Dissertation

On

DESIGNING OF NEW CHUTE PLATE FOR QUICK DIE CHANGE

ON HIGH SPEED PRESSES

Submitted in partial fulfillment of the requirement for

the award of degree of

MASTER OF ENGINEERING

IN

CAD/CAM & ROBOTICS

Submitted By

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JUNE-2011

CERTIFICATE

I hereby Certify that the work in this thesis report entitled "**DESIGNING OF NEW CHUTE PLATE FOR QUICK DIE CHANGE ON HIGH SPEED PRESSES**" is an authentic record of my study carried out as requirement for the award of degree of **Master of Engineering (CAD/CAM & Robotics)** at **Thapar University, Patiala** under the guidance of **Dr. AJAY BATISH,** Professor, **ANIRBAN BHATTACHARYA,** Assistant Professor, Thapar University, Patiala and **Mr. SACHIN MORE,** Senior Manager, Crompton Greaves Limited, Global R&D Centre, Mumbai during **July 2010 to June 2011.** The matter embodied in this report has not been submitted in part or full to any other university or institute for the award of any other degree.

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This is to certify that above declaration made by the student concerned is correct to the best of our knowledge & belief.

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ACKNOWLEDGEMENT

Words are often less to revels one's deep regards. With an understanding that work like this can never be the outcome of a single person, I take this opportunity to express my profound sense of gratitude and respect to all those who directly or indirectly helped me through the duration of this work.

I take the opportunity to express my heartfelt adulation and gratitude to my supervisors, ***Dr. Ajay Batish***, ***Anirban Bhattacharya*** *and M****r. Sachin More*** *for their unreserved guidance, constructive suggestions, thought provoking discussions and unabashed inspiration in the nurturing work. It has been a benediction for me to spend many opportune moments under the guidance of the perfectionist at the acme of professionalism. The present work is testimony to their activity, inspiration and ardent personal interest, taken by them during the course of this work in its present form. I am grateful to* ***Mr .Dilip Wakode*** (WM)*, Crompton Greaves for providing the facilities for the completion of the work.*

The Crompton Greaves staff Mr. Abhijit Kulkarni, Mr. BalaKrishna Nair, Mr. Ikbal mullla, Mr. Ram Padulkar, Mr. Mayur Lokhande, Mr.Angad Kulkarni deserves special thanks for their help during the period of this work. I offer special regards to Mr. Subash Sindhe for providing his immense support in performing the manufacturing and implementation the design. No words acknowledge the support I received from my friends for their valorous help and co-operation.

I take pride of myself being son of ideal parents for their everlasting desire, sacrifice, affectionate blessings, and help, without which it would not have been possible for me to complete my studies.

I would like to thank to all the members and employees of Mechanical Engineering Department, Thapar University Patiala and Stamping Division, Crompton Greaves Ltd. for their everlasting support. Above all, I express my indebtedness to the "ALMIGHTY" for all His blessing and kindness.

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CONTENT

ABSTRACT

Stamping process uses high productive level machines. Machine capacity utilization is a key goal in achieving minimum time consumption for setup change time or idle time. Tool change over process is recognized as possible area for reducing the time consumption. The main objective of the present study is to identify the root causes of bottlenecks operation and implement possible solution to the problems. Single minute exchange of die (SMED) method and quick die change (QDC) technology were applied at major bottleneck setup operation in one of major company in India (Crompton Greaves Ltd.). Chute plate design was found as the major cause for high setup time. A standard chute plates was designed for rotor and stator chute with software solid work 9.0™ and designed some other relevant assembly component required for easy setting of chute. Stress analysis of chute plates was performed by using software ANSYS 11.0 before actual manufacturing of component to ensure design safety. The SMED method has been improved by additional technology QDC and design modification implementation of chute plate was simultaneously applied. Significant time savings have been achieved with minimum investment.

LIST OF TABLE

LIST OF FIGURE

ABBREVIATION

SMED	Single minute exchange of die
QDC	Quick die change
WIP	Work in process
ROI	Return of investment
CGL	Crompton Greaves Limited
TIG	Tungsten inert gas
MAG	Metal active Gas
JIT	Just in time
IMVP	International motor Vehicle program
TPS	Total production system
FEM	Finite element method
PNA	Productivity need analysis
TOC	Theory of constraints
BDC	Bottom dead center
RPM	Revolution per minute
ISO	Indian standard organization

CHAPTER 1
INTRODUCTION

1.1SETUP TIME

The survival of any industry in today's competitive market place depends on response time, production costs and flexibility in manufacturing. In recent years, companies have become increasingly focused on market demand and customers responsiveness. This has led to the implementation and adoption of lean manufacturing techniques in the automotive industry. Due to the complexity and demand behavior from customers, the role of better change over or setup time reduction that enable better response and small batch manufacture. Reducing setup time has many benefits such as increased manufacturing flexibility and capability, shorter lead time, reduced inventory levels and production costs. Basically, short setup time can be achieved if overall lead times are reduced. Short setup time reduces wastes and defects, and thereby improved product quality. The main goal of setup time is to reduce machine down time. Reducing machine down time will boost your company's capacity, increase your manufacturing flexibility, and help increase overall output. Setup time can be reduced by using Single Minute Exchange of Die (SMED) concepts, which can be achieved through better planning, process redesign and product.

SMED is a scientific approach to reduce setup time that can be applied in any factory to any machine. The ultimate goal of SMED is to perform machine setup and changeover operations in less than ten minutes. Several practitioners have proved that the SMED method really works in practice and in some situations reductions of 90 percent or more are feasible [1 2].

1.2 MAJOR ISSUE

In the present competitive market wastage is the major issue of any industries .There are some major issues in the any industries are mainly due to wastage in waiting. Some of the basic type of wastage is explained [3].

1.2.1 Basic Types of Waste

One contribution of Toyota Motor Company to modern manufacturing is its strong advocacy of waste elimination as a strategy for continuous improvement. Toyota defines waste as anything other than the minimum amount of materials, equipment, parts, space, or time which is essential to add value to the product. Though sources of waste vary within and across organizations, the similarities are great. The following sources of waste, identified by Toyota and first described by Taiichi Ohno, are universal in manufacturing [3]:

i. Transportation waste: Carrying work in process (WIP) long distances, creating inefficient transport, or moving materials, parts, or finished goods into or out of storage between processes.

ii. Process Waste: Taking unneeded steps to process the parts. Inefficiently processing due to poor tool and product design, causing unnecessary motion and producing defects. Waste is generated when providing higher-quality products than is necessary.

iii. Inventory Waste: Excess raw material, WIP, or finished goods causing longer lead times, obsolescence, damaged goods, transportation and storage costs, and delay. Also, extra inventory hides problems such as production imbalances, late deliveries from suppliers, defects, equipment downtime, and long setup times.

iv. Waste of motion: Any wasted motion employees have to perform during the course of their work, such as long looking for, reaching for, or stacking parts, tools, etc. Also, walking is waste.

v. Waste from product defects: Production of defective parts or correction. Repair or rework, scrap, replacement production, and inspection mean wasteful; handling, time, and effort.

vi. Waiting time: Workers merely serving to watch an automated machine or having to stand around waiting for the next processing step, tool, supply, part, etc., or just plain having no work because of stock outs, lot processing delays, equipment downtime, and capacity bottlenecks.

vii. Overproduction: Producing items for which there are no orders, which generates wastes such as overstaffing and storage and transportation costs because of excess inventory.

1.2.2 Common Causes of Waste

The common causes of generation of above seven types of waste are as per below list [3].

1. Long tool setup time
2. Layout (distance)
3. Incapable processes

4. Poor maintenance
5. Poor work methods
6. Lack of training
7. Inconsistent performance measures
8. Ineffective production planning
9. Lack of workplace organization
10. Poor supply quality/reliability

1.2.3 Long Tool Changeover (Setup Time)

Tool change over time is the major issue in the plant it wastes more time in all setup operation. For resharpening of tool and variety of products, frequent tool die changes are required on the press. This process takes a considerable time i.e. in hours. It causes several problems [3]-

1. Reduce the machine efficiency
2. Reduce the flexibility of machine
3. Reduce the productivity of plant
4. Dispatch delay

To reduce the losses caused by more setup time new techniques have been taken into practice i.e. Single Minute Exchange of Die and Quick Die Change

1.3 SINGLE MINUTE EXCHANGE OF DIES (SMED)

Single minute exchange of die (SMED) is one of the many lean production methods for reducing waste in a manufacturing process. It provides a rapid and efficient way of converting a manufacturing process from running the current product to the next product.

"Single minute exchange of die is a philosophy where the target is to reduce all set up time less than ten minutes or in single digits" [2, 4].

1.3.1 Need of SMED

The industries change refers to manufacturing different part in increasingly small series which have to produce minimal time consumption. These very strict requirements are creating lot of problem in worldwide industries. Generally, additional time is needed for setup caused by poor design of equipment .the solution can be achieved both by fast responding of market demands and with early application of new method and technologies. Continuous process improvement and SMED can fix this problem. The SMED method has originated from production work shop out of necessity to minimize tool exchange time due to frequent tool exchanges and is one of the methods presented in

Japan production philosophy. the motto “less is more” comprehend the basic idea of Japan production philosophy that is how to produce more, to wasting less time ,to using less production area, as well as less material and human resources, simultaneously keeping quality and quantity constant as require by costumer [2].

1.3.2 History

The concept of SMED arose in the late 1950s and early 1960s, when Shingo, was consulting to a variety of companies including Toyota, and contemplating their inability to eliminate bottlenecks at car body- Molding presses. The bottlenecks were caused long tool changeover times which drove up production lot size. The economic lot size calculated from the ratio of actual production time to change over time. The changeover is the time taken to stop the production of a product and start production of same or another product. If change over time takes a long time then the lost production due to change over’s drives up the cost of actual production itself. The “economic lot size is a well known manufacturing concept. Historically, the overhead cost of retooling a process was minimized by maximizing the number of items that the process should construct before changing to another model. This makes the change over head per manufacturing unit low. According to some source optimum lot size occurs when the interest costs of storing the lot size of items equals the value lost when the production line is shut down. The difference, for Toyota, was that the economic lot size calculation included high overhead costs to pay for the land to store the vehicles. Engineer Shingo could do nothing about the interest rate, but he had total control of the factory processes. If the change-over costs could be reduced, then the economic lot size could be reduced, directly reducing expenses. Indeed the whole debate over EOQ becomes restructured if still relevant. It should also be noted that large lot sizes require higher stock levels to be kept in the rest of the process and these, more hidden costs, are also reduced by the smaller lot sizes made possible by SMED.

Over a period of several years, Toyota reworked factory fixtures and vehicle components to maximize their common parts, minimize and standardize assembly tools and steps, and utilize common tooling. These common parts or tooling reduced change-over time. Wherever the tooling could not be common, steps were taken to make the tooling quick to change [2, 4].

1.3.3 Principle of SMED- the basics principles of SMED [7].

1. Distinguish internal and external setup operations
2. Separate internal and external setup operations
3. Convert the internal setup operation to external setup operation
4. Streamlining all setup of operation

1) Internal and External operations of the Setup

a) Usually, in the traditional Setup processes, all kinds of operations start taking place only after the machine has stopped, and continue all the way until they are finished, then the machine is re-started and hopefully in the first few cycles the output is completely acceptable and in compliance with specs. That is when the setup can be declared Finished. This is not acceptable in the Lean Manufacturing environment; therefore the SMED process was developed. We all understand that there are a good number of those operations that we could group as "Preparation", meaning they can be performed even while the machine is still working on the ending run.

