Research Paper on Design and Manufacturing of Bevelling Machine for Steel Pipe

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Abstract- In general, we utilise chamfering machines for welding operations in maintenance and manufacture, but we still use manually controlled chamfering machines, and we have to do all of the setups by hand for each operation. This manual interference takes longer and poses a greater risk of bodily injury to others who work nearby. The major goal of this work is to investigate all viable alternatives for converting manual chamfering machines to automated chamfering machines, in order to boost productivity and eliminate human involvement during machine operation. Various previously used chamfering machine operation methods are covered in this paper. The analysis took into account a variety of previously utilised strategies in order to identify one new strategy that will aid in the functioning of chamfering machines that employ hydraulic systems. We will make a portable chamfering machine that can go in various pipe diameters in this project. The project will be divided into two parts: the first is the mounting of the machine, which will be spring loaded and should be able to set itself in various pipe diameters, and the second part is the mounting and development of the rotating mechanism for the surface grinder so that chambering in various angles will be possible. The machine is mathematically constructed for a safe design, and a CAD model is created to make manufacture easier.

Keywords- Pipe, Chamfering, Portable, Productivity, Beveling.

I. INTRODUCTION

In this era of automation, where it is broadly defined as the substitution of manual effort by mechanical power in all manufacturing applications, industrialization is heading towards automation. Chamfering is one of the most important procedures in the pipe production process. There are numerous small and medium-sized businesses in the manufacturing industry that perform this service according to the needs of the customer. Many industrial applications necessitate the chamfering of round pipe welding utilising various techniques. The industry's time and manpower are consumed by this mass production process. We invented and developed a round pipe chamfer machine to reduce the amount of time and energy spent by workers.

2.OBJECTIVE

The following points should be addressed as much as possible while working on the project:

• Design a mechanism to rotate the cutting Tool / Grinder in circular path

• Design a mechanism to the fix the center of Grinde / tool arm exactly at pipe center

• To design a mechanism to vary the tool angle and tool position for a various angular chamfering requirement

• Design a spring to absorb vibration due to cutting forces

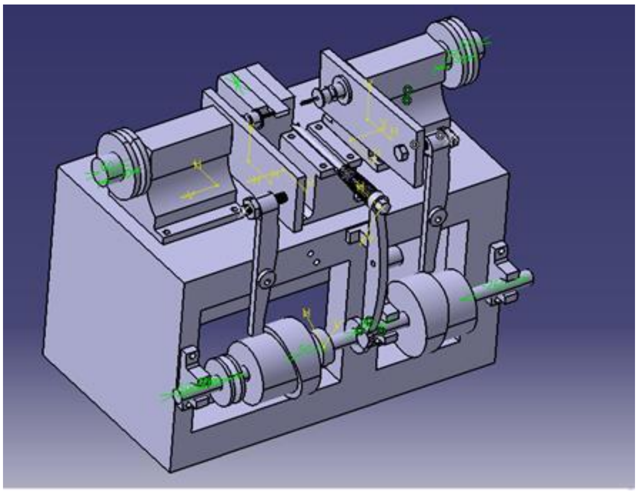
3. LITERATURE REVIEW

All Manufacturing in today's world is a demanding environment where process improvement is a constant requirement. There are fewer tasks that require a human to do as automation advances. Because the workforce is highly competent, automating routine operations frees up talented workers to concentrate on more difficult tasks. Grinding a chamfer onto each leading edge of various diameter pipe is one of these tasks. This project's goal was to develop an automated chamfer grinding system. A whole semester was spent planning and designing the system to achieve optimum design possibilities. This has continued into the current semester, with a variety of approaches being employed, the most prominent of which is 3D computer-aided design using

Solidworks. When a design is finished, it can be printed, After receiving company permission, the construction procedure will commence. Component testing will be place concurrently with assembly to ensure that the chosen components will work as expected. By the end of the semester, Company will have a finalised device that they can use in their daily operations.

