A Project Report on

“Design And Analysis Of Chuck Loader / Unloader For Lathe Machines”

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[2021-22]

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C E R T I F I C A T E

This is to certify that 1. **Mr. Piyush Mukesh Sharma,** 2. **Mr. Gaurav Sharad Aher,** 3. **Ms. Tejal Motilal Jaiswal,** 4. **Ms. Shrutika Dipak Thorat** has successfully completed the Project Report entitled "**Design And Analysis Of Chuck Loader / Unloader For Lathe Machines**" under my supervision, in the partial fulfillment of Bachelor of Engineering – Mechanical Engineering Of University Of Pune

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ACKNOWLEDGEMENT

We take this opportunity to thank **Dr. S.N. Khan** for his valuable guidance and for providing all necessary facilities, which were indispensable in completion of this work. First of all we are thankful to Dr. **Rachayya R. Arakerimath** (HOD Mech. Engg. Dept.) to give us a presentation facility.

We are thankful to all staff members of the mechanical engineering department. We would also like to thank the college for providing required journals, books and access to the internet for collecting information related to the project. Finally, we are also thankful to my friends and well-wishers for their valuable suggestions.

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ABSTRACT

The use of lathe chucks in machine building companies is the result of a great deal of work and the development of technical thought. Due to the progress and the possibility of increasing efficiency and at the same time relieving people from work that requires a lot of effort, especially physical effort, the use of better and more efficient production methods is a target that should be pursued nowadays. In the manufacturing process, these objectives can be achieved with the use of dedicated equipment. Chuck Removal is a hefty job for workers on the shop floor as a chuck is a heavy asset to lift and demands a lot of man power to lift. Occasional changing of chuck on a lathe requires manpower to rotate the chucks for unscrewing and lifting of the same till a shelf or to the floor. A solution to the above problem can easily be found if there can be an attachment to the lifting crane in a workshop that can facilitate clamping and lifting of the chuck over it. After successful implementation of this solution, we will have a safe alternative method for loading and unloading lathe machine chucks without any safety issues to the workers. This attachment will make it a less stressful job for the person to exchange chucks at his disposal easily and safely without risking his personal being.

(Keywords: Lathe, Chucks, Machinery, Lift, Crane)

1. INTRODUCTION

The Lathe Machine or Universal Machine is an integral part of any tool-room workshop and is required day to day for important tasks in the industry. A Lathe is a machine tool that rotates a work-piece about an axis of rotation to perform various operations such as cutting, sanding, knurling, drilling, deformation, facing, and turning, with tools that are applied to the work-piece to create an object with symmetry about that axis.

In the lathe machine, chuck is a handy part that machinists usually interact with to tighten or loosen a machine job on which lathe operations are to be done or are already done. These chucks come in various sizes and types for different types of machine jobs according to the needs of the machinist and scale of the material to be held.

As we discussed, for different types of jobs different chucks are to be used, there is a regular need of changing the chuck on a particular lathe machine every now and then. This change requires loosening of the pre-attached chuck from the lathe spindle and tightening of the required one.

1.1 PROBLEM STATEMENT

Occasional changing of chuck on a lathe requires manpower to rotate the chucks for unscrewing and lifting of the same till a shelf or to the floor. This can be a really hefty job for workers on the shop floor as a chuck is a heavy asset to lift and demands a lot of man power to lift. Hence, this work usually requires 2 or 3 workers on the shop floor to unload a chuck and load another on the lathe for safe exchange of the chucks.

It is not possible for a single worker to rotate a heavy chuck till it unscrews from the spindle and then keep it down on the shop floor and finally loading another chuck on the machine.

1.2 PROPOSED SOLUTION

A solution to the above problem can easily be found if there can be an attachment to the lifting crane in a workshop that can facilitate clamping and lifting of the chuck over it. Also the attachment should facilitate the rotation of the chuck over the spindle threads so that the chuck can be easily unscrewed from the spindle.

As this attachment has to be used over a hoist/floor crane it should also consist of a hook so that it can easily be lifted by the crane at one point. Hence the attachment can eliminate extra manpower and allow the machinist alone to load or unload and fasten or unfasten a chuck from the machine.

1.3 METHODOLOGY

Our solution consists of a hollow pipe allowed to rotate over a rod through bearings and the rod then being attached to a crane with the help of a hook which can facilitate lifting the chuck from the machine to the shop floor and vice-a-versa. It can help a person lift the chuck easily and allow him to rotate as it is supported on bearings.

Since we can’t lift the chuck from both sides because of fastening of the chuck on spindle threads from one side, it is important to maintain balance of the chuck while lifting it from one end itself so that it doesn’t topple in any direction while it is being loaded or unloaded. If it is not centrally balanced it can cause sudden movement causing safety problems for the machinists.

Hence for keeping the chuck straight throughout the process, we are going to put markings on the pipe to where the chuck is to be tightened so that the center of mass lines with the lifting point of the crane. This will ensure secure lifting of the chuck while being completely straight throughout the loading and unloading procedure.

2. LITERATURE REVIEW

A lathe is a machine commonly used to cut metal or wood. It works by rotating the workpiece against a stationary tool which provides cutting action. The primary application of the lathe is to get rid of undesirable parts of material and form the required shape and size. The job to be machined is held and rotated in a lathe chuck; a cutting tool is advanced which is stationary against the rotating job. Since the cutting tool material is harder than the work piece, the metal is easily removed from the job [1]. A feed refers to the tool's motion in one direction.

People have used lathes to make components for different machinery, in addition to forte gadgets like bowls and musical instruments. Whatever the sort and function, all of them perform the use of this simple hold and rotating mechanism. Some of the common operations performed on a lathe are facing, turning, drilling, threading, knurling, and boring etc. [1] The basic structure of a machine tool consists of base and column arrangement which serves as a balancing support for the entire machine. Here, depending on the machining process, the tool is fixed in the tool post and the work piece is held on the chuck of a typical lathe structure. The relative motion is achieved by movements parallel to the three spatial axes. This is achieved by means of linear guide ways and bearings, axial movements along the screws, rack and pinion arrangements etc. The machine is built of heavy steel and iron parts. The base of the machine is rigid and usually is of cast iron.

Since the Egyptians, lathes have existed in some form. Consider the similarities to the pottery wheel: thrown pottery has been around for thousands of years, so it's only natural that lathes, which operate on the same principle but with a workpiece moving against a stationary cutting tool, would follow.

The most basic lathes permitted workers to remove materials by hand. Metal and wood lathes became more technologically advanced throughout time, eventually evolving into machine tools with integral heads. Each head was mounted on cross-slides that ran the length of the lathe bed and were used to rotate the workpiece

Basic lathes were used for precision metalworking until the introduction of the engine lathe, which used an automated feed to the cutting tool. Even back then, each lathe was different, but the process was the same. Engine lathes aided in the birth of the Industrial Revolution, which saw the introduction of steam-powered lathes capable of higher rotation rates and torque, allowing for the spinning of heavier parts. Lathes had evolved into heavy-duty machining machines. The lathe machine, like the milling machine, simplified the machining process as they became more advanced. With the introduction of Computer Numerical Control in the second half of the twentieth century, the next significant leap forward was made (CNC). Operators might programme a set of instructions for each machine tool using CNC-equipped lathes. This enabled for exact repetition of those instructions, resulting in increasingly accurate components and a reduction in the number of workers required to keep each machining tool running at the same time. Today's technology allows for more precise CNC programming with an ever-increasing number of axes.

COMPONENTS

The essential components of a lathe are the bed, headstock, tailstock, spindles, carriage, chuck, tool holder and motor.

2.1 Bed

The bed is made up of two heavy metal slides that run lengthwise and have ways or 'V' created on them that are rigidly held by cross girths. It is the lathe's foundation and one of the criteria that determines the piece's size. That is, the maximum diameter limit is determined by the distance between the main spindle and the bed. It has three main uses:

- It is suitably stiff and has a high damping capability for vibration absorption.
- It prevents the cutting forces from causing deflection.
- It supports the lathe machine's headstock, tailstock, carriage, and other components

2.2 Headstock

The principal action takes place on the headstock. This is where the motor's power is transferred to the workpiece. The drive mechanism and electrical mechanism of a Lathe machine tool are housed in the Head Stock, which is located on the left side of the lathe bed. The work is held in place by the spindle nose, which has external screw threads and an internal Morse taper for retaining the lathe centre. It rotates at a varied speed thanks to a cone pulley or an allgeared drive. A hole runs the length of the spindle to accommodate long bar work. The feed rod, lead screw, and thread cutting mechanism all receive power from the spindle via the Head Stock.

Below the headstock is a separate speed change gearbox that reduces the speed so that variable feed rates for threading and automatic carriage lateral movement can be achieved. Most turning activities are performed with the feed rod, while thread cutting operations are performed with the lead screw.

2.3 Spindle

The machine tool spindle provides the relative motion between the cutting tool and the workpiece which is necessary to perform a material removal operation. In turning, it is the physical link between the machine tool structure and the workpiece, while in processes like milling, drilling or grinding, it links the structure and the cutting tool. The spindle is supported by two bearings separated by different spans.[5] The cylindrical work piece is held in this portion of the lathe machine. Different attachments and accessories can be added to the spindles, including the rotating main spindle that holds the workpiece. The primary spindle is generally hollow and threaded on the outside to accommodate these fittings. Centre's, chucks, and faceplates are all helpful attachments for the main spindle. These can be used to position and hold the workpiece in place.

2.4 Tailstock

The tail stock is located above the lathe bed on the right side. The tailstock is a non-rotating spindle that travels down the bedways and is concentric with the main lathe spindle. The tailstock is typically used to support the ends of long workpieces, but it can also be equipped with a drill chuck to perform drilling and other holemaking operations.

2.5 Carriage

When the machining is finished, the carriage is utilised to support, guide, and feed the tool against the job. It houses the compound rest over. It is in charge of holding, moving, and controlling the cutting tool. During operations, it provides stiff support for the tool. It uses an apron mechanism to transfer power from the feed rod to the cutting tool for longitudinal cross-feeding. With the help of a lead screw and half-nut mechanism, it makes thread cutting easier.

