A PROJECT REPORT

ON

"DESIGN AND FABRICATION OF AUTOMATED CHISELLING MACHINE"

Submitted by

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In partial fulfillment for the award of the Degree

Of

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UNDER THE GUIDANCE

Of

Prof. Javed Kazi.

DEPARTMENT OF MECHANICAL ENGINEERING

ANJUMAN-I-ISLAM

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ANJUMAN-I-ISLAM

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CERTIFICATE

This is to certify that the project entitled

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To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University Of Mumbai**, is approved.

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APPROVAL OF DISSERTATION

This is to certify that the thesis entitled

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(Internal Examiner) **(External Examiner)**

Prof. Javed Kazi ____________________

Date: 29 /04/2016

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Sagar Sable

Ganesh Jankar

Suraj Dadas

DECLARATION

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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ABSTRACT

DESIGN AND FABRICATION OF AUTOMATED CHISELLING MACHINE

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 box bar by different machining processes in order to reduce human fatigue, with increased quality of product, reduce unwanted noise, reduce time.

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CHAPTER 1

INTRODUCTION

"BELL FLUID TECHNIQUE PVT.LTD." has been in the field of Hydraulic control system, Hydraulic valves Pumps and cylinders since 1992 with a team of dedicated engineers and highly skilled work force. Bell Hydromatics is the leading hydraulic equipment manufacturer of hydraulic equipments, hydraulic tank jacking equipments, industrial hydraulic equipment, hydraulic systems and cylinders, hydraulic jack, lifting jack, tank jack, electric operated jack, hydraulic power jack since the last one and half decade. With the latest in-house machinery and infrastructure less than one "Bell Hydromatics" is manufacturing a wide range of hydraulic equipments and industrial hydraulic equipment of different size and capacities according to customer's request. Bell Hydromatics is now not only manufacturing hydraulic equipment's and industrial hydraulic equipment but also exporting their products to meet demands the world over and can proudly say that their products are now being used in the oil and gas refineries, power generation, chemical and fertilizer fields, etc. **Bell Hydromatics stands for precision & durability.**

1.1 Hydraulic Jacks:

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 for storage tanks with different roof types, these hydraulic jack provide for optimum functionality support in given process. 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 used with minimum shell plate width of 1400mm. some disadvantages include suitable for handling small to large diameter tanks, finding use in building/erecting storage tanks storage capacity and others.

1.2 Working Principle of Hydraulic Jack:

Basically jack climb up on the jack rod with the required pressure to lift up the load. Its action is similar to monkey that climbs a trunk tree i.e., first it holds up on to the trunk with its legs and lunges upwards, and then it holds on to the trunk with its hands and lifts its legs up. At any time, either its hands or legs have a grip on the trunk that prevents it from falling down. Similarly, the air hydraulic jack, air hydraulic bottle jack and jack is provided with two pairs of jaws, a lower pair of jaws and an upper pair of jaws for a perfect grip. During lifting, both the pairs are "locked". In this position the jack is only allowed to move upwards. During lifting, the lower pair of jaws grips the trestle rod while the jack lifts up. After completing the full stroke, the upper pair of jaws grips the trestle rod while the base of the jack moves upward. During the process of lowering, any one of the pairs is always locked.

1.3 Storage tank:

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 tones. For formation of storage tank, metal sheets are lifted to a required height with the help of hydraulic jacks and then it is welded.

Figure1.1 Storage tank

Construction of storage tank:

- First foundation is completed, base/bottom plates and top most shell plates are erected and welded, roof structural, roof plates & top angle ring welded for truss supported roof of the tank.
- Tank jacking equipment's placed/erected at adequate distance.
- Hydraulic connections are made to all the jacks and to the power pack with the help of hoses and fittings.
- Clean hydraulic oil is filled in the oil tank through the oil filler breather provided at the oil tank till the level mentioned at the oil level gauge.
- Electric motor is started and cares to be taken for the direction of electric motor-should be as per the arrow mentioned on the cover of the electric motor.

- On energizing the hydraulic power pack, the shell plates along with the roof is lifted by the hydraulic jacks to the required height.
- Next shell course is erected and welded.
- Jacks are lowered and shell is connected to the new shell plates and operation is repeated for the balance shell plates.
- After the last shell plates are welded in position, the jacking units are dismantled.Shell to bottom plates welding is completed.

Figure1.2 Construction of storage tank

1.4 Trestle Box:

Trestle box section is mild steel bar with hardness 24HRC consist of three sections that is upper square bar of dimensions $36 \times 36 \times 4000$ mm^3, middle plate of dimension $10 \times 50 \times 4000$mm^3, Lower square bar of dimension $100 \times 100 \times 4000$mm^3. These three sections are welded with the help of fillet weld. Roughness is provided on two faces of this Trestle box for griping the jaw of Hydraulic jack.

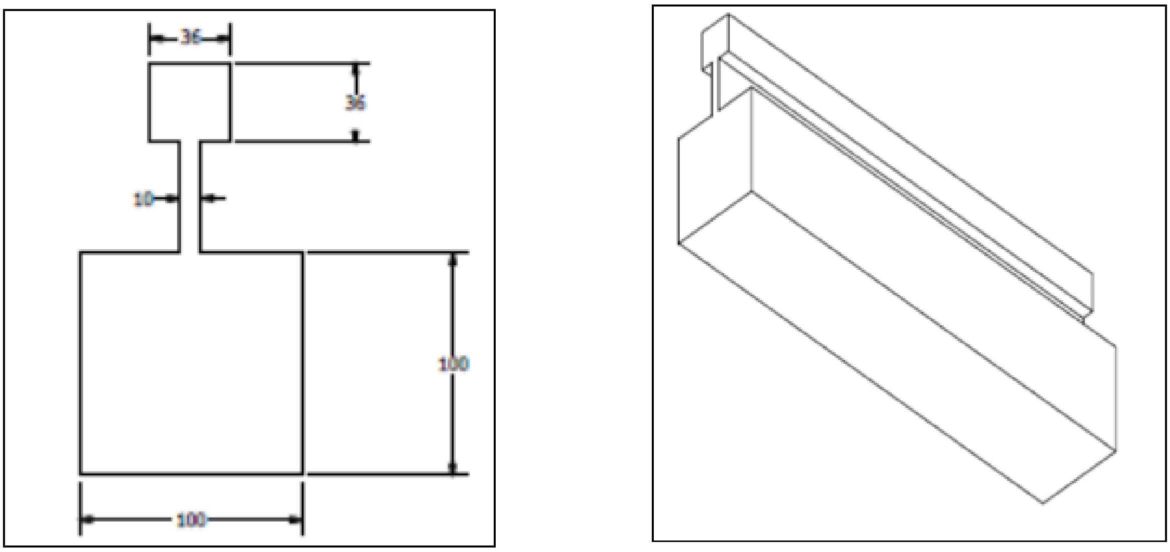


Figure1.3 Trestle Box

Table 1 Specification of trestle box

PART NAME	UPPER SQURE BAR	MIDDLE PLATE	LOWWER SQURE BAR
Dimensions (mm)	4000×36× 36	4000 × 10 × 50	4000×100×100
Material	MILD STILL (MS)	MILD STILL (MS)	MILD STILL (MS)
Hardness(HRC)	24HRC	24HRC	24HRC
Density(kg/mm^3)	7850	7850	7850
Volume(mm^3)	5.184×10^6	2×10^6	4×10^6
Mass(Kg)	41	16	314

1.5 Problem definition:

"Hydraulic Lifting Jack" plays very important role for vertical lifting of heavy sheets of weight about 12 tonnes. This lifting jack consists of two jaws, working each at a time. This jack is mounted on trestle beam (Trestle box) and at the same time another jaw moves upward along with the sheet. During next stroke second jaw will grip the metallic bar and first jaw moves upward motion along the length of bar. Friction between Trestle box and jaw of hydraulic jack plays important roll to grip this jack on Trestle box. To lift such heavy sheets more griping i.e. more rough surface is required on Trestle box.

To produce require area for griping the cold process chiselling is currently done on metal bar. A chiselling process is mostly done manually by the assistance of hammer and a chisel. Chiselling process is a cold working metal removal process. But this manual chiselling requires more time, money as well as more involvement of workers.

The objective of this project is to make Rough surface on trestle beam (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 and at minimum cost and time.

Figure1.4 Manual chiselling on trestle box

The following problems raised while manual chiselling:

1. **Operator fatigue :**
   The operator has to perform the same job repeatedly which leads to mental as well as physical fatigue.

2. **Spacing between two consecutive marks:**
   Since the work is done manually the accuracy of the job is low which leads to improper spacing between the marks.

3. **Quality :**
   Quality of the job is also depends on the manual measurement and judgement.

4. **Time Constraint :**

   The length of beam is 4 meter so to make rough surface by manual chiselling 30 minutes are required.

5. **Unwanted noise :**

   In manual chiselling process the hammer is strike on chisel due to this more noise generates, which is producing mental as well as physical stress to operator.