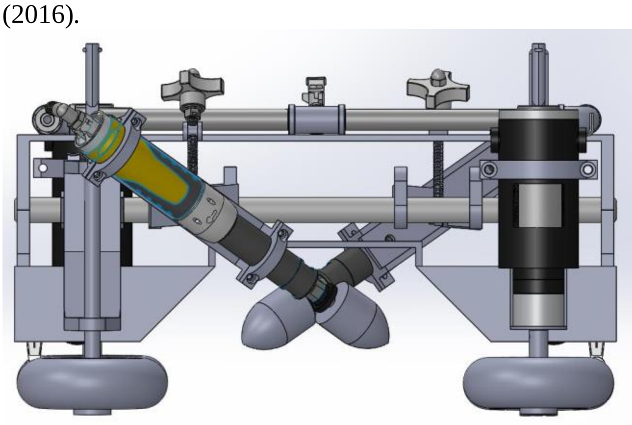
3.1 AUTHORS AND THEIR WORK

Sangram Kotkar1, Dr.R.J.Patil2, Dr.D.Y.Patil Institute of Engineering and Technology Ambi. International Journal of Engineering Research & Technology (IJERT) 2014 Review on Chamfering Machine Operations



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. The amount of the vertical force that we are applying must be greater than the amount of cutting force as we are using this force to holding the gear plates. Here we need to design hydraulic system and its components and will fixed so that we get required force in vertically downward direction.

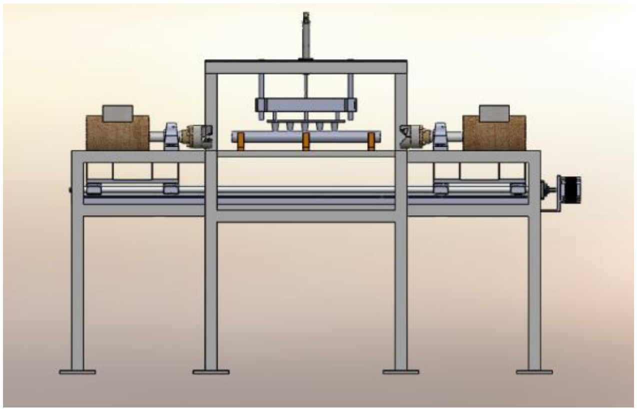
William E. Johnson 2017 by TopSCHOLAR Johnson, William, "Designing and Building an Automatic Chamfer Grinder" (2016).



A main goal of this system was for it to be extremely simple to use. Ignoring all the negative reasons to have an operator perform a grinding operation, it does not get any simpler than having them perform the task. Since this device is being made to take the place of the operator, it must be easy to implement or else it will not get used. If they have to spend ten or fifteen minutes setting the device up and getting it ready to use, then they will eventually relegate it to the trash bin and just go back to doing it by hand. For this reason, every design decision was made in line with making an intuitively easy system operation.

Xian-Li Liu1, Jin-Kui Shi1, Wei Ji1,2* and Li-Hui Wang2, Chinese Journal of Mechanical Engineering 2018 Experimental Evaluation on Grinding Texture on Flank Face in Chamfer Milling of Stainless Steel (1) A set of cutting tools with five angles of texture angle, i.e., 0°, 15°, 30°, 45° and 60°, are modelled, simulated, machined and tested accordingly to evaluate the grinding texture on flank face. Cutting force, surface quality and surface roughness are observed. The cutting force is decreased with texture angle increasing from 0° to 45°, and then is increased. The lowest cutting force is achieved at 45° grinding texture angle. The burn and the coarse texture are the main defect patterns in chamfer milling of stainless steels. The best surface quality is achieved at 45° grinding texture. Surface roughness Sa is decreased with texture angle increasing from 0° to 45°, and then is increased. It is obvious that the best state of surface roughness is archived by the tool with 45° grinding texture. Combining the results of cutting force, surface quality, and surface roughness, it is obvious that the best machining state is obtained at 45° texture angle, i.e. the lowest cutting force, the best surface form, and the lowest surface roughness.

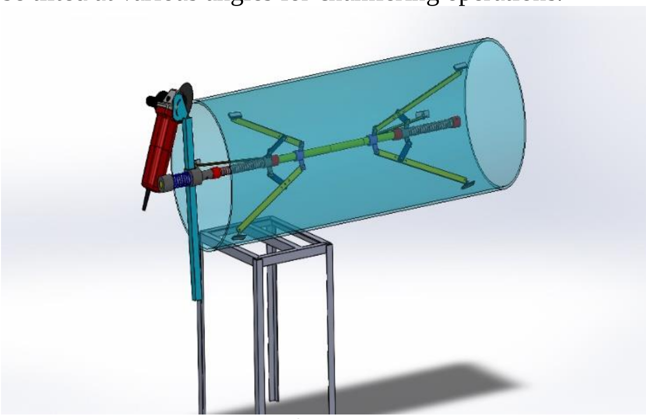
Yash D. Shah1Tusharkumar Raut2International Journal of Engineering Research & Technology (IJERT) 2021 Double Head Chamfer Machine Design & Development of Double Head Chamfer Machine



The conceptual design of double head chamfer machine is prepared or designed in Solidworks software and analysis in Ansys software. 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.

