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Fixture Development for Straightening Operation of Front Axle Beam

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Abstract:- *In front beam axles industries, axles are manufactured and machined. During machining process, the axle moves through straightening process where the axles are straightened. Different axle with different dimensions is mounted on the same machines with the help of fixture. So we have to design fixtures for the axle (Die No. 2675) for straightening operation. This paper analyzes the modification of the existing fixture by incorporating an electric motor in the screw in order to make fitment easier. In this modified design, the power screw is rotated through it hydraulic motor. Connecting gear rotated with required speed reduction and increased torque to drive the power screw. The significance and purpose of this work is to modify the existing clamping procedure in order to make the operation easier, safer and more reliable in order to reduce health risks especially back ache problems associated with doing work in a bent or squatting position for a long period of time for workers.*

The designing of axle beam and fixtures are carried out by creating solid 3D models in SOLIDWORKS software.The dimensions of beam geometry are found out for best placing dimensions for fixtures. The designed fixture will also save time and requires less human energy to operate. The design when adopted will effectively curb the problems associated with Ergonomics - which is a fundamental concept of the design process. The Design a mechanical fixture is for straightening operation for front axle beam Military tank having weight 147kg

Keywords- *Fixture, Solidworks, Front Axle Beam, Straightening.*

I. INTRODUCTION

The jigs and fixtures are the economical ways to produce a componentin mass so jigs and fixtures are used and serve as one of the most important facilities of mass production system these are special work holding and tool guiding device. Quality of the performance of a process largely influenced by the quality of jigs and fixtures used for this purpose. What makes a fixture unique is that each one is built to fit, a particular part or shape. The main purpose of a fixture is to locate and in the cases hold a workpiece during an operation. A jig differs from a fixture in the sense that it guides the tool to its correct position or towards its correct movement during an operation in addition to locating and supporting the workpiece.

An example of the jig is when a key is duplicated; the original key is used as the base for the path reader which guides the movement of tool to make its duplicate key. The path reader of a CWC machine here works as a jig and the original is called template. Sometimes the template and jig both are the names of same part of a manufacturing system.

An auto industry is one of the important and key sectors of the Indian economy. The auto industry includes of automobile sector, auto components sectors and includes commercial vehicles, passenger cars, multi-utility vehicles, two wheelers, three wheelers and related auto parts. The demands on the automobile designer increased and altered rapidly, first to meet system safety needs and later to reduce weight so as to satisfy fuel economy and vehicle performance requirements. Engine location important to provide greater stability and safety at high speeds by lowering the centre of gravity of the road vehicles; the complete centre portion of the axle is dropper.

Front axles are subjected to both bending and shear stresses. In the static condition, the axle might be considered as beam supported vertically upward at the ends (at the centers of the spring pads

Under the dynamic conditions, a vertical bending moment is increased due to road roughness. Thus it is very difficult to find the crack propagation in short time. So it is necessary to incorporate finite element methodology. During the operation on a vehicle, road surface irregularity causes cyclic fluctuation of stresses on the axle, which is the main load carrying member.

Therefore it is necessary to make sure whether or not the axle resists against the fatigue failure for a predicted service life. Axle experiences completely different loads in the different direction, primarily bending load or vertical beaming due to curb weight and payload, torsion, due to driving torque, cornering load and braking load.

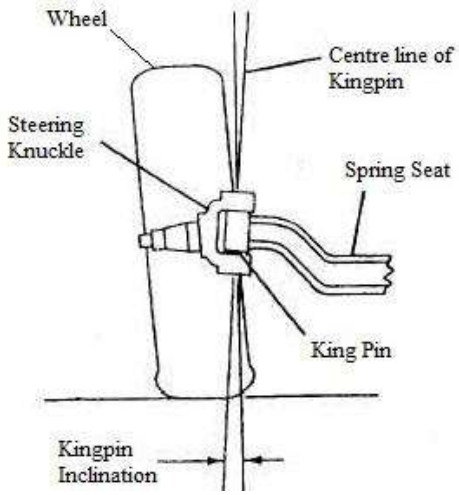


Fig 1.1 Axle assembly

Front axle will experience a 3G load condition when the vehicle goes on the bump. Performing physical test for vertical beaming fatigue load is expensive and time consuming. So there is a necessity for building FE models which may virtually simulate these loads and can predict the behaviour. Even though the FEA produce fairly accurate

Results, solution accuracy heavily depends on the accuracy of input conditions and overall modelling methodology used to represent the actual physics of problem.