1.6 Objectives of project:

- To reduce time consumptions
- Better spacing
- High quality
- Very less or no involvement of operator
- To reduce unwanted noise

CHAPTER 2

LITERATURE REVIEW

Diamond Micro Chiselling of large-scale retro reflective arrays. Ekkard Brinksmeier, Ralf Gläbe, Lars Schönemann. Year 2012[1]. From various cutting experiments and surface characterization, electro less nickel, nickel silver N37 and UFG aluminium were identified as suitable materials for machining optical microstructures on a small scale. However, when machining larger patterns on mould 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 Chiselling of two 10 mm × 10 mm retro reflective 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 during cutting. 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 “whole 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 plain 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 work piece, 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 making 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 analysed 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.

CHAPTER 3

REPORT ON PRESENT INVESTIGATION

3.1 Methodologies used:

1. Manual chiselling
2. By using Leonardo Da Vinci's cam hammer mechanism
3. By using knurling mechanism

3.1.1 Manual chiselling

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. Chiselling is a process of removing material from a work piece.

In this process rough surface on Trestle box section is made chiselling 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.

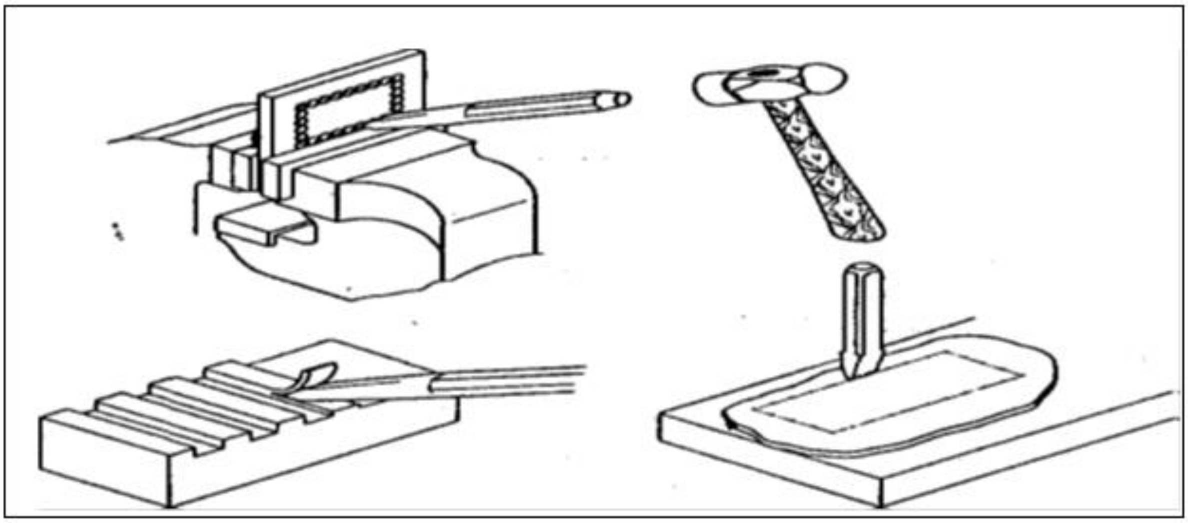


Figure3.1 chiselling by assistance of chisels and hammers

Parts of a chisel:

A chisel has the following parts

- Head
- Body
- Point or Cutting Edge

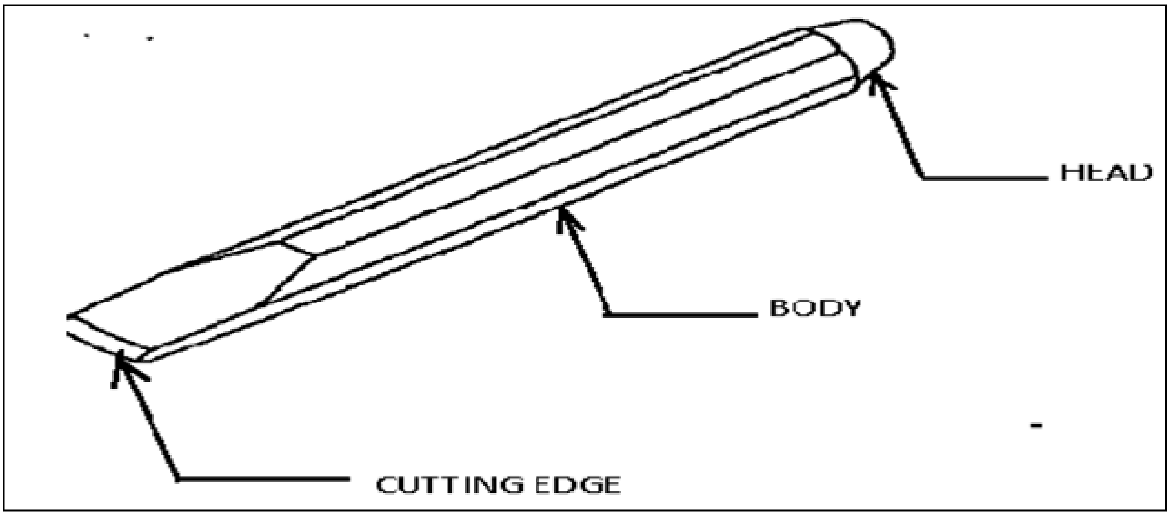


Figure3.2 parts of chisel

There are four common types of chisels:

- Flat chisel
- Cross-cut chisel
- Half-round nose chisel
- Diamond point chisel

Flat chisels:

They are used to remove metal from large flat surfaces and chip excess metal off weld joints and castings.

Cross-cut or cape chisels:

These are used for cutting keyways, grooves and slots

Half round nose chisels:

They are used for cutting curved grooves (oil grooves).

Diamond point chisels:

These are used for squaring materials at the corners.

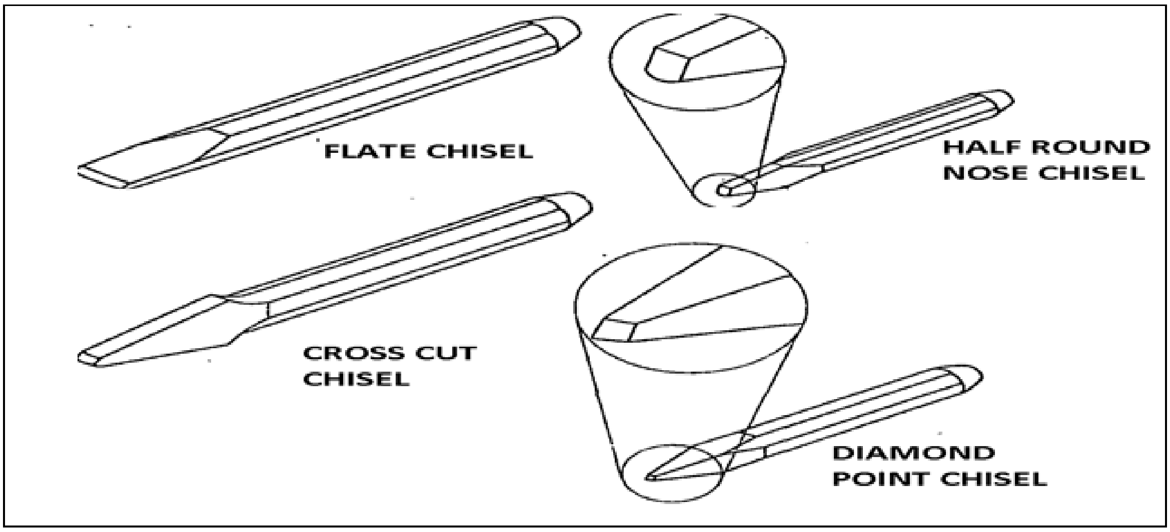


Figure3.3 types of chisel

Chisels are specified according to their:

- Length
- Width of the cutting edge
- Type
- Cross-section of the body.

The length of the chisels ranges from 150 mm to 400 mm. The width of the cutting edge varies according to the type of chisels.

Angles of chisels:

Point angles and materials:

The correct point/cutting angle (β) of the chisel depends on the material to be chipped. Sharp angles are given for soft materials, and wide angles for hard materials. The correct point angle and angle of inclination generate the correct rake and clearance angles.

Rake angle:

Rake angle (γ) is the angle between the top face of the cutting point, and normal to the work surface at the cutting edge.

Clearance angle:

Clearance angle (α) is the angle between the bottom face of the point and tangent to the work surface originating at the cutting edge.