Some examples of these preparation operations:

1. Bringing all the tools and materials (rags, cleaner fluids, spatulas) that we may need to perform the setup, close to the machine
2. Having handy all new parts, components, dies, cutters, etc, that need to be installed for the next run.
3. Have all the team members who will intervene in the setup prepared and made aware of which actions each one will perform. In some cases of complex setups, a rehearsal is convenient. Even professional pit teams do that before each and every race.
4. Have the members of the team discuss and then write on flipchart pages in detail and best possible order each of those preparation operations, step by step. Use as many pages as needed. We want those to be easily read from every seat in the classroom.

b) These preparation operations will be considered "External", since they do not need for the machine to stop in order to be performed.

c) Now, let us think of the operations that can and must be done only when the machine is out of service. These operations will be called "internal".

d) Finally, we will go through the series of operations that can and should take place after the machine is ready to run, these can be clean-up the area, putting back in place the tools, parts, components that were removed. All these operations will be grouped as “After-Setup” and are also considered “External”, since the machine can be back in operation with the new run while they are performed.

2) Separate the Internal and External Setup Operation

When reviewing the element breakdown- the process steps of the changeover. The team immediately determines which setup elements are complete wastes of time, which are external and which are internal as was noted above. External steps, those that can be done while the machine is running, can be pulled out of setup right away, but procedure must be developed to ensure that these steps are completed before a current run are finished. External steps include getting parts, fixture, gauges and cutting tools ready for the next run. Internal steps, those that must take place when the machine is not running, must be streamlined.

After distinguish the internal and external setup operation separate the external setup operation from the internal one and performed these operation when the machine is in process, means complete these operation for the next run when machine is in process for previous run. The most important step is to examine the entire setup operations and segregate the internal and external setup operations. If we make a conscious effort of scientific analysis, it is possible to reduce the setup time by this process alone, to the extent of 30 to 50 %.

3) Convert as many internal setups as possible to external setup

A 30 to 50% reduction in setup time may be considerably substantial but it is still not enough. Hence the second stage of examining such operations which are prima-facie considered internal, to see if these can be made external by one means or another. Each internal setup operation should be examined critically to see, if the whole or a part of it can be made external**.**

For example, in press work, adjusting the shut height after a tool is positioned and clamped is normally considered internal. After careful examination, it is possible to see how this could be made external. Once a die runs through the particular run, it should be examined to see whether it is in a fit condition for another production run in future.

This can be done either by examining the die itself or by examining the last few parts produced with the die or both. Many a times, a regular pattern of die wear can be established in which case the need for maintaining a die can be predicted without having to examine either the die or the parts produced. Sometimes it may be best to have both preventive maintenance as well as examination of the die and the parts by the end of each production run.

Whichever method identifying the need for maintaining the die, once the die is maintained by re-grinding the cutting faces or working surface, the shut height changes. If no corrective action is taken, the next time the die is located in the press, an adjustment to compensate this change in the shut height is inevitable. However, this adjustment of the shut height setting can be avoided if only at the time of maintaining the die. Adjusting shims are used to compensate the change in shut height and bring it back to the standard. By this, we achieve converting an internal setup operation to an external setup operation.

4) Streamline all setup operations

When we have segregated the apparent external and internal setup operations in Stage I and then converted as many internal setup operations to external , we are left with very minimum of internal setup operations.

Now the improvement comes by reducing the time to perform each internal and also external setup operations. The reduction in the internal setup time will reduce the down time of the machine. Reduction in the external setup time will save the labour which is spent in performing these tasks.

1.) Improve internal setups (include adjustment)

a) Use specially design cart to organized tool
b) Use quick release fasteners instead of bolt and nut
c) Use stopper to quickly position the die
d) Use rolling bolsters instead of crane
e) Use overhang mechanism to handle heavy jigs
f) Use locating pins and holes (socket) to eliminate the adjustment.
g) Use standardized die height
h) Standardize bolt types and sizes, screw type and sizes, etc.

2.) Improve external setups.

a) Apply visual control principal
b) Use checklist to avoid omission.
c) Use specially design cart to help organized tools.
d) Organize workplace (5S) to reduce search.

3.) Effect of setup reduction

As we eliminate waste through change over time reduction, these reductions may bring the following impact to the shop floor.

a) Lot size can be reduced.
b) Help to reduce inventory.
c) Reduce the cost of setup labor.
d) Increase the capacity on bottleneck equipment.
e) Help to eliminate the setup scrap.
f) Reduce the potential for quality problem.
g) Reduce the probability of product obsolescence from being in inventory too long.

1.4 QUICK DIE CHANGE (QDC)

Quick die change is a snappy buzz phrase that is often associated with quick die change hardware such as hydraulic clamp, die roller, bolster extension, die cart, etc as shown in Figure 1.1. The goal, simply put, is to minimize the downtime from the last good hit on one die to the first good hit on the next one and that requires a well- formulated efficient process. In fact, the process is probably more important that the equipment, especially in the initial stage of implementation.

All job changeovers entail similar activities: clearing the press area, unclamping the die, removing and storing the die, retrieving the new die, placing the die in the press, clamping the die, setting up the workplace (coil line, bins, conveyors, etc), and first part approval. However, since each company's situation is unique, and individual job changes are different depending on size and type of press and die, what follows here is not a comprehensive, tailored plan... But hopefully it will help to get started developing a plan to minimize job changeover downtime [8].

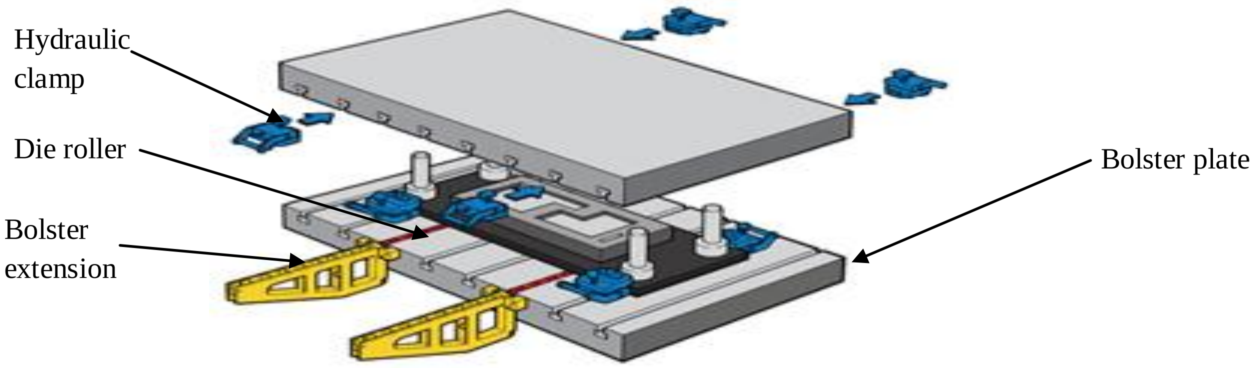


Figure 1.1: Quick die changeover hardware attached with die and bolster [8]

1.4.1 Steps to Implement Quick Die Change

Few lean manufacturing methods increase manufacturing uptime, lower per part costs, and provide an immediate return on investment (ROI) as readily as quick die change (QDC) does. Although the merits of QDC likely are well understood within the stamping field, tailoring a program to a company's current equipment and operational requirements can be challenging.

Generally implementing a QDC program is an easy and straightforward process, if it is done by grouping dies and presses in an orderly way. For each group of presses, QDC implementation consists of clamps, die lifting devices, and die removal equipment [8].

1. Choose clamp style
2. Calculate clamp size
3. Verify clamp Noninterference
4. Determine die lifting requirements
5. Select lifting device style
6. Calculate lift capacity
7. Choose die removal method
8. Select support equipment and installation method

1. Choose Clamp Style

To facilitate quick clamping and unclamping, standardize the clamping method and clamping height for a particular press or group of presses. Grouping presses by size and die type is the best way to break down your equipment into common components. Look at which dies go into a particular press (or group of presses) and how all the dies are clamped

- Use a single clamp style or size for all the plate and clamp combinations, or
- Standardize dies around one clamping method and, preferably, one clamp late thickness.

Typically, find it beneficial to standardize the clamp plate thickness and clamping method for all dies going into a particular press. Examine the current plate style provide the information you need to determine which clamp style need to grip the clamp plate properly.

2. Calculate Clamp Size

Choose the clamp size needed to exceed the clamping requirements of the most demanding die. Calculate size is driven by maximum die weight that will be run in the press. Typically, you should choose a clamping force for the upper clamps equal to four times the die weight, and then divide that by number of clamps. Balance the press using an equal number of bottom upper clamps.

$$Force\ require\ per\ clamp = (maximum\ die\ weight \times 4) \div No.of\ clamp \quad (1.1)$$

Alternatively, for large presses that require many small clamps to distribute the load per clamps by reversing the formula –

$$No.of\ clamp\ needed = (maximum\ die\ weight \times 4) \div clampforce(each) \quad (1.2)$$

3. Verify Clamp Noninterference

Ensure that the clamp can be moved for die removal and don't interference with die operation. Generally, clamps are removed from the slots before a dies is inserted or removed. However, if the die size or press arrangement prevents removal, it may be desirable to slide the dies in under the clamps.

In any case , ensure that the ram and bolster plates have the necessary number of slots and locations for the clamps to reach all the dies in the press , as well as clear the dies during installation and removal.

4. Determine Die Lifting Requirements

Determine if die lifting is needed to mobilize the die easily during changeover. Inspect all the dies in the press to ensure their bottoms are flat. Examine the bolster plates, which require full or temporary supports during lifting, for large cutouts or other features that may interfere with a lifting system. Typically, the bolster has two or more slots under each die running the entire bed length in the direction of die travel. In addition, the die bottoms usually are flat, which allows the dies to ride smoothly on rollers or balls. Small holes and access points are not a problem, if the surface is smooth and large enough to distribute the load over the lifting mechanism. If the bottom plates are not flat or the bolsters have large cutouts, have to consult a supplier for additional, optional equipment.

5. Select Lifting Devices

Die density drives the selection of lifting device style.

Low-density dies those that are thin or small relative to their footprint in the press ,generally can be lifted with ball roller rails, spring-loaded ball rails, or ball cartridges, which allow the die to be moved in any direction.

High-density dies usually require several ball-style rails or a pair of heavy-duty roller rails, which move in only one direction, the direction it is inserted, or inline. If you want movement in both the inline and transverse direction, a pair of insertion rails and a pair of transverse rails are required.

It is important to consider if both directions of movement are needed during the planning process. Generally, it is recommended to plan for both directions of movement to take full advantage of the QDC equipment's ability to index the die's exact location and alignment prior to clamping.

6. Calculate Lift Capacity

Select a die lifter with enough power to lift the maximum die weight and move the die in the desired direction. List out die sizes and weights; calculate the die load in pounds per foot for each pair of lift rails.

$$Die\ weight(lbs.) \div W = Die\ load\ in\ lbs./ft. \tag{1.3}$$

V = Bolster bed length in the direction of slots in feet

W = Die width in the direction of the slots in feet (assuming the slots are in the same direction as die insertion)

Calculate each die's density as defined here and determine which has the greatest density. (Note that this is the density along one dimension only and not a volume density calculation.)Then calculate the lift capacity it needs (available from the manufacturer) in pounds per foot and select the rail type that can lift that densest die. Check the number of slots available under the die, and record it.

Warning: It is very important that you do not select rails' lift capacity by the overall length. Rails that are as long as the entire bolster allow for the die insertion, but only the length of the rails that is under the die at any given time is actually lifting the die.

Once you have calculated for the heaviest die, confirm that the lifters chosen have the capacity to lift all the dies. Typically, choosing the heaviest die density will ensure correct capacity. However, slot location can be a problem if both large and small dies are run in the same press, because some of the dies might be too small to have all the rails under them.

For example, four die lifters are in the bolster to lift a large die, but when small dies are added, only the two middle lifters actually are in a position to do the lifting. You need to verify that the two middle ones can lift all the smaller dies.

