

Design and Fabrication of Automated Chiselling Machine

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Abstract: Nowadays world is focusing into automation in industrial field each and every work of human is reduced by machine. Machining is term use to describe a variety of material removal processes in which cutting tool removes unwanted material from a work piece to produce a desired shape. The objective of this project is to make Rough surface on Trestle box which will enables it to grip the jaws of Hydraulic jack to lift the heavy metallic sheets for making an storage tank with very less involvement of worker. So this project is aim to remove material from Trestle boxby different machining processes in order to reduce human fatigue, with increased quality of product.

Keywords: Trestle box, Hydraulic jack, Storage tank.

I. Introduction

Storage tanks are containers that hold liquid, compressed gases (gas tank) or medium used for the short-or long-term storage of heat or cold. Metallic sheets are used to make such a storage tank. These tanks can have different sizes, ranging from 2 to 60m diameter or more. These tanks are made of heavy metallic sheets, each sheet has a weight of about 12 tone. For formation of storage tank, metal sheets are lifted to a required height with the help of hydraulic jacks and then it is welded.

Finding suitability for use on different tank types like cryogenic tanks that are used for storing propane/ammonia ,gasholder tanks for holding material in gaseous form of or storage tanks with different roof types, these synchronized jack provides for optimum functionality support in given processes. We can offer these jacks with single lifting capacities of 8 tons, 12 tons, 25 tons and others. Further these are developed as standard jacking equipment and can be use with minimum shell plate width of 1400mm. some of these advantages include suitable for handling small to large diameter tanks, finding use in erecting/building storage tanks, use for enhancing capacity and others.

Trestle box section is mild steel bar with hardness 24HRC consist of three sections that is upper square bar of dimensions $36 \times 36 \times 4000 \text{ mm}^3$, middle plate of dimension $10 \times 50 \times 4000\text{mm}^3$.lower square bar of dimension $100 \times 100 \times 4000\text{mm}^3$.these three sections are welded with the help of fillet weld.

II. Literature Review

Diamond Micro Chiseling of large-scale retroreflective arrays. Ekkard Brinksmeier, Ralf Gläbe, Lars Schönemann. Year 2012^[1]. From various cutting experiments and surface characterization, electroless nickel, nickel silver N37 and UFG aluminum were identified as suitable materials for machining optical microstructures on a small scale. However, when machining larger patterns on mold inserts, the choice of materials is limited to N37 as the machining exhibits negligible tool wear. Thus, nickel silver N37 was used for Diamond Micro Chiseling of two $10 \text{ mm} \times 10 \text{ mm}$ retroreflective arrays which were replicated into plastic optics and then measured for optical functionality.

Effects of the chisel edge on the chatter frequency in drilling. D.N. Dilleya,1, P.V. Baylya , A.J. Schautb. Year 2004^[2].The fixed–pinned model closely matches the experimental data; however this model does not allow the tip to move, which is shown to move duringcutting. Therefore, an analytical fixed–embedded model that closely matches the frequencies found by experimental modal analysis is determined by using an appropriate spring coefficient.

Sawing, Chisels and Files. Tony Atkins. Year 2009^[3]. A saw consists of a series of narrow single cutting edges (teeth), arranged either along a straight edge (reciprocating hand saw or continuous band saw) or around the circumference of a disc (circular saw). Specialist saws include hole (trepanning) saws where the teeth are arranged around the end of a tube; the corresponding “hole knife” is the cork borer, apple corer, or hollow cheese sampler. The cutting edges of saw teeth are perpendicular or oblique to the direction of motion of the saw and this distinguishes saws from knives. In plan view, saw teeth are bent (set) sideways alternately to right and left, and therefore cut a path slightly wider than the thickness of the blade. This reduces contact between blade and workpiece, hence reducing friction, heat generation, possible overheating, and damage of the blade. A chisel is a type of knife but unlike a hand-held knife where “sawing” often occurs, the principal motion is perpendicular to the cutting edge. Bolsters are chisels splayed out at the edge for cutting bricks. Different materials respond differently to chisels: a large piece of timber can be split down the grain by a blow from a

chisel but it is impossible to split a block of metal by hand with a cold chisel owing to the much higher toughness of metals and the fact that the deformation is in the ductile range