Hence the correct design of the front axle beam is very critical. The approach in this project has been divided into two steps. In the first step analytical method used to design front axle. For this, the vehicle specifications, its gross weight and payload capacity in order to find out the stresses and deflection of the beam has been used. In the second step, front axle was modelled in 3D. The model was solved in SolidWorks software system.The axle material considered for structural analysis is AISI 1045 steel and following are its important mechanical properties.

Sr.no	Property	Value	Units
1	Elastic Modulus	205000	N/Mm^2
2	Poisson's Ratio	0.29	-
3	Shear Modulus	80000	N/Mm^2
4	Mass Density	7850	Kg/M^3
5	Tensile Strength	625	N/Mm^2
6	Compressive Strength	-	N/Mm^2
7	Yield Strength	530	N/Mm^2
8	Thermal Expansion Coefficient	1.15e-005	/K
9	Thermal Conductivity	49.8	W/(M·K)
10	Specific Heat	486	J/(Kg·K)
11	Material Damping Ratio	-	N/A

Table 1: Axle Material properties

II. Objectives of Fixture Design

The objectives considered for designing fixture –

1. Introduction of jigs and fixtures,
2. purpose and advantages of jigs and fixtures,
3. important considerations while designing jigs and fixtures,
4. Principles of location,
5. Explain the clamping and its different type.
6. The requirements of a good clamping device.
7. Know the different types of clamps.

III. Advantages of Fixtures

Due to use of the fixture for performing the operation the numerous advantages are obtained.

1. It reduces or sometimes eliminates the efforts of marking, measuring and setting ofworkpiece on a machine and maintains, the accuracy of performance
2. The workpiece and tool are relatively located a, their exact positions before the operation automatically within negligible time. So it reduces product cycle time.
3. Variability of dimension in mass production is very low so manufacturing processes supported by use of jigs and fixtures maintain a consistent quality.
4. Due to low variability in dimension assembly operation becomes easy, low rejection due to less defective production is observed.
5. It reduces the production cycle time also increases production capacity.
6. Simultaneously working by more than one tool on the same workpiece is possible.
7. The operating conditions like speed, feed rate and depth of cut can be set to higher values due to rigidity of clamping of workpiece by jigs and fixtures.
8. Operators working become comfortable as his efforts in setting the workpiece can be eliminated.
9. Semi-skilled operators can be assigned the work so it saves the cost of manpower also.
10. There is no need to examine the quality of products provided that quality of employed jigs and fixtures is ensured.

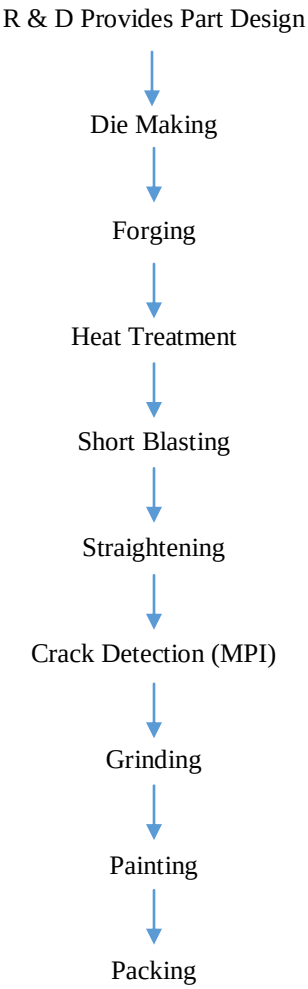
IV. Considerations While Designing Fixtures

Designing of jigs and fixtures depends upon so many factors. These factors are analyzed to get design inputs for jigs and fixtures. The list of such factors are –

1. Study of workpiece and finished component size and geometry.
2. Type and capacity of the machine, its extent of automation.
3. Provision of locating devices in the machine.
4. Available clamping arrangements in the machine.
5. Available indexing devices, their accuracy.
6. Evaluation of variability in the performance results of the machine.
7. Rigidity and of the machine tool under consideration.
8. Study of ejecting devices, safety devices, etc.
9. Required level of the accuracy in the work and quality to be produce

V. Processes In The New Front Axle Beam

Process from design to dispatch of front beam axle is carried out in a pattern as per flow chart.
The machines are arranged according to the process in the new fab line.



