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# Double Head Chamfer Machine Design & Development of Double Head Chamfer Machine

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***Abstract*: The Industrialization is moving towards automation and in this era of automation where it is broadly defined as replacement of manual effort by mechanical power in all applications of manufacturing. Chamfering is one of the major operations in manufacturing of automotive parts. In manufacturing industry there are many small scale and medium scale industries are there who performs this operation and as per the requirement or customer. For many industrial applications round bars and square bars are required to be chamfered using different machines. This operation for mass production consumes time and manpower of the industry. To reduce the time consumption and energy consumption of worker we have designed and developed double head chamfer machine.**

***Key Words: Automated, linear guided, double head, chamfering, automation, chamfer tool, SPM***

## I. INTRODUCTION

This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased.

In present condition many non-automatic operated chamfering machines of different companies with different specifications are available for the use in shop floor. As the requirement of mass production for industries they need to perform this operation in high rate which is not obtained by the conventional machines. So there is a need of improvement in design and technology of such machines. This machine can chamfers both side of component simultaneously and can also achieve mass production with maximum profit for that company. This machine after improvement overcomes all the drawbacks of conventional machines, which are later beneficial for small and medium scale industries. It is also helpful for small-scale industries due to its simple working and operating conditions along with its compatibility, efficiency and affordable price. A chamfer is a 45-degree bevelled edge that is built into various designs, including architectural and tech products. This paper proposes the model of double head chamfer machine.

This is able to chamfer simultaneously without any jerk and minimum vibrations. This model overcomes the limitations of conventional chamfering machines, which can chamfer single piece at a time. It is able to chamfer metal bars of different materials at same time and will be helpful in many industries due its compatibility, reliability and efficiency.

## II. DESIGN APPROACH

The setup of our project consists of a bed on which the chamfering tools and other parts are mounted. The chamfering tools are mounted on the ends of the base table and at the centre the work piece is being held with the use if pneumatic cylinder and grippers. The work piece is moved forward with the help of feed tracks and motor. To perform this operation tools are moving ahead and back according to the size of work piece with the help of guide rails and guide block placed at the bottom of motor plate. After this when tool and work piece comes in contact the chamfering is done.

Following are the main parts of this project:

- Bed
- Chamfering Tool
- Motor
- Lead screw
- Pneumatic cylinder
- Linear guide rails and block
- Electronic components

### *A] BED*

Bed or the base of the machine is our primary element on which all the other components are to be mounted and the required operations are to be performed. The dimensions are also mentioned below.

- Width of the bed (with cutting mechanism) = 1.5meter
- Length of the bed = 1.5meter
- Area =$2.25\times10^4$ cm$^2$

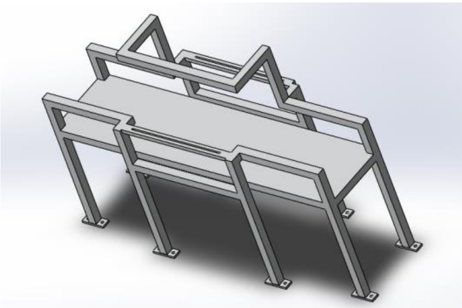


Figure 1 BED

### *B] CHAMFERING TOOL*

This is the chamfer tool designed according to our project. Considering the centre of work piece should not move after the rotation of feed track. So to keep the work-piece stationary the cutting tool or the cutter needs to be rotated

and we cannot use single point cutting tool for such operation.
Therefore we decided to design a whole new cutter by taking concepts of milling cutters on CNC machines.

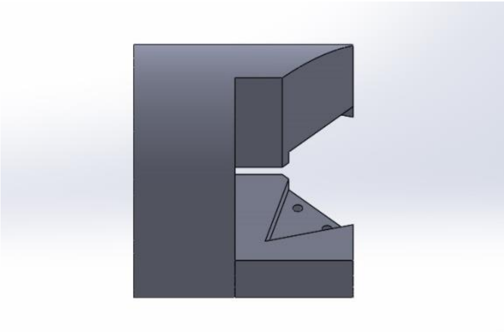


Figure 2 TOOL

### C] MOTOR

- Induction motor

The cutter tool assembly is directly mounted on induction motor of 0.5 HP rotating with max. Speed of 1380 rpm this motor is selected according to the common motor used in lathe machine. Since cutting force for chamfering is less therefore rated power of in motor is also less compared to motor used in lathe or CNC milling machine. The motor is mounted on motor plate, which moves along the axis of woe pieced with the help of lead screw and guide rails.