3. METHODOLOGY

The machine we're building will work with pipes with diameters ranging from 300mm to 600mm, and the diameter of the pipe may be expanded by adding further attachments to the machine's link legs. The centre shaft of the machine is the most important component, and we have provided adjustable mechanism for adjusting the force being apllied by tool cutting blade over the pipe. We can also adjust the angle of grinding tool for obtaining required angle. The legs are loaded with a compression spring which exerts pressure on legs and the machine's leg will extend and apply pressure inside the pipe, causing the machine to become fixed inside the pipe. When the machine is rigidly secured inside the pipe, another mechanism is built on the handle side, on which the grinder can be mounted. The force will be applied by a pring mechanism on the surface grinder, which can be tilted at various angles for chamfering operations.



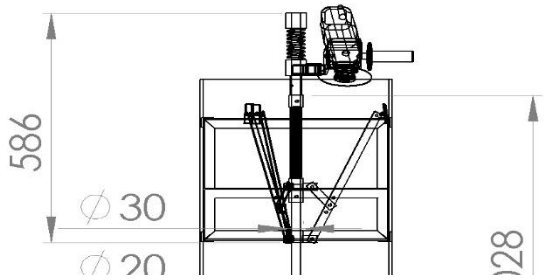
Pipe Chamfering Schematic dia.

The operator simply lifts the machine by hand and places it inside the pipe. After placing the machine inside the pipe, the operator rotates the handle and the machine is rigidly fitted inside pipe. After fitting the machine, spring pressure is applied to the grinder wheel, and grinding can begin once the pipe surface is uniformly smooth. The grinder will be tilted at various angles to allow for chamfering at various angles. Once the chamfering is complete, the operator will remove the main shaft and the entire assembly from the pipe, with welding done on the pipe edges.

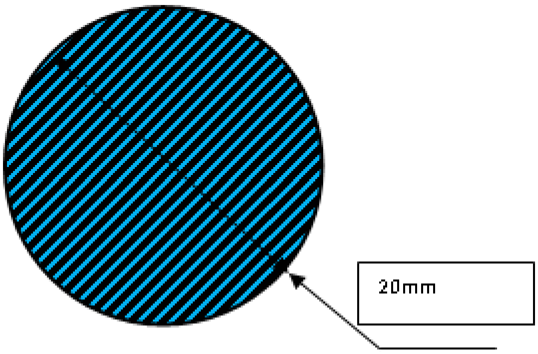
CALCULATION

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



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



$Z= \pi/32 \times d^3$
$Z= \pi/32 \times 20^3$

$Z= 785\ mm^3$

σ_b (induced)= M/Z = 57428/785 = 73.15 N/mm^2

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

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/mm^2.
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

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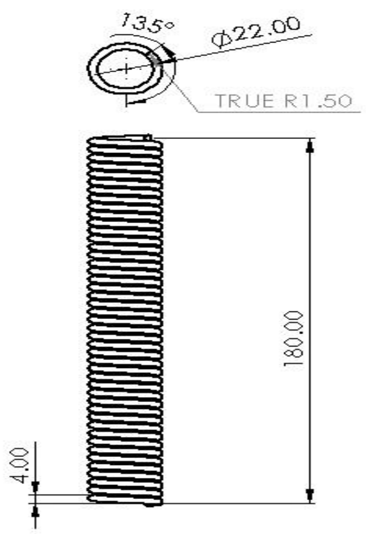
Now to find 'P',
We know

$$\text{Shear strees} = \frac{8\,K\,P\,Do}{3.14\,d^3}$$

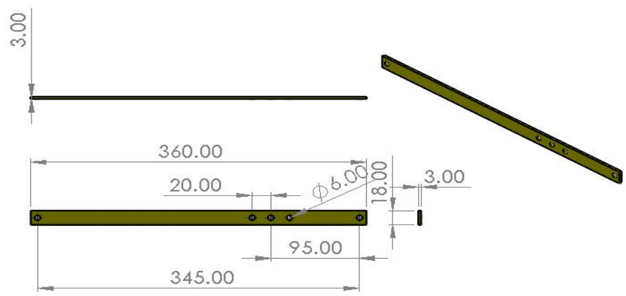
$$P = \frac{42 \times 3.14 \times 4^3}{8 \times 0.1 \times 24}$$