2.6 Tool Post

The cutting tool is held in place by a tool post that is firmly secured in the T-slots of the compound rest. Tool posts can have a variety of designs, but the following are the most common:

- Quick Release Tool Post: This tool post is becoming increasingly popular. In the ready-to-use holders, an infinite number of tools are pre-programmed. Tool height may be quickly and easily modified using a fastener, and it can be pre-set for each tool that has been removed from the lathe.
- Index Tool Post: This tool post allows for four tools to be mounted on the turret at the same time. Each tool is safeguarded separately, allowing you to utilise anywhere from one to four tools at the same time. The turret's outstanding indexing system allows it to be placed in 24 locations, each at 15 degrees, allowing the widest range of machining processes. With a millionth of an edge repeatability, it is possible to index from one cutting tool to another in less than one second.
- Pillar Type Tool Post: The Pillar Type Tool Post, also known as the American Pillar, is commonly used for light-duty lathes. Shaking the boat part in its round seating adjusts the tool height quickly and easily. Unfortunately, this type of tool post lacks the inflexibility required for the tool's mission. The useful cutting angles vary depending on how far the boat component is advanced or changed.
- Clamp Type Tool Post: Clamp type tool post, also known as English Clamp, is simple and effective, with the exception of some difficulty. The tedious process of adding or subtracting stuffing and shims until the tool is at the exact height with the spindle axis is the only way to keep the tool's height. This must remain consistent as the tool adjusts. Furthermore, only one tool is accepted at a time, and fast tool change is not possible while machining a small batch

of complicated components.

- Turret (4-Way) Tool Post: This form of tool post saves tool changing when constructing a mechanism, with each tool swinging into place as needed. The number of tools in this array is limited to four, and vertical changes are made by inserting packing beneath the tool. The tool's shank size is too small.
- Super Six Index Turret: When multi-process work necessitates the use of more than one tool, the index turret tool post is designed to make machining easier and more efficient on Engine Lathes. For outside and inside machining processes, the rotary index turret can be equipped with up to six tools. Every tool has its own height adjustment in this unit, and tool changes take less than a second.

2.7 Chuck

Chucks are accessories that are used to hold a workpiece or cut down tool on a machine tool. The chuck is actually essential to a lathe's functioning as it fixtures the portion to the spindle axis of the work-holding machine [6]. It is connected to main spindle of the headstock. Lathe chucks are used to clamp a workpiece accurately on a lathe for turning operations or on an indexing fixture for milling activities. A screw or pinion opens or closes the jaws of a manual lathe chuck. The jaws of a power lathe chuck are closed by hydraulics, pneumatics, or electricity. They are designed for mass production and have a high grasping accuracy.

Different types of chuck used in the lathe machine are: 1. Three jaw chuck 2. Four jaw chuck 3. Magnetic Chuck 4. Collet Chuck 5. Combination Chuck 6. Air/ Hydraulic Operated 7. Drill Chuck

Self-Centering Chucks: Since all jaws work in unison and automatically centre the item, self-centering scroll chucks are suitable for holding cylindrical or concentric work. The scroll's jaws are opened and closed by a wrench that rotates on a pinion. As a stationary fixture, 2-jaw self-centering are employed for rectangular shaped pieces. The most versatile and ideal for handling spherical items are 3-jaw selfcentering jaws (bars, rings and pipes.) For square pieces, 4-jaw self-centering is used. For thin-walled items, 6-jaw self-centering is used. More gripping points ensure that clamping forces are distributed evenly and that distortion is avoided.

Independent Jaw Chucks: Jaws in independent chucks are designed to move separately rather than together. Ideal for eccentric operations or holding oddly shaped workpieces. They require more time to set up than self-centering chucks.

Three Jaw Chuck: The three jaw chuck is the most frequent method of holding a workpiece on a lathe. It's simple and quick to use. However, it can only hold workpieces that are round, triangular, or hexagonal. Though it is quite exact, it is rarely as accurate as a four jaw chuck, yet it is adequate for many projects. To hold a workpiece, both the three jaw and four jaw chucks would almost invariably be attached to the spindle in the headstock. However, they can be utilised to hold a tool or even be attached to the tailstock in select situations. It is possible to create three-jaw chucks with reversible jaws. Three jaw chuck have advantage of self centering and limitation is that it not recommended for high-speed load condition.

Four Jaw Chuck: For Non-Self Centering Four Jaw Chuck, each of the chuck stepped jaws are controlled by a separate screw giving them independent movement. This feature allows the four-jaw independent chuck to secure any form. Using two to four of the various jaws, this type of chuck may fasten circular, rectangular, square, irregular, and other shapes. Self-Centering Four Jaw Chucks are never utilised in metalworking as in woodworking. A four-jaw chuck with self-centering jaws can hold both round and square pieces. For a carpenter, this covers significantly more jobs than for a metalworker. A self-centering four jaw chuck loses the advantages of a four jaw chuck to the metal worker – great accuracy and the ability to handle odd shapes. However, the craftsman is uninterested in these. However, he finds it incredibly useful to be able to grip round and square forms simply and swiftly. Four Jaw Chucks are critical units of the high-speed horizontal lathe, while the interference fit between the chuck and spindle is one of most important factors influencing the performance of the high-speed horizontal lathe. It is very important to monitor the chucking condition of the power chucks for safety consideration in Lathes, especially highspeed lathes. They can be used to hold irregularly shaped parts. Multiple gripping method is one of the advantages of four jaw chuck.[3]

Magnetic Chuck: The magnetic chuck is used to hold very thin parts in place. These thin pieces are made of a magnetic substance that can't be grasped in a standard chuck. Due to the pressure of typical chuck jaws, there is a risk of the work piece bending, buckling, twisting, or deforming in any way. Magnetic lathes are employed in these situations. The radiated magnetic flux is obtained by the chuck from these magnets. This magnetism helps the chuck keep the work item in place. • Collet Chuck: Collet chucks are commonly used in factories and industries to hold bar stock where it must be quickly fixed and properly centred. A collet is a bushing that resembles a lean cylinder and has carved slots running the length of its edge. The collet's internal bore can be hexagonal, cylindrical, square, or any other shape. The shape of the workpiece passing through it determines its shape. The collet has a tapered outside surface. This tapered surface fits into the taper hole on the chuck's body, and the threaded tail end interlocks with a key.

Combination Chuck: A combination chuck can be used as a self-centering and independent chuck at the same time. This aspect of this chuck contributes to the benefits of both types of chucks. The jaws are operated by separate screws. The scroll discs control all the jaws independently. The bottom frame is carved with teeth that interlock with the scroll. The screws, like the jaws, move in a radial manner. This movement occurs when a pinion turns the scroll.

Air/Hydraulic Chuck: Most of the time, air chucks or hydraulic chucks are useful in mass production processes. To operate an air or hydraulic used chuck, a hydraulic or air cylinder is required. This chuck's holding calibre is quick and effective. This cylinder is attached to the rear end of the headstock spindle and rotates. Fluid pressure is transferred to the cylinder by operating a valve with a lever, causing the piston to drop within the cylinder. The piston's motion is transmitted to the jaws via a connecting rod and links, which securely grip the workpiece.

Drill Chuck: Drill chucks are spindle-mounted mechanisms used to hold a drill or other cutting tool. They are available in keyed, keyless, and hybrid systems, which allow for quick drill bit changes. Drill Chucks are frequently connected to a machine's spindle via a removable Drill Chuck Arbor. The arbour is essentially a steel shaft with two ends, one machined to fit into a machine's spindle and the other to fit into the rear of a drill chuck. Jaws are commonly used in chucks to hold the tool or workpiece. Jaws (also known as dogs) are typically arranged in a radially symmetrical pattern, similar to the points of a star.

Permanent Jaws for retaining a workpiece in a lathe chuck are known as hard lathe chuck jaws. They're composed of case-hardened steel and include a serrated clamping surface to keep the piece secure during machining. It's ideal for parts that haven't been finished yet. Lathe Chuck jaws that are soft (machinable) are used to hold a workpiece while it is being turned on a lathe. They're constructed of soft materials like aluminium or mild steel and can be machined to precise dimensions for precisely aligning the workpiece during an operation. They can be trimmed to match the diameter of a certain item, increasing the contact surface area. Use on finely machined items to get the best results. Two sets of jaws are usually included in a three-jaw chuck. The internal jaws are one set. These can be utilised to retain the work item on its outside surface using the long edges. They can also use the stepped faces on the interior of the workpiece to hold it. The external jaws are the other set. Only the internal stepped edges are ground on these, and they are intended to be used to hold the workpiece, hence the workpiece is always held on an external surface when using these. These are normally hardened and ground, and must be utilised as is. When employing soft jaws, the location of the jaws is never important because the edge that will hold the workpiece can be produced anywhere on the jaw. The main criterion is that it is preferable to utilise, as little metal as possible while still completing the task. The teeth and alignment slots are the most significant parts of the soft jaws. It should be feasible to make parts that fit on these as long as they work. When these components wear out, they are unbolted and replaced with new components.

When twisting the soft jaws to hold a part on its exterior, the jaws must be forced out at the same time. Holding a circular portion that contacts the rear of the jaws is one way to accomplish this. Even if the cut isn't precisely round, it'll be concentric when the jaws are tightened on a round object. Similarly, the jaws must be driven out when holding the workpiece on an inside edge.

As we discussed, for different types of jobs different chucks are to be used, there is a regular need of changing the chuck on a particular lathe machine every now and then. This change requires loosening of the pre-attached chuck from the lathe spindle and tightening of the required one.

Occasional changing of chuck on a lathe requires manpower to rotate the chucks for unscrewing and lifting of the same till a shelf or to the floor. This can be a really hefty job for workers on the shop floor as a chuck is a heavy asset to lift and demands a lot of man power to lift. Hence, this work usually requires 2 or 3 workers on the shop floor to unload a chuck and load another on the lathe for safe exchange of the chucks.

The spindle end facing the tailstock is called the spindle nose. The spindle nose has a morse taper hole (self-locking taper) and threads on outside. The morse taper is used to accommodate lathe centre or collet chuck and threaded portion for chuck or face plate. The design of the lathe spindle and its bearings forms important feature, as the thrust of the cutting tool tends to deflect the spindle. Anti-friction bearings are used in the headstock, and the spindle, which is made of high-tensile steel suitably hardened and tempered, is supported in roller bearings. The front spindle bearings take both the axial and radial loads on the spindle and the rear bearing is so designed that the spindle may float axially from the front bearings to allow the expansion and contraction.