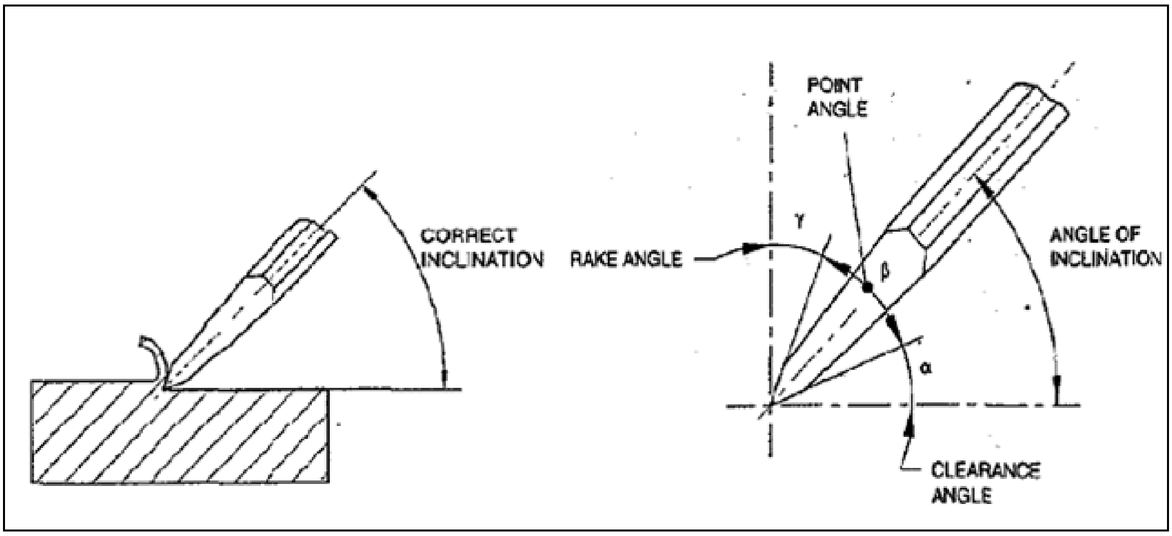


Figure3.4 cutting angles in chiselling

If the clearance angle is too low or zero, the rake angle increases. The cutting edge cannot penetrate into the work. The chisel will slip. If the clearance angle is too great, the rake angle reduces. The cutting edge digs in, and the cut progressively increases.

3.1.2 Leonardo Da Vinci's cam hammers mechanism:

Leonardo's invention the cam hammer is another example of thinking centuries ahead of his time. This machine would be used extensively several hundreds of years after his death during the industrial revolution. They would be powered by Steam engine and could hammer at up to twenty times per second. They were used to draw out the sheet metal for ships and armored machines for war such as the tanks in World War 1.

As you can see it was intended to be hand cranked. This would rotate the cam upon which the hammer mechanisms rests and follows. When the cam is rotated the weight of the hammer ensures that the bar connected to it always wants to be tight up against it due to the force of gravity. Eventually the hammer and its mechanism follow to cam all the way around until the cam suddenly drops off – this makes the hammer fall also.

Hammers like these would continue to be in use until the early 20th century where they were replaced by rolling mills, these were much more powerful and efficient at rolling sheet metal down to its desired dimensions; they rely on the brute force that can be utilized with today's modern machinery using hydraulics.

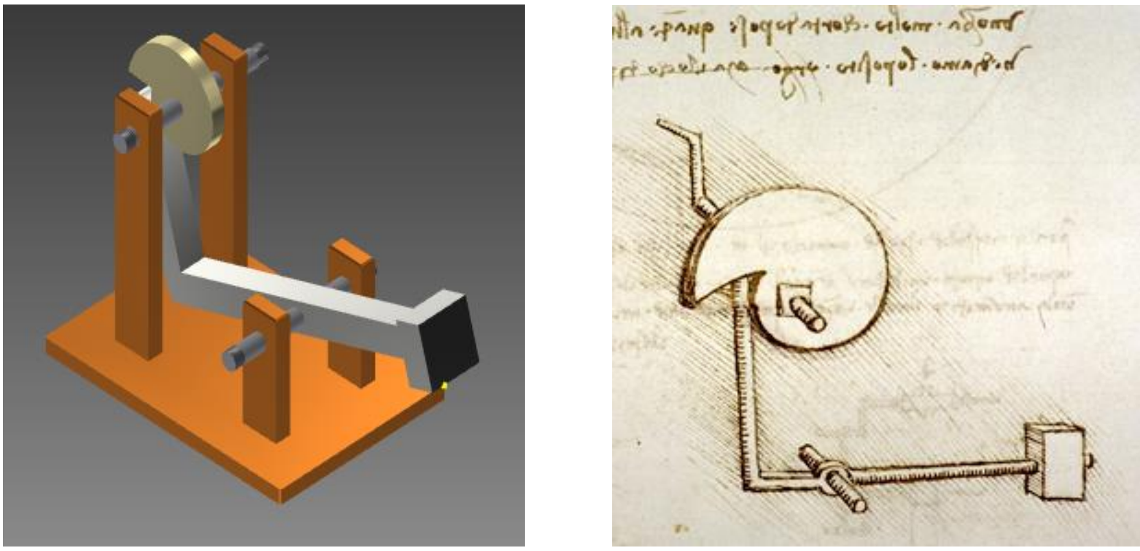


Figure3.5 Leonardo Da Vinci's cam hammers mechanism

Disadvantages of this mechanism:

1. Space require for this mechanism is more.
2. Requirement of another mechanism is needed for feeding the bar.
3. Complicated design and costly.
4. To drive the cam External power supply is required.
5. Machine is stable at one spaced only.

3.1.3 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 essentiality a roughening of the surface and is done to provide a better griping surface.

Knurling allows hands or fingers to get a better grip on the knurled object than would be provided by the originally smooth material surface. Occasionally, the knurl pattern is a series of straight ridges or a helix of “straight” ridges rather than the more usual criss-cross pattern.

Knurling may also be used as a repair method because a rolled in knurl surface has risen up areas surrounding the depress areas; these raised can make up for wear on the part. In the days when labour was cheap and parts expensive this repair method was feasible on piston of internal combustion engines, where the skirt of worn piston was expanded back to the nominal size using knurling process. As auto parts have become less expensive, knurling has become less prevalent than it once was, and is specifically discouraged by performance engine builder.

Figure3.6 object with knurling operation

Applications of Knurling:

- Knurling has a wide variety of applications in day to day use. It is most commonly used for decorative purposes and for seriating surfaces where components are locked or keyed together in unit assemblies.
- The term "knurling" designates both the process and the knurled portion of the work.
- Knurling is obtained by displacement of the material when the knurl is pressed against the surface of a rotating work blank. A knurled tooth is "V" shaped.
- Knurling tools are used for producing straight, diagonal, or diamond patterns, having teeth of uniform pitch on cylindrical surfaces.

Two ways to achieve knurling:

1. **Forming:**

   Knurl forming is achieved by pushing the knurl wheels against the blank while rotating. This will cause the material to be displaced in cold form, reproducing the same wheel pattern on the blank circumference. The blank is increased accordingly to the T.P.I. The force applied through forming is increased in larger diameters making knurling difficult and slow.

2. **Cutting:**

   Knurl cutting is achieved by using knurl wheels to actually cut instead of forming the blank. The knurl wheels are set at an angle, making the knurling edges of the knurl wheels cut into the blank. Pressure is minimized while speed and feed is increased.

Types of Knurls:

- **Annular rings**

  Frequently used when the mating part is plastic. Rings allow for easy mating but ridges make it difficult to pull the components apart.

- **Linear knurl**

  Used with mating plastic pieces, the linear knurl allows greater torsional between components.

- **Diamond knurl**

  A hybrid of Annular rings and linear knurling in which a diamond shapes is formed. It is used to provide better grip on components, and is the most common type is used on everyday objects.

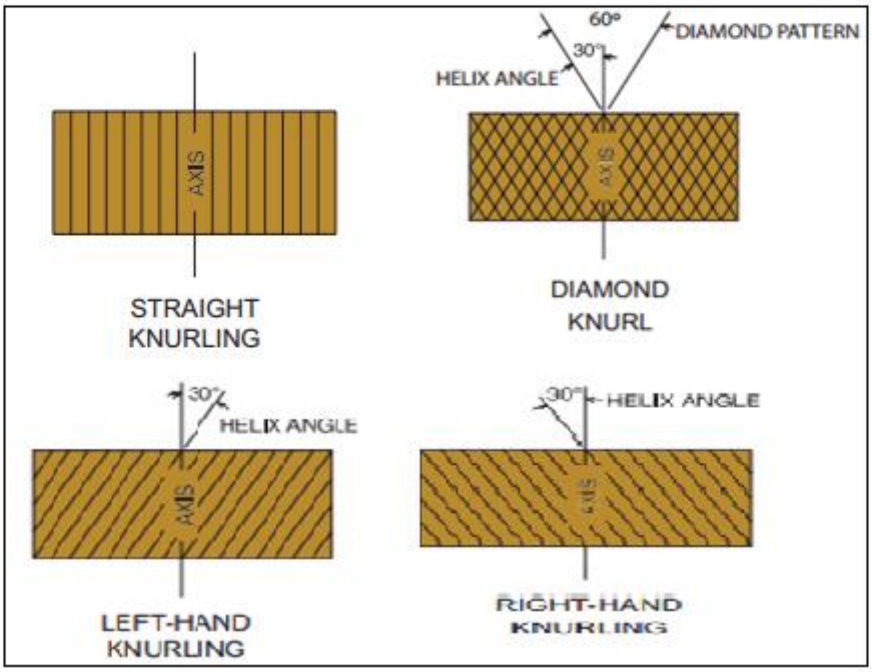


Figure3.7 types of knurling patterns

Terms used in knurling tool:

Tooth Form:

A knurled tooth is V-shaped and the depth of the tooth is less than the depth of a theoretical V-form. The tooth has a rounded root and crest. The relationship between the actual depths of tooth to the theoretical V varies with the pitch of the teeth. On finer pitches, the tooth is a smaller proportion of the theoretical V-depth than coarser pitches. Also, female diamond patterns have shallower tooth depth than male diamond patterns.