Perform this calculation for all dies to verify that each die can be lifted from the available no. of die lifter:

$$Die\ weight < [W \times (Lifting\ density) \times (No.\ of\ rails\ under\ the\ specific\ die)] \tag{1.4}$$

Once determined which type of die lifter rail and capacities are needed, then determine the needed overall rail length and slot configuration (3⁄4-inch slots, 1-in. slots, T slot, or rectangular) through the bolster plate slot.

7. Choose Die Removal Method

Getting the operating die out and the new die in begins by choosing a die removal method, based on space needs and press operations.

For all die sizes, there are three basic options:

- Mobile platform, such as a forklift
- Permanently mounted die table
- Removable-style bolster extension

Mobile Platform: This is a mobile device that takes the die to the press; provides some type of alignment to it; and has a means of moving the die into the press directly—akin to a very precise forklift with an insertion device. It provides some interesting options, but the control and accuracy limitations of bulk moving equipment typically available may seem contrary to smooth and accurate die placement. For full plant automation installations, such as rail car carts, a mobile platform can provide advantages.

Permanently Mounted Die Table: This is basically a heavy-duty table with rollers attached to the press. It allows die staging and eliminates the need to remove dies from the area, consistent with lean manufacturing principles. However, die tables can interfere with press access and press operations and are a fixed investment.

Bolster Extension: These are equipped with rollers that are level with the press's die lifters and are attached to the press during die movement. Once the die is moved onto the bolster extensions, it is easily accessible from the bottom for removal. Bolster extensions can be removed or pushed aside as shown in Figure 1.2, allowing press access. Some styles can be moved from press to press. Bolster extension styles are:

- Small liftoff
- Large rolling liftoff
- Swing-away

Figure 1.2: Removable style bolsters extension [8]

For proper sizing, determine which die the most is demanding, as done with the die lifters, and choose extensions that exceed those requirements. Calculate the bolster extension densities compared to the actual load per foot and select the correct bolster extension.

Review all dies for a particular group of presses and consider using only a few pairs of extensions to serve a few (five or six) presses when common die densities make this practical.

8. Select Support Equipment and Installation Method

Consider the controlling/activating equipment i.e. pumps, controls, hoses, manifolds, and mounting devices for the clamps, lifters, and extensions as well as room for mounting them.

Generally, you'll need to pay the most attention to selection of manual valves to operate the clamps either full hydraulic or hydraulic with mechanical locks and permanently mounted pumps.

Traditionally, fixed hydraulic equipment is attached to presses to facilitate QDC installations. More recently electronic valve controllers tied into the press control or at the press control via keyed switches are used instead. By recording all the component types on a press-by-press basis, you will notice commonalities and find it easier to standardize some components, which may result in cost reductions and even great ROI on QDC implementations.

The above issue is being faced by Crompton Greaves stamping division. There are many high speed presses for stamping of rotor and stator lamination. A variety of stator and rotor lamination is being manufactured with progressive tool die. Tool change over time was the major issue in the plant it wastes more time in all setup operation. For resharpening of tool and variety of products, frequent tool die changes are required on the press. After survey found tool change over time was in hours which reduce the productivity of plant, reduce machine flexibility, and delay in dispatch. The root cause of bottleneck was more of the work performed manually and unevenly. Chute setting, slide setting and tool clamping required more setting time. These operations are required design and engineering improvements. Then after survey this project has been taken for setup time reduction.

1.5 CROMPTON GREAVES – AN OVERVIEW

1.5.1 Brief History

A pioneering leader with almost 60 years of experience and expertise in the management and application of electric energy and noticeable presence in electronics and telecom, CGL is extensively engaged in manufacturing and marketing operations, offering an incredible portfolio of products and services. Building on its strong manufacturing and marketing roots, CGL has grown from a single unit making AC Industrial Motors and Ceiling Fans to a multi-dimensional corporation with business interests in many product areas including transformers, motors, switch gears, control panel accessories, water pumps, electronic and telecom equipment's and services. With its 28 manufacturing plants countrywide marketing and support network, CGL effectively provides value to its customer. In 1942 the Crompton Parkinson Ltd. of England appointed Greaves Cotton Company in India as sales concessionaires of their products in India which were manufactured in England. In 1937 Crompton Parkinson established Crompton Parkinson Works India Ltd. at Worli, Bombay, manufacturing a range of electrical and allied equipment. In the same year a separate company in the name of Greaves and Crompton Parkinson Ltd. Was formed with the objective of distribution and sales of products of Crompton Parkinson LTD, in India especially in South. The Indianisation Process started gradually from 1948 onwards. The company consolidated its position in 1966 when Greaves Cotton & Crompton Parkinson amalgamated with Crompton Parkinson Works (India) to form a new company Crompton Greaves Limited. As a result of this, the combined activities of manufacturing, distribution and sales, installation, servicing and contracting were brought under the common management of CGL.

In 1968 Crompton Parkinson Ltd. UK was taken over by Hawker Siddley group of companies. As a result of this, Crompton Greaves Ltd. India gained access to the HSPT's technology of Transformer as well. Transformer manufacturing operation soon became an independent diversion of CGL and today is one of the major diversions Crompton

Greaves Ltd. with annual sales being 20% of total sales. CGL has over the years pursued its electrifying objectives through a sharply focused growth strategy. It recognizes Total Quality Management as a vehicle to achieve excellence in all its business operations. CGL understands that Technology and Business Process are two pillars of a successful enterprise. Not only it focuses on order-fulfillment processes but also promotes an R&D culture of self - reliance, leveraging the best skill and resources to maintain its competitive advantage. CGL realizes that customers don't care about technologies. They want business benefits. Hence it follows the imperative...Exploit the technologies to maximize convenience of the customers [3].

1.5.2 Stamping Division

For the last 28 years the Stamping division of Crompton Greaves Ltd., has been making electric stampings for their captive consumption for their range of motors and fans using the latest technology.

Crompton Greaves currently manufactures stampings from mini to large motors. Crompton Greaves Ltd., use their high speed presses with progression tools and auto feeds viz. Gripper feeders, roll feeders etc.

The product range of stamping division includes:

- All types of motor stampings, stator and rotor packs duly riveted, cleated or die casted as per customer requirements.
- All types alternator laminations.
- All types of fans, mixers, submersible and mono block stampings.

1.5.3 Stamping

Stamping includes a variety of sheet-metal forming manufacturing processes, such as punching using a press, blanking, embossing, bending, flanging, and coining. This could be a single stage operation where every stroke of the press produce the desired form on the sheet metal part, or could occur through a series of stages. The process is usually carried out on sheet metal, but can also be used on other materials, such as polystyrene. These operations are done with dedicated tooling also known as *hard tooling*. This type of tooling is used to make high volume parts of one configuration of part design. All these operations can be done either at a single die station or multiple die stations performing a progression of operations, known as a *progressive die*. In the stamping division of Crompton Greaves, the stator and rotor lamination are produced of motor and fan. Once the lamination are punched, then built into pack of require core length.

Figure 1.3 shows the laminated stator and rotor of an induction motor. Both the rotor and stator have a cylindrical core of ferromagnetic material, usually steel. The parts of the core that are subjected to alternating magnetic flux are built up of thin steel laminations that are electrically insulated from each other to impede the flow of eddy currents, which would otherwise greatly reduce motor efficiency. These thin steel laminations are punched using a press in desire form on the sheet metal part.

Figure 1.3: Stator & Rotor of an Induction Motor [3]

The processes in the stamping division are broadly classified into Punching processes and Pack building processes [3, 5, 6].

1.5.4 Punching

The principle of producing stampings is that of press tools where the punch punches the stamping from the stock in the die. The principle is the same for all the methods but the tools used for this producing different stampings are different depending on the characteristics. The different types of machines that are used for stampings are Gang slotting, notching and high-speed machines (Progressive tooling) [3].

1.5.5 Gang Slotting

Gang slotting is the conventional method being followed by the division from the past 28 years. This process consists of a sub-process of blanking in which coil or sheet is fed into press to get stator and rotor blanks. These blanks are then individually fed into another press for gang slotting. Gang slotting tool punches all the slots for all the electrical winding in the blank simultaneously. Gang slotting is very time-consuming and it requires higher man and machine hours. Hence it has lower productivity as compared to progressive tools. Also, the handling and number of tools required increases because of blanking. However the tooling cost is low in comparison to progressive tools. Gang slotting is used for medium sized and slow moving frames [3].

1.5.6 Notching

Notching is the process in which each slot is individually notched from the blank. Each blank is hand fed into the notching machine. The blank is located in the machine and the slots are notched in the blank. The stator and rotor are obtained separately from a single blank sometimes. This method is also slow and requires more man and machine hours. But this process is economical for large size frames [3].

1.5.7 High Speed Progressive Punching

High-speed tools, as the name suggests, have higher productivity than gang slotting as well as notching tools. Progressive tools can produce tools can produce almost three times more the number of stampings than conventional gang slotting. In progressive tools blanking and gang slotting process are carried out at the same time. The strip is advanced through a series of stations, which perform the various operations. After the strip reaches the last station of the die, a complete stamping is produced with each stroke of the ram. But, the tooling cost for progressive tools is very high. Hence, Progressive tools are suitable for items, which are fast moving and have repeat orders.

The quality of stampings obtained from progressive tools is very good as it does not involve intermediate processes and the finished product is obtained directly from the coil in one handling [3].

1.5.8 Pack Building

Once the laminations are punched, they are aligned and tied together. Non silicon material is then sent for heat treatment. The laminations are then built into packs of required core lengths. The various pack building operations are riveting, cleating and welding [3].

a) Riveting: The laminations are aligned using drifts to specified core lengths. Rivets are then inserted into the rivet holes. The aligned laminations are then located on the building mandrel of the riveting machine with inner diameter as the locating surface. The ram pressure is applied on the pack so as to impart compactness. The lower end of the rivet is then punched to form a shape which locks the laminations to form a compact pack.

b) Cleating: In cleating the stampings are located directly on the building mandrel of the cleating machine. Then the ram pressure is applied on the pack. Cleats are then placed on the dovetail slots of the laminations and then the rollers run over the cleats. Due to the shape of the cleats and the dovetail slots, the cleats clamp the stampings with specified pressure. The cleat ends are then flattened by means of a hammer.

c) Welding: Two types of welding types are used in the shop.

1) Tungsten Inert Gas (TIG) Welding

2) Metal Active Gas (MAG) Welding

Welding is done on medium and large size packs. First the stampings are located on specially designed welding fixtures. The stampings are aligned by using drifts and are then compressed. In TIG Welding, the Tungsten rods are used for fusion of the material, locally, by using Argon as the gas for the inert atmosphere. In MAG Welding, instead of Tungsten, Copper wires are used as the filler metal. The welding is carried out in an atmosphere of Carbon Dioxide gas. The metal wire is fed using automatic feeding mechanism [3].

1.5.9 Heat Treatment

Heat treatment is done only on non- silicon material stampings. Heat treatment is done in order to impart electrical properties to the steel and make it compatible to Silicon steel. After the stampings are obtained from various punching operations they are tied together in packs with the help of MS wires. Then they are mounted on the specially designed carriage, which is then loaded in the furnace. The charge is thus heat treated [3].

1.5.10 Autostack System

A recent development in the stampings division has been the introduction of autostacking and autoskewing devices. Autostack means the interlocking of each lamination over the other in a stacked form to a required core length during punching operation itself, instead of manual core building after punching thereby inviting a secondary operation [3].

1.6 PROBLEM DEFINITION

The survival of any industry in today’s competitive market place depends on response time, production costs and flexibility in manufacturing. In recent years, companies have increasingly focused on market demand and customers responsiveness. This has led to the implementation and adoption of lean manufacturing techniques in the automotive industry. Due to the complexity and demand behavior from customers, better change over or setup time reduction enables better response and small batch manufacturing. The setup time of a high speed press in Crompton Greaves stamping division is in hours. This addition time is needed for setup by poor design of chute plate and equipment. Chute setting operation is required more time because each die has a separate chute plate and are needed to replace every time die is changed. To reduce the setup time it is required to design a standard chute plate for all die. The objective of this research is to reduce setup time with the implementation of standard chute plate design, SMED principle and QDC technology. Quick die change is a technology which provides the hardware for fast tool changeover means automize the change over process. A design is implemented for easy setting of chute and solid work 9.0™ is used for designing the component and assembly. ANSYS 11.0 is used for stress calculation of designed component.