The spindle nose is designed for rapid mounting and removal of chucks and fixtures on it, and also for positioning them accurately and securely. Screwed type spindle nose with two locating cylindrical surfaces in front and rear, and threads in between is used. The overhang of the spindle nose is kept to minimum to guard against bending. The spindle is made hollow to allow long bars to pass through. On the front side, it has a taper socket to mount a live centre which rotates with the spindle. The various face plates and chucks are secured to the flange of the spindle nose by bolts or studs, and positioned by taper spigot. Types Of Spindle Noses Are: 1. Threaded 2. Tapered 3. Cam-Lock.

On a larger scale, lathes can be rather massive, but a toolroom lathe is typically a smaller machine tool. Because of its versatility, a metal lathe is the workhorse of many small machine shops and tool-and-die shops. A lathe is useful to many professionals and amateurs outside of the machine shop.

Today, every industrial metalworking lathe is completely automated, with multiple-bit-holding heads. This means that a single lathe can handle a variety of tasks: rough bits for grinding out material, finer bits for refining pieces, and even sanding and polishing bits. A trained operator can use a CNC lathe to programme a metalworking lathe to take a single workpiece from raw material to completed product with no human intervention after the programme is started.

Work holding refers to any device that is used to a secure a workpiece against the forces of machining. The most basic work holding device is a simple clamp, but work holding can also involve complex fixtures that are custom-built for particular parts. Other common work holding devices include vises and chucks, as well as indexers or rotary tables that are able to change the part position while it is held, so the machine can reach various features. In most machining applications, work holding also locates the part. On a machining center, for example, a vise or fixture may also provide the precise position and orientation where the machining program expects to find the workpiece.

When holding a round bar, the axis of the bar must be concentric with the axis of the spindle for a three-jaw chuck to be accurate. There are two types of errors that could occur here:

When a piece of ground round stock is clamped in a three jaw chuck and tested with a dti, it is frequently found to be a few hundredths off. In a lot of circumstances, this is perfectly okay. This inaccuracy varies depending on the wear of the chuck's scrolls, therefore it could be different for workpieces of different diameters.

If a workpiece is held in a three chuck that is off centre, any surfaces turned on it in one pass, that is, without removing it from the chuck, will be concentric relative to each other and to the spindle's axis of rotation. This means a workpiece can have any number of round surfaces as long as they are all concentric. Turning between centres is made possible by this feature. However, if the workpiece is held in a chuck for some reason, it is not possible to turn the surface that is being held. As a result, it usually indicates that the part can be created but must subsequently be disassembled. The workpiece must be large enough to be turned down to the required size. As a result, we won't be able to use any existing surface on the final workpiece because it will be eccentric to any.

The lathe machine has proved to be one the most versatile and helping piece of machine tool in a tool room workshop and has variety of applications for making possible operations required to make a workpiece its desired shape and size. We have studied various parts of the workshop lathe giving information about the bed, the tailstock, the toolpost and its types, the headstock, the carriage, chucks and their types, jaws and their types.

3. CHAPTER 1 - DESIGN APPROACH

Need Based Analysis -

Needs analysis definition involves the process of identification and evaluation of needs. It is the first step that should be taken in order to successfully develop an effective training program. It is a vital process that helps businesses determine the specific training and training period they need to provide their employees for them to become productive and efficient.

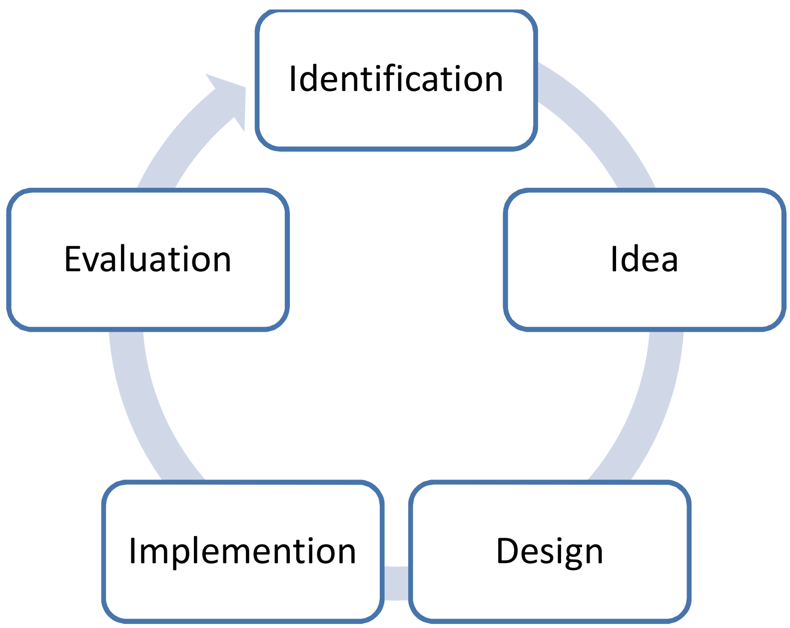


Chart 1: Need Based Analysis

4. CHAPTER 2 - NEED IDENTIFICATION

The outside of the spindle nose can have either a threaded nose, a long taper with key drive, or a camlock. Threaded spindle noses are used mostly on older lathes. The chuck or face plate is screwed on a course right-hand thread until it is tight. The tapered key drive spindle nose relies on the principle that a tapered fit will always repeat its original position. The key gives additional driving power.

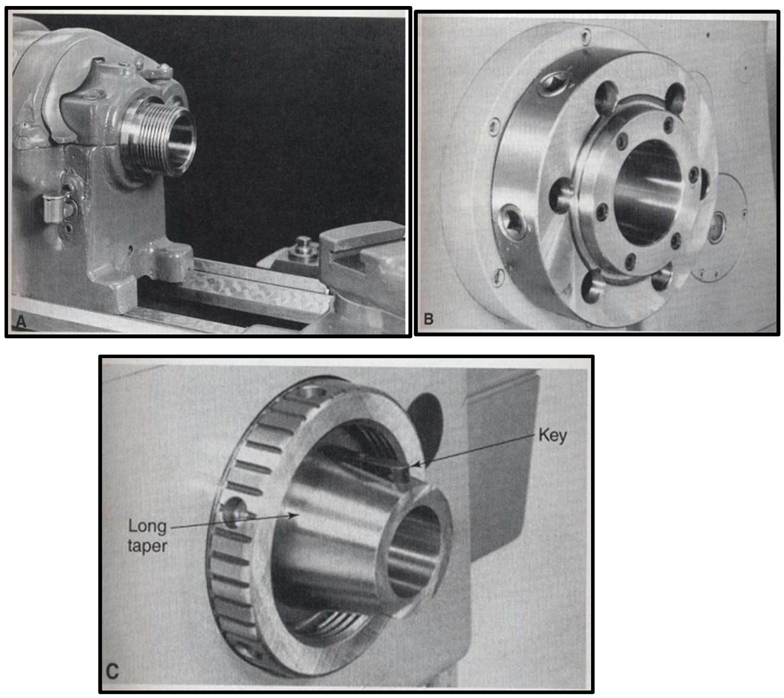


Fig.1: Types Of Spindle Noses

It is not possible for a single worker to rotate a heavy chuck till it unscrews from the spindle and then keep it down on the shop floor and finally loading another chuck on the machine. On an industrial scale, large lathes turn out a huge number of parts, such as automobile driveshafts, table legs, and so on. A gigantic metal cone or disc can be turned with large-scale lathe equipment, whereas a metal chess piece can be carved out with small-scale devices.

5. CHAPTER 3 - IDEA

Our solution consists of a hollow pipe allowed to rotate over a rod through bearings and the rod then being attached to a crane with the help of a hook which can facilitate lifting the chuck from the machine to the shop floor and vice-a-versa. It can help a person lift the chuck easily and allow him to rotate as it is supported on bearings.

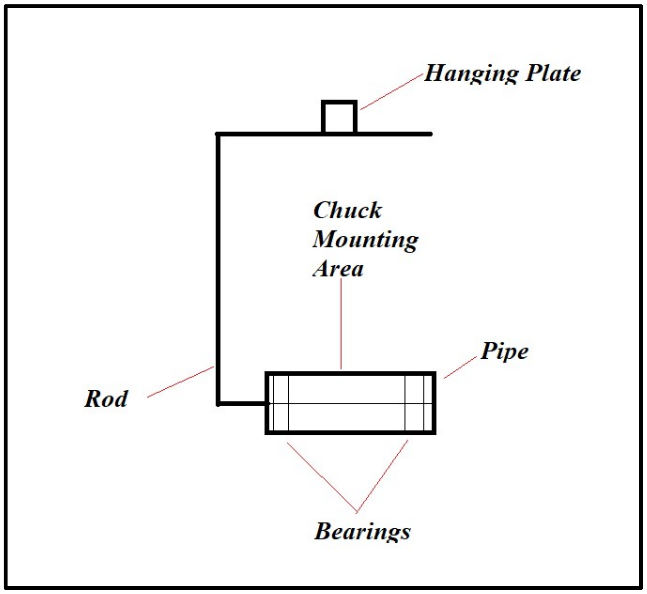


Fig.2: Initial Idea

Since we can't lift the chuck from both sides because of fastening of the chuck on spindle threads from one side, it is important to maintain balance of the chuck while lifting it from one end itself so that it doesn't topple in any direction while it is being loaded or unloaded. If it is not centrally balanced it can cause sudden movement causing safety problems for the machinists.

Hence for keeping the chuck straight throughout the process, we are going to put markings on the pipe to where the chuck is to be tightened so that the center of mass lines with the lifting point of the crane. This will ensure secure lifting of the chuck while being completely straight throughout the loading and unloading procedure.

6. CHAPTER 4 - DESIGN

6.1 Calculations

6.1.1 Hollow Pipe Calculations

Fig.3: FBD for Pipe

Reactions:

Ay=96.138 N

$\Sigma Ma = 0$

-M+2.69+9.325=0

M=12.015 Nm

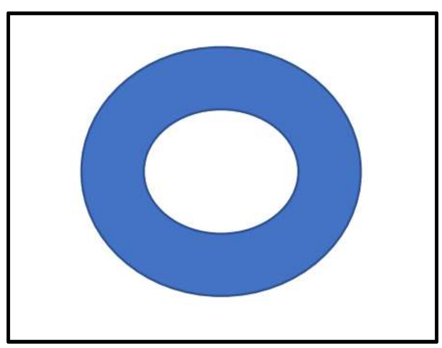


Fig.4: Hollow Pipe Cross-section

Point of Contraflexure:

$$\frac{48.069}{x} = \frac{48.069}{0.07 - x}$$

BF = $x = 0.035$

$$Ixx = \frac{\pi}{64}(D^4 - d^4)$$

$$= \frac{\pi}{64}(50^4 - 36^4)$$

$$= \frac{\pi}{64}(625 \cdot 10^4 - 1679616)$$

$$= 224234.4m^4$$

Reactions:

Ra + Rb =96.138 N

Ra =48.069, Rb=48.069

6.1.2 Shaft Calculations

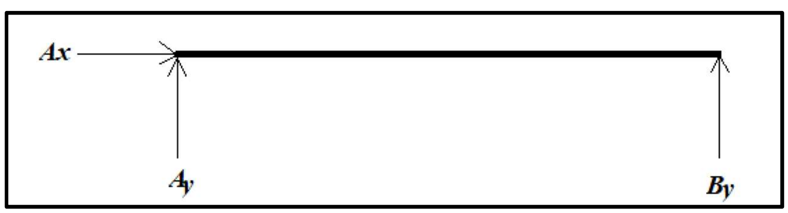


Fig 5: FBD of Shaft

Reactions:

R_a=48.069 N R_b=48.069 N

To Find Deflection we use

$EI\ \frac{d^2y}{d^2x}$ = 48.069x + [$-140\frac{(x-0.035)^2}{2}$] + [$\frac{140(x-0.105)^2}{2}$] - - - - - - - - (1)

Integrating Above equation, we get

$EI\ \frac{dy}{dx}$= [48.069$\frac{x^2}{2}$ + C_1] + [-140$\frac{(x-0.035)^3}{6}$] + [140$\frac{(x-0.105)^3}{6}$] - - - - - - - - - (2)

Again Integrating equation (2)

$EI\ y$ = [48.069$\frac{x^3}{6}$ +C_1x + C_2] + [-140$\frac{(x-0.035)^4}{24}$] + [140$\frac{(x-0.105)^4}{24}$] - - - - - - (3)

Boundary Conditions To find C_1 & C_2

At $x = 0$ $y = 0$ C_2=0

At $x = 0.14$ $y = 0$ C_1= -0.1529

Substituting C_1 & C_2 in EIy we get

$EI\ y$ = [48.039$\frac{x^3}{6}$ $- 0.159x$] + [-140$\frac{(x-0.035)^4}{24}$] + [140$\frac{(x-0.105)^4}{24}$]

By Calculating above equation, we get

EI =44846

Substituting the value & To find Deflection at center put $x = 0.07$ In equation (3)

$EI\ y$ = [$48.069 \cdot \frac{(0.07)^3}{6} - 0.1529 \cdot 0.07$] + [$-140 \cdot \frac{(0.07-0.035)^4}{24}$]+[$140 \cdot \frac{(0.07-0.105)^4}{24}$]

We Get

EIy = -7.955 x 10^{-3}

Deflection $y = \frac{-7.99 \cdot 10^{-3}}{EI} = \frac{-7.99 \cdot 10^{-3}}{44846}$

y = -1.77 x 10^{-7}

6.2 Basic Structure:

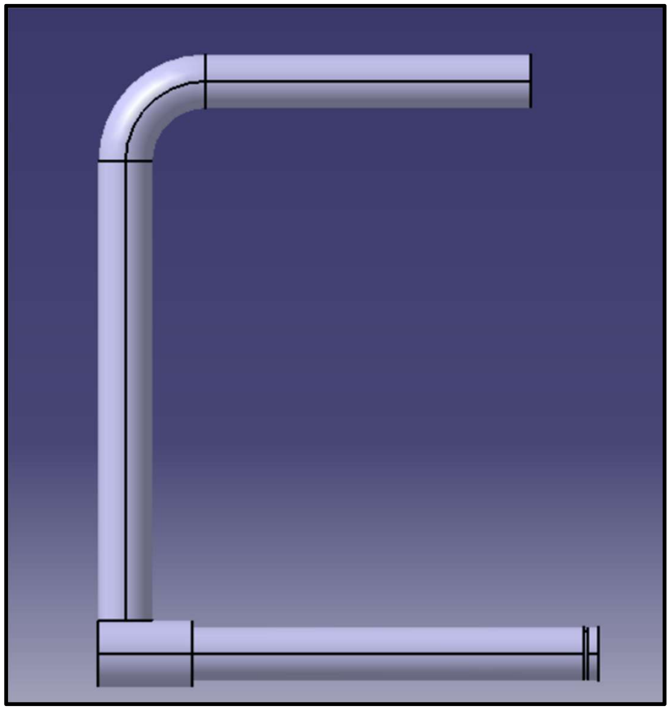


Fig 6: Basic Struture

6.3 MATERIALS

MILD STEEL

Density	:	7860 Kg/M3
Melting Point	:	1370-1400°C
Modulus Of Elasticity	:	190-210 Gpa
Thermal Conductivity	:	42.7w/M.K
Thermal Expansion	:	16-17 Mm/M-K
Yield Strength	:	345 Mpa
Tensile Strength	:	485 Mpa
Proof Stress	:	0.2%
Hardness	:	70 Hrc
Elongation (In 200mm)	:	20% Minimum

Important Properties:

High Tensile Strength

High Impact Strength

Good Ductility and Weldability

6.4 BEARING

6004-2Z

Deep groove ball bearings

2Z: Shield on both sides

DIMENSIONS

d	:	20 mm	Bore diameter
D	:	42 mm	Outside diameter
B	:	12 mm	Width
d1	≈	27.2 mm	Shoulder diameter
D2	≈	37.19 mm	Recess diameter
r1,2	:	min 0.6 mm	Chamfer dimension

Selected based on:

1. Allowed space
2. Bearing load capacity
3. Ease of Installation and Removal

6.5 DIMENSION SUMMARY (PARTS)

6.5.1 Shaft

a. Major Dia - 25 mm
b. Minor Dia - 20 mm (Bearing Size)
c. Circlip Slot - 1.5 x 1.5 mm
d. Total Length - 200 mm

6.5.2 Pipe

a. Outer Diameter - 50 mm
b. Inner Diameter - 40 mm
c. Bearing Sheet Step Size ID - 44 mm
d. Total length - 150 mm

6.5.3. Hanging Rod

a. Diameter - 20 mm
b. Bend Angle - 900
c. Central axis Length - 340.87 mm
d. Bend Deduction - 34.13mm
e. First Side Straight Length - 180mm
f. Second Side Straight Length - 130 mm

6.5.4. Hook Plate

a. Raw Material Dimensions - 70 x 80 x 8mm
b. Hole Size - 25 mm
c. Tangent Circle Diameter - 40 mm
d. Hole Coordinates - (35 , 60) mm
e. Hanging Coordinates on assembly - (125 , 285) mm

6.6 CALCULATION SUMMARY

1. Reactions on pipe
   a. Ra = 48.069 N
   b. Rb = 48.069 N
2. Point of contraflexure = 0.035 m
3. Flexural Rigidity(EI) = 44846 Nm
4. Maximum deflection at center = -1.77 x 10-7 m
5. Moment on fixed end of shaft = 12.015 Nm
6. Reaction on fixed end = 96.138 N
7. Weight of Assembly = 2.549 kg
8. Center of Gravity of bare assembly = (90.099 , 0) mm
9. Center of Gravity of assembly with dummy chuck weight of 54 kg for 14” chuck = (123.412 , 0) mm

6.7 CAD:

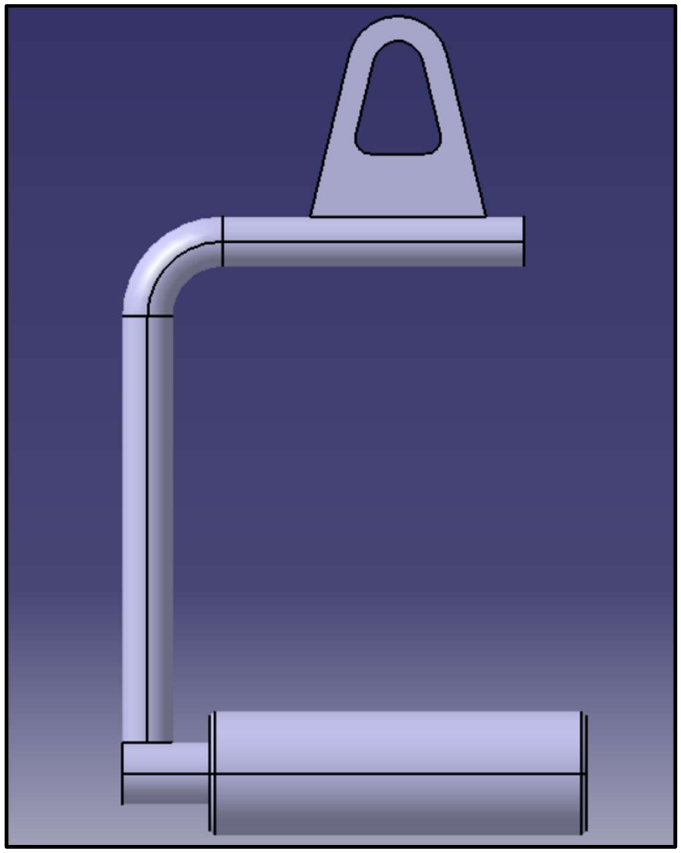


Fig.7: CAD Model Side View

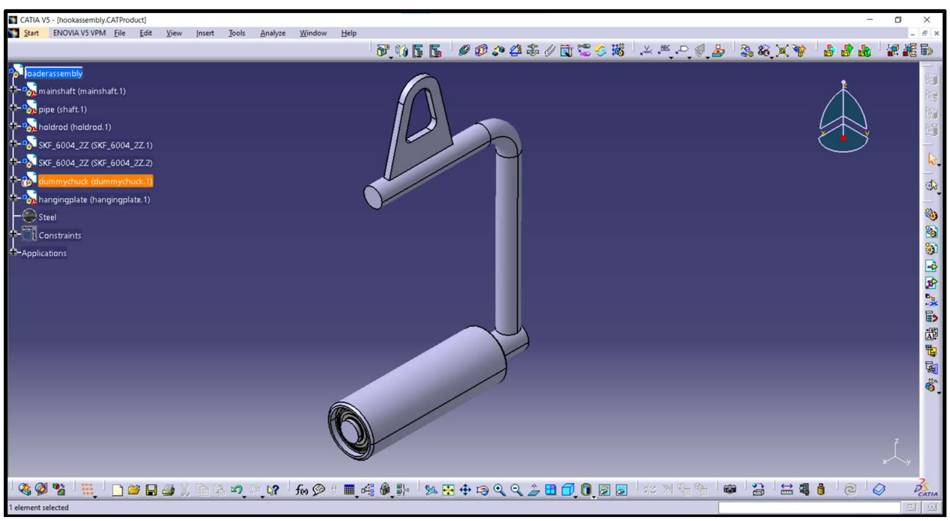


Fig.8: Isometric View

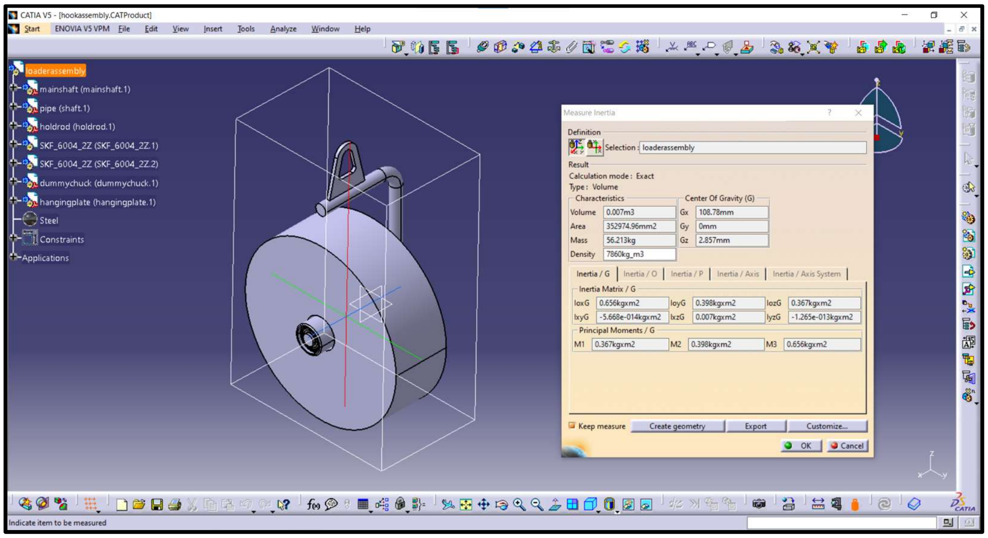


Fig.9: Confirming COG Calculations With CAD Model using Dummy Cylinder

6.8 Analysis:

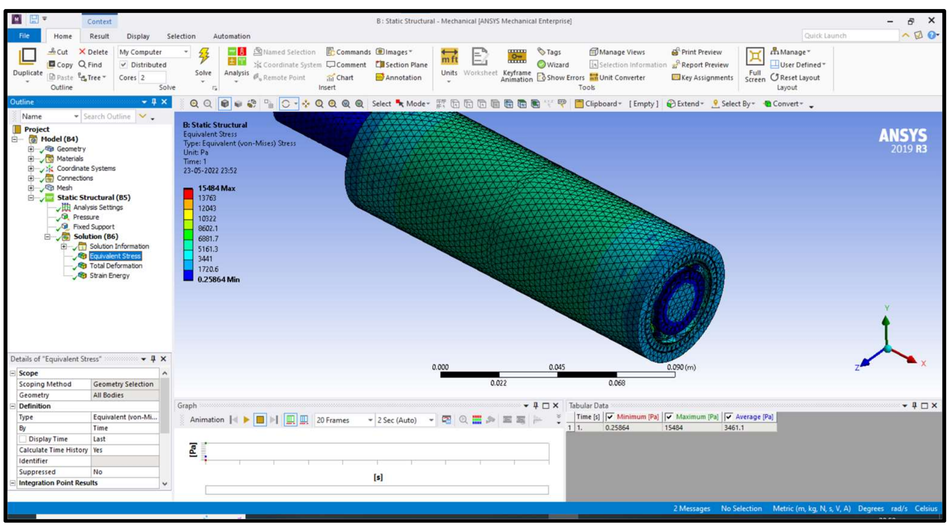


Fig.10: Stress Analysis on Ansys

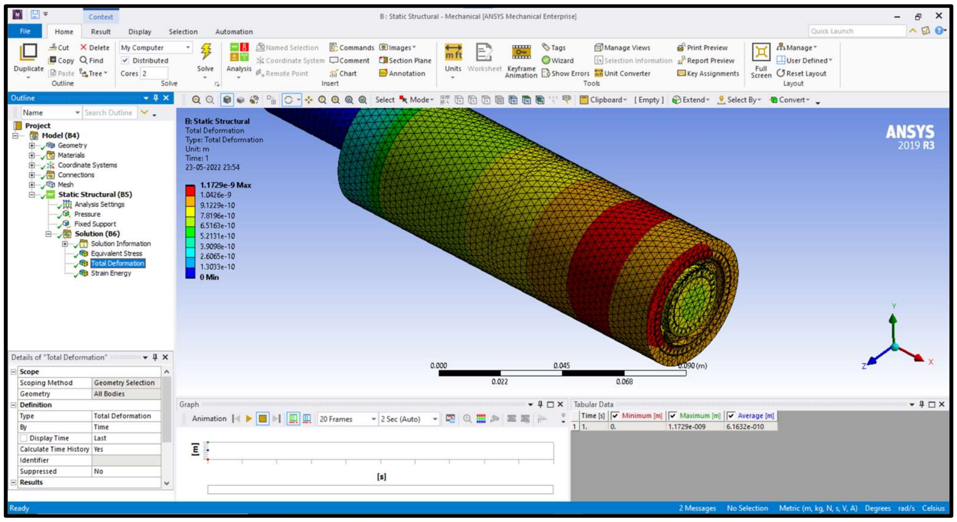


Fig.11. Deformation Analysis On Ansys

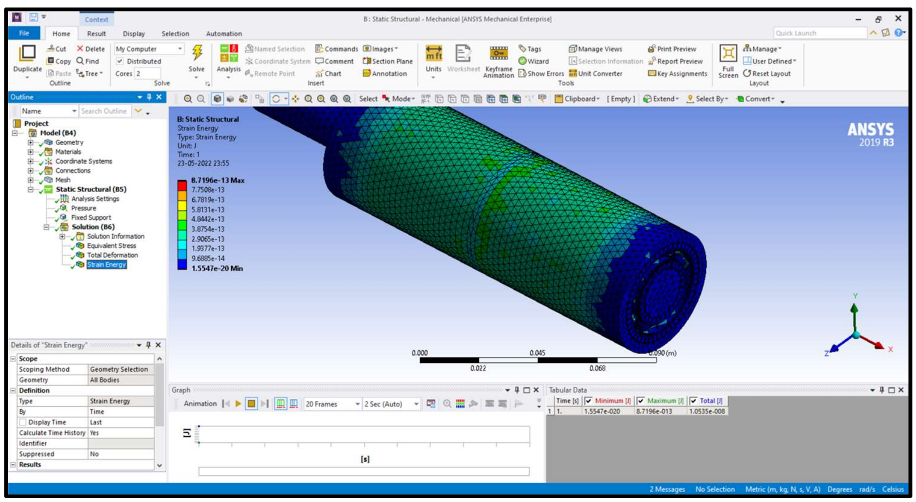


Fig.12: Strain Energy Analysis On Ansys

Hence, the design shows no sign of failure upto weight of 150 kg longitudinally on the shaft given loading capacity of bearing and material strength.

7. IMPLEMENTATION

7.1 Technologies

7.1.1 Laser Cutting

Laser cutting starts, naturally, with a laser beam. The beam is focused until its intensity is sufficient for the job at hand, whether that's cutting through metal, human tissue or cardboard. A computer program guides the laser itself and specifies the pattern the laser beam will cut. Once it begins, the laser will then follow the pre-programmed guide to complete its work.

Depending on the material and the desired result, the laser beam will both move around and vary its focal length. This way, it can reach different depths and cut different layers of material. With metals, this is useful for techniques like engraving. In other applications like medicine, however, its pinpoint accuracy allows it to cut medical devices.

Laser cutting is truly amazing technology. It lies at the confluence of computers and the human touch. Its applications are already broad, but more will undoubtedly emerge as technology continues to improve.

7.1.2 CNC Machining

CNC stands for computer numerical control and refers to a machine operated by a computer system. A CNC lathe is operated with precise design instructions to machine parts to precise specifications. A CNC lathe is a machine tool where the material or part is held in place and rotated by the main spindle as the cutting tool that works on the material is mounted and moved on various axes.

A simple CNC lathe operates on two axes with the cutting tool in a fixed position at 8 to 24 station turret. The rotating action of the workpiece is called "turning." This is why certain types of CNC lathes are called CNC Turning Machines. CNC lathes produce precise round shapes with an outer diameter (OD) and an inner diameter (ID). Many different kinds of structures can bemachined with this machine tool, depending on their various industries' needs. They are commonly used in oil and gas, automotive, aerospace, medical, electronics, mining, power plant, steel and paper mills, and shipbuilding industries.

Modern CNC lathe machines usually come with tools that could work on multiple axes. Different types of machines can include both X and Y-axis, incorporate a second turret with other tools, or include a second spindle. This means a CNC lathe can perform additional milling, drilling, and tapping operations, resulting in a complete and even complex part manufacturing process and eliminating the need to transfer the part to another machine for a second operation.

7.2 Manufacturing:

It consist Of Few Steps Where All Manufacturing Process Takes Place

Fig.13: Raw Material Needed to machined

Hollow Pipe: We Consider a hollow Pipe Which Can Easily Withstand the Weight Of 50kg By Specific ID and OD. Following

Up We do a Turning Operation on Hollow Pipe Where Excess Material Is Removed by Rotating It. After This We Apply Bearing Sheet. After This Steps We get a Nice finish And To achieve Sharpness On pipe we do blackodising. It is Nothing but Black Oxide Coating Which Adds Thickness to Product and Also Reduce Corrosion and Friction in the product.

Fig.14: Raw material for hollow pipe

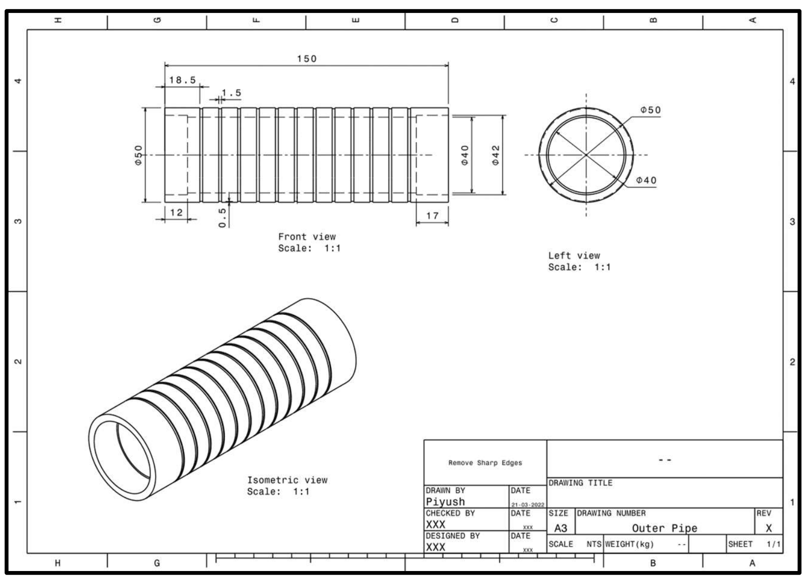


Fig.15: Draft of Shaft for Machining and Grinding

Step 2: We consider A Thick Shaft Which We pass Through

Hollow Pipe. We Perform Certain Operation On Shaft Before Passing It In Hollow Pipe viz Turning and Grinding.

Fig.16: Raw Material for inner shaft

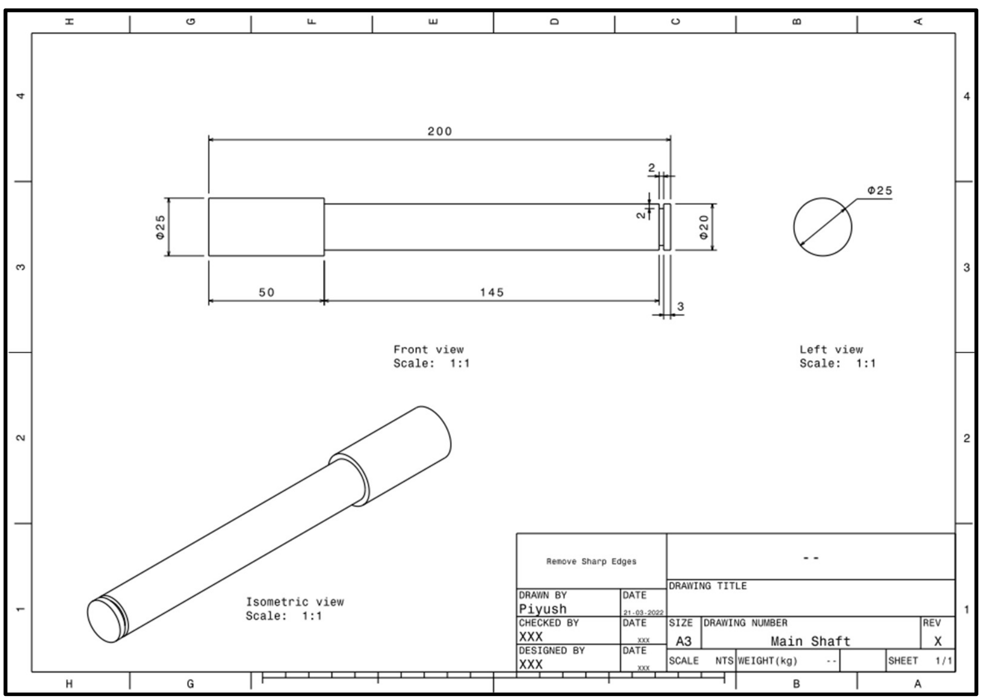


Fig.17: Draft of Shaft for Machining and Grinding

Fig.18: Machining Shaft On Lathe

We take a Rod Which We Attach The Back End Of A shaft By Electric Arc Welding.

Firstly We Do Knurling On rod And bend It At Top end. We do Stress Relieving At That Point. Usually stresses are induced while Performing Operation which Causes Tolerance, cracking and Other Failure on Rod. We remove Internal (residual) stress by This Stress relief Operation Which To avoid Stress Related Failures In Rod.

After This We Also Did Coating On rod same As in Hollow Pipe i.e Blackodising For Sharpness And Thickness.

Fig.19: Raw Material for Rod to Bend

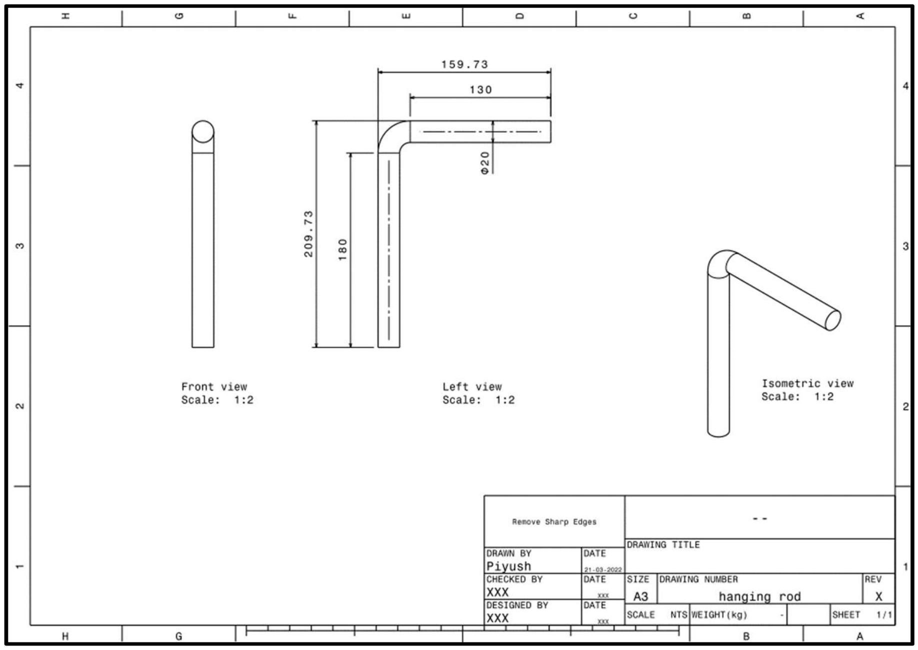


Fig.20: Draft of Rod for Machining

Step 3: Hanging Plate- We take a plate of MS Material And do A Cut On plate For specific Shape. We Attach It on Rod By electric Arc Welding. This Hanging Rod Will Help for Hooking The Attachment On crane.

Fig.21: Laser Cutter Hanging Plate

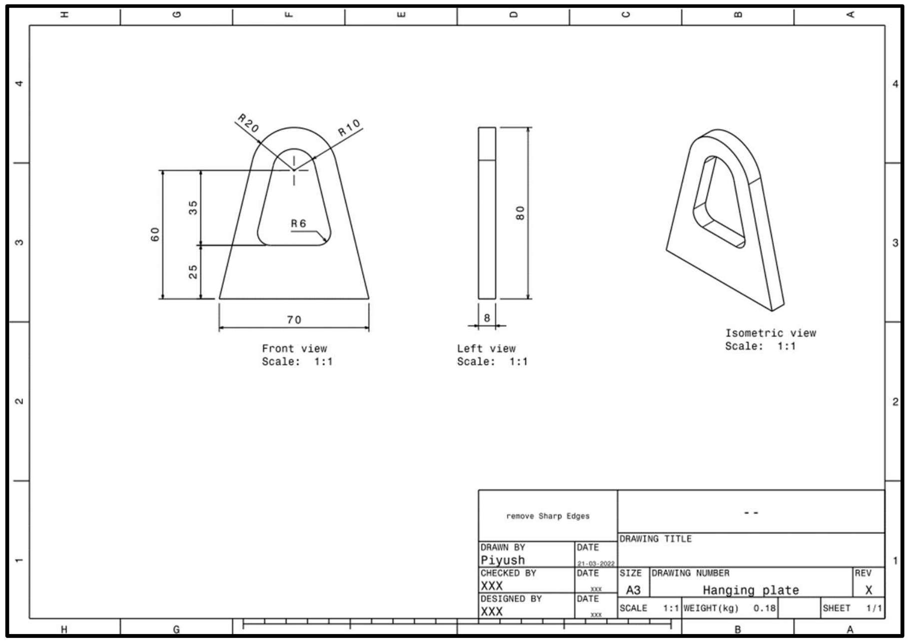


Fig.22: Draft of Hanging Plate

7.3 Assembly Of Product:

Mechanical assembly is the process of putting together components on an assembly line. In addition to this, it also refers to an assembled product or part made in this way. In either case, mechanical assembly carries the connotation of putting parts together, making a complete product to perform a function.

As mentioned In Manufacturing Part all the parts are connected together to form an assembled product

Step 1 : We pass the shaft through the Hollow pipe and weld its back end by Electric

Arc Welding. This Weld Provides strong Bond between Shaft and Rod

Step 2: As we continue we Bend Top end of the Rod and do stress Relieving on that part to Eliminate the residual stress present in it which can cause tolerance, Cracking etc.

Fig.23: Welded Assembly

Step 3 : The Product is now perfectly welded we Attach an hanging rod to the top end of the rod which will help to hook it to the crane and at the end we provide a circlip.

Step 4 : Last but not least we Put bearing at the front and rear end of hollow pipe which will provide the free movement i.e. freely Rotation of pipe. We assemble the pipe on the bearings and attach a circlip to lock the attachment.

A circlip is a type of fastener or retaining ring consisting of a semi-flexible metal ring with open ends which can be snapped into place, into a machined groove on a dowel pin or other part to permit rotation but to prevent axial movement.

Fig. 24: Final Assembly

Hence, the assembly is completely with all the procedure are done with safety and under supervision of a guide.

8. Evaluation

8.1 Time Study

Time study is a structured process of directly observing and measuring human work using a timing device to establish the time required for completion of the work by a qualified worker when working at a defined level of performance.

The observer first undertakes preliminary observation of the work (a pilot study) to identify suitable elements which can be clearly recognized on subsequent occasions and are of convenient length for measurement.

Subsequent studies are taken during which the observer times each occurrence of each element using a stopwatch or other timing device while at the same time making an assessment of the worker's rate of working on an agreed rating scale. One of the prime reasons for measuring elements of work, rather than the work as a whole is to facilitate the process of rating. The rate at which a worker works will vary over time; if elements are carefully selected, the rate of working should be consistent for the relatively short duration of the element.

Time study, when properly undertaken, involves the use of specific control mechanisms to ensure that timing errors are within acceptable limits. Increasingly, timing is by electronic devices rather than by mechanical stopwatch; some of these devices also assist in subsequent stages of the study by carrying out the process of "extending" or converting observed times into basic times. The basic time is the time the element would take if performed at a specified standard rating.

The number of cycles that should be observed depends on the variability in the work and the level of accuracy required. Since time study is essentially a sampling technique in which the value of the time required for the job is based on the observed times for a sample of observations, it is possible using statistical techniques to estimate the number of observations required under specific conditions. This total number of observations should be taken over a range of conditions where these are variable and, where possible, on a range of workers.

Time study is a very flexible technique, suitable for a wide range of work performed under a wide range of conditions, although it is difficult to time jobs with very short cycle times (of a few seconds). Because it is a direct observation technique, it takes account of specific and special conditions but it does rely on the use of the subjective process of rating. However, if properly carried out it produces consistent results and it is widely used. Additionally, the use of electronic data capture devices and personal computers for analysis makes it much more cost effective than previously.

8.2 Observations

Operation :Loading Of Chuck (Traditional Method)

Tools And Gauges:Stopwatch

Product Part :Chuck

Material : Cast Iron, Forged Steel

Total Time required: 890 Seconds

Avg Time : 178 Seconds

Sr No	Element Description	Observed Time in (sec)					Total Observed Time in(sec)	Avg Time in (sec)
		1	2	3	4	5		
1	Unmount from spindle	51	56	59	58	55	279	55.8
2	Keep on Bed Floor	20	26	21	19	23	109	21.8
3	Cleaning Thread On 2nd Chuck	12	09	10	10	14	55	11
4	Keeping 2nd Chuck On Bed	24	27	24	25	25	125	25
5	Mounting Chuck on Spindle By Rotating	67	61	69	66	59	322	64.4

Table.1: Time Study Table For Traditional Method

Fig.25: Unloading Chuck from Lathe Traditionally (1)

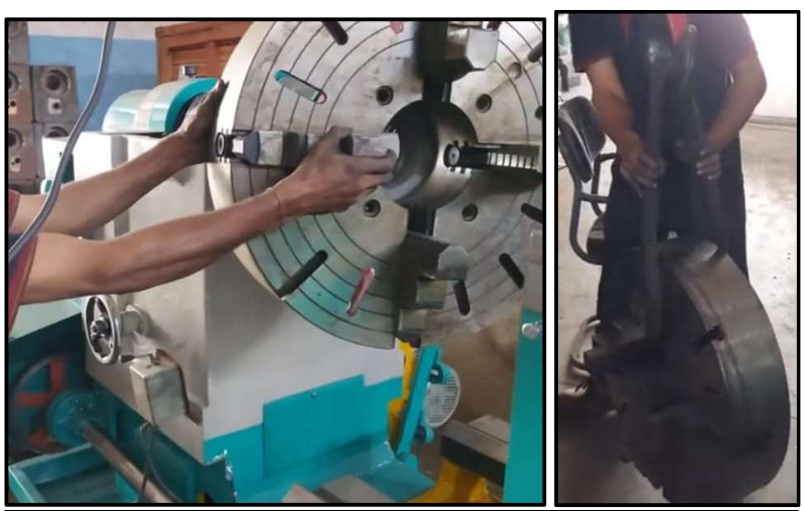


Fig.26: Unloading Chuck from Lathe Traditionally (2)

Fig.27: Loading Of Chuck Traditionally

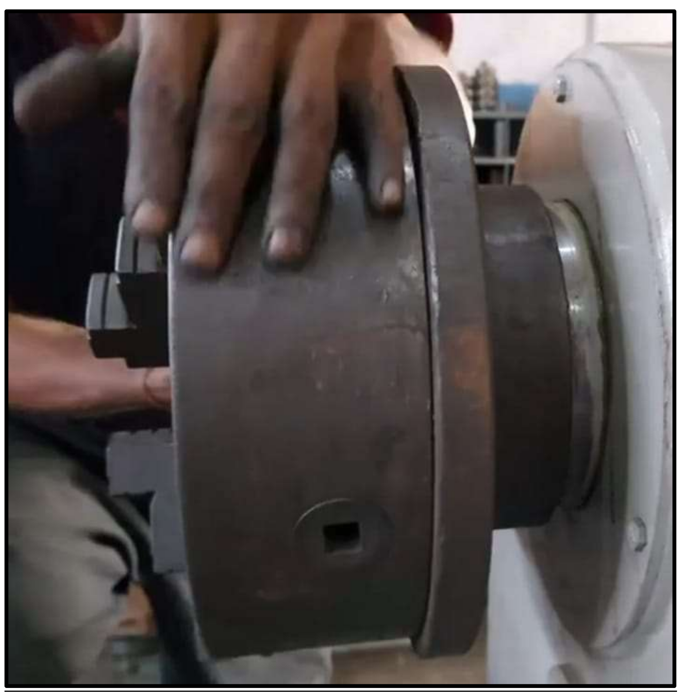
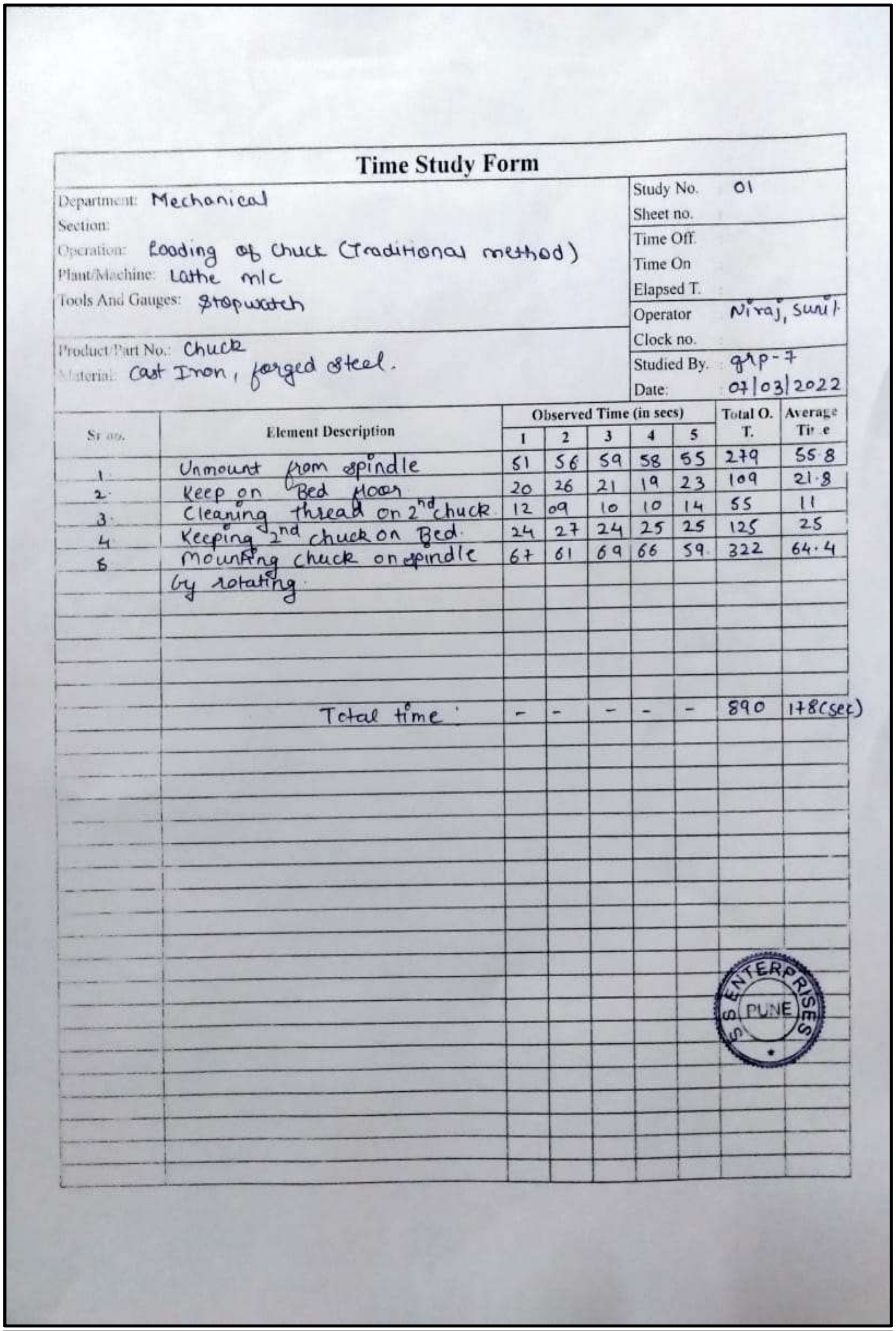


Fig.28: Loading Of Chuck Traditionally



Time Study Form

Department: Mechanical	Study No. 01
Section:	Sheet no.
Operation: Loading of Chuck (Traditional method)	Time Off.
Plant/Machine: Lathe m/c	Time On
Tools And Gauges: Stopwatch	Elapsed T.
	Operator Niraj, Suraj.
Product/Part No.: Chuck	Clock no.
Material: Cast Iron, forged steel.	Studied By. grp-7
	Date: 07/03/2022

Sr no.	Element Description	Observed Time (in secs) 1	2	3	4	5	Total O. T.	Average Time
1.	Unmount from spindle	51	56	59	58	55	279	55.8
2.	Keep on Bed floor	20	26	21	19	23	109	21.8
3.	Cleaning thread on 2nd chuck.	12	09	10	10	14	55	11
4.	Keeping 2nd chuck on Bed.	24	27	24	25	25	125	25
5	Mounting chuck on spindle by rotating.	67	61	69	66	59.	322	64.4
	Total time :	-	-	-	-	-	890	178(sec)

S S ENTERPRISES PUNE

Fig.29: Time Study Form For Unloading and Loading Of Lathe Chuck Traditionally

Operation : Loading Of Chuck (Revised Method)

Tools And Gauges : Stopwatch

Product Part :Chuck

Material : Cast Iron , Forged Steel

Total Time required :518 Seconds

Avg Time : 103.6 Seconds

Sr No	Element Description	Observed Time In Seconds					Total Observed Time(Sec)	Avg Time(sec)
		1	2	3	4	5		
1	Tightening Jaws on Attachment	12	10	15	13	10	60	12
2	Unmounting Chuck from Spindle	14	16	16	15	17	78	15.6
3	Keeping Chuck in Rack	19	23	22	26	23	113	22.6
4	Lifting 2nd Chuck & Aligning in front of spindle	08	10	07	08	11	44	8.8
5	Cleaning Thread On chuck & spindle	20	23	21	25	24	113	22.6
6	Mounting Chuck On spindle	08	12	08	07	10	45	9
7	Untightening jaws from attachment	11	14	13	12	15	65	13

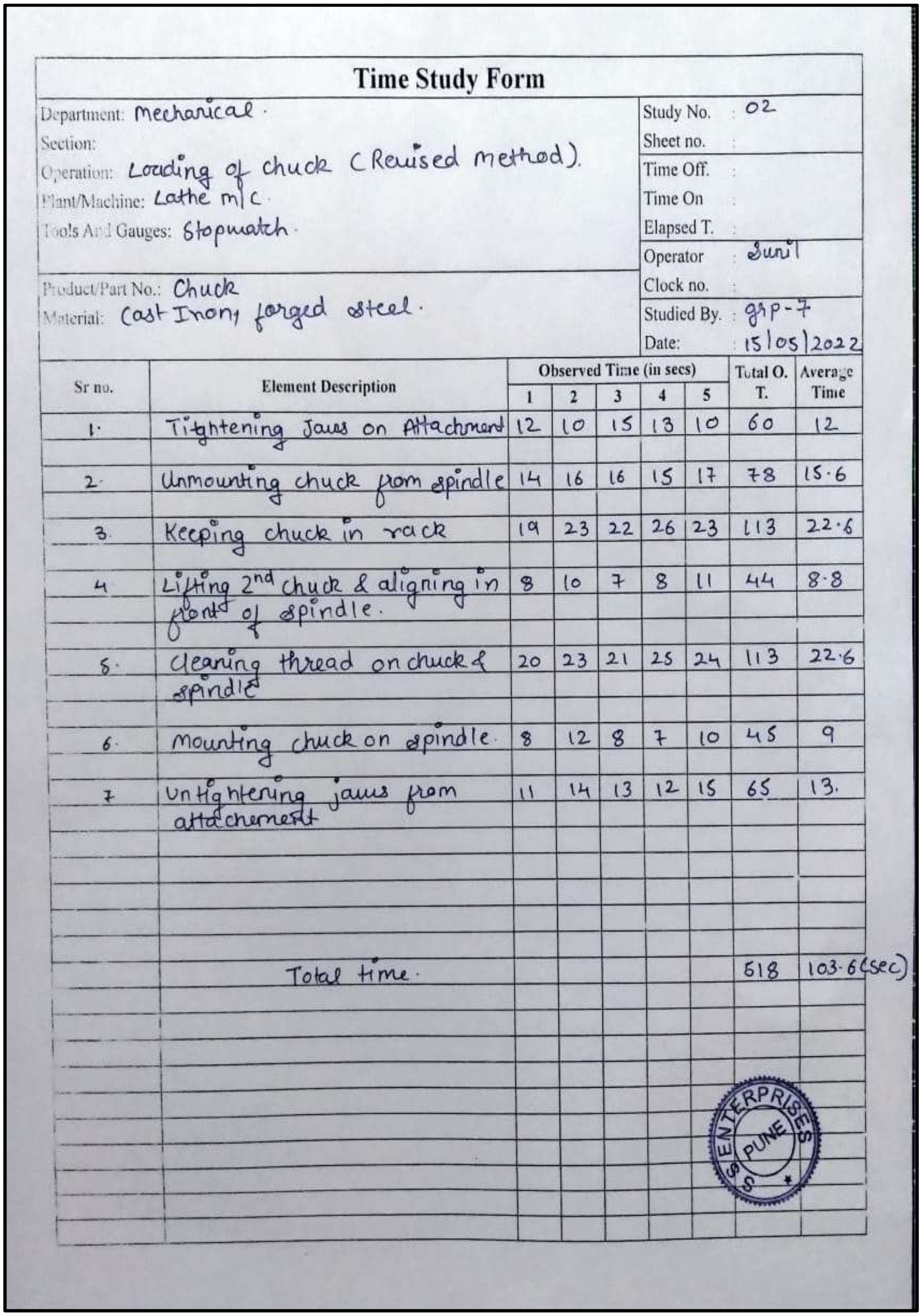
Table 2: Time Study Table For Revised Method

Fig.30: Unloading of Chuck by revised Method

Fig.31: 200kg Hoist Used for Loading And Unloading of Materials and Chuck

Fig.32: Loading Of Chuck by Revised Method

Fig.33: Loading Of Chuck by Revised Method



Time Study Form

Department: Mechanical.
Section:
Operation: Loading of chuck (Revised method).
Plant/Machine: Lathe m/c.
Tools And Gauges: Stopwatch.
Product/Part No.: Chuck
Material: Cast Iron, forged steel.

Study No. : 02
Sheet no. :
Time Off. :
Time On :
Elapsed T. :
Operator : Sunil
Clock no. :
Studied By. : grp-7
Date: 15/05/2022

Sr no.	Element Description	Observed Time (in secs) 1	2	3	4	5	Total O. T.	Average Time
1.	Tightening Jaws on Attachment	12	10	15	13	10	60	12
2.	Unmounting chuck from spindle	14	16	16	15	17	78	15.6
3.	Keeping chuck in rack	19	23	22	26	23	113	22.6
4	Lifting 2nd chuck & aligning in front of spindle.	8	10	7	8	11	44	8.8
5.	Cleaning thread on chuck & spindle	20	23	21	25	24	113	22.6
6.	Mounting chuck on spindle.	8	12	8	7	10	45	9
7	Untightening jaws from attachement	11	14	13	12	15	65	13.
	Total time.						518	103.6 (sec)

S ENTERPRISES PUNE

Fig.34: Time Study Form For Unloading and Loading Of Lathe Chuck by Revised Method

8.3 Percentage Time Saved:

Let's Consider An example: A worker needs to change chuck 10 times and has a wage of 80 rs/hr. We will Calculate the Percent Time saved by 2 method That are Traditional and Revised

Solution:

Traditional Method:

Avg time=178 sec =178/(60*60) ; N =No of times =10

People (Worker)= 2

Time in Hours to change 10 chuck

= N * t * p - - - - - - (in hrs)

= 10 *178/3600 * 2

= 0.988 hrs

Revised Method :

Avg Time=103.6 sec =103.6/(60*60) ; N=No of Times=10

People (Worker)=1

Time in Hours to change 10 chuck

= N * t * p - - - - - - (in hrs)

= 10 * 103.6/3600 * 1

= 0.287 hrs

Time Saved In %

= Traditional Method - Revised Method /Traditional Method *100
= 0.988-0.287/0.988 * 100

Time Saved In % = 70.95 %

9. CONCLUSION

Hence, we can conclude that we can readily solve the problem of loading and unloading heavy chucks from the lathe machine by adding an attachment to previously used cranes and handles. We can by the given attachment be able to eliminate accidental conditions in small workshops.

Fig.35: Final Version

This attachment after complete construction is cost effective and be made for small as well as big workshops making use of lathe machines. Modern technologies may have been able to eliminate human effort in how and when operations are done in lathe machines in form of CNC and VMC but still could not eliminate the replacement security risks in changing chuck of a CNC lathe machine too. This attachment will facilitate and solve all the problems caused and will make it easy and efficient the procedure of changing a chuck altogether.

After successful implementation of this solution, we have a safe alternative method for loading and unloading lathe machine chucks without any safety issues to the workers. The above attachment can make the task of unscrewing convenient to follow without having any problems of handling the chuck between two hands. Also it will make unscrewing and screwing of the chuck and then lifting it possible for a single machinist. This will greatly save worker time and will provide continuity in work at the shop floor.

While a worker or machinist remains alone doing a particular job, this attachment will make it less stressful for the person to exchange chucks at his disposal easily and safely without risking his personal being.

Hence the following attachment makes the process of loading and unloading of the chuck:

1. Completely Safe
2. More Effective in Handling
3. Less Time Consuming
4. Efficient in Manpower

9.1 Estimated Cost of Product

This project involves the manufacture and testing of the attachment. There are costs involved in procurement of material as well as processing/ machining costs, which are included with suitable assumptions.

Sr.no.	Component/Process	Quantity	Price
1	Shaft 22 OD	1	460.00
2	Rod 20 OD	1	820.00
3	Hanging Hook	1	110.00
4	Seamless Pipe	1	340.00
5	Bearing	2	520.00
6	Circlip	1	30.00

Table. 3: Cost Estimate

The cost estimate of such attachment comes out to be roughly Rs.2280.00

9.2 Future Scope:

1. As the above attachment only works for Jaw chucks it will not be able to attach on magnetic chuck and hence, we have to make another attachment that can be able to hold a magnetic chuck over it. This will enable the machinist to hold a magnetic chuck in the attachment and change it with a normal jaw chuck.

2. Since the rotation of the check is made by the machinist himself it is is possible to automate this process as well by using a micro motor that can be attached to the shaft that can rotate a threaded chuck over and help the machinist in winding or unwinding the chuck.

3. As the attachment now only works on a hoist, we can make a separate attachment that will only hold chucks and will help the machinist to keep it in the rack. This can be done by making a trolley that will hold a crane that can hang the check attachment on it and hence help the machinist Move It freely over it's arm.

4. The attachment that has been prepared is made completely on need based design and hence can be optimized by using strength analysis on the elements and hence its weight can be reduced and its strength

taking capacity can be increased by optimizing its elements.

5. The attachment can be made adaptable to a CNC to make it possible to change the chucks with different types of nose attachments on a CNC lathe machine. This will help the machinist to change a CNC chuck rapidly without any errors.

6. The seamless pipe on the attachment has knurling over it and Hence we can add markings on them so that the center of gravity of the chucks will align with attachment it and the chuck will stay a completely upright over the attachment every time the machinist leaves it hanging.

Hence, here we have studied and designed a attachment for lathe machine chuck to be a helping hand to a machinist in time of need, reducing human effort. It proves to have variety of application and to save time by up to 70% on practical basis in a toolroom workshop for increased efficiency and safety.

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