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Design and Manufacturing of industrial pipe chamfering machine

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ABSTRACT

Generally, for welding operations in maintenance and manufacturing we use chamfering machines but still we are using manually operated chamfering machines and for every operation we have to do all the setups by human interference. This manual interference is more time consuming and have more chances of physical injuries to the human working nearby to it. The main aim of this paper to study all the possible solutions for converting manual operated chamfering machines to automated chamfering machine, increase productivity of them and reduces human interference while operating of the machines. In this paper various previously used method of operation of chamfering machine are discussed. Analysis has is done considering various previously used techniques and find out one new method that will helpful for the operation of chamfering machine by using hydraulic systems. In this project we are going to manufacture the portable chamfering machine which can go in variable pipe diameter, the project will consist of mainly two parts, first part is the mounting of machine which will be spring loaded and should be able to set itself in variable pipe diameter and second part is mounting and developing the rotating mechanism for surface grinder so that chambering in various angle should be possible. The machine is mathematically designed for a safe design and CAD model is develop for or easy in manufacturing.

Keywords: Grinder, Enhancement of chamfering machine, Accuracy in chamfering, Reduced time.

INTRODUCTION

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 pipes. 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 pipe welding is required to be chamfered using different machines. This operation for mass production consumes time and labour of the industry. To reduce the time consumption and energy consumption of worker we have designed and developed round pipe chamfer machine.

DESIGN APPROACH

The setup of our project consists of a frame on which the chamfering tool is fixed at one end and other parts are mounted. The frame having lead crew and adjustable arm arrangement for better fitment in the work piece according to the size of pipe. The frame having chamfering tool at one side is freely rotate about the circumference of the work piece which chamfering has to be done.

Following are the main parts of the project:

- Frame
- Chamfering Tool
- Lead Screw
- Movable Arm
- Sleeve
- Compression Spring

1] Frame

Frame 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.

Fig.1 Bed

2] Chamfering Tool

Here we are using Hand Grinder as a chamfering tool, The Hand Grinder is adjustable. It can be adjusted according work piece diameter by moving it to upward and downward on the rod which supported by frame. Hand grinder is move over the circumference of the work piece to be chamfered. It also having an adjustment to set angle according to the chamfer requirement.

Fig.2 Hand Grinder

3] Lead Screw

Lead screw is the main part of the frame having other supporting parts. The basic concept of working of the lead screw is same as the working in lathe machines.
The lead screw is designed in such a way that it carries both right hand and left hand Sleeves & arms on it. This enables the left and right side movement of both the arms.

4] Movable Arm

Here the Arm is used as a 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.

Fig.3 Movable Arm

5] Sleeve

Here sleeve is used to lock the arms in the work piece or support to arm mechanism.

Fig.4 Sleeve

6] Compression Spring

Here the spring is mounted on the lead screw between the sleeves to apply pressure on the arm to provide support for work piece.

Fig.5 Spring

DESIGN CALCULATIONS

1. Design of robot shaft

Let the load of grinder and assembly coming on shaft be 10 kg
Length of robot shaft is 4 ft. = 1220mm

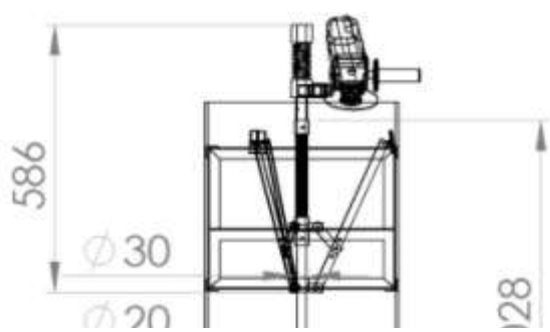

Fig.6 cantilever distance of shaft from load

M= W X L
The shaft diameter = 20 mm
M = 98 x 586 = 57428 N-mm

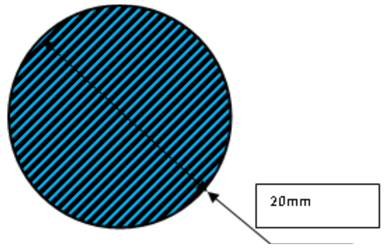

Fig.7 Shaft

$Z = \pi/32 \times d^3$
$Z = \pi/32 \times 20^3$
$Z = 785\ mm^3$
σ_b (induced)= M/Z = 57428/785 = 73.15 N/mm²
As induced bending stress is less then allowable bending stress i.e. 270 N/mm^2 design is safe.