Chisel-Edge Modification of Small HSS and Carbide Drills for Improved Machine ability. A. Bhattacharyya, A.B. Chattopadhyay, R. Roy. Year 1981^[4]. Drills, specially small drills, are characterized by relatively High thrust force due to large negative rake and negligible small cutting speed at the chisel edge which, again is quite sizable compared to the drill size in case of small drills. Such large thrust force causes deformation of Work-Tool-Machine-Fixture system, Vibration and rapid wear leading to inaccuracy, poor surface finish and reduced tool life. The authors of the present paper attempted to reduce thrust by developing suitable technique of modifying the chisel edge of small drills of both HSS and carbide types. The results reported here indicate significant Improvement.

A novel technique for driveline assembly applications. David k. Harrison & anjali k. M. De silva. Year 2011^[5]. A novel technique for drive train assembly. Mill-Knurling and Press-Fitting (MKPF) is projected as a substitute to laser welding or bolting. This joining practice involves the press fitting of two mating surfaces, one with mill knurled Teeth and the other which is of a comparatively softer material, enabling it to stream over the teeth mating a joint. This process has been applied within an automobile rear axle differential which is subjected to random torque loads. Experimental analysis and simulation has been used to evaluate the serviceable viability and the latent benefits of mill knurled joints with both laser welded and bolted joints currently used by BMW.

Vibration Studies of Dynamically Loaded Deep Groove Ball Bearings in Presence of Local Defects on Races. V. N. Patel, N. Tandon, R. K. Pandey. Year 2013^[6]. Theoretical and experimental vibration studies of dynamically loaded deep groove ball bearings having local circular shape defects on either race are reported in this paper. The shaft, housing, raceways and ball masses are incorporated in the proposed mathematical model. Coupled solutions of governing equations of motion have been achieved using Runge-Kutta method. The model provides the vibrations response for the shaft, balls, and housing in time and frequency domains. A dynamic model for vibration study of deep groove ball bearings having local defects on either race is presented in this paper considering dynamic loading. The vibration amplitudes (velocities) and frequencies are numerically computed by solving the coupled governing equations of motion. A dynamic model for vibration study of deep groove ball bearings having local defects on either race is presented in this paper considering dynamic loading. The vibration amplitudes (velocities) and frequencies are numerically computed by solving the coupled governing equations of motion. In case of defective inner race, characteristic defective frequency along with the side bands at shaft rotation frequency is noticed.

A review on effect of various parameters on cutting tool in orthogonal metal cutting process. Sandeep B. Survase P. D. Darade, Ganesh K. Lamdhade. Awadhesh Pal et al^[7]. experimentally investigated the effect of work piece hardness and cutting parameters on the different responses which was analyzed by performing analysis of variance (ANOVA) technique. The AISI 4340 steel used as a material and TiC mixed alumina ceramic tool used for soft and hard turning. From the experiment they observed that all the components of cutting forces increases with the increase in depth of cut and the magnitude of the cutting forces increases with the increase in work piece hardness. The results also show that surface roughness decreases with increase in hardness level of work piece and average value of the chip-tool interface temperature increases with increase in cutting speed.

Dry turning of AISI 304 austenitic stainless steel using AlTiCrN coated insert produced by HPPMS technique. Atul P. Kulkarni, Girish G. Joshi, Vikas G. Sargade, , Procedia Engineering, 64, 2013^[8]. experimentally investigated the effects of machining parameters on the surface finish, cutting force, tool wear, chip thickness and tool life. The AISI 304 austenitic stainless steel used as a work piece and AlTiCrN coated insert produced by High Power Pulsed Magnetron Sputtering (HPPMS) used for dry turning. The experiment was carried out at different cutting speed and feed with constant depth of cut. The results show that the surface roughness value increases with increase in feed and low at the high cutting speed. The flank wear was prominently affected by cutting speed and feed.