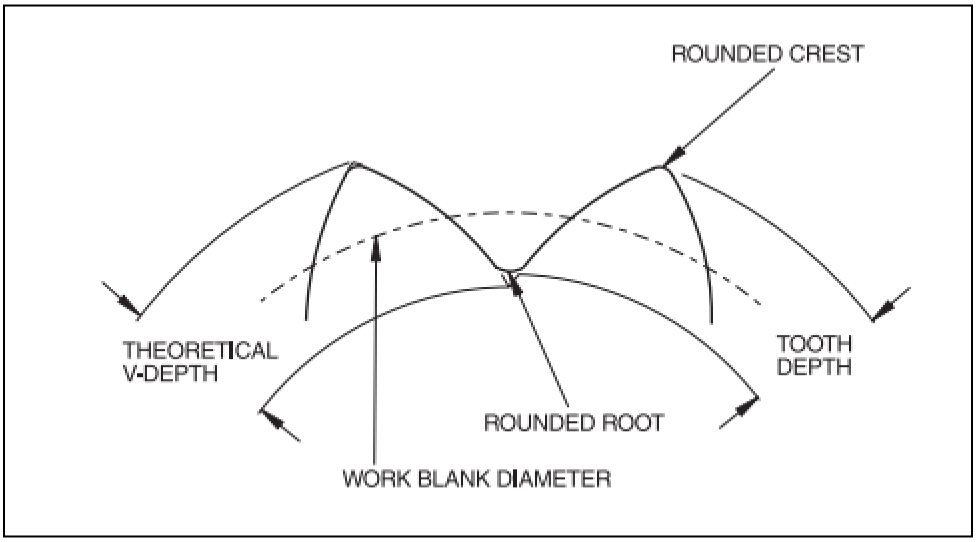


Figure3.8 terms used in knurling tool

The Circular Pitch System:

Circular pitch knurling is related to the distance between the teeth on the circumference of the work blank. It is usually expressed in terms as the number of teeth per inch, TPI, although sometimes erroneously referred to as pitch.

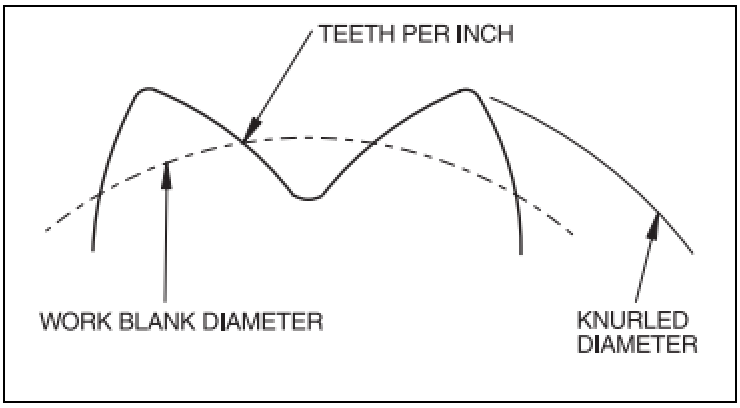


Figure3.9 circular pitch system

Number of Teeth per Inch – TPI:

TPI refers to the number of teeth per inch measured on the circumference of the work blank diameter. The approximate TPI, however, may be measured on the outside diameter of the knurling for reference purposes. TPI is used and is measured perpendicular to the teeth or helix angle.

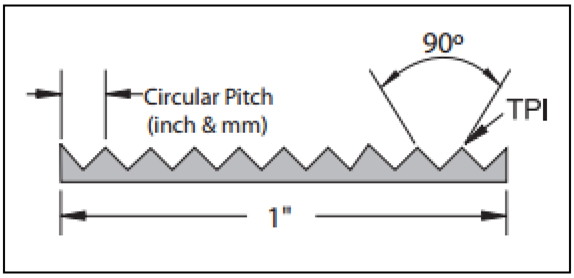


Figure3.10 tooth per inch

- TPI system is the number of teeth per inch (measured on a linear inch).
- Circular pitch Inch system is the distance from tooth to tooth, or is derived from 1"divided by the number of teeth per inch.
- Circular pitch metric system is the distance from tooth to tooth.
- Diametric pitch system is derived by the number of teeth on the work divided by the theoretical work blank diameter

3.2 Knurling tool mechanism

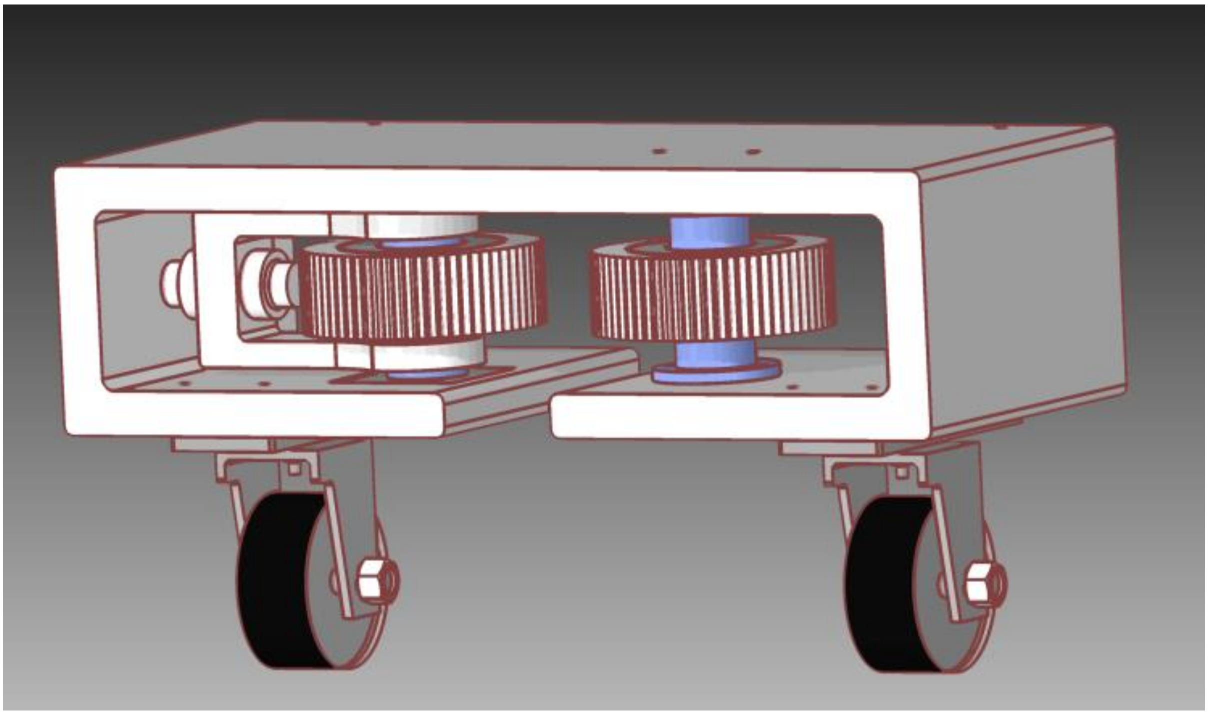


Figure3.11 knurling tool mechanism

Introduction:

Knurling machine is a useful machine for producing required rough surface on Trestle box.

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.

A**dvantages 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.
5. It helps to improve quality of product.

Following Components used in knurling tool mechanism:

1. Knurling tool
2. Bearings
3. Support plate
4. Nut and bolts
5. Handle
6. Support wheels
7. Lifting or pushing hydraulic jack

- **Knurling tool:**

A knurling tool is used to press a pattern onto a bar. The pattern is normally used as a grip for handle. Apprentice engineers often manufacture screwdrivers. These have patterned handles, to provide a grip and this achieved through the technique called knurling. The pattern produced is called a “knurled pattern”.

The required distance between two consecutive marks on Trestle box is 5.2 mm. So as per the requirement knurling wheel is constructed, such a way that the pitch between two marks will be same.