CHAPTER 2
LITERATURE REVIEW

This chapter covers detail review of literature on the various aspect of set up time reduction using SMED and QDC**.**

Deros *et al.* [1] found fast setups and a changeover was required to reduce setup time and manufacturing costs. The two main objectives of this study were: first, to identify the root causes of bottlenecks operations and implement possible solutions to the problems; second, to study the cost saving effect after reducing the setup time. Single Minute Exchange of Die (SMED) methods were applied at two major bottlenecks setup operations; cast on strap and heat seal. The result shows significant reduction of cast on strap setup time to 54% and heat seal setup time to 47%. This study had achieved more than the target 35% of setup time reduction. From setup time reduction, a total cost savings of RM168, 000 was achieved in assembly line A. Meanwhile the company level a total saving of RM1.11million was achieved for all assembly lines in Company X.

Perinic *et al.* [9] discussed about Continuous process improvement and SMED methodology because the automobile industry changes refer to manufacturing different part in increasingly small series which have to produce with minimal time consumption. These very strict requirements are creating lot problems in automotive industry worldwide. Generally, additional time is needed for setup caused by poor design of equipment the solution can be achieved both by fast responding on market demands and with early application of new method and technologies. Continuous process improvement and SMED can fix this problem. A key parameter to achieving minimal production time is machine capacity release. A new approach to improving die casting process is to integrating the SMED method and 5S techniques as presented in this article. The proposed method application resulted in the following improvement: average tool change time period decreased, machine flexibility was raised due to reduce tool exchanges in controlled time period increasing in this way different parts production possibilities

Sherali *et al.* [10] explained that this body of work largely addressed situations involving a single machine with no specific worker related issues. In practice, there were exist multiple machines or workstations that form a machine line, and that need set-up operations to be performed by multiple workers. The importance of ensuring short set-up times in manufacturing has been well-documented in the literature over the past years. However, the existing literature does not provide adequate methodologies for set-up reduction in such cases. This paper described a quantitative modeling and algorithmic approach for scheduling activities or tasks in order to minimize the set-up time in such situations, also taking into account relevant secondary objectives such as balancing the workload amongst the workers, concentrating slack toward the end of the set-up process, and minimizing. In this paper, author proposed a significant extension to the existing body of literature on set-up reduction methods. Set-ups involving multiple workers and multiple machines can now be studied using a quantitative approach in order to find optimal schedules and set-up task assignments for a multi-objective program that optimized the following objectives in a preemptive priority fashion: overall downtime of the line, balanced of the workload, the slack pattern, and the movement costs of the workers.

Saurin *et al.* [11] described the impacts of lean production on working conditions was well-known, few in-depth empirical data were available concerning lean production applications in contexts other than automobile plants located in developed countries. This study presented an assessment of the impacts of lean production on working conditions in a harvester assembly line of an American-owned plant in Brazil. Differently from most previous assessments of lean production impacts on working conditions, which were based on surveys, this study was based on multiple sources of evidence, such as face-to-face interviews, questionnaires, direct observations and the analysis of production procedures. However, a large number of issues raised by workers and managers during the interviews made it difficult to perform a deep investigation into every topic encompassed by the four constructs established for data analysis (work content; work organization; continuous improvement; and, health and safety).

Trovinger *et al.* [12] discussed about setup time reduction for electronic assembly combining simple (SMED) and sophisticated methods. Setups determine downtime, capacity, product quality, and to some extent costs. As much as 50% of effective capacity can be lost to setups in some electronics assembly. In this work it was shown that large reductions in setup time possible for electronics assembly and used a two-part approach. The first part consists of classic process re-engineering using “Single Minute Exchange of Dies” (SMED) concepts developed by Shigeo Shingo for metal fabrication. The second part used a sophisticated factory information system, with hand-held wireless computers and barcode scanners, to further reduce setup times and increase setup accuracy. This two-part approach gave a reduction of about 86% in key setup times, plus labor savings, quality improvements and other benefits. One narrow measure of performance gave an order of magnitude improvement. The results showed that SMED was applicable well outside its traditional domains such as stamping and metal-working. The author confirmed that the seemingly extreme benefits claimed by SMED advocates are achievable, but only with the assistance of modern information technology.

Cakkmakci *et al.* [13] researched the sustainability as important factor to keep desire point of time reducing in change over process achieved by SMED method. To reach aimed sustainability well arranged standard procedures must be prepared. Optional changeover procedure was constituted with aid of predetermined time system (MTM-UAS) to standardize and preserve the improved changeover operations.

McIntosh et al. [14] explained in this paper assessed on-machine maintenance in the context of recent work to improve changeover performance. The techniques employed to improve changeovers equally might be applied in maintenance situations. With brief reference to case studies from the authors' research, it is further argued that focused maintenance activity can also directly influence changeover performance, particularly by ensuring that items involved during a changeover (change parts, product, fixed machine components and consumables) were in satisfactory condition. The role of design to improve either changeover or maintenance performance was also discussed. Likewise, maintenance activity to ensure that items involved in a changeover are of requisite quality can significantly enhance changeover performance. Those engaged in changeover improvement should be aware of the potential value of a higher focus upon maintenance issues.

Holweg *et al.* [15] defined that Lean production was not only successfully challenged the accepted mass production practices in the automotive industry, significantly shifting the trade-off between productivity and quality, but a wide range of manufacturing and service operations beyond the high-volume repetitive manufacturing environment. Despite the fact that the just-in-time (JIT) manufacturing concept had been known for almost a decade prior, the book played a key role in disseminating the concept outside of Japan. While the technical aspects of lean production had been widely discussed, this paper sets out to investigate the evolution of the research at the MIT International Motor Vehicle Program (IMVP) that led to the conception of the term ‘lean production.

First, the lean concept itself was not a single point invention, but the outcome of a dynamic learning process that adapted practices emanating from the automotive and textile sectors in response to environmental contingencies in Japan.

Jayaram *et al.* [16] suggested that the systematic method in combination with lean practices typify the TPS. In contrast to prior research on the Toyota Production System (TPS) that tended to focus on the micro issues or structural issues; it was took an integrated approach of TPS to included the rules or principles underlying TPS. Expand upon this body of work by empirically examined the suggestions on a large sample data comprising manufacturing plants in several industries. Several main effects of TPS practices on performance were found. Similarly, TPS rules were found to be positively related to manufacturing performance. Finally, it found a positive interaction effect between the TPS practice of preventive maintenance and the TPS rule of decentralized decision making on all performance measures in this study, i.e. manufacturing cycle time, quality, cost, and delivery speed. Implications for theory building and for practitioners were offered.

Unlike prior research on the TPS, in this work was adopted an integrated perspective to include the rules underlying TPS. The research had the typical limitations of single respondent survey studied, although rigorous efforts were made to cross- verify reported data. In order to minimize explanatory complexities, it was not explored three- way interactions, providing thus an opportunity for future research that could look at such higher order interactions.

Qiu *et al.* [17] focused on the static response problem and the stress distribution of structures with bounded uncertainties. In terms of the vertex notation in interval analysis, a new mathematical proof of the vertex solution theorem which was used to determined the supremum and the infimum of the static responses of structures with bounded uncertainties was given. Then, this theorem extended for calculating the interval stress and the deformation distributions, which was only used to determine the supremum and the infimum of the static responses of structures with bounded uncertainties. The basic idea of the vertex solution theorem is to convert the interval linear equations into systems of equivalent deterministic linear equations. The resulting deterministic linear equations are then solved by using the familiar techniques like the Gauss elimination method or the Gauss–Seidel iteration method. Another advantage of this method was that the increase in number of the uncertain parameters in a structure element will not result in the increase in number of the uncertain elements in the stiffness matrix. In this work, the parallel arithmetic of the vertex solution theorem was presented, which can be used in large-scale computations in practical engineering to avoid much runtime.

Karaoglu *et al.* [18] analyzed the stress of a truck chassis with riveted joints was performed by using FEM. The commercial element package ANSYS version 5.3 was used for the solution of the problem. Determination of the stresses of a truck chassis before manufacturing is important due to the design improvement. In order to achieve a reduction in the magnitude of stress near the riveted joint of the chassis frame, side member thickness, connection plate thickness and connection plate length were varied. Numerical results showed that stresses on the side member can be reduced by increasing the side member thickness locally. If the thickness change is not possible, increasing the connection plate length might be a good alternative. The analysis showed that increasing the side member thickness can reduce stresses on the joint areas, but it was important to realize that the overall weight of the chassis frame increases. Using local plates only in the joint area can also increase side member thickness. Therefore, excessive weight of the chassis frame was prevented.

Yokoyama *et al.* [19] scheduled a model for production system including machining; setup and assembly operations were considered. Production of a number of single-item products was ordered. Each product was made by assembling a set of several different parts. First, the parts were manufactured in a flow-shop consisting of multiple machines. Then, they were assembled into products on a single assembly stage. Setup operation and setup time are needed when a machine starts processing the parts or it changes items. The operations are partitioned into several blocks. Each block consists of the machining operations, the setup operations, and the assembly operation(s) for one or several products. The parts of the same item in a block were processed successively. The objective function was the mean completion time for all products. It was considered a problem to partition the operations into blocks and sequence the parts in each block so as to minimize the objective function. Solution procedures used pseudo-dynamic programming and a branch-and-bound method was proposed. Computational experiments were carried out to evaluate the performance of the solution procedures. It was found that a good near-optimal schedule was obtained efficiently by the proposed solution procedures.

Andre *et al.* [20] discussed about classical Simple Assembly Line Balancing Problem (SALBP) which had been widely enriched over the past few years with many realistic approaches and much effort was made to reduce the distance between the academic theory and the industrial reality. The scheduling of the execution of tasks assigned to every workstation followed the balancing of the assembly line was scarcely reported in the scientific literature. The problem presented in this paper adds sequence-dependent setup time considerations to the classical SALBP in the following way: whenever a task was assigned next to another at the same workstation, a setup time must be added to compute the global workstation time. After formulating a mathematical model for this innovative problem and showing the high combinatorial nature of the problem, eight different heuristic rules and a GRASP algorithm were designed and tested for solving the problem in reasonable computational time.

Herron *et al.* [21] described a model which was developed to direct and generate productivity improvement in a group of manufacturing companies. The companies are of all sizes including Small and Medium Enterprises (SMEs) and form a cross-section of industries and abilities with regard to manufacturing. There was a wide range of manufacturing efficiency improvement methods available to the companies, such as Just in Time (JIT), or a range of lean manufacturing tools. A methodology had therefore been developed which consists of three clearly defined steps, starting with a Productivity Needs Analysis (PNA), which gives an overview of the current manufacturing condition of the company, identifies the key productivity measured for the plant and forms the basis for a detailed study of production efficiency.

Mcintosh *et al.* [22] assessed two fundamental mechanisms by which better change over might be achieved. Better allocation of tasks to the resources necessary to conduct them was sought, where the task themselves remain essentially unchanged. The second mechanism was to seek structural change to existing task, there by intrinsically enabling them to be completed more quickly. These two mechanism were described in relation to use of the SMED method where greater of potential improvement options can be gained.