III. Methodologies Used

1. Manual chiseling

A chisel is a tool with a characteristically shaped cutting edge (such that wood chisels have lent part of their name to particular grind) of blade on its end, for carving or cutting a hard material such as wood, stone or metal by hand, struck with mallet, or mechanical power. Chiseling is a process of removing material from a work piece.

In this process rough surface on Trestle box section is made chiseling process which is done manually. The cold chisel is a hand cutting tool used by fitters for chipping and cutting off operations. Chipping is an operation of removing excess metal with the help of a chisel and hammer. Chipped surfaces being rough, they should be finished by filing. Currently chiseling is done on trestle box manually

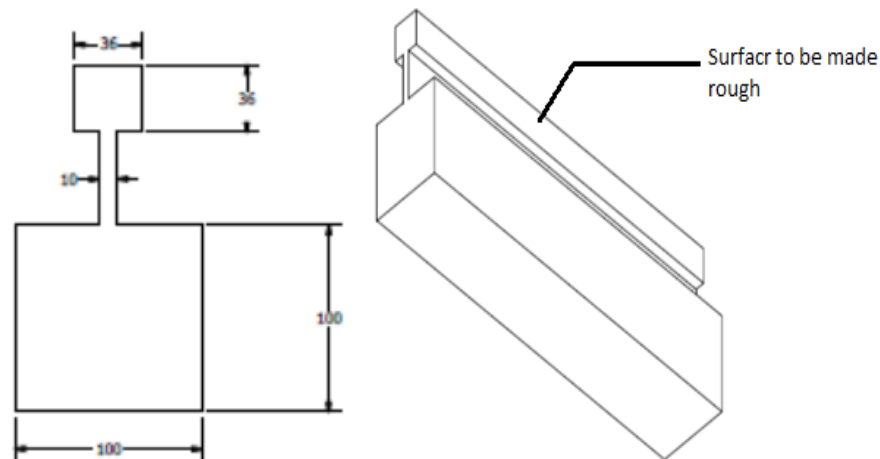


Figure shows Trestle box section

The following problems raised while manual chiseling

1. Operator fatigue
2. Spacing between two consecutive marks
3. Quality
4. Time Constraint
5. Unwanted noise

2. By Knurling process:

Knurling is another method is use to make an impression on Trestle box section. Knurling is a manufacturing process, typically conducted on lathe, whereby pattern of straight, angled or crossed lines is cut or rolled into the material. The knurling is a process of embossing (impressing) a diamond-shaped or straight line pattern into the surface of work piece. Knurling is essentially a roughening of the surface and is done to provide a better gripping surface.

Knurling tool mechanism:

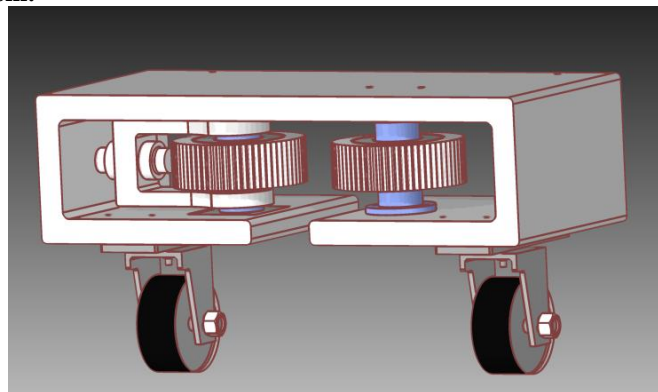


Fig. inventor drawing of knurling tool mechanism

Working principle: A rotating knurling tool exerts a large radial force on the Trestle box (Trestle Beam) and the required marks are produced. The removal of metal in knurling operation is by shearing and compression.