Table 2: Knurling tool specification

Knurl pattern	Straight
Form or cut type	Form
Material	Mild steel
Hardness	70HRC
Knurl diameter(mm)	105
Face width(mm)	36
Hole diameter(mm)	72
Pitch(mm)	5.2
Number of teeth	64

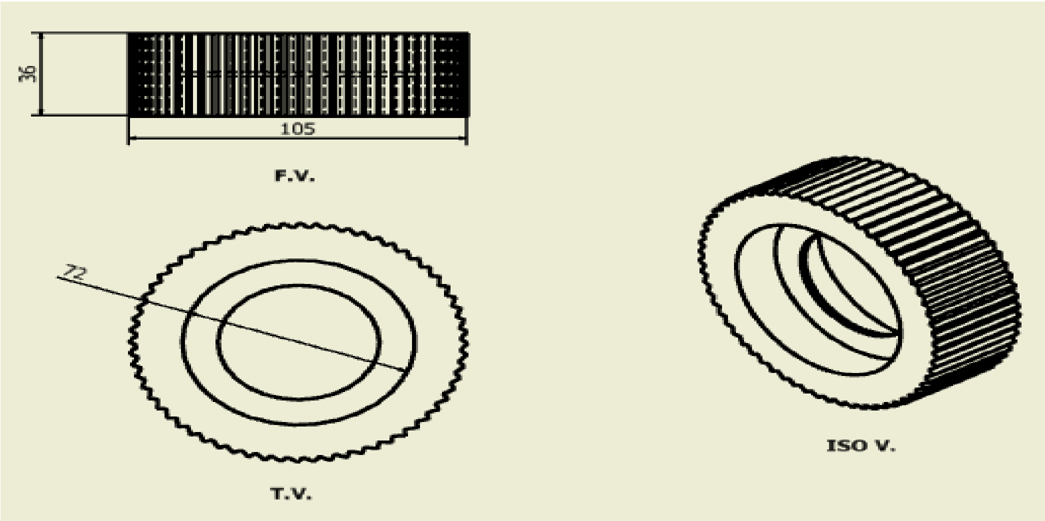


Figure3.12 2D & 3D view of knurling wheel

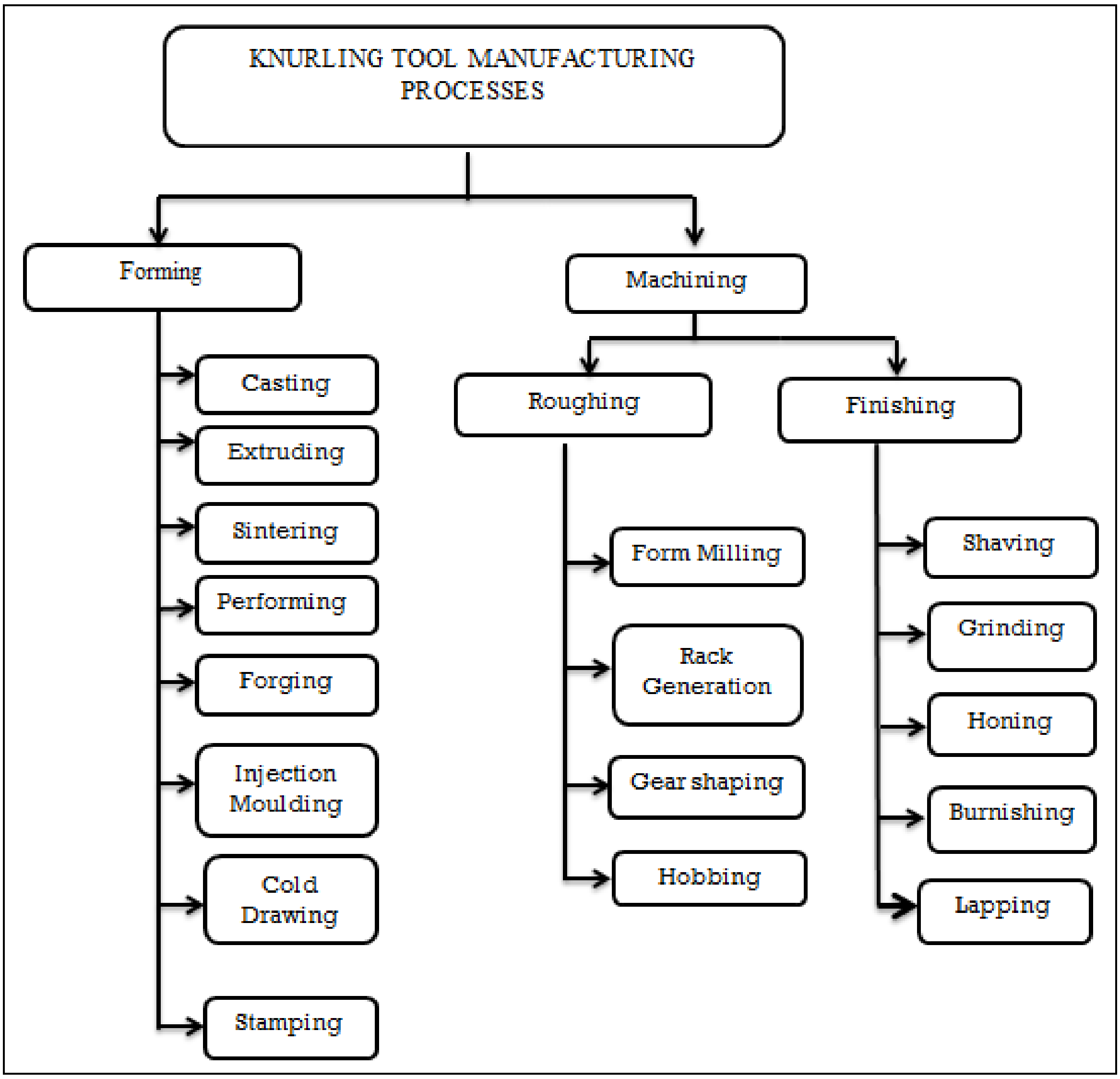


Chart of different knurling tool manufacturing processes

After machining operation surface hardening is done on the teeth of the knurling tool for increase hardness up to 70 HRC

What is heat treatment?

Heat treatment is the heating and cooling of metals to change their physical and mechanical properties, without letting it change its shape. Heat treatment could be said to be a method for strengthening materials but could also be used to alter some mechanical properties such as improving formability, machining, etc. The most common application is metallurgical but heat treatment can also be used in manufacture of glass, aluminum, steel and many more materials. The process of heat treatment involves the use of heating or cooling, usually to extreme temperatures to achieve the wanted result. It is very important manufacturing processes that can not only help manufacturing process but can also improve product, its performance, and its characteristics in many ways.

Processes for Surface Hardening are as follows:

• Thermochemical treatments to harden surface of part (carbon, nitrogen)

• Also called case hardening

• May or may not require quenching

• Interior remains tough and strong.

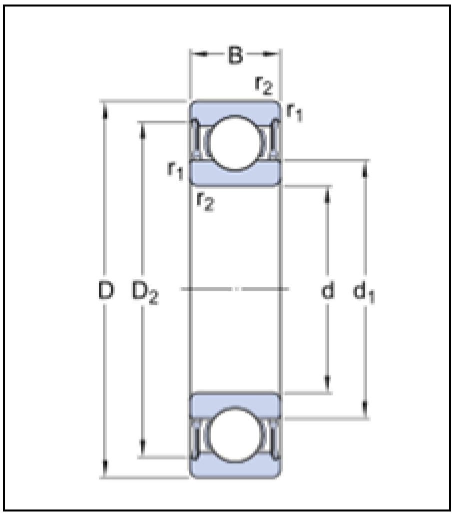
- **Bearings**

A bearing is a machine element that constraint relative motion to only the desire motion, and reduced friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving parts or for free rotation about fixed axis.

Ball bearing is type of rolling element bearing that uses balls to maintain the separation between the bearing races. The purpose of ball bearing is to reduce rotational friction and support radial and axial load. It achieves this using at least two races to contain the balls and transmit the load through the balls. In most applications, in race is stationary and other race is attach to the rotating assembly.

Table 3: Bearing specification

ISI NO	35BC02
DESIGN NO.	SKF 6207
d(mm)	35
D(mm)	72
B(mm)	17
Static capacity C_o(kgf)	1370
Dynamic capacity C(kgf)	2000
Maximum RPM	100000



d		35	mm
D		72	mm
B		17	mm
d_1	≈	46.94	mm
D_2	≈	62.7	mm

Figure3.13 Sectional view of bearing

- **Support plate**

To take the weight of knurling tool and bearings one support plate is used. It is design in such a way that it will take axial force of pushing given by the hydraulic jack mechanism.