Patel *et al.* [23] reported a study into set-up time reduction and mistake proofing methods in a small company involved in the machining of precision components in small batches with high variety for the aerospace industry. The company had made some set-up reductions mainly using work study related methods and in one manufacturing cell by the use of the Single Minute Exchange of Die (SMED) methodology. Mistake proofing devices in the form of fouling pins and offset holes had been developed for the family of components manufactured in this cell. Until recently the set-up times were not measured and worse still were considered as productive hours. There was a lack of awareness and motivation amongst operational personnel to reduce set-up times and knowledge of SMED was limited to a small group of individuals. This, along with the lack of investment in mechanisms to aid set-up time reductions and prevent errors, has restricted the use of this type of methods and technology. However, there was evidence that the demands made by the company's major customer will lead to increased efforts to put into place these types of changes.

Mcintosh *et al.* [24] explained about SMED in this work, in which a case study is also presented, argues that in the sequential application of stages, the 'SMED' methodology (including the sequential application of improvement techniques that are assigned to those stages) need not always represent an effective improvement route. Shigeo Shingo's 'SMED' methodology has been at the forefront of retrospective changeover improvement activity since the mid-1980s. The 'SMED' methodology's dominant objective of translating tasks into external time is also considered. It argued that the 'SMED' methodology was not sufficiently promote some important improvement options, particularly those that seek to reduce the duration of existing changeover tasks or eliminate them altogether. Opportunities for improvements of this type particularly arise when design changed to the existing manufacturing system were contemplated. The issue of design in the context of incremental kaizen improvement was also investigated.

Innovation in methodology

The published research papers indicated different methods for implementing SMED or QDC principle. The scopes of implementation of these principles are majorly process specific. In the present study a detail investigation was completed to identify the critical operations that are the key for higher setup changing time. Chute setting was identified as the key operation which took more than half of the total set up time as there were no scientific and methodical way to change the chute and setting was done manually. A new design for chute plate has been proposed, fabricated and implemented. Major components were analyzed using Finite Element Simulation for stress and strain at desired loading conditions (using ANSYS). Methods were proposed and designed for easy sliding and to facilitate quick assembly. Some other implementation also completed for clamping. With all the changes made the setup time was possible to reduce to only 15 minutes where as previously 228 minutes was taken for total changing of the set up.

CHAPTER 3
METHODOLOGY

This chapter introduces overall design of study, which includes the methodology adopted for carrying out the work. Details of work done in each setup operation are discussed in stamping division of Crompton Greaves Ltd at high speed press. A complete study of recorded tool change over data process and implementation of SMED principles and QDC technology to reduce set up time. A design of plan has been developed to reduce setup time.

1. Data collection
2. Implementation of SMED principles
3. Designing of chute plate and supporting components
4. Design improvement of other setup operations

3.1 Data Collection

Statistical data is collected and analyzed to measure the machine setup time at high speed presses. First, data check sheet is prepared or developed prior to data collection and measured by using a stop watch. The production flow and standard operation procedure is briefly reviewed before developing the data collection check sheet. Based on actual production, data is collected and video recorded on the daily basis by different type of time loss in tool die changeover process at high speed.

3.2 Implementation of SMED Principles

Initially complete tool change over data is recorded and SMED principles are implemented in recorded data. Single minute exchange of die is a philosophy to reduce setup time in less than 10 minute or single digit of minutes.

3.3 Designing of Chute Plate and Supporting Components

The chute plate setting was the critical problem it takes maximum time in one complete changeover. Then a standard chute plates is to be designed for rotor and stator chute to overcome this problem. After this design improvement there is no need to change the chute plate for all die only replace the cylinder without any clamping. A lead screw and slotted bar is to be attached with chute plates for easy sliding at bolster. In existing design chute is tied up with wires and supported with channel and wooden block for maintaining the height of chute from the pit base and this operation required more setup time and labor fatigue. To eliminate this operation a sliding support is designed for hanging the chute. Standard chute plate is designed for rotor and stator .Solid work 9.0 is used for modeling and assembly of the component. Stress analysis of chute plates was performed by using software ANSYS 11.0.

3.4 Design Improvement of Other Setup Operations

The root causes of bottleneck are be founded from the process study of change over. All these causes are studied in detail and found the appropriate solution to overcome. The solutions are to be implemented step by step at all setup operation continuously. The improvement are implemented at all causes is discussed as-

1. Clamping of tool die

Threaded bolts are used to clamp the die with manual clamping and eight bolts required for clamping the die. This is also a time consuming process and required more labor fatigue. Manual clamping is to be replaced with hydraulic clamp to reduce the clamping time, and standardize the clamping slot dimension of tool die so that can be used hydraulic clamp for all die.

2. Slide setting

The press shut height varies according to die. So due this reason every time while changing tool die, press shut height has to be changed according to die. A pneumatic gun is used for shut height setting and it required more labor and time. For reducing this time and labor fatigue a motor and reduction gear box assembly is attached with slide.

3. Tool availability

After examinations of tool change over process it is found that movement of worker from machine to tool room is more than 10 times for bringing the tools regarding to changeover. To eliminate this time a tool kit trolley is designed and all tools and required components like spacer, feeder transmission gear assembly for new die in SMED are placed in tools trolley.

CHAPTER 4
DATA COLLECTION

Statistical data is collected and analyzed to measure the machine setup time at high speed presses. First, data check sheet is prepared or developed prior to data collection and measured by using a stop watch. The production flow and standard operation procedure is briefly reviewed before developing the data collection check sheet. Based on actual production, data is collected and video recorded on the daily basis by different type of time loss in tool die changeover process at high speed presses. Initially a video is recorded of current tool changeover process and later each setup operation is examined and record the time in data check sheet. Later, a statistical pie chart is plotted to monitor and analyze the problems. These methods help to identify the main contributor to high time loss in the tool change over process and help to visualize and better understanding the root cause of the problems.

All change over details are video recorded and complete work activity sequence is written down. Every operator's moves and all activities have to be recorded in detail, since any unnecessary activity contribute to obtaining even worse results. The same recording procedure should be done after implementing the method to establish the efficiency in both applying the method and achieving the result (SMED).

Initially examined tool change over at all high speed presses in Crompton Greaves i.e. CHING FONG, DANLY, AIDA 125, and NEW AIDA.

4.1 Change over Data of CHING FONG Press

All change over data is video recorded and complete work activity sequence is written down manually and the time of manual recorded activity is noted down with stop watch while changeover performed. The recorded average change over data of all activities at CHING FONG press is shown in Table 4.1 and activity distribution in terms of percentage is shown in Figure 4.1.

The used die which is to be removed and new die mounted at press is progressive tool die. In the recoded data setting of chute take maximum time 28% of total change over time. This is a more time consuming operation and required more labor fatigue. This setup operation has more scope to reduce time. Second more time consuming activity is mounting of tool die it take 22% of total changeover time because the clamping of die is done manually. Mechanical feeder gear box is used to feed the sheet and setting of gear box takes 16% time of total changeover. Movement of worker from station to tool room takes 14% time and transportation takes 5% time shown in Figure 4.1 of total changeover time.

Table 4.1: Activity duration table of CHING FONG press

S. No.	Activity / Operation	Actual time (min.)
1.	Dismantling of tool die	31
2.	Setting of chute	60
3.	Transportation of die	10
4.	Mounting of tool die	47
5.	Setting of feeder gear box	35
6.	Movement of worker	30
7.	Total time	228

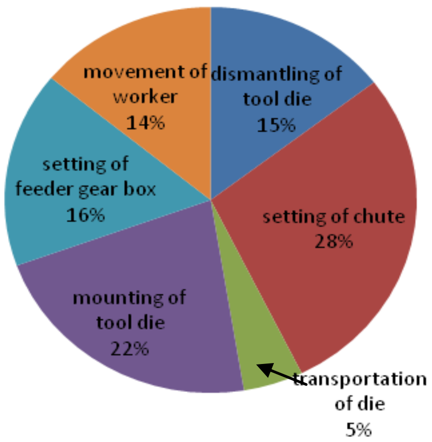


Figure 4.1: Activity duration distribution chart of CHING FONG press

4.2 Change over Data of DANLY Press

All change over data is video recorded and complete work activity sequence is written down manually and the time of manual recorded activity is noted down with stop watch while changeover performed. The recorded average change over data of all activities at DANLY press is shown in Table 4.2 and activity distribution in terms of percentage is shown in Figure 4.2.

In the recoded data setting of chute take maximum time 33% time of total change over time. This is a more time consuming operation and required more labor fatigue. This setup operation has more scope to reduce time. The second time consuming activity is mounting of tool die 26% of total changeover time because the clamping of die is done by manually. The setting of feeder takes 6% of the total change over time. At this machine feeder setting takes less time compare to CHING FONG because servo feeder is used in the place of mechanical feeder, it take less time in setting. Movement of worker from station to tool room takes 12% time and transportation takes 6% time of total changeover time.

Table 4.2: Activity duration table of DANLY press

S. No.	Activity / Operation	Actual time (min.)
1.	Dismantling of tool die	30
2.	Setting of chute	60
3.	Transportation of die	10
4.	Mounting of tool die	47
5.	Setting of feeder gear box	11
6.	Movement of worker	22
7.	Total time	180

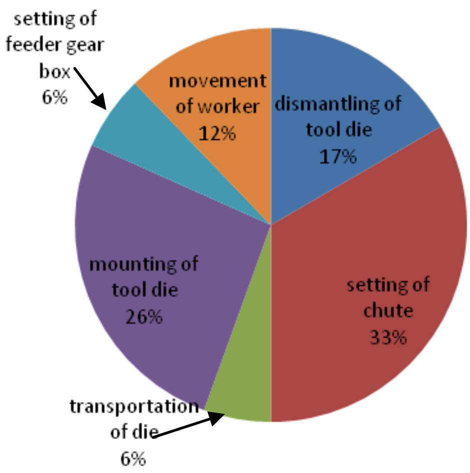


Figure 4.2: Activity duration distribution chart of DANLY press

4.3 Change over Data of New AIDA

All change over data is video recorded and complete work activity sequence is written down manually and the time of manual recorded activity is noted down with stop watch while changeover performed. The recorded average change over data of all activities at NEW AIDA press is shown in Table 4.3 and activity distribution in terms of percentage is shown in Figure 4.3. There is no chute used at this press the stator and rotor lamination is collected through conveyor. The maximum time taken by the activity in this changeover is mounting of tool die which is 36% of total change over time. Dismantling of tool die takes 20%. Movement of worker from station to tool room takes 25% time and transportation takes 8% time of total changeover time. The feeder setting takes 11% of the total change over time. It also take less time compare to CHING FONG because it is comprises with servo feeder.

Table 4.3: Activity duration table of NEW AIDA press

S. No.	Activity / Operation	Actual time (min.)
1.	Dismantling of tool die	24
2.	Setting of chute	No chute
3.	Transportation of die	10
4.	Mounting of tool die	43
5.	Setting of feeder gear box	13
6.	Movement of worker	30
7.	Total time	120

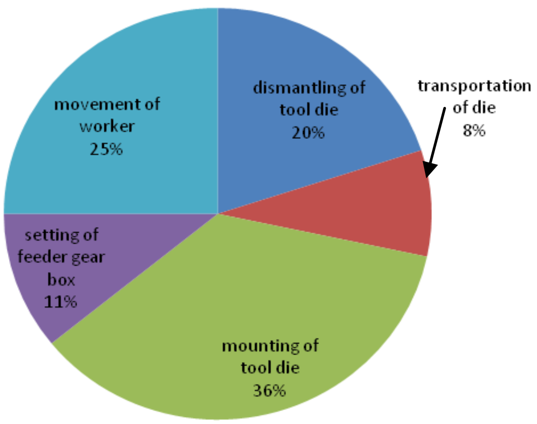


Figure 4.3: Activity duration distribution chart of NEW AIDA press

4.4 Change over Data of AIDA 125

All change over data is video recorded and complete work activity sequence is written down manually and the time of manual recorded activity is noted down with stop watch while changeover performed The recorded average change over data of all activities at AIDA 125 press is shown in Table 4.4 and activity distribution in terms of percentage is shown in Figure 4.4. In the recoded data the activity setting of chute takes maximum time, it takes 28 % of total change over time. This is more time consuming operation and required more labor fatigue. The second time consuming activity is mounting of tool die it take 22% of total changeover time because the clamping of die is done by manually. The setting of feeder takes 11% of the total change over time. At this machine feeder setting takes less time compare to CHING FONG because servo feeder is used in the place of mechanical feeder, it take less time in setting. Movement of worker from station to tool room takes 17% and transportation takes 5% of total changeover time.

