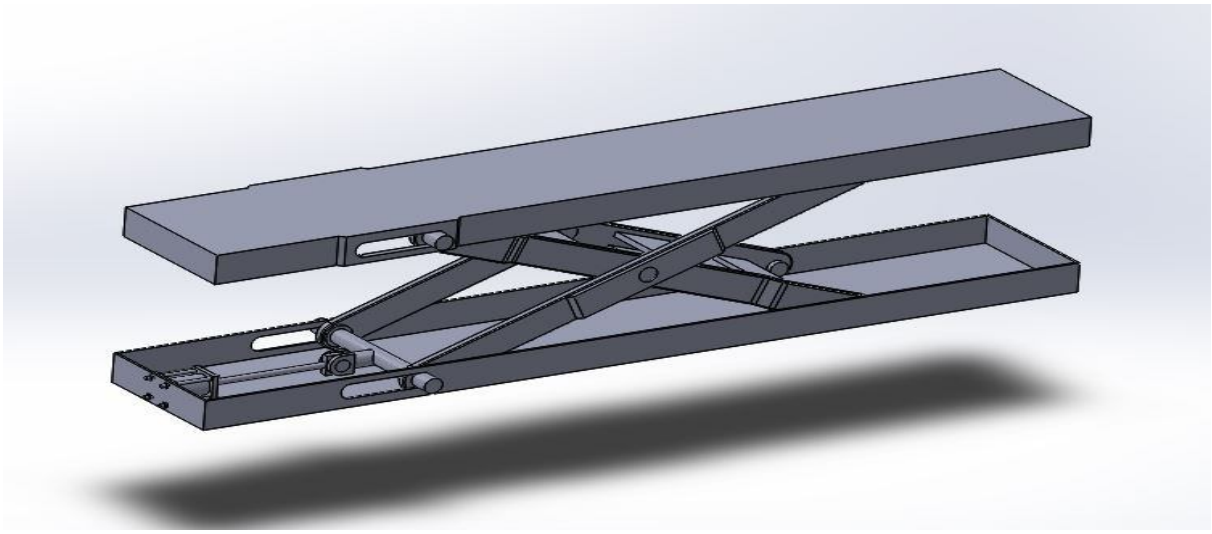

Fig: Hydraulic Jack Assembly

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VII. ANALYSIS

Analysis of hydraulic jack is carried out using the software ANSYS. Stress analysis and deformation analysis completed and fatigue life is calculated. The ANSYS results are shown in figure.