VI. Meaning of Location:

It is very important to understand the meaning of location before understanding about the jigs and fixtures. The location refers to the establishment of a desired relationship between the workpiece and the Jigs or fixture correctness of location directly influences the accuracy finished product. The Jigs and fixtures are desired so that all undesirable movements of the workpiece can be restricted. Determination of the locating points and clamping if, the workpiece serve to restrict movements of the component in any direction, while setting it in a particular preceded position relative to the jig.

Before deciding the locating points it is advisable to find one, the all possible degrees of freedom of the workpiece. Then some of the degrees of freedom of all of them are restrained by making suitable arrangements. These arrangements are called locators.

VII. Principles Of Locations:

The principle of location is discussed here with the help of a most popular example which is available in any of the book covering jigs and fixtures. It is important that one should understand the problem first.Any rectangular body many have three axis along x-axis, y-axis and z-axis. It can move along any of these axes or any of its movement can be released to these three axes. At the same time, the body can also rotate about these axes too. So total degree of freedom of the body along which it can move is six. For processing the body it is required to restrain all the degree of freedom (DOF) by arranging suitable locating points and then clamping it in a fixed and required position. The basic principle used to locate the points is desirable below.

VIII. Six Points Location Of A Rectangular Block:

Considering the six degrees of freedom of a rectangular block as shown in Figure. It is made to rest on several points on the jig body. Provide a rest to the workpiece on three points on the bottom x-y surface. This will stop the movement along z-axis, rotation with respect to x-axis and y-axis. Supporting it on the three points is considered as better support then one point or two points. Rest the workpiece on two points of side surface(*x*-*z*), this will fix the movement of workpiece along y-axis and rotation with respect to z-axis.

Provide a support at one point of the Adjacent surface *(}>-z)* that will fix other remaining free movements. This principle of location of fixing points on the workpiece is also named as 3-2-1 principle of fixture design as the number of points selected at different faces of the workpiece is 3, 2 and 1 respectively.

Body to be restrained (each of the Axis can be divided into two Halves positive and negative)

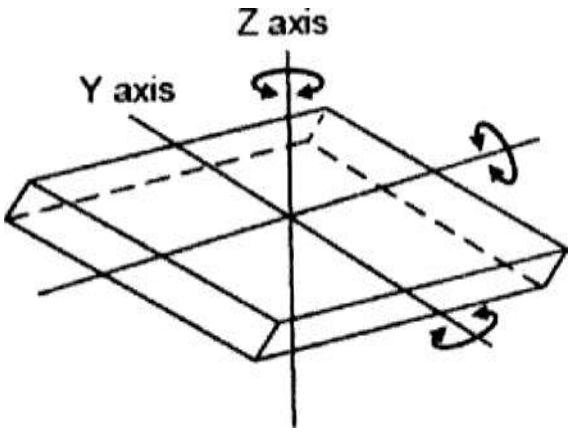


Fig 8.1: Available Degree of Freedom of Rectangular Block

IX. Comparison for Type Of System To Be Used For Tool.

Criteria	Pneumatic	Hydraulic	Hydro pneumatic
Cost	lowest (Running Cost highest)	High (Running Cost lowest]	low (Running Cost
Clamping force.	Light - 2 to 3 ill mat. Higher forces with no space constraints	Medium and heavy - above 5KN	Medium and heavy from 5 KN to l00 KN
Clamping Cylinder Size	Bulky for even medium, clamping force (0p.Pr. 5 bar)	Compact(For SPM 0prPr. 30 to 70 bar)	Most Compact for heats. forces (0p.Pr.to to 200 bar)
Clamping Stroke -	Wide range from short to very long	Wide range from short to very long	Short stroke - 50 mm max.
Clamping Speed	Very last	Fast	Fast