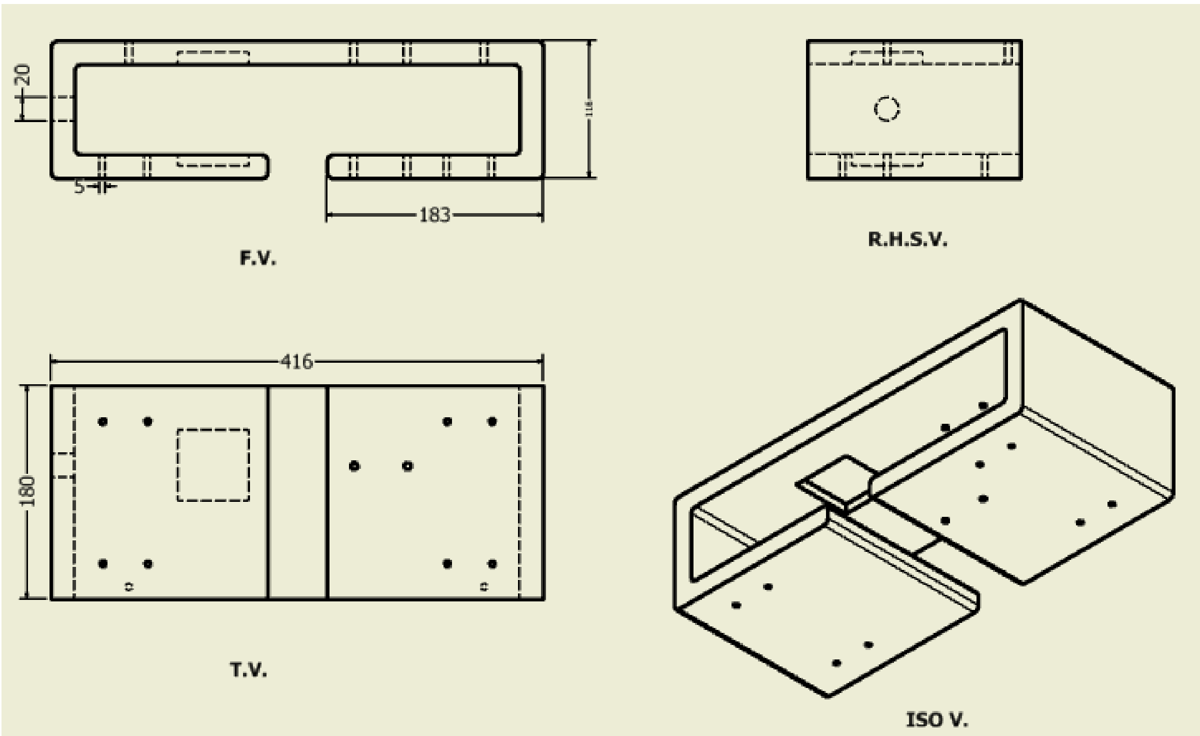


Figure3.14 2D & 3D view of support plate

- **Nut and bolts**

A nut is a type of fastener with a threaded hole. Nuts are almost always used opposite a mating bolt to fasten a stack of parts together. The two partners are kept together by a combination of their threads friction, a slight stretch of the bolt and compression of the parts. In applications where vibration or rotation may work a nut loose, various locking mechanisms may be employed: adhesive, safety pins or lock wire, nylon inserts, or slightly oval shaped threads.

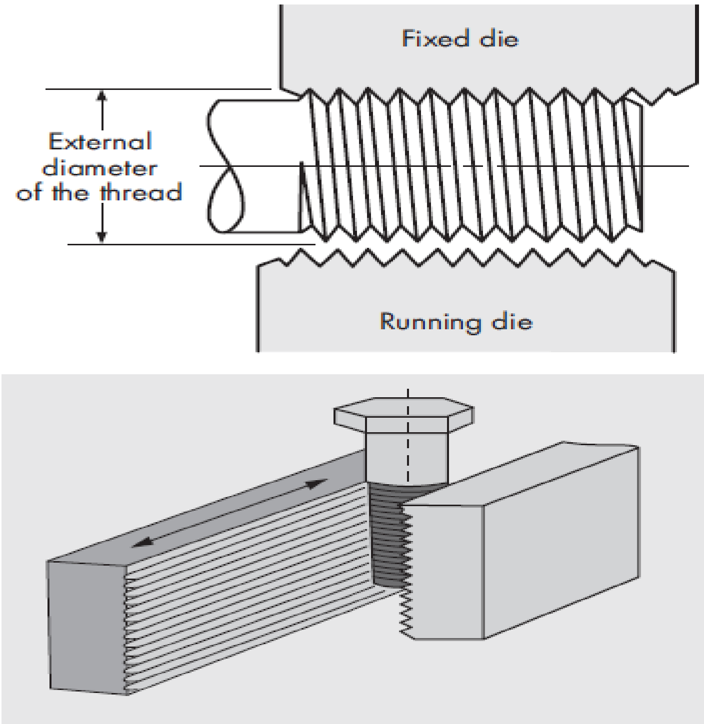


Figure3.15 Formation of threads on bolt

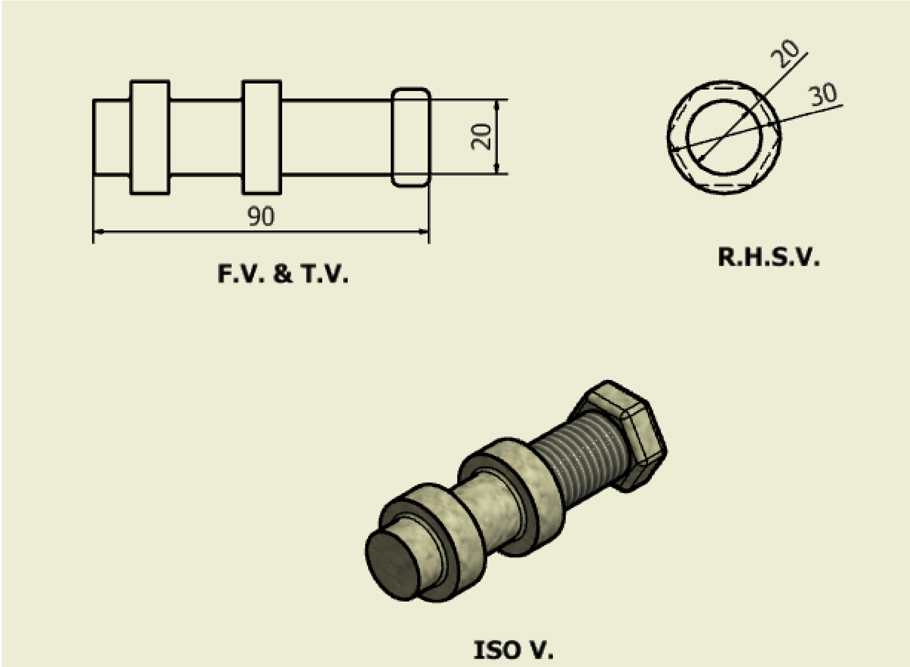


Figure3.16 2D & 3D view of pushing bolt

- **Handle:**

After completion of chiselling operation on trestle box, handle is used in this mechanism for pushing the machine from one trestle box to other trestle box.

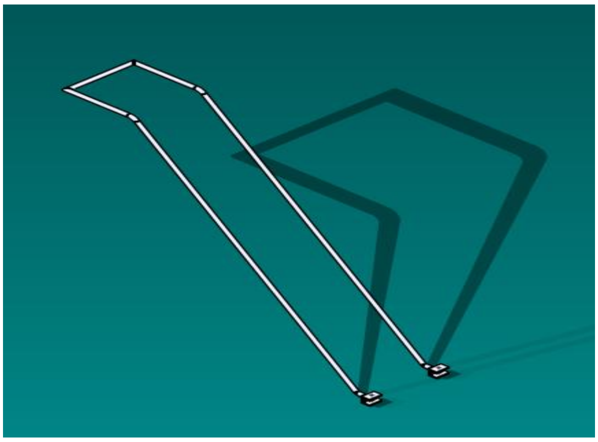


Figure3.17 3D view of handle

- **Support wheels (castor wheel):**

If providing flexible-path mobility is what non-powered equipment does so well, it's important to select the industrial casters and wheels that will do your job best. In this way you can be sure of getting top performance without excessive investment. Wheels and casters are offered in a variety of types and sizes-not to confuse you, but because differences in applications can create big differences in what will perform best. And equally important, selecting the right wheel or caster will save money in the long run by heading off downtime, excessive maintenance costs, and premature replacement. For original equipment manufacturers, it can mean the difference between enhancing the mobility and life of a product... or inviting complaints with every sale.