- Stepper motor

The weight acting on lead screw is high, so that the torque require to rotate lead screw is also high also the speed at which lead screw will move is less so if we use induction motor for rotating lead screw at high and low speed gear box will be introduced between lead screw and motor. Therefore instead of using induction and gear box we can directly use stepper motor having high toque transmission capacity with low rotational speed the stepper motor used in this machine is NEMA 34

### D] LEAD SCREW

The basic concept of working of the lead screw is same as the working in lathe machines. In conventional lathe machines when the anti-backlash nut is engaged the tool post attached to the nut starts moving with the lead of the lead screw. Similar concept is used in this machine.
The lead screw is designed in such a way that it carries both right hand and left hand screws on it. This enables the inward and outward movement of both the cutters with help of single motor since both the cutters are in opposite directions.

### E] PNEUMATIC CYLINDER

Here the pneumatic cylinder is used for the upper support for our work piece so while operating it does not displace or move from the centre. A gripper type arrangement is applied to the cylinder which ensures that the component does not move from its position while the machining takes place.

### F] LINEAR GUIDE RAILS AND BLOCKS

GUIDE RAILS

The main purpose of lead screw is to move the cutting motor forward and backward but the diameter is small so it alone cannot withstand the weight of motor and motor plate also the dimension of motor plate is very large, there are chances of misbalance of motor plate. To ensure the balance of motor plate and the overall weight distribution of motor and motor plate guide rails are used. This guide rails helps in smooth and transit motion of the motor plate forward and backward also it helps in reducing the torque existing on stepper motor which is used to rotate the lead screw. This guide rails have foot mounting which can be mounted on bed so that it damped all the vibration occur by induction motor. The diameter of gr selected is 25 mm to ensure a proper safety and carry out the whole operation without failure of lead screw.

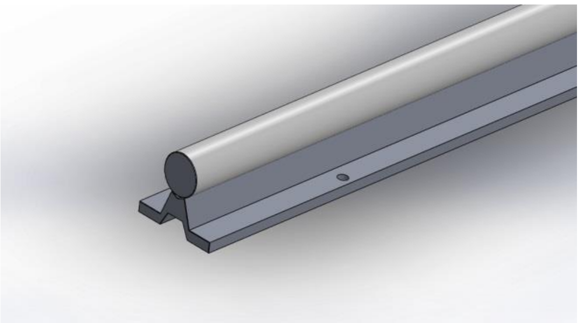


Figure 3 GUIDE RAILS

GUIDE BLOCKS

The guide rail blocks are used so that it ensures proper mounting of motor plate on guide rails. This blocks contains ball bearing inside them and has section cut from bottom so that it can have smooth and antifriction sliding on guide rails

### G] FEEDTRACK AND MOTOR

Feed track is made in such way that a cylindrical component placed would not slip or move from its place and components of all diameters can be held in the plates for machining and so the shape of the feed track is selected with the v-shaped grooves.
According to the weight and the surface area of feed track the motor is decided as the feed track will use the power to transfer the components from one position to other

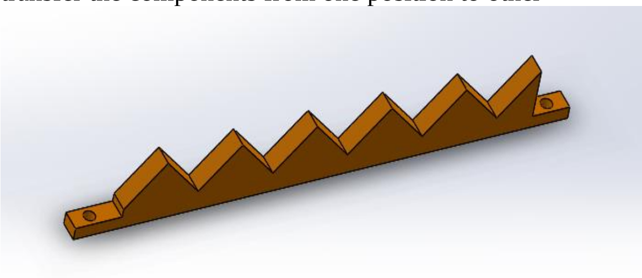


Figure 5 FEED TRACKS

H] ***ELECTRONIC COMPONENTS***

To automate the machine and ensure the proper working of the machine without any failures many electronic and computational components are required. Names of components used are mentioned below:

1. Arduino mega
2. SMPS
3. 5×2 Direction control valve 9DCV0
4. FRL unit

## III. DESIGN CALCULATIONS

### *[A]. FEEDTRACK AND MOTOR*

Time =2sec

d=10cm

Velocity=d/t =10/2 =5 cm/sec ……………… (I)

Acceleration =v/t =5/2 =2.5 cm/sec$^2$ …… (II)

$F_h$ = m × a = 157×2.5 =0.392 N…………….. (III)

$F_v$ =0.392 N

$F_R = \sqrt{F_t + F_v} = \sqrt{0.392+0.392} = 0.8854$ N…….. (IV)

θ =45˚

τ = r × F = 50 × 0.8854………. (V)

τ = 44.27 N.cm

FOS= 5

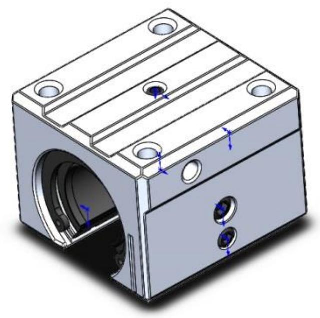
$\tau_{safe}$ = 44.27 x 5

$\tau_{safe}$ = 221.35 N.cm

P = 2πNT/60……………….. (VI)