Construction and working: The machine consists of two knurling wheels mounted on the shaft (axle) with the help of bearing in interference fit. Out of these shafts one is fixed and welded to the support plate and another is movable with the help of threaded bolt. To move this whole mechanism the hydraulic jack is used. Handle and support wheels are used to move the machine from one work piece to another work piece.

- Trestle box is placed on the ground.
- Knurling machine is move towards the Trestle box with the help of handle and it is mounted on Trestle box.
- Distance between two knurling wheels is adjusted with the help bolt.
- This whole assembly is moved by hydraulic jack.

- Both the knurling wheels are rotated in opposite direction along with the Trestle box. In this way required impressions are produced on the Trestle box.

Advantages of knurling machine are as following:

1. Knurling machine is compact in size.
2. While operating, job is fixed and machine is movable.
3. Weight of machine is less, so it can be easily transport from one place to other place.
4. For operating the machine only one worker is required.

Cost by manual chiselling process:

- Time required to complete the whole operation on both sides of trestle box is 30 minutes.
- Two men are required to complete the operation at a time. Therefore time required for chisel one bar 60 minutes.
- There are 300 trestle boxes to be chiseled per month. Therefore, time required for complete this batch production is 18000 minutes that is equal to 300 hours.
- A labor can work 8 hours per day and costs Rs. 350 per day. Therefore, 300 hours is equal to Rs.13125 per month.

Cost by knurling machine:

- Knurling machine does the same work in 4 days, therefore operator cost is Rs.1400
- Cost of power required for operation of hydraulic jack is Rs.900
- Therefore, total cost to chisel 300 trestle bars is Rs.2300 per month.

IV. Design And Calculation

1) Design parameter of Knurling Wheel:

Notations to be use are as follows,

D_w = Theoretical work blank diameter

N_w = Number of teeth on work

P = Circular Pitch = 5.2mm = $\frac{13}{64}$ inch

TPI = number of theet per inch measured on cicumference of blank diameter

- **Number of teeth per inch (TPI):**

$$TPI = \frac{1}{Pitch}$$

$$TPI = \frac{64}{13} = 4.923 \text{ per inch}$$

Therefore number teeth per inch=4.923

- **Number of teeth on work (N_w) :**

$$N_w = \frac{3.1416 \times D_w}{Pitch}$$

$$N_w = \frac{3.1416 \times 105}{5.2} = 63.44$$

Take number of teeth on Blank work are 64

- **Module of knurling wheel (m):**

$$\text{Module} = \frac{\text{diameter of knurling wheel}}{\text{number of teeth on knurling wheel}}$$

$$m = \frac{105}{64}$$

$$m = 1.64 \text{ mm}$$

2) Force required for rotating knurling tool:

The torque required to removed material from bar is given by,

Torque = $F \times D$

Where,

F =Impact force of Hammer

D =Distance of Hammer from Beam

D = 1000mm (Approximately)

Mass of hammer, m =6 kg

Distance between I-beam surface to the head of the hammer, h =1m

Travelling time of hammer, t =0.5 sec.

Force of impact, F =?

Notations used:

- V= velocity of hammer
- g= acceleration due to gravity

$$V = \sqrt{2gh}$$

$$= \sqrt{2 * 9.81 * 1}$$

$$= 4.43 \text{ m/s}$$

Change in momentum=mass*velocity
 =6*4.43
 =26.58 N-sec

Change in momentum = Impulse
 Impulse = F*t=26.58
 F= (26.58)/t
 = (26.58)/0.5
 = 52.16 N

Therefore,
 Torque = 52.16 × 1000
 Torque = 52160 N-mm
 Taking more torque
Torque = 60000N-mm

This is also equal to the torque required to Rotate Knurling tool
 Therefore

Torque = Force required to rotate Knurling tool × Radius of Knurling tool
 60000 = Force required to rotate Knurling tool × $\frac{105}{2}$

Force required to rotate Knurling tool (P) = 1142.85 N

3) Design of support plate bolt;

Select material C45 for bolt from PSG 1.9.