2. Force generated by spring for gripping pipe

Fig.8 Compression spring

The spring is used to expand three legs of robot to grip the inner surface of pipe in up word direction. From trial-and-error method we select spring with inner diameter 20 mm due to size restriction of shaft.
Di = 20 mm
For average service life 42 N/mm².
Wire diameter is d 4 mm
D mean diameter = 22
Outer diameter of spring = Di + (4)
Do = 24 mm.
Calculating the load bearing capacity of spring
Spring index = C = D/d = 22/4= 5.5
C = 5.5
K = [4C – 1 / 4C-4] - 0.615 / C = (21/18) - 0.615
= 0.51/5.5 = 0.100
For C = 5.5 K= 0.100
Now to find 'P',
We know
8 K P Do

Shear stress = -------------
$3.14\ d^3$

$$P = \frac{42 \times 3.14 \times 4^3}{8 \times 0.1 \times 24}$$

P = 8444.6/ 19.2

P = 439.8 N

P = 44.8 kg

We know, the weight applied by spring is 44.8 kg = 439 N

Formulae of equilibrium

F1 x L1 = F2 x L2

F1 x 345 = 439 x 95

F1 = 41705/345 = 120 N = 12.3

We are using three arms so load applied by spring on each arm will be **4.1 kg = 40.29 N**

3. Design arm, which may fail under bending

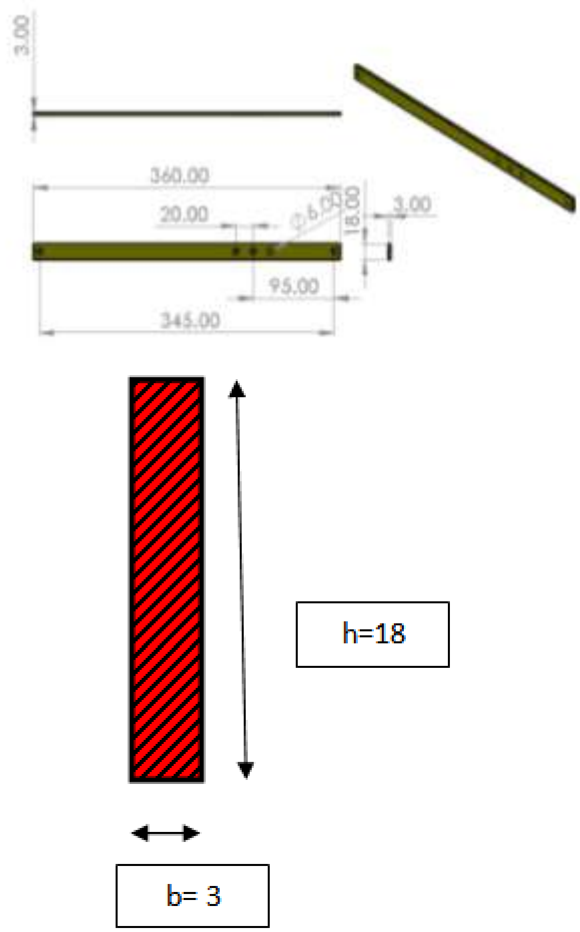

Fig.9Arm

This link may fail under bending

t = thickness of arm in mm.

Fb = 270 N/mm^2

B = width of arm in mm = 3 mm

Load is acting like a cantilever

W = maximum force applied by spring = 40.29 N

M = W x L
M = 40.29 x 345 = 13900 N-mm
And section modulus = Z = 1/6 bh^2
Z = 1/6 x $3x18^2$
Z = 1/6 x 972
Z = 162 mm^3.
Now using the relation,
Fb = M / Z
Fb= 13900/ 162 = 85.80 N/mm^2
Induced stress is less then allowable (270 N/mm^2) so design is safe

4. Design of bolt: -

Bolt is to be fastened tightly also it will take load due to rotation. Stress for C-45 steel ft =420 kg/cm^2. Std nominal diameter of bolt is 4 mm. From table in design data book, diameter corresponding to M6 bolt is 5 mm

Fig.10Bolt

Let us check the strength:-
Also initial tension in the bolt when belt is fully tightened.
P = 18.4 N is the value of force
P = 18.4 N
Also, P = Π /4 dc^2x σ

$$\sigma = \frac{18.4 \times 4}{3.14 \times (4)^2} = 73.6/50.2 = 1.46\ N / mm^2$$

The calculated σ is less than the $\sigma_{tensile}$ and σ_{shear} hence our design is safe.