Impact while clamping	Present	Not Present	Not Present
Reliability	Low - as can be overpowered due to the compressibility of air.	Most safe - due to the check valve and incompressibility of oil	Safe - as factor of safety for force selection can be more
Sequencing	Possible	Possible	Difficult
Piping & Circuit	Complicated	Complicated	Simple
Oil heating problem	Not Present	Present	Not Present
Return stroke speed and power	Fast due to double acting cylinder. but low power	Fast, with power and positive due to double acting cylinder	Sluggish due to spring return cylinders
No. of clamping points	No limit	No limit	Limited, 3 to 5 per intensifier
Other applications	Material handling, Valve actuation, Door movement	Peed cylinders, Earth moving equip, Cutting, Hole punching,	Deep drawing, Pressing assembly, Riveting, crimping, cutting

X. Design Procedures to Study

1. Axle fitment in the machine.
2. Axle impede on the machine during rotation.
3. Torque required to rotate the assembly of axle in the machine.

For completing the project, the work is categorized into 7 steps-

1. Creating 3D model of the rotary mounting.
2. Creating 3D model of the front beam axle.
3. Meshing the rotary mounting and axle beam.
4. Finding the best suited section for mounting.
5. Providing the machine tolerance.
6. Finding the tools required to fit in the mounting.
7. Finding the torque required for driving the axle.

All steps are studied and calculated and the results are placed.

1. Creating 3D model of the rotary mounting.

   The rotary axle mounting dimensions were taken and the software used for the designing is SOLIDWORKS. The mounting consists two chucks and the four rods attached to them.