Table 4.4: Activity duration table of AIDA125 press

S. No.	Activity / Operation	Actual time (min.)
1.	Dismantling of tool die	30
2.	Setting of chute	50
3.	Transportation of die	10
4.	Mounting of tool die	40
5.	Setting of feeder gear box	20
6.	Movement of worker	30
7.	Total time	180

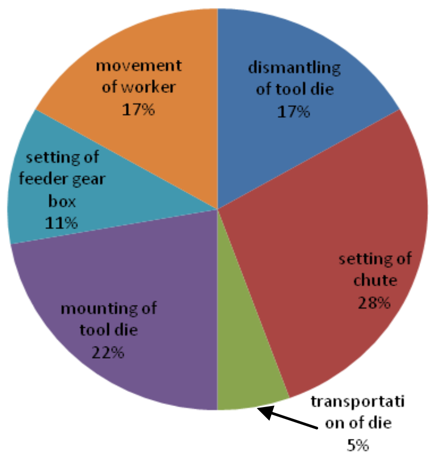


Figure 4.4: Activity duration distribution chart of AIDA 125 press

4.5 Comparison of Tool Change over Time at High Speed Presses

It is seen from the recorded data that CHING FONG used to takes more setup time compared to other press. It takes maximum time in feeder setting compare to other because it has mechanical feeder gear box which require large setup time. The all setting in mechanical feeder gear box is done manually. The other presses have servo feeder so it take less lime in setting. It also take maximum time in chute setting compare to other because the bed size of this press is bigger than the other machine except NEW AIDA but at NEW AIDA the chute is not used for collecting the lamination, conveyor is to be used in the place of chute. All operation at CHING FONG takes maximum time compare to other three machines. After all this comparison the conclusion is that CHING FONG has maximum scope of improvement so first of all CHING FONG is focused for SMED implementation. The comparison of tool change over time at four high speed press is given in Table 4.5.

Table 4.5: Total change over time comparison of four high speed presses

S. No.	Machine Name	Capacity (ton)	Total change over time (Hrs.)
1.	AIDA 2 (NEWAIDA)	300	2
2.	DANLY	200	3
3.	AIDA 125	125	3
4.	CHING FONG	200	3.48

4.6 Causes of More Change over Time

The current setup time in all processes at high speed press was noted down and analyzed thoroughly to investigate the bottleneck process. This data analysis is vital to observe the current setup time activities and performance to identify which current setup processes need to be focused on this study before SMED can be implemented on press at actual tool change over.

There are many causes of more change over time-

1. Type of Setup operations
2. Setting of chute
3. Clamping of free end of chute
4. Clamping of tool die
5. Slide setting
6. Tool availability
7. Lack of skilled worker

4.6.1 Type of Setup operations

Observing changeover process it is investigated that all the operations are performed when machine is in stop condition and there is no external setup of operations. Complete change over process is recorded and all activities and movements of worker at CHING FONG are noted down. Further internal external setup operations are distinguished. After implementation of first phase of SMED the internal and external setup operations are required to be separated. This process improvement can save upto 35% of total tool changeover time.

4.6.2 Setting of Chute

Chute is a channel down for collecting and transporting falling material within guide way. At this machine two different chutes are used for collecting the rotor and stator blank individually. These chutes are attached with chute plate which is clamped on the bolster plate with a defined position varying for all models of die. Setting of chute plate requires changing while tool die changeover which is required to be aligned with the center of stator and rotor blank with an accuracy of micron. A large time is lost in alignment of rotor and stator chute plate. When the changeover is performed chute plate also have to be changed as shown in Figure 4.5 because in rotor blank stage the coming scrap is different in size for different models of die. During the changeover the chute is full of laminations and about 2 ton weight is active on the chute plate. 8 Allen bolts are used for clamping one chute plate with the bolster plate.

The operation performed while setting of the chute:-

1. Unclamp the chute plate from bolster.
2. Lift the chute above the bolster with over head crane.
3. Unclamp the chute plate from chute.
4. Change the chute plate.
5. Lower the chute and place at bolster resting.
6. Position the chute plate by sliding manually. Due to more load attached at chute plate, it is not easy to slide the chute plate. So operators are required to hammer it for sliding.
7. Then clamp the chute plate with bolster.

This complete process takes an average 60 minute and more labor involvement. Standard chute plates are designed for rotor and stator chute to eliminate the chute plate changing process for all model of die. The design study is discussed in detail later.

Figure 4.5: Chute plate changing process using overhead crane
[Crompton Greaves, Ahmednagar]

Table 4.6: Activity duration of chute setting

Activity	Time taken by activity (min.)
Setting of chute	60

4.6.3 Clamping of Free End of Chute

While changing the chute plate, chute is lifted with overhead crane and clamped with bolster. Wires are used to tie the free end of chute as shown in Figure 4.6 and a base support is given with a channel and wooden block. Even this process takes a considerable time to execute. A design is made for eliminate chute tie operation with wire after ever changeover which is discuss in detail later.

Figure 4.6: Old process of clamping the free end of chute
[Crompton Greaves, Ahmednagar]

4.6.4 Clamping of Tool Die

After setting of chute plate over head crane is used to place the die on loading arm. Loading arm and die lifter support the die to slide smoothly at bolster and placement of die is required within precision of microns. After positioning the die at bolster it is clamped manually with threaded bolt shown in Figure 4.7. Manual clamping required more time or labor fatigue. Two operators required to performed bolt tightening operation and time taken by complete activity is 30 minute. To reduce die clamping time QDC hardware hydraulic clamping is used in the place of manual clamping.

Table 4.7: Activity duration of too die clamping

Activity	Activity duration (min.)
Clamping of tool die	30

Die is clamped with two part of press- a) Bolster plate, b) Ram

a) Bolster Plate

The bolster plate (or bed) is a large block of metal upon which the bottom portion of a die is clamped, and it is stationary. Large presses have a die cushion integrated in the bolster plate to apply blank holder forces. This is necessary when a single acting press is used for deep drawing. The ram is also a solid piece of metal that is clamped to the top portion of a progressive die and provides the stroke (up and down movement) resulting in production of parts from sheet metal being fed

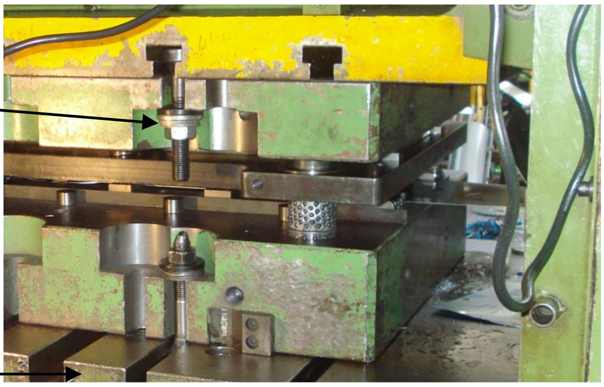


Figure 4.7: Clamping of tool die at bolster with threaded bolt [Crompton Greaves, Ahmednagar]

b) Ram

Stamping presses can be classified into mechanically driven presses and hydraulically driven presses. The most common mechanical presses use an eccentric drive to move the ram, whereas hydraulic presses use hydraulic cylinders. The nature of drive system determines the force progression during the ram's stroke. Advantage of the hydraulic press is the constant press force during the stroke. Mechanical presses have a press force progression towards the bottom dead center depending on the drive and hinge system. Mechanical presses therefore can reach higher cycles per unit of time and are usually more common in industrial press shops.

4.6.5 Slide Setting

The distance in a press between the bottom of the slide and the top of the bed indicate the maximum die height that can be accommodated. This is known as shut height, which depends on different die model. Ram is required to slide up and down to maintain this height. Currently pneumatic gun is used for maintaining shut height. Three operator performed this operation due to damaged gun and improper operation. A single operator could not handle the gun due to vibration produced by individual gun. This operation requires more labor fatigue and take about 10 minute. The operation of shut height setting is shown in Figure 4.8 and pneumatic gun used for slide setting is shown in Figure 4.9. To eliminate the use of pneumatic gun a motor is to be attached with slide.

Table 4.8: Activity duration of slide setting

Activity	Activity duration (min.)
Slide setting	10

Figure 4.8: Shut heights setting with pneumatic gun [Crompton Greaves, Ahmednagar]

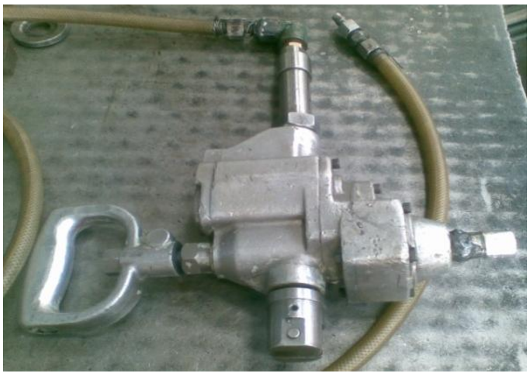


Figure 4.9 : Pneumatic gun [Crompton Greaves, Ahmednagar]

4.6.6 Feeder Gear Box Setting

The sheet is fed through a feeder and pitch is varying for different models of die. The pitch is to be changed by a feeder gear box setting as shown in Figure 4.10. A mechanical feeder gear box is used to change the pitch and there are four gears in this assembly which are required to change for every setting.

1. Driver
2. Driven
3. Transmission gears assembly

Figure 4.10: Feeder gear box assembly
[Crompton Greaves, Ahmednagar]

There are 25 allen bolts, which are to be loosened and tightened while changing gears. This process is more time consuming and require skilled labor. Time taken by setting of feeder gear box is 35 minute. A process innovation is done in operation to reduce feeder gear box setting time which is discussed in detail later.

Table 4.9: Activity duration of feeder setting

Activity	Activity duration (min)
Setting of feeder gear box	35

4.6.7 Worker Skill and Tools Availability

It is also observed that workers are not properly skilled and there is lack of coordination and timing. Benchmark studies estimate that about 40% time is spent on arranging parts. All setup operations are performed in off-line mode. After examination of tool change over process it is found that movement of worker from machine to tool room more than 10 times for bringing tools takes about 30 min.

4.7 MACHINE SPECIFICATION (CHING FONG)

A CHING FONG made high speed press of 200 ton capacity is to be used for setup time reduction study. The maximum speed of press is 150 strokes per minute and stroke length is 30mm. The maximum height die can run in this press is 400mm and the bolster plate area is 1800×900mm2. The capacity of main motor which run the press is 4pole 50 horse power (v.s.50HP×4P). A double headed Double head uncoiler with hydraulic expansion device and straighten with S-loop is used for decoiling the coil. One head is in working the other one remain standby with loaded coil. As the coil length is finished at one head, operator stops the machine and changes the head of decoiler with new coil attached at this. The feeding pitch is varying for all die according to strip layout of tool so a change-gear type cam index feeder is attached with the press. And the feeding pitch is to be changed according to gear ratio of gear box. The image of this press with decoiler is shown in Figure 4.11. The specification of machine is shown in Table 4.10.

Figure 4.11: High speed punching press (CHING FONG) [Crompton Greaves, Ahmednagar]

4.7.1 Machine Layout

A view of High Speed Press layout (CHING FONG-200) is given in Figure 4.12. In this case operator A operates machine as well as tie the rotor with wire and operator B collects the stator from collection chute and tie it with wires. These wire tied packs are stored in a bin and then shifted to various places for next operation. In some cases, the stators are sent to vendor for the cleating operation. After completion of cleating operation, the same batch again comes back to the factory and dispatched to the customer.