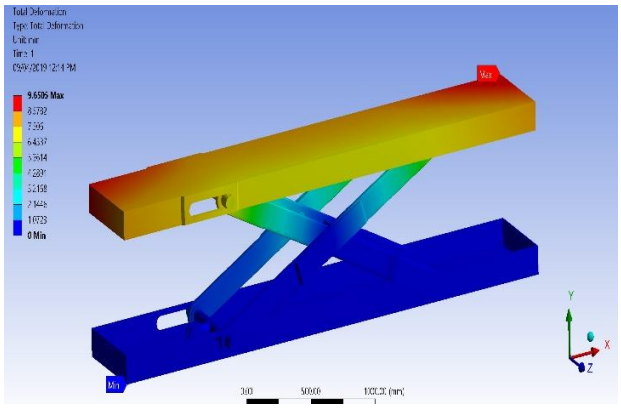

Fig: total deformation

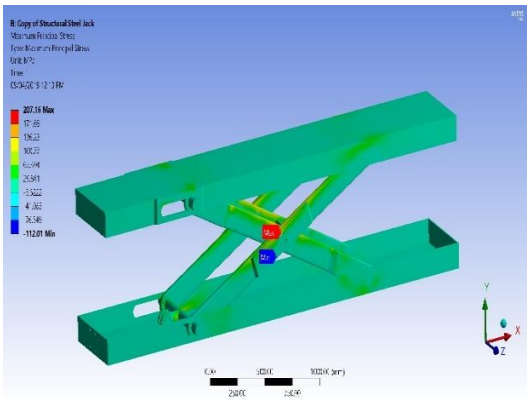

Fig: Max principal stress

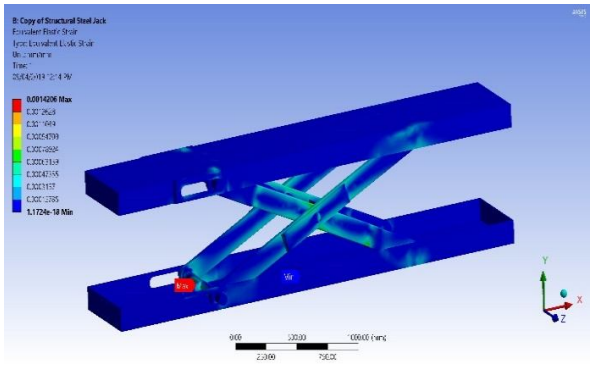

Fig: Equivalent elastic strain

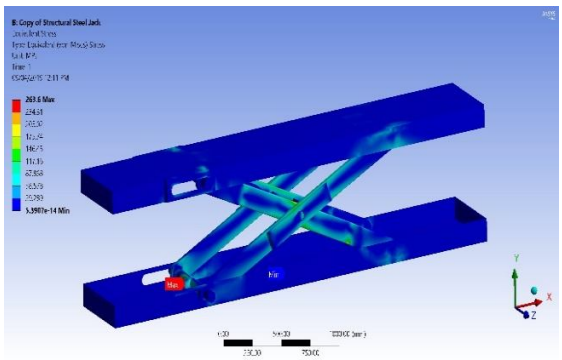

Fig: Equivalent elastic stress

VIII. RESULTS

A. Max principle stress is 207.16 MPA
B. Max Von-mises stress is 263.6 MPA
C. Max deformation is 9.65 MM
D. Fatigue Life is 20150 cycles

IX. CONCLUSION

The system has reached all the functional requirements and objectives. The center matching problem has solved successfully. As loading and unloading is repeated fatigue failure is checked and hence life of the hydraulic jack. The time required for assembly get reduced efficiently. Hence the overall production rate is highly increased.

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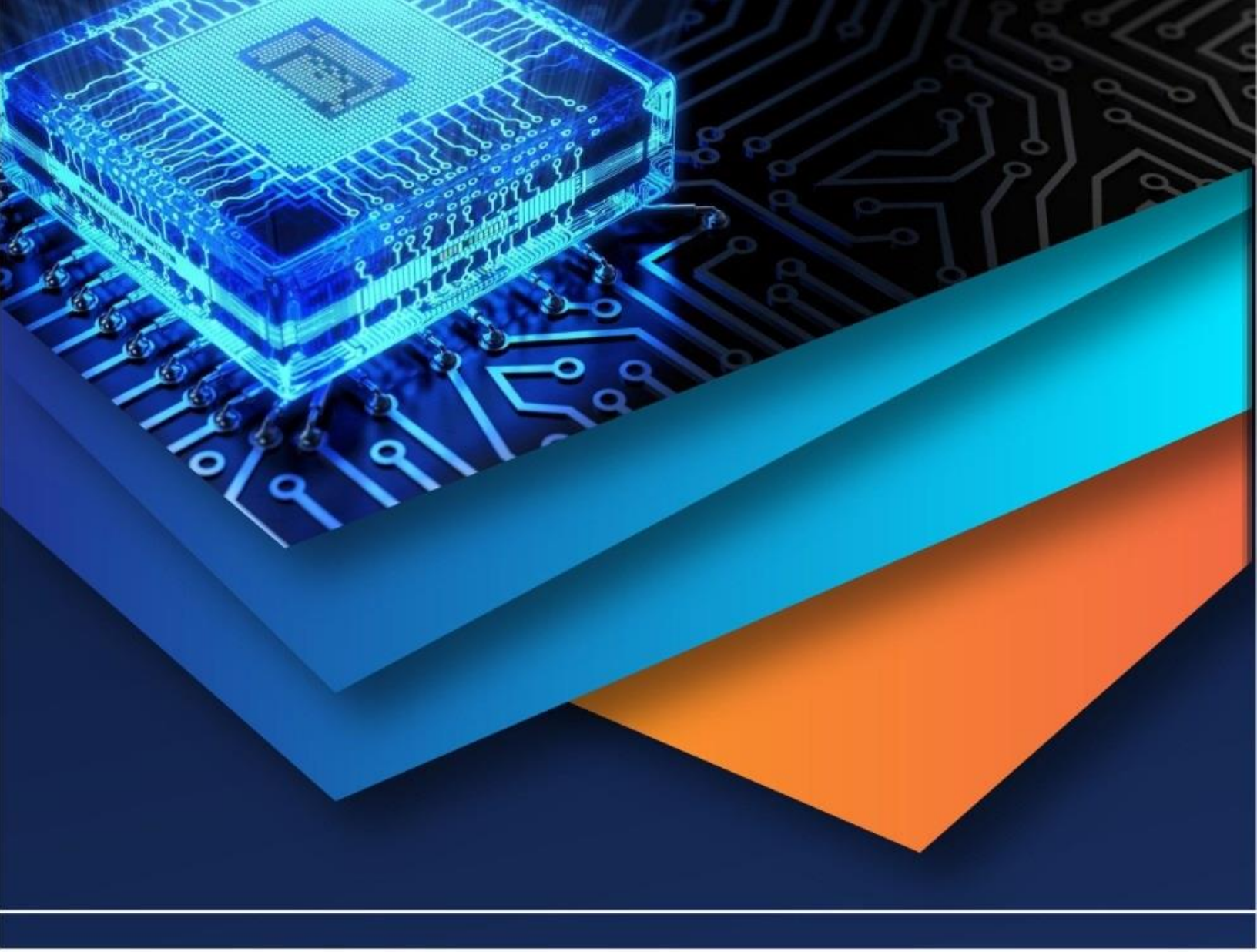

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