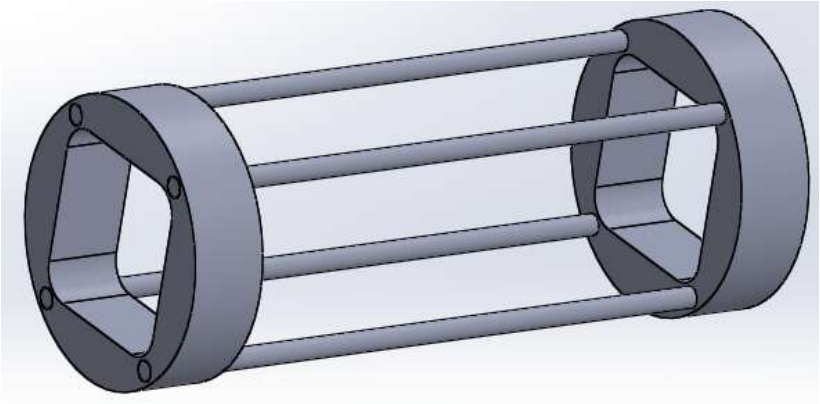


Fig10.1.3D model of the rotary mounting

2. Creating 3D model of the front beam axle.

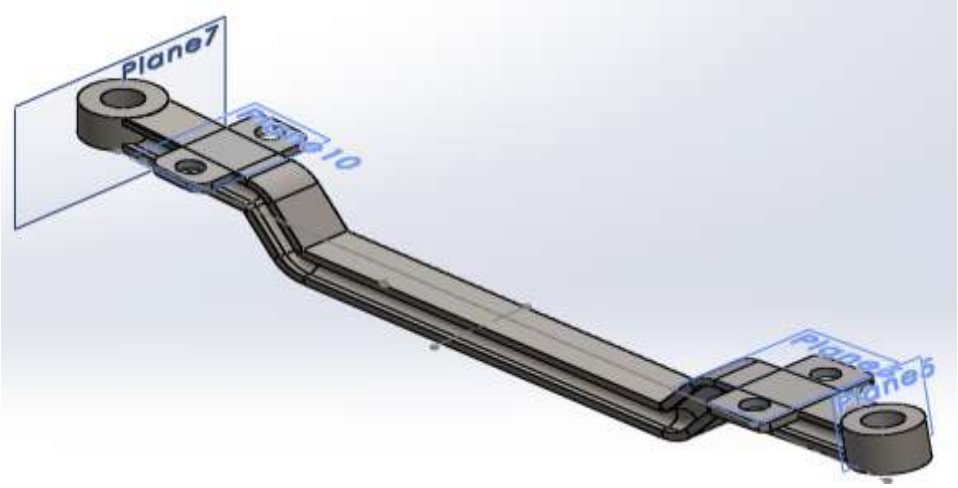


Fig10.2. 3D modelling of Front Axle Beam

3. Meshing the rotary mounting and axle beam.

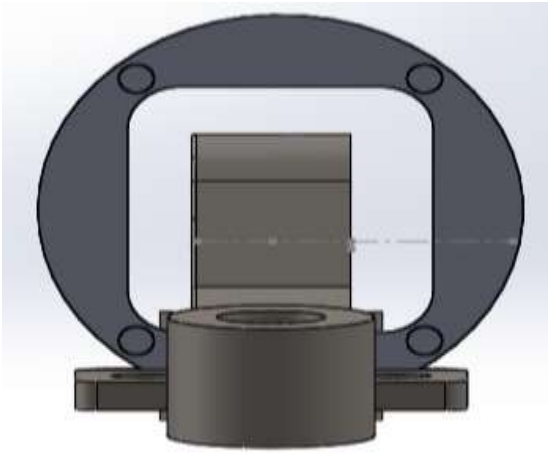


Fig 10.3. Assembly side view

The gap between the axle beam and chuck plate is the tooling design portion. The gap between them is used to fit the tools for holding the support.

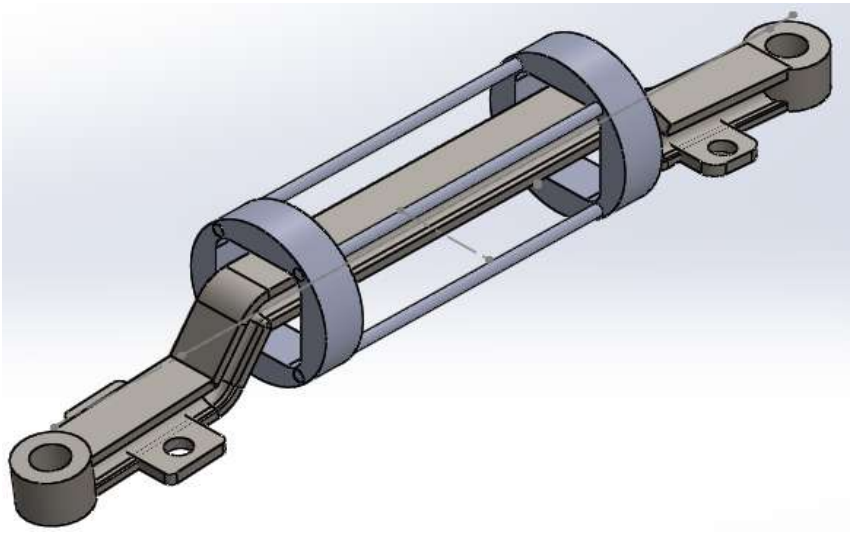


Fig 10.4. Assembly isometric view

4. Finding the best suited section for mounting.

There are 2 conditions for clamping the axle in the chuck.

Sr.no	Holdings Position	Problem	Solution
1.	Holding the job at I-Section.	1. Circumference during rotation 2. Motor torque.	1. Providing the height for rotor.
2.	Holding the job at GG section	1. Circumference during rotation. 2. Press and job distance Tooling design problem.	1. Should change the machine

5. Providing the machine tolerance –

The machine tolerance are provided as constrained in the software, the assembly is run to stimulation. The desired results are found.

6. Finding the tools required to fit in the mounting –

The open space found in the gap between the axle and the rotary mounting. The space obtained can be used for tool fitment designing.