= (2× π×100×221.35×10$^{-2}$)/60000

P = 0.03 HP



### *[B]. LEAD SCREW*

AC = 225mm

$R_a = R_b = \frac{355}{2} = 177.5$N

$$P = \frac{2\pi NT}{60}$$

$$0.0559 \times 10^3 = \frac{2 \times \pi \times 60 \times T}{60}$$

T = 8.896×10$^3$ N.mm

B.M = $R_A$ × AC……….. (VII)

= 177.5 × 225

B.M = 39.94×10$^3$ N.mm

$M_t = \sqrt{(k_b.BM)^2 + (k_t.T)^2}$……….. (VIII)

$= \sqrt{(1.5 \times 39.94 \times 10^3)^2 + (1 \times 8.896 \times 10^3)^2}$

$M_t$ = 60.567× 10$^3$ N.mm

Considering SS-304 material for the lead screw

$\sigma_y$ = 215 N/mm$^2$

F.O.S = 3

$\tau = \frac{0.5 \times \sigma_y}{F.O.S}$ ……………… (IX)

$\tau = \frac{0.5 \times 215}{3}$

τ = 35.833 N/mm$^2$

$M_t = \frac{\pi}{16} \times d^3 \times \tau$…………… (X)

$$60.567 \times 10^3 = \frac{\pi}{16} \times d^3 \times 35.833$$

$\therefore d = 22.55 \approx 25mm$

### *[C]. PNEUMATIC CYLINDER*

Considering 0.5HP of motor and cutting tool speed as 720rpm

$$P = \frac{2\pi NT}{60}$$

$$0.373 \times 10^3 = \frac{2 \times \pi \times 720 \times T}{60}$$

∴ T = 4.9471 Nm

T = $force \times diameter\ of$ component

4.9471 = F ×54×10$^{-3}$

∴ F = 91.613N ≈ $92N$

Since minimum force is required to be exerted by pneumatic system is 100N.

Taking 5bar pressure,

$P = \frac{F}{A}$……………… (XI)

$\frac{\pi}{4}$ ×d$^2$= 0.5×100

∴ d = 15.94 mm ≈ 20 mm … (Cylinder diameter)

## *IV.ASSEMBLED MACHINE*

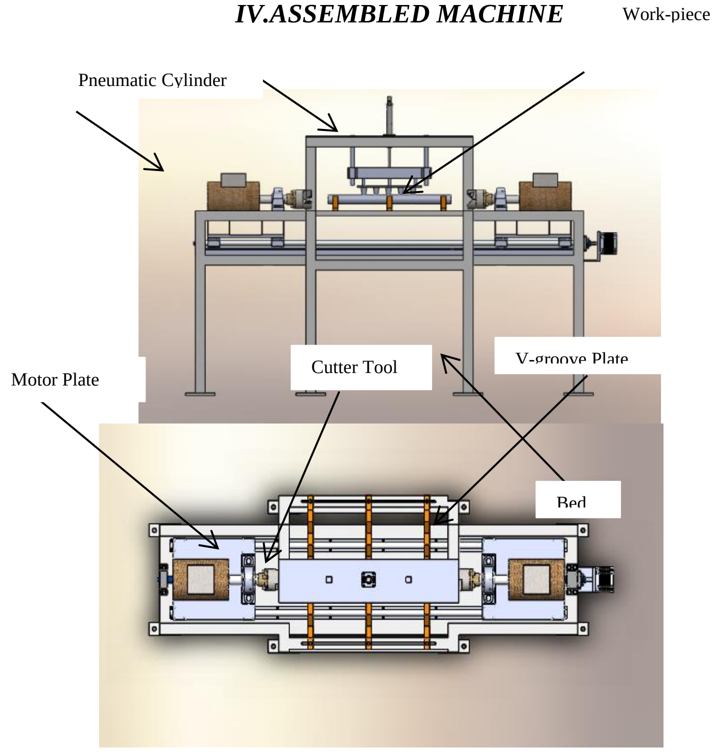



Figure 5 FRONT VIEW

Figure 6 TOP VIEW

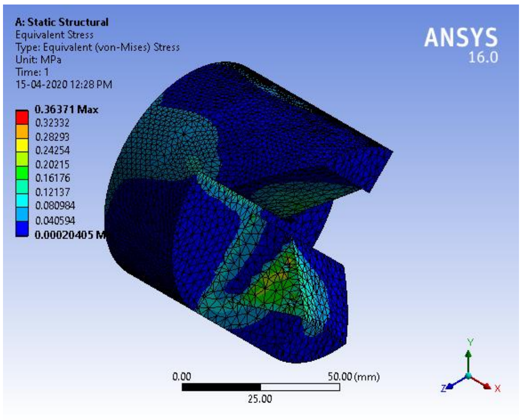
## V. RESULTS & DISCUSSION

***A] Analysis on tool:***

After completion of the design and calculating all the forces acting on the cutting tool and the speed at which the cutting tool is going to be rotated, ansys analysis for the tool was done so as to ensure that the tool won't fail while working on the work-piece.