Designation	%C	%Mn	Ultimate Tensile strength (N/mm ²)	Yield strength (N/mm ²)	Brinell hardness (HB)
C45	0.4-0.5	0.6-0.9	630-710	360	229

Take, Ultimate Tensile strength (S_{ut}) = 650 N/mm²

Factor of safety (F.O.S.) = 5;

$$\text{Shear stress } (\tau) = \frac{0.5 \times S_{ut}}{F.O.S.}$$

$$\text{Shear stress } (\tau) = \frac{0.5 \times 650}{5} = 65 \text{ N/mm}^2;$$

$$\text{Tensile strength } \sigma_t = \frac{S_{ut}}{F.O.S} = \frac{650}{5} = 130 \text{ N/mm}^2;$$

▪ **Finding bolt diameter in shearing**

Force (P) = $\tau \times A$;

P=1500N;

$$1500 = 65 \times 2 \times \frac{\pi}{4} \times d^2$$

d= 3.833mm

Select standard diameter (d) = 5mm.

4) Selection of Bearing;

Selection of bearing from PSG page no. 4.13

ISI NO.	DESIGN NO.	d(mm)	D(mm)	B(mm)	Static capacity C ₀ (kgf)	Dynamic capacity C(kgf)	Maximum RPM
35BC02	SKF6207	35	72	17	1370	2000	10000

$$L_{mr} = \frac{L_{hr} \times N \times 60}{10^6};$$

$$L_{mr} = \frac{43200 \times 6 \times 60}{10^6};$$

L_{mr} = 15.552 mrev.

5) Design of shaft:

▪ **Failure of shaft in bending:**

Moment = force × perpendicular distance
 = 1500×38
 = 57000 N-mm

Select material C45 for bolt from PSG 1.9.

Designation	%C	%Mn	Ultimate Tensile strength (N/mm ²)	Yield strength (N/mm ²)	Brinell hardness (HB)
C45	0.4-0.5	0.6-0.9	630-710	360	229

Factor of safety (F.O.S.) = 5;

Shear stress (τ) = $\frac{0.5 \times S_{ut}}{F.O.S.}$;

Shear stress (τ) = $\frac{0.5 \times 650}{5} = 65 \text{ N/mm}^2$;

Tensile stress (σ) = $\frac{S_{ut}}{F.O.S.} = \frac{650}{5} = 130 \text{ N/mm}^2$;

Crushing stress (σ_{cr}) = $1.2 \times \sigma = 1.2 \times 130 = 150 \text{ N/mm}^2$

$M = \frac{\pi}{32} \times \sigma b \times \frac{(D^4 - d^4)}{D}$

$57000 = \frac{\pi}{32} \times \sigma b \times \frac{(35^4 - 28^4)}{35}$

$\sigma b = 22.94 \text{ N/mm}^2 < 130 \text{ N/mm}^2$

Hence shaft is safe in bending.

6) Design of pushing clamp:

Select material C45 for bolt from PSG 1.9.

Designation	%C	%Mn	Ultimate Tensile strength(N/mm ²)	Yield strength (N/mm ²)	Brinell hardness (HB)
C45	0.4-0.5	0.6-0.9	630-710	360	229

Factor of safety (F.O.S.) = 5;

Shear stress (τ) = $\frac{0.5 \times S_{ut}}{F.O.S.}$;

Shear stress (τ) = $\frac{0.5 \times 650}{5} = 65 \text{ N/mm}^2$;

Tensile stress (σ) = $\frac{S_{ut}}{F.O.S.} = \frac{650}{5} = 130 \text{ N/mm}^2$;

Crushing stress (σ_{cr}) = $1.2 \times \sigma = 1.2 \times 130 = 150 \text{ N/mm}^2$

▪ **Failure of pushing clamp in crushing:**

$\sigma_{cr} = \frac{F}{\pi \times (D-d) \times t}$
 $150 = \frac{1142.85}{\pi \times (35-28) \times t}$
 $t = 0.4547 \text{ mm}$

Taking t as 20mm.