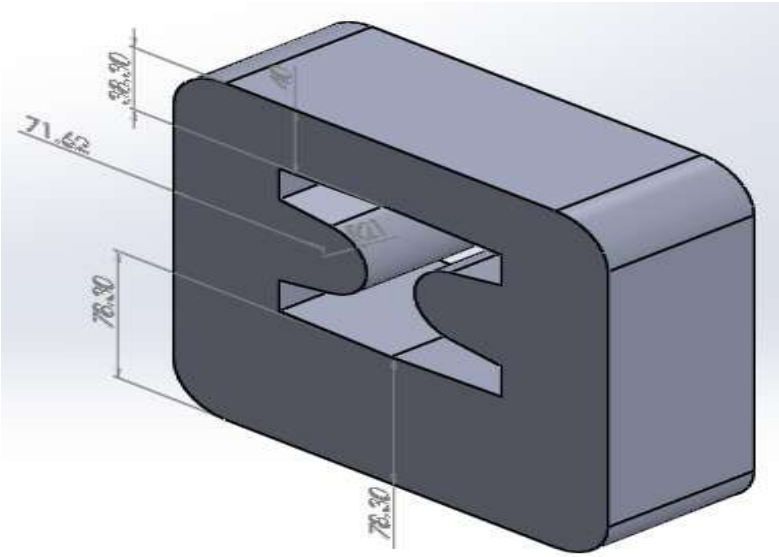


Fig 10.5. Free space Isometric view

XI. Tools Designed For The Fitment Of Axle Beam On I Section.

For fitment between the gaps a accurate dimensions need to be designed and tested. The parts for the fixtures designed are –

Part No 1. Side Clamper

2 sets are clampers are used for clamping operation on the side section of chuck. The clamps are used to clamp near I- section of the beam

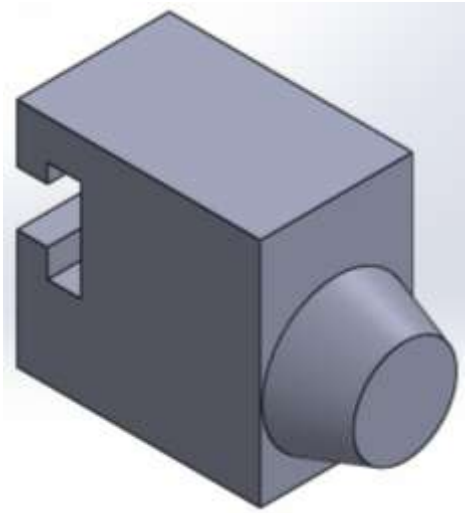


Fig 11.1.Side Clamper

Part No 2.Base support

1 set of clamp is used for supporting operation on the base of chuck. The supporters are used to clamp the beam at bottom position of beam during rotation.

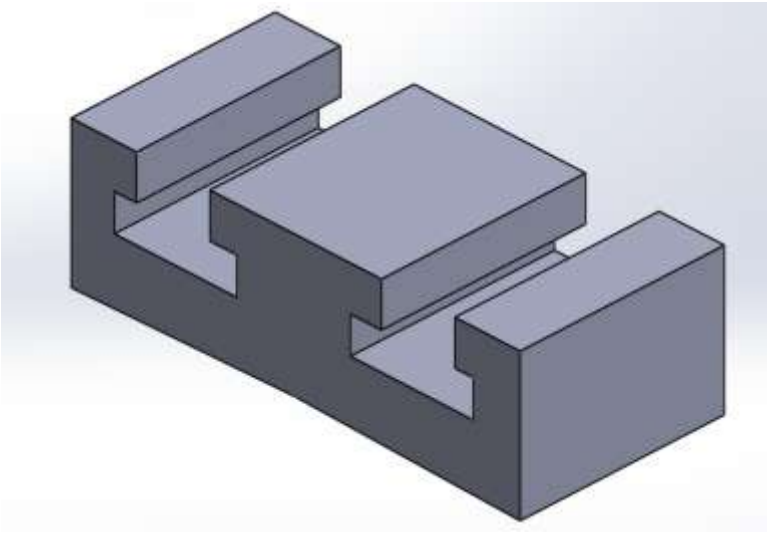


Fig 11.2. Base Support

PartNo 3. Rectangular plate

1 set of plate used for clamping operation on the top section of chuck. The clamp are used to clamp near top section of the beam