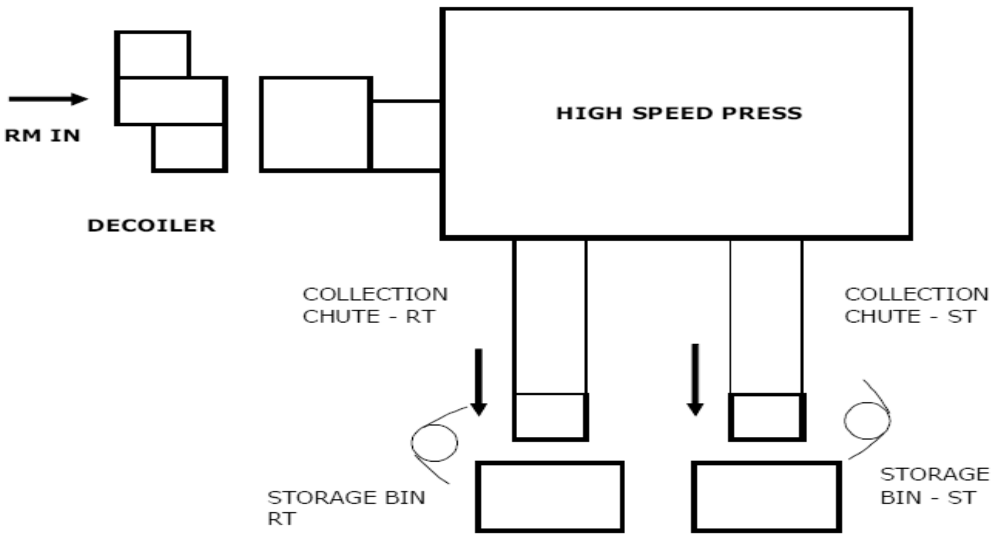


Figure 4.12: Work flow layout of material at high speed press

Table 4.10: Specification of high speed press(CHING FONG)

Type / HSD-200 **Machine no.-/A31559**		
Main Specification		
S.No.	Component Name	Specification
1	Frame type 3 parts (material FC300)	8 side gibs
2	Clutch & brake pneumatic	
3	Capacity	B.D.C 3.2mm, 150SPM,200ton
4	Stroke length	30mm
5	Die height	400mm
6	Slide adjustment	60mm
7	Slide area	1700×700mm
8	Bolster area	1800×900mm
9	Bolster thickness	200mm
10	Bed opening	1535×350mm
11	Slide opening	450×450mm
12	Height from feeding line to bolster (feeding level from bolster)	160+20mm
13	Working height	1010mm
14	Press total height(from ground)	4500mm
15	Main motor	v.s.50HP×4P
16	Lubrication system motor	1hp×6P
Double head uncoiler with hydraulic expansion device and straighten with S-loop		
A	Model	DUS-30
B	Maximum coil width	300mm
C	Maximum coil O.D	1300mm
D	Coil I.D.	508+20mm
E	Max. Coil weight	2500×2kg
F	Feed speed (max.)	60m/min
G	Leveler motor	3HP×4P
Change –gear type cam index feeder		
A	Model	ISIS R660G
B	Maximum coil width	400mm
C	Material thickness	3.2 mm
D	Feed height	165+20mm
E	Feed length	20~300mmMax

CHAPTER 5
IMPLEMENTATION OF SMED

Initially complete tool change over data is recorded and SMED principles are implemented in recorded data. The steps followed in implementation are as follows-

1. Distinguish the internal and external set up operations from the recorded data.
2. Separate the internal and external setup operations.
3. Convert the internal setup operation into external setup operations.
4. At last streamline all setup operations.

5.1 SMED methodology implementation

1. First considered the process and its constraints identified a process area that is a constraint and consider how beneficial SMED might be for the whole system's performance. The operations performed during changeover are given in Table 5.1.
2. After recording change over time at all machine found that CHING FONG takes maximum time as shown in Table 5.2 then we select this machine for SMED implementation.
3. After selection of machine Form a setup reduction team included machine operator, milling machine operator and one member from maintenance department.
4. Study the current change over process at CHING FONG and documented the activity as sown in Table 5.2 and duration of the current change over or set up process and used this as the starting bench marking.
5. Then classified the setup operations into internal and external setups given in Table 5.2.
    a) Internal setup-operation that can only be performed while the machine is shut down.
    b) External setup-operations that can be performed without shutting down the machine.
6. Eliminated extra activities from internal and external setup of operations.
7. All operation are performed while the machine is stop then after observation converted as many the internal setup operation into external setup operations.

All setup operation performed sequentially during the tool change over process is shown in Table 5.1 and the SMED steps implementation are shown in Table 5.2. This is the one complete changeover process data collection and implementation of SMED phase at each activity; means distinguish and separate all activity into internal and external setup operations.

Table 5.1: Operation performed during tool changeover process

S.NO.	Activities
1	Cut sheet and remove it out
2	Unclamp the die
3	Unclamp the mister switch
4	Place loading arm
5	Insert die lifter
6	Release the ram
7	Remove die
8	Chute changing and setting a. Unclamp the chute plate b. Lift the cute above the bolster c. Change the chute plate d. Place the chute plate at the bolster e. Slide chute plate for measurement f. Clamp chute plate
9	Place new die at m/c bed
10	Alignment of die with measurement
11	Setting of shut height
12	Remove loading arm
13	Remove die lifter
14	Remove tool die
15	Setting of feeder gear box a. Unclamp the gear from gear box b. Change gear for new die c. Clamp the gear
16	Place the mister switch

5.2 Activity Classification

This step is comprised of recoded material analysis and activities divided into two groups: the internal and external ones. External activities are all the setup activities that can be performed while machine is in operation. Internal setup activities are the ones that can be performed only if the machine is not in operation. Internal activities refer to the dismantling of used tool, to the mounting of new ones and establishing communication in line machine tool (SMED). The all recorded activities during changeover at CHING FONG press is shown in Table 5.2.

Table 5.2: All activities and duration of activities performed at CHING FONG press

S.No.	Activity	Time (min)	Operation	Separation
1	One operator goes to tool room and bring the spanner and sheet cutter	1	*External*	*External*
2	Cut the sheet and remove it out from the tool	1	Internal	*External*
3	One operator start opening bolt of tool die	4	Internal	*External*
4	One operator goes down in the pit and push the previous material from the chute	4	Internal	*External*
5	One operator again go to tool room for Allen key	4	*External*	*External*
6	Release the ram	1	Internal	*External*
7	Place the loading arm	1	Internal	*External*
8	One operator go to tool room for eye bolt	3	*External*	*External*
9	Crane remove the die from the machine	2	Internal	*External*
10	Again one operator go to tool room	3	*External*	*External*
11	One operator start setting of chute plate	38	Internal	Internal
12	Clean the machine bed	1	Internal	Internal
13	Insert the die lifter	1	Internal	Internal
14	Again one operator goes to tool room	2	*External*	Internal
15	One operator brought the gears	22	*External*	Internal
16	One operator brought the pneumatic gun	2	*External*	Internal
17	Setting of shut height	3	Internal	Internal
18	Crane place the tool die in the press	6	Internal	Internal

19	Clean the die before place at bolster plate	2	Internal	Internal
20	Remove loading arm	1	Internal	Internal
21	Setting the die (chute alignment error)	15	Internal	Internal
22	Remove the die again	9	Internal	Internal
23	Crane place the die to the machine bed	8	Internal	Internal
24	Remove the loading arm	1	Internal	Internal
25	Setting the die against measurement	5	Internal	Internal
26	Setting of shut height	5	Internal	Internal
27	Again one operator go to tool room	2	*External*	Internal
28	Fastening the die	28	Internal	Internal
29	Again one operator go to tool room	5	*External*	Internal
30	Make adjustment for clamping	15	*External*	Internal
31	Setting of sheet	14	Internal	Internal
32	Setting of shut height	4	Internal	Internal
	Total	213		

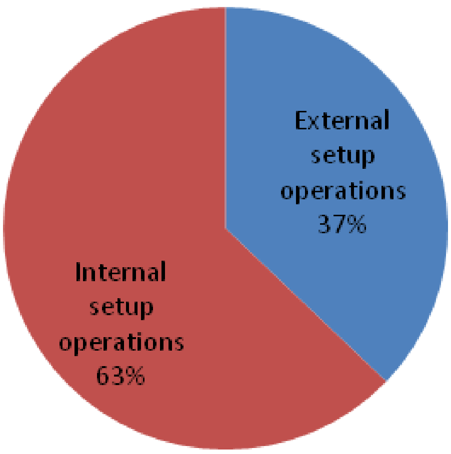


Figure 5.1: Percentage distribution of time in internal and external setups

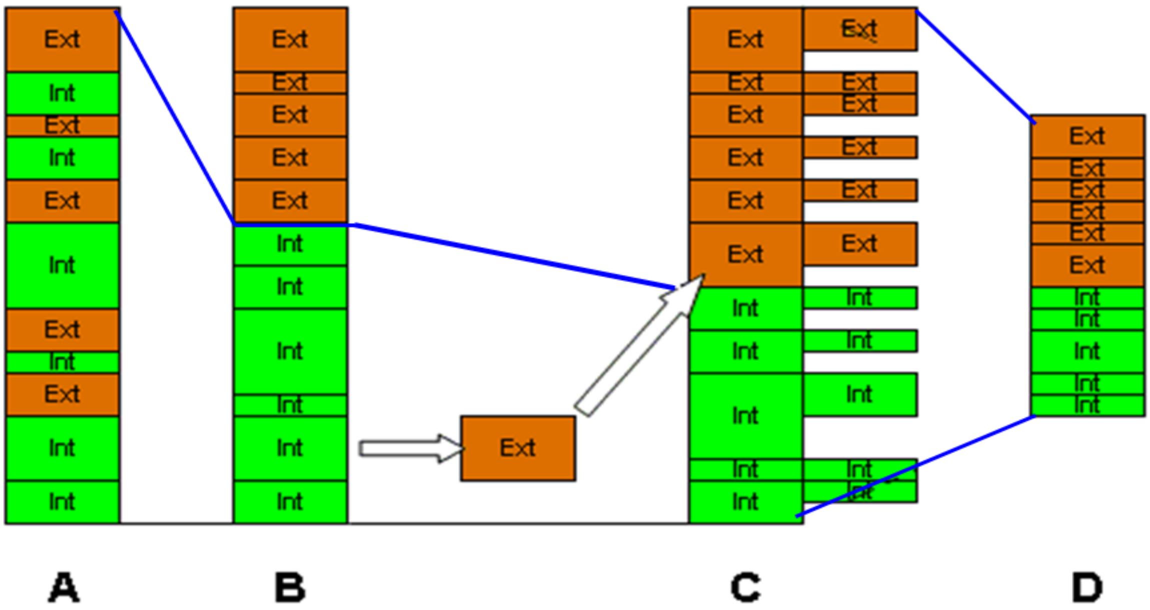


Figure 5.2: Four phases of SMED

A- Distinguish the internal and external setup operation

B- Separate the internal and external setup operation

C- Convert internal setup operation into external setup operation

D- Streamlining of all operations

5.3 Implementation Results

After distinguish, the external setup operation are separated from the internal one and performed these operation when the machine is in process, means completed these operation for the next run when machine is in process for previous run. The setup time is reduced 37% of the total changeover time as shown in Figure 5.1 by this process improvement only.