5. Let the total weight (P) of our machine be 40 kg, now this 40 kg weight is kept on four angle, so it may fail under bending.

P = 40 kg.
P = 40 x 9.8 = 392 N.
L = 510 mm.
M = WL/4 = 392 × 510/4
= 199920 N-mm
Z= $B^3/6 – b^4/(6 \times B)$
Z= $25^3/6-22^4/(6\times25)$
Z= 1042 mm^3
= M/Z = 199920/1042 = 191.86 N/mm^2

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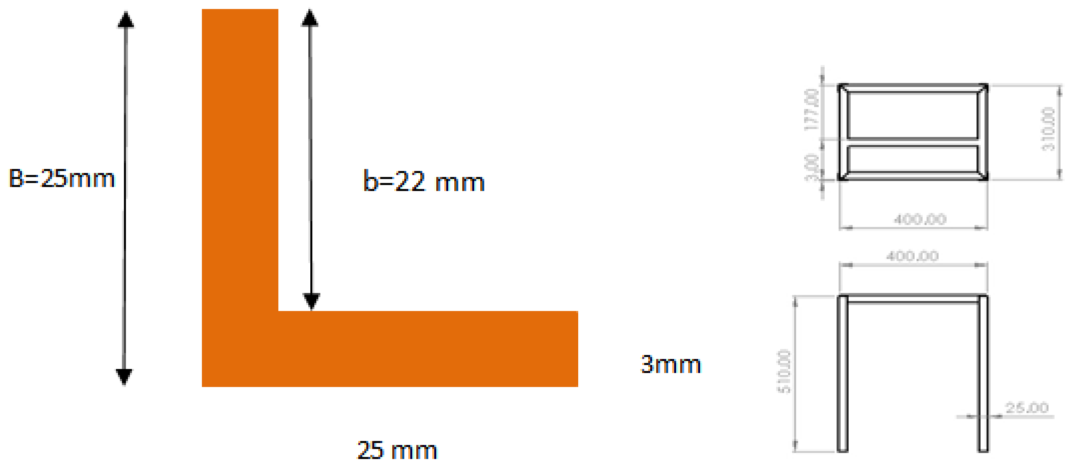

Fig.11Bed

As induced bending stress is less then allowable, bending stress design is safe.

ASSEMBLED MACHINE

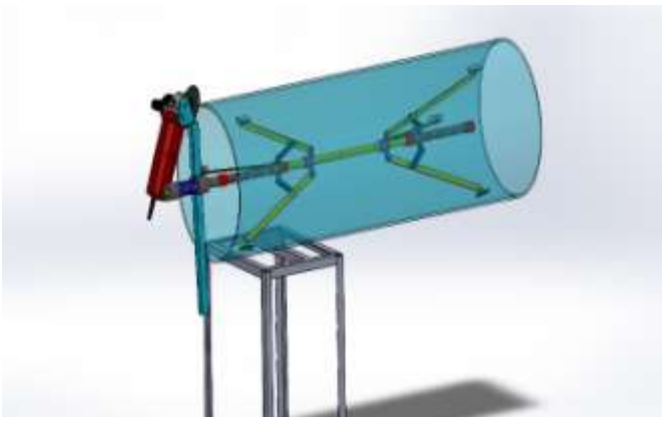

Fig.12 Pipe Chamfering Machine

RESULTS

The Machine Was found to be as per the design criteria. The Portable form factor of machine enables to use for different sizes of pipes and to save time of shifting the heavy pipes to workshop.

Sr. No	Parameter	Manual Chamfering	Chamfering machine
01	Time required for chamfering of 400mm dia. Pipe.	60 mins	20 mins
02	Manpower 1.For setting 2.For operation	 1 Operator 3 Operators	 2 Operators 1 Operator
03	Chamfering Accuracy	Less / Non-uniform chamfer is formed.	More / Uniform chamfer is formed.
04	Operational Safety	Less safety	More safety
05	Productivity	Less	More

CONCLUSION

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

1. Time required for chamfering is reduced as compare to manual chamfering.
2. Chamfering of no of pipes is done by using less manpower as compare to manual chamfering.
3. Good chamfering accuracy is achieved.
4. Operational safety is more than manual chamfering.
5. Chamfering operation is done smoothly by using chamfering machine.

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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