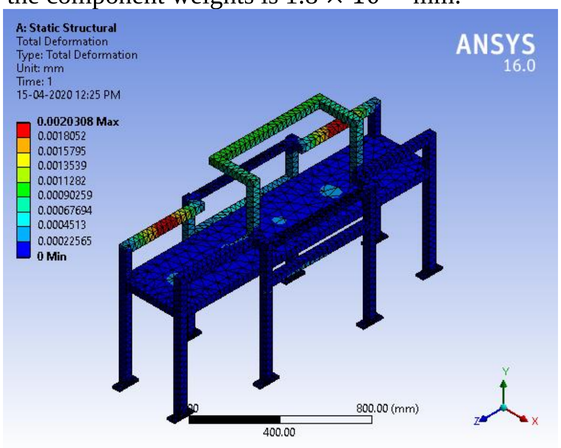
The maximum deformation of the tool body will take place at the cutting edges which will come in contact with the work-piece creating a resistance force. The maximum deformation that will take place is 0.00017018mm i.e. $1.7 \times 10^{-4}$mm.

The result for the same is as shown in the figures below.



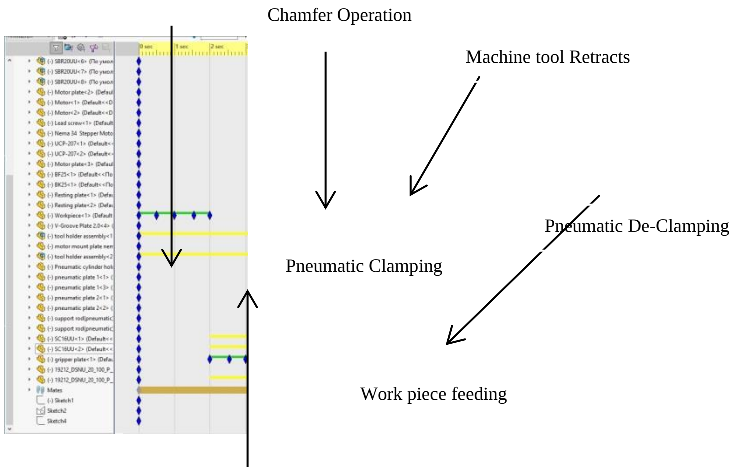

***B] Analysis on bed:***

To ensure that the machine structure is rigid and the material selected for the frame work is of high fatigue and has high strength the Ansys analysis for the frame work was done considering all the loads and weights acting on the frame work. All the vibrations which would be damped the bed were also taken into considerations. The results obtained for the same are as shown in the figure below. Maximum deformation would take place at the sections which will act as overhanging beams having no ground support. The maximum deformation caused due to loading and the component weights is $1.8 \times 10^{-3}$ mm.




***C] Time Study:***

Time required for completion of one machining cycle was animated and analysed on Solid-works software. The input data given was the speed of the stepper motor on which the cutting tool mounted on motor would rotate, also the pneumatic cylinder actuation time was also included. Feed was also given according to the lead, pitch and number of start of the lead screw. The automatic work-piece feed rate is also considered in the cycle timing. The total time to complete one machining cycle observed and analysed is as mentioned.




***D] Comparision of Old and New System:***

Time required for machining on lathe machine= 40sec
Time required for machining on Double Head Chamfer Machine= 2+2+3+3 = 10 sec
Work piece feed time= 2sec
Pneumatic Gripper Clamping= 2sec
Cutter feed and cutting= 3sec
Cutter retraction and pneumatic gripper retraction= 3sec
Time saved in machining= 40-10= 30sec
This concludes that the production rate can increase 4 times using this new and improved machine.

## VI. CONCLUSION

The conceptual design of double head chamfer machine is prepared or designed in solidwors software and analyzies in ansys software.

This project can conclude that the operations permorming on this machime will overcome the disadvantage of conventional machine and will provide us high rate manufacturing with less time consumption and less consumption of manpower.

## VII. FUTURE SCOPE

1] The chamfering machine can be redesigned as per there requirements of an industrial component also it can be redesigned for different operation with changing the tool.

2] With the help of job feeding mechanisms, job carryout mechanisms & different sensors, the machine can be effectively used in any kind of chamfering operation on all different sized jobs.

3] Automating the entire manufacturing line in the industry.

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