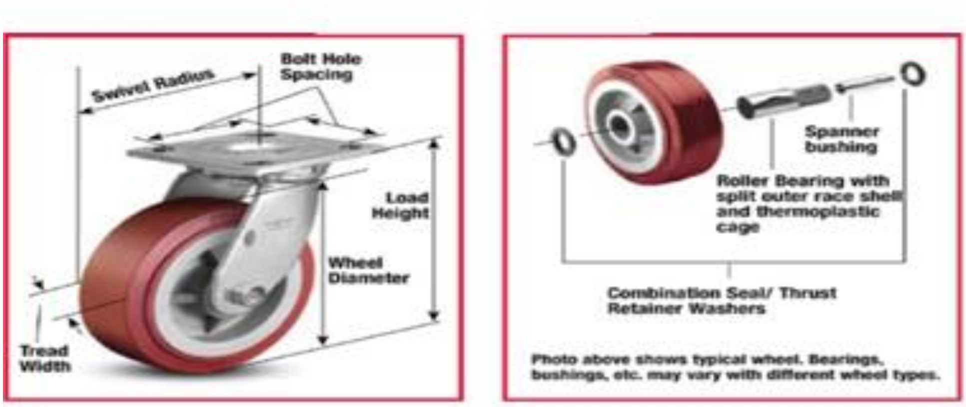


Figure3.18 castor wheel

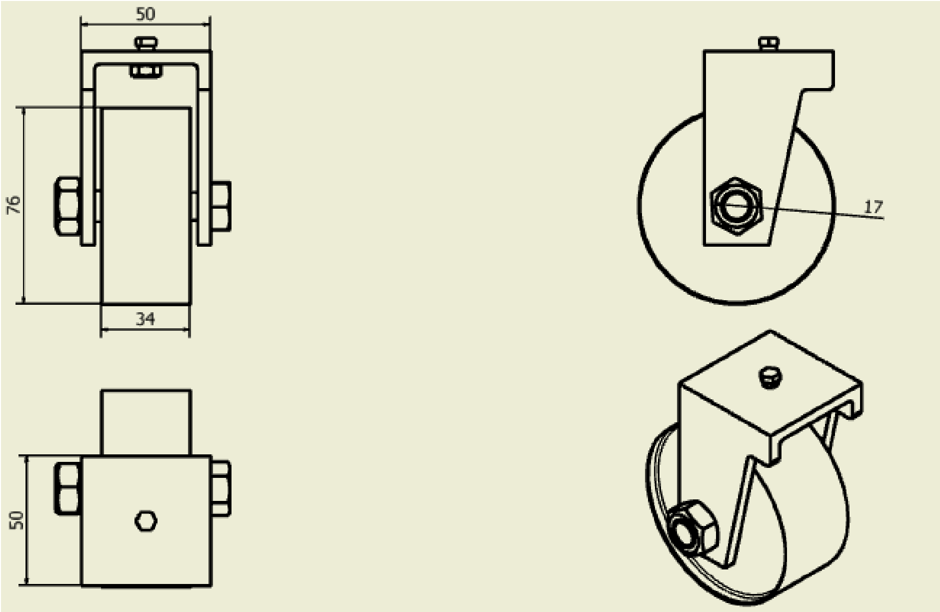


Figure3.19 2D & 3D view of castor wheel

- **Lifting or pushing hydraulic jack:**

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 for storage tanks with different roof types, these hydraulic jack provide for optimum functionality support in given process. 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 used with minimum shell plate width of 1400mm. some disadvantages include suitable for handling small to large diameter tanks, finding use in building/erecting storage tanks storage capacity and others.

Table 4: Specifications of hydraulic jack

MODEL	BH-12-100-SA	BH-18-100-DA	BH-25-100-DA
Capacity	12 MT	18 MT	25 MT
Hydro-Testing at	18 MT	27 MT	37.5 MT
Recommended distance between jacks	Max 3.0 mt	Max 3.0 mt	Max 3.0 mt
Suitable for shell/plate width	Min 1.4 mt and Max 3 mt	Min 1.4 mt and Max 3 mt	Min 1.4 mt and Max 3 mt
Plate thickness	6-40 mm	8 mm and above	8 mm and above
Stroke of Jack	100 mm/stroke	100 mm/stroke	100 mm/stroke
Hydraulic working Pressure	106 bar	115 bar	160 bar
Test Pressure Hydraulic	160 bar	172 bar	240 bar
10 HP Powerpack	34 jacks	24 Jacks	24 Jacks
15 HP Powerpack	50 Jacks	36 Jacks	36 Jacks
20 HP Powerpack	65 Jacks	50 Jacks	50 Jacks
30 HP Powerpack	80 Jacks	60 Jacks	60 Jacks

Figure3.20 Lifting hydraulic jack of Bell fluidetechnics

Applications:

- Building of field erected storage tanks
- Increasing tank capacity by adding shell rings or courses
- Dismantling of old tanks
- Repair or replacement of tank bottom plate
- Repair to tank foundation
- Erection of other circular structures such as reactor shields in nuclear power stations.

- **Pushing clamp:**

Material of pushing clamp is mild steel (MS). It is manufactured by machining on CNC and welding process. Before the starting of operation on trestle box the distance between two knurling wheels is adjusted with the help bolt and pushing clamp.

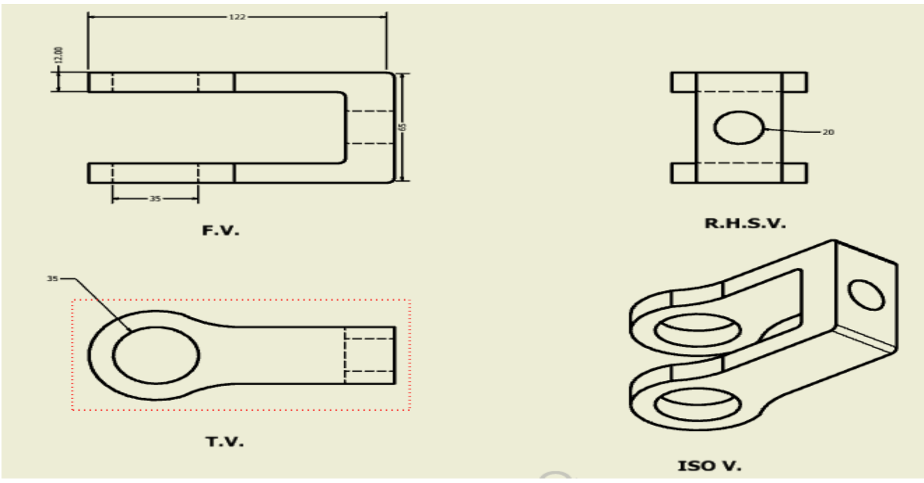


Figure1.21 2D & 3D view of pushing clamp

3.3 Bill of material

1. **Knurling wheel:**
   - Material Cost = Rs. 160

     Process cost: Hobbing = Rs. 2000

     Surface hardening = Rs. 800

   Cost of one knurling wheel: Rs. 3760

   Total cost of two knurling wheel: 2×3760 = Rs. 7520

2. **Bearings:**
   Standard bearing is selected that is SKF 6207
   Cost of one bearing = Rs. 368
   Total cost of bearings = 4×368 = Rs. 1472

3. **Pushing bolt :**
   - Material cost = Rs. 130
   - Machining cost = Rs. 800

   Total cost of pushing bolt = Rs. 930

4. **Support plate:**
   - Material cost = Rs.1440
   - Process cost : Machining = Rs. 300
     Welding = Rs. 180

   Total cost of support plate = Rs. 1920

5. **Castor wheel:**
   Standard castor wheels are selected
   Cost of one caster wheel = Rs. 350
   Total cost of caster wheels = 2×350 = Rs. 700

6. **Standard nuts and bolts :**
   Standard nuts and bolts are selected that is M6
   Cost of one nut and bolt = Rs. 5
   Total cost of nuts and bolts = 8×5 = Rs.40

7. **Hydraulic jack and power pack:**
   Hydraulic jack and power pack are already available in the industry.

8. **Pushing clamp:**
   - Material cost = Rs. 180
   - Process cost : Machining = Rs. 800
     Welding = Rs. 140

   Total cost of pushing element = Rs. 1120

9. **Handle:**
   - Material cost = Rs. 200
   - Process cost = Rs. 200

   Total cost of handle = Rs. 400

10. **Shaft / Axle:**
    - Material cost = Rs. 180
    - Machining cost = Rs. 160

    Cost of one shaft = Rs, 340

    Total cost of shafts = 2×340 = Rs. 680

Table 5: Bill of material

SR. NO.	PARTS	QUANTITY	RATE (Rs)	COST (Rs)
1	Knurling wheel	2	3760	7520
2	Bearing	4	368	1472
3	Pushing bolt	1	930	930
4	Support plate	1	1920	1920
5	Castor wheel	2	350	700
6	Standard nuts and bolts	8	5	40
7	Hydraulic jack and power pack	1	30000	Already available
8	Pushing clamp	1	1120	1120
9	Handle	1	400	400
10	Shaft / Axle	2	340	680
			Total =	14782

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 30 minutes.
- There are 300 trestle boxes to be chiselled per month.
- Therefore, time required for complete this batch production is 18000 minutes that is equal to 300 hours.
- A labour 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:

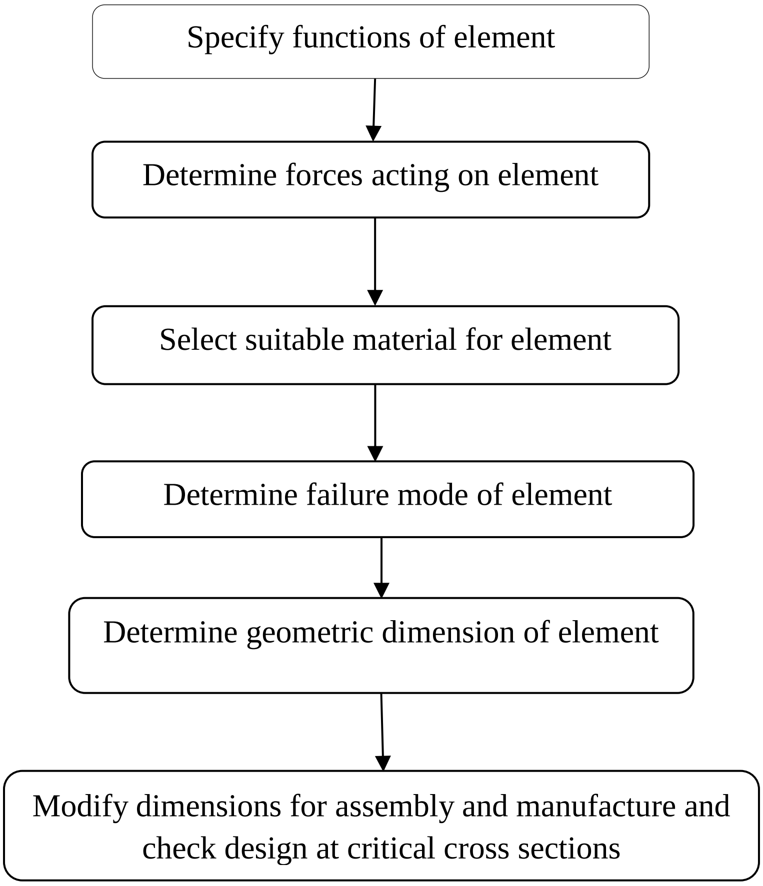
- Knurling machine does the same work in 4 days, therefore operator cost is Rs.1400
- Cost of power required for operation of hydraulic jack is Rs.900

Therefore, total cost to chisel 300 trestle bars is Rs.2300 per month.