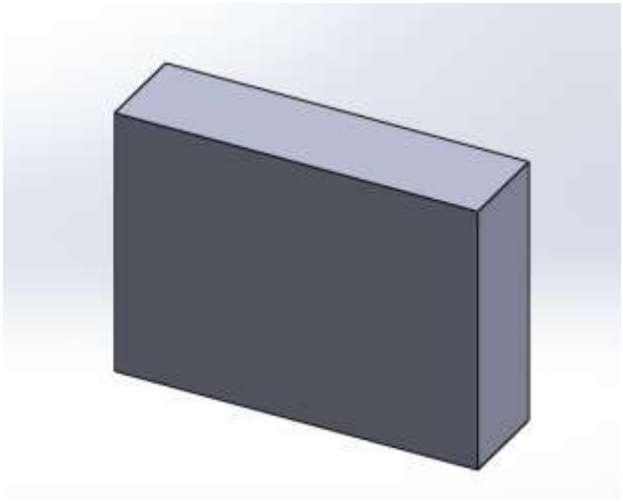


Fig 11.3. Rectangular Plate

7. Finding the properties of axle and torque required for driving the axle.

The properties are found by stimulating the meshing done of the model. The centroid positon is found out as I_{xx} ,I_{yy} , I_{zz} and the axle beam is same to be placed in the directions obtained

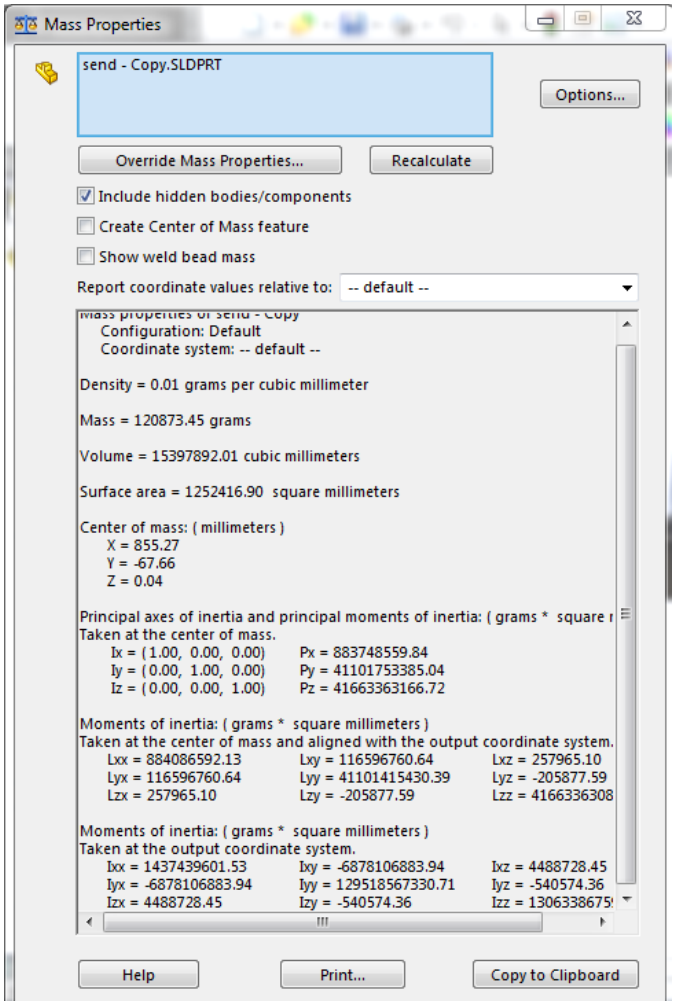


Fig 11.4. Mass Properties

XII. CONCLUSION

The fixture designed helps in loading and unloading the workpiece quickly which helps in time saving.The component and material selected for fixture design helps in holding the workpiece securely, so that machining operation can be carried out properly. The following changes should be carried out for performing the straightening operation of axle (die no 2675).

1. The clamping should be at I section
2. The axle should be placed on a plate with height form (78 to 84 mm)
3. The upper plate of axle should be within range 2.4 to 3
4. The current motor used in the machine is Atlas Copco LZB33 Reversible which is having a torque capacity of 0.34 Nm to 305 Nm. The motor should be replaced with Atlas Copco LZB42 for having higher torque.

XIII. RECOMMENDATION

1. Further research should be carried out onhow to minimize vibration and noise duringoperation.
2. Design applicable to vehicles weighing over1000 kg should be carried out

XIV. ACKNOWLEDGEMENT

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