▪ **Failure of pushing clamp in shearing:**

$\tau = \frac{F}{A}$
 $\tau = \frac{F}{2 \times (\frac{D-d}{2}) \times t}$
 $\tau = \frac{1500}{2 \times (\frac{55-35}{2}) \times 12}$

$\tau = 6.25 \text{ N/mm}^2 < 65 \text{ N/mm}^2$

Hence, pushing clamp is safe in shearing.

7) Design of bolt:

Select material C45 for bolt from PSG 1.9.

Designation	%C	%Mn	Ultimate Tensile strength(N/mm ²)	Yield strength (N/mm ²)	Brinell hardness (HB)
C45	0.4-0.5	0.6-0.9	630-710	360	229

Factor of safety (F.O.S.) = 5;

$$\text{Shear stress } (\tau) = \frac{0.5 \times S_{ut}}{F.O.S.};$$

$$\text{Shear stress } (\tau) = \frac{0.5 \times 650}{5} = 65 \text{ N/mm}^2;$$

$$\text{Tensile stress } (\sigma_t) = \frac{S_{ut}}{F.O.S} = \frac{650}{5} = 130 \text{ N/mm}^2;$$

$$\text{Crushing stress } (\sigma_{cr}) = 1.2 \times \sigma_t = 1.2 \times 130 = 150 \text{ N/mm}^2$$

▪ **Bolt in compression:**

$$\sigma_c = \frac{F}{\frac{\pi}{4} \times d^2}$$

$$= \frac{1142.85}{\frac{\pi}{4} \times 20^2}$$

$$\sigma_t = 3.84 \text{ N/mm}^2 < 45 \text{ N/mm}^2$$

Hence bolt is safe in compression.

▪ **Bolt end in crushing:**

$$\sigma_{cr} = \frac{F}{A}$$

$$\sigma_{cr} = \frac{F}{\frac{\pi}{4} \times (D^2 - d^2)}$$

$$= \frac{1500}{\frac{\pi}{4} \times (30^2 - 20^2)}$$

$$\sigma_{cr} = 3.82 \text{ N/mm}^2 < 150 \text{ N/mm}^2$$

Hence, Bolt end is safe in crushing.

▪ **Bolt end in shear:**

$$\tau = \frac{F_r}{A} = \frac{F_r}{\pi \times d_i \times t}$$



$$65 = \frac{1500}{\pi \times 20 \times t}$$

$$t = 0.36 \text{ mm}$$

Taking thickness of bolt end as 20 mm

V. Result And Discussion

Comparison between manual chiselling and knurling machine:

Sr. no.	Point of comparison	Manual chiselling	Knurling machine
1	Time required to complete chiselling on one trestle box (minutes)	30	6
2	Cost per month (Rs.)	13125	2300
3	Operator fatigue	More	Very less
4	Spacing between two consecutive marks	Not equal	Equal
5	Noise	More	Less
6	Involvement of worker to chiselled one trestle box	2	1
7	Pictures after completion of operation by respective process		

VI. Conclusion

As the development of project, the final output of the knurling machine is satisfactory. The cost of knurling is also compatible. This project is the best option for chiseling on trestle box. This project improves the process of chiseling on “Trestle box”, which earlier was laborious, expensive and time consuming.

From the above comparison it is clear that time required for operation is less, spacing between two consecutive marks is constant, the quality of chiseled bar is good, unwanted noise is reduced, less operated

fatigue, less involvement of worker. As the machine is not too bulky so we can easily move and transport from one place to other place.

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