CHAPTER 4

DESIGN CALCULATION

4.1 Basic procedure of design of machine



4.2 Selection of Material:

Four basic factors, which are considered in selecting the material, are availability, cost, mechanical properties and manufacturing considerations.

For example, flywheel, housing of gearbox or engine block have complex shapes. These components are made from cast iron because of casting processes produces complicated shapes without involving machining operations. Transmission shafts are made from plain carbon steels, because they are available in the form of rods, beside their higher strength. The automobile body and hood are made from low carbon steels because their cold formability is essential to press the parts. Free cutting steels have excellent machinability due to addition of sulphur. They are ideally suitable for bolts and studs because of ease with which thread profiles can be machined. The crankshaft and connecting rod are subject to fluctuating forces and nickel-chromium steel is used for these components due to is higher fatigue strength.

4.3 Failure criterion:

Before finding out the dimensions of components, it is necessary to know the type of failure that the component may fail when put into service. The machine components may said to have 'failed' when it is unable to perform its function satisfactorily.

The basic types of failures as follows:

1) Failure by elastic deflections;

2) Failure by general yielding;

3) Failure by fracture.

In applications like transmission shaft, which is use to support gears, the maximum force acting on the shaft is limited by the permissible deflection. when this deflection exceeds a particular value(usually 0.001 to 0.003 times of span length between two bearings), the meshing between teeth of gears is affected and the shaft cannot perform its function properly. In these cases, the shaft is said to have 'failed' due to elastic deflection. Components made of ductile materials like steel lose their engineering usefulness due to large amount of plastic deformation. This type failure is called failure by yielding. Components made of brittle material like cast iron fails because of sudden fracture without any plastic deformation. There are basic modes of gear-tooth failure breakage of tooth due to static and dynamic load and surface pitting. The surface of gear tooth is covered with small 'pits' are resulting in rapid wear. Pitting is surface fatigue failure. The components of ball bearing such as rolling element, inner and outer races fail due to fatigue cracks after certain number of revolutions. Sliding contact bearings fail due to corrosion and abrasive wear by foreign particles.

4.4 Design parameter of Knurling Wheel:

Notations to be use are as follows,

D_w = Theoretical work blank diameter =105mm

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) :**

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

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

Take number of teeth on Blank work are 64

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

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

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

Module (m) = 1.64 mm

4.5 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 Trestle box surface to the head of the hammer, h=1m

Travelling time of hammer, t=0.5 sec.

Force of impact, F=?

- **Calculation of impact force:**

Notations used:

V= velocity of hammer
g= acceleration due to gravity

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

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

=4.43 m/s

Change in momentum=mass×velocity

=6×4.43

=26.58 N-sec

Change in momentum = Impulse

Impulse = F×t=26.58

$F = \frac{26.58}{t}$

$= \frac{26.58}{0.5}$

= 52.16 N

Therefore,

Torque $= 52.16 \times 1000$

Torque $= 52160$ N-mm

Taking more torque

Torque $= 60000$N-mm

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

Therefore

Torque $=$ Fored require to rotate Knurling tool$\times$ Radius of Knurling tool

60000 $=$ Forced require to rotate Knurling tool $\times \frac{105}{2}$

Forced required to rotate Knurling tool (P) $=$ 1142.85 N

Considering safety factor 30%, therefore force (P) = 1142.85×1.3 = 1500 N

4.6Design 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/mm^2

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

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

Shear stress (τ) $= \frac{0.5 \times 650}{5} = 65\ N/mm2$;

Tensile strength$\sigma t = \frac{Sut}{F.O.S} = \frac{650}{5} = 130\ N/mm2$;

- **Finding bolt diameter in shearing**

Force (P) = τ$\times A$;

P=1500N;

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

d= 3.833mm

Select standard diameter (d) = 5mm.

4.7 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

$$Lmr = \frac{Lhr \times N \times 60}{10^6};$$

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

L_{mr}= 15.552 million of revolutions.

4.8 Design of shaft:

- **Failure of shaft in bending:**

Moment = force × perdincular 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) = $\frac{0.5\times Sut}{F.O.S}$;

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

Tensile stress $(\sigma t) = \frac{Sut}{F.O.S} = \frac{650}{5} = 130\ N/mm^2$;

Crushing stress (σ_{cr}) = 1.2×σt = 1.2×130 = $150\ ^{N}/_{mm^2}$

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

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

σ_b =22.94 $^{N}/_{mm^2} < 130\ ^{N}/_{mm^2}$

Hence shaft is safe in bending.

4.9 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) $=\frac{0.5\times \mathrm{Sut}}{\mathrm{F.O.S}}$;

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

Tensile stress (σt) $= \frac{\mathrm{Sut}}{\mathrm{F.O.S}} = \frac{650}{5} = 130\ \mathrm{N/mm^2}$;

Crushing stress (σcr) = 1.2×σt = 1.2×130 = 150 $^{N}/_{mm^2}$

- **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=0.4547mm

Taking t as 20mm.

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

$$`\tau = \frac{F}{A}$$

$$\tau = \frac{F}{2\times(\frac{D-d}{2})\times t}$$

$$\tau = \frac{1500}{2\times(\frac{55-35}{2})\times 12}$$

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

Hence, pushing clamp is safe in shearing.

4.10 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;

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

Shear stress (τ) $= \frac{0.5 \times 650}{5} = 65\ N/mm2;$

Tensile stress $(\sigma t) = \frac{Sut}{F.O.S} = \frac{650}{5} = 130\ N/mm2;$

Crushing stress (σcr) = 1.2×σt = 1.2×130 = $150\ {}^{N}/_{mm^2}$

- **Bolt in compression:**

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

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

$\sigma t = 3.84\ {}^{N}/_{mm^2}\ < 45\ {}^{N}/_{mm^2}$

Hence bolt is safe in compression.

- **Bolt end in crushing:**

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

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

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

$\sigma cr = 3.82\ ^{N}/_{mm^2} < 150\ ^{N}/_{mm^2}$

Hence, Bolt end is safe in crushing.

- **Bolt end in shear:**

$\tau = \frac{Fr}{A}$

$\tau = \frac{Fr}{\pi\times di\times t}$

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

t = 0.36 mm

Taking thickness of bolt end as 20 mm

4.11 GANTT CHART

Table 6: Gantt chart

Task Name	Duration	Start	Finish	Status
SURVEY IN INDUSTRY	21d	07/24/15	08/13/15	Complete
PROJECT TITLE	6d	08/07/15	08/14/15	Complete
PROBLEM DEFINITION	6d	08/15/15	08/20/15	Complete
FOCUS ON CONCERN	18d	08/21/15	09/09/15	Complete
LITERATURE REVIEW	39d	09/04/15	10/12/15	Complete
PAPER DOWNLOAD	16d	09/18/15	10/09/15	Complete
FEASIBLE SOLUTIONS	21d	09/25/15	10/23/15	Complete
PL & EXAMS	40d	10/26/15	12/18/15	Complete
1.PREPARATION OF 2D MODEL	21d	01/01/16	01/21/16	Complete
2. CONVERSION IN 3D MODEL ON INVENTOR	30d	01/04/16	02/12/16	Complete
MODIFICATION ON DESIGN	10d	02/12/16	02/24/16	Complete
APPROVAL OF DESIGN	6d	02/24/16	02/28/16	Complete
FABRICATION OF MACHINE	40d	02/29/16	04/11/16	Complete
TESTING OF MACHINE	5d	04/12/16	04/15/16	Complete
RESULTS	4d	04/16/16	04/18/16	Complete
CONCLUSION	3d	04/18/16	04/19/16	Complete
SOFT COPY FOR BLACK BOOK PREPARATION	53d	02/18/16	04/20/16	Complete
VERIFICATION OF SOFT COPY FROM GUIDE AND PC	6d	04/20/16	04/25/16	Complete
PRINTING OF BLACK BOOK	2d	04/26/16	04/27/16	Complete

CHAPTER 5

RESULT, DISCUSSIONS AND CONCLUSION

5.1 Result and discussions:

5.1.1 Time:

a. Time required with manual chiselling process was 30 minutes per rod.
b. Time required with knurling machine is 6 minutes per rod.

5.1.2 Cost:

a) Cost by manual chiselling process is Rs.13125 per month.
b) Cost by knurling machine is Rs.2300 per month.

5.1.3 Quality:

a) Because of manual errors spacing between marks is not equal.
b) Since pitch of knurling teeth is constant therefore spacing between the marks is equal.

5.1.4 Noise:

a) Noise produce by manual chiselling is too high.
b) Noise produce in knurling operation is negligible as compared to manual chiselling.

Table 7 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		

5.2 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 chiselling on trestle box. This project improves the process of chiselling 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 chiselled 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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