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



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

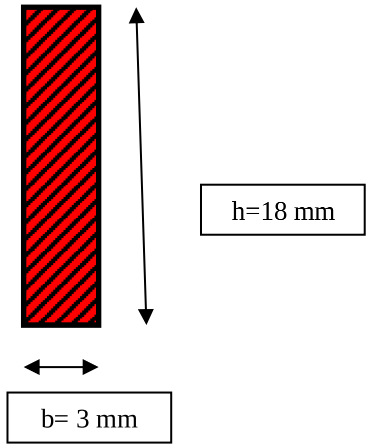
4. Design of bolt: -

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
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^{2}x σ

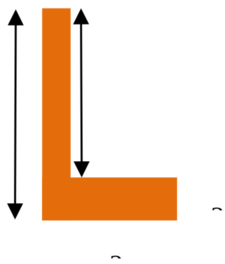
$$\sigma = \frac{18.4 \times 4}{3.14 \times (4)^2} = 73.6/50.2 = 1.46\ \text{N / mm}^2$$

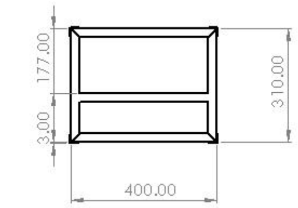
The calculated σ is less than the $\sigma_{tensile}$ and σ_{shear} hence our design is safe.

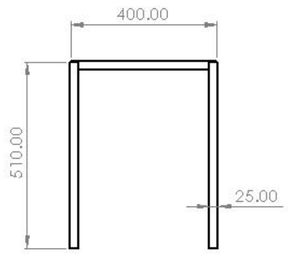


5. Let the total weight (P) of our machine be 40 kg, now this 40 kg weight is kept on four angle, so it may fail under bending.

P = 40 kg.
P = 40 x 9.8 = 392 N.
L = 510 mm.
M = WL/4 = 392 × 510/4
= 199920 N-mm







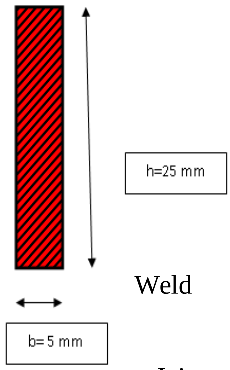
$Z = B^3/6 - b^4/(6 \times B)$
$Z = 25^3/6 - 22^4/(6 \times 25)$
$Z = 1042\ mm^3$

$= M/Z = 199920/1042 = 191.86\ N/mm^2$

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

6. Design of transverse fillet welded joint.

Hence, selecting weld rod size = 3.2 mm



Area of Weld = 0.707 x Weld Size x L

= 0.707 x 3.2 x 25
= $56.56\ mm^2$

Force exerted = ---N

Stress induced = Force Exerted / Area of Weld

21 = F / 56.56

F= 1187.76 N = 121.07 kg

Maximum Allowable Stress for Welded Joints = $21\ N/mm^2$

4. RESULT AND DISCUSSION

The machine was determined to meet the design specifications. The machine's portable form factor allows it to be used for a variety of pipe diameters while also saving time in transporting heavy pipes to the workshop. A few of the applications, as well as their future potential, are detailed below.

4.1 Applicattions

The application of machine is to grind the pipe properly and make the surface uniformly flat around the circumference. Second application is to make the chamfering operation manual free for eliminating all the error. The application of machine will be at various work site like HVAC chilled water piping, firefighting system, industrial pipe line underground water pipe line, dam construction line, Gas supply line and pipe manufacturing industries.

4.2 Scope

- 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.
- 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.
- Automating the entire manufacturing line in the industry.

5. CONCLUSION

Solidworks software is used to prepare or design the conceptual design of the double head chamfer machine, as well as to analyse it. This project concludes that the activities performed on this machine will overcome the disadvantages of traditional machines, allowing us to produce high-volume products in less time and with fewer people. Following the conclusion of the document, it was determined that the machine would be manufactured for various pipe diameters and could be successfully employed in a variety of construction site mending and pipe manufacturing businesses.

6. REFERENCES

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