CHAPTER 6

DESIGNING AND SIMULATION OF CHUTE PLATE AND SUPPORTING COMPONENTS

6.1 CHUTE PLATE DESIGN

Chute is a channel down for collecting and transporting falling material within guide way. At high speed press chute is used for collecting the rotor and stator laminations and this chute is attached with bolster through chute plate. The position of chute at the bolster should be aligned with the centre of rotor and stator blanking stage of tool die. For different die models chute plate has to be changed and new chute plate is to be placed with an accuracy of microns to prevent the tool breakage. A solid model is a digital representation of the geometry of an existing and envisioned physical object. Solid model play a major role in discrete- part manufacturing industries where precise models of parts and assemblies are created using solid modeling software. Solid modeling impacts a great variety of design and manufacturing activities. These are includes early sketches, design decision, space allocation negotiations, detailed design, drafting, interactive visualization of assembly. The modeling and assembly of some few components is done with software solid work 9.0.

6.1.1 Rotor Chute Plate design

There are two blanking stage in progressive die at high speed press i.e. rotor blanking, stator blanking. These lamination blank pass through the chute attached with chute plate. In the rotor blanking stage the scrap is cut along with rotor lamination. The scrap cut in this stage is in triangular form .This scrap pass through the triangular slot of rotor chute plate shown in Figure 6.1 and the size of triangular scrap vary for different die models. So due to this reason rotor chute plate has to be changed for all die models. A new design for chute plate is introduced to overcome this timely chute plate changing process.

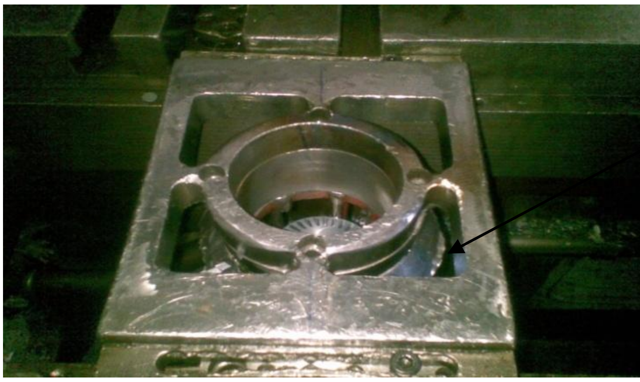


Figure 6.1: Old rotor chute [Crompton Greaves, Ahmednagar]

The steps followed in the design study are as-

1. First procure the drawings of strip layout for all die models mounted at CHING FONG press.
2. Noted down the size (outer diameter) of rotor and stator laminations for all models of die.
3. Determine the size of triangular scrap of all model of die.
4. Comparison of rotor O.D. and triangular scrap size.

Size (outer diameter) of rotor and stator lamination, scrap size is determined with the help of strip layout of all die running at CHING FONG press and a cylinder for a series of range is predicted. Considering all these parameter a standard rotor chute plate is designed with interchangeable cylinder. There are two cylinders for all dies running at CHING FONG press. These cylinders are placed in a spigot of chute plate. Now only the cylinder is required to change according to specifications of die rather than changing complete chute plate. The triangular scrap cut in this stage slide through the profile of chute plate. Solid model of newly designed rotor chute plate is shown in Figure 6.3.

First cylinder is used from frame 80 to 100 outer diameter of rotor lamination. The outer diameter of this cylinder is 115mm and inner diameter is 100mm.

Second cylinder is used from frame 100 to 132 outer diameter of rotor lamination. The outer diameter of this cylinder is 165mm and inner diameter is 145mm.

A *strip layout* of super 91 model of die shown in Figure 6.2 is made to determine the strip width and pitch. The bridge width between the parts and the edge allowance between the part and the edge of the strip has to be selected to meet the following requirements:

1. Width of sheet

2. Pitch
3. Scrap size and type
4. No. of stage
5. Outer diameter of rotor and stator lamination

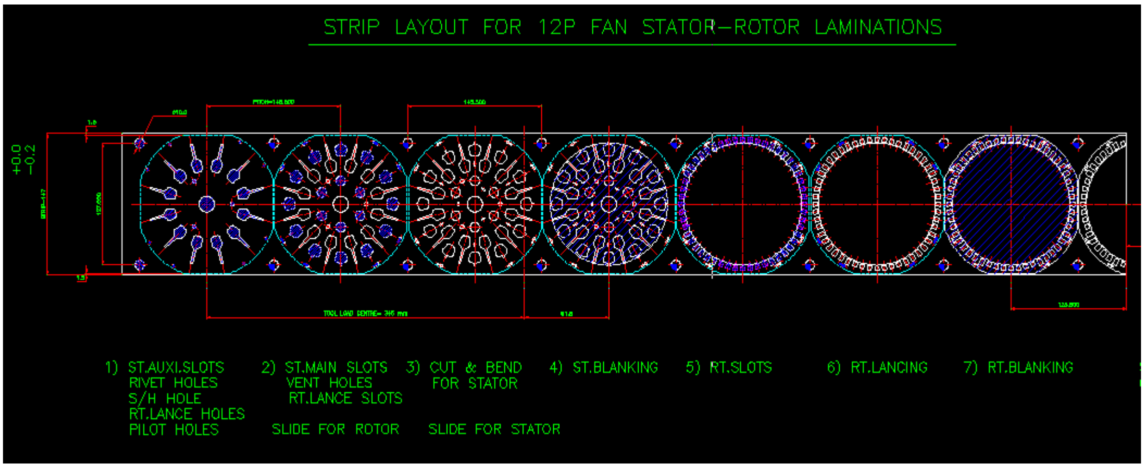
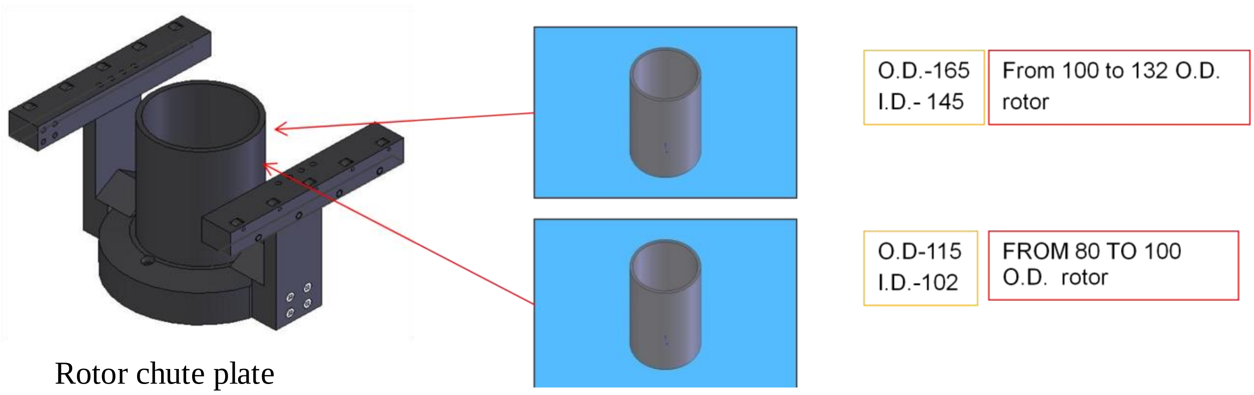


Figure 6.2: Strip layout of super 91 model die [Crompton Greaves, Ahmednagar]



Rotor chute plate

Interchangeable cylinder

Figure 6.3: Rotor chute plate design with interchangeable cylinder

6.1.2 Stator chute plate design

As there is no scrap produced in stator blanking stage so there is no triangular slot in the stator chute plate. The existing design of stator chute plate shown in Figure 6.4 is flat; there is no slot for scrap. But in some models of tool die conveyor and flipslide are used in the place of chute for collecting the laminated rotor and stator. In that condition chute plate is to be removed from bolster because it creates hindrance to flow the scrap.

Figure 6.4: Existing stator chute plate [Crompton Greaves, Ahmednagar]

To eliminate this chute plate removing operation a standard chute plate with removable cylinder is designed. While using conveyor and flipslide only cylinder is to be removed from the chute plate to enable scrap pass through the chute plate. The solid model of newly design stator chute plate is shown in Figure 6.5.

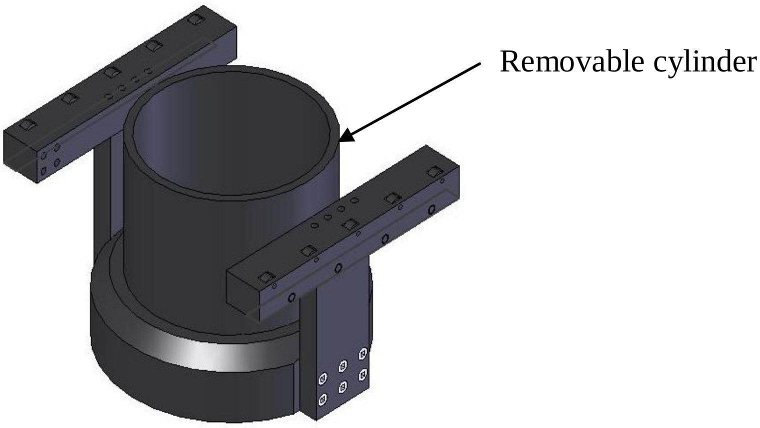


Figure 6.5: New design of stator chute plate with removable cylinder

While positioning it is required to slide the chute plate according to tool die stator and rotor blanking stage. For easy sliding of chute plate at bolster, needle roller bearing at the sliding surface of rotor and stator chute plate are used. The size of needle roller bearing is defined as Inner diameter- 15mm, Outer diameter-21 mm, Width -12mm. Sliding part of chute plate with needle bearing is shown in Figure 6.6 and the needle roller bearing is shown in Figure 6.7.

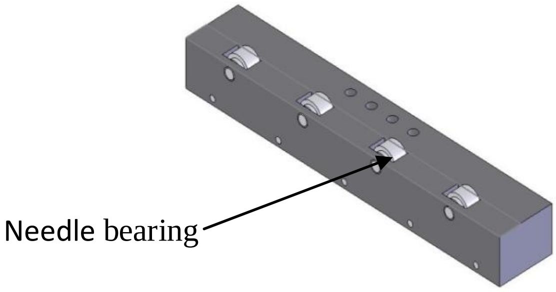


Figure 6.6: Sliding part of chute plate with needle bearings

Figure 6.7: Needle roller bearing

6.2 SIMULATION OF CHUTE PLATES

The setting of chute takes maximum time in one complete tool change over process and the reason of this was clumsy and non standard existing chute plate design. For eliminate these bottlenecks, design standard chute plate with interchangeable cylinders and a lead screw assembly for smooth sliding .Therefore a 3D modeling approach is being adapted to find the standard chute plate design. The software used for 3D modeling is SOLID WORK 9.0. The chute plate is attached with more weight so it is required to calculate the stresses for safe design. A simulation is done for calculating the stresses with the help of software ANSYS 11.0. Determination of the stresses of chute plates before manufacturing is important due to the design improvement

6.2.1 Simulation Methodology

ANSYS is a general purpose finite element modeling package for numerically solving a wide variety of mechanical problems. These problems include: static/dynamic structural analysis (both linear and non-linear), heat transfer and fluid problems, as well as acoustic and electro-magnetic problems. A fundamental premise of using the finite element procedure is that the body is sub-divided up into small discrete regions known as finite elements. These elements defined by nodes and interpolation functions. Governing equations are written for each element and these elements are assembled into a global matrix. Load and constraints are applied and the solution is then determined.

In general finite element solution may be broken onto three stages-

- Preprocessor
- Solution
- postprocessor

ANSYS 11.0 is used for simulation the component and the type of analysis is used static structural for calculating the stresses.

6.2.2 Static Structural Analysis

A static structural analysis determines the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects. Steady loading and response conditions are assumed; that is, the loads and the structure's response are assumed to vary slowly with respect to time. The types of loading that can be applied in a static analysis include:

a) Externally applied forces and pressures
b) Steady-state inertial forces (such as gravity or rotational velocity)
c) Imposed (nonzero) displacements
d) Temperatures (for thermal strain)

6.2.3 Material selection

Material is selected on the basis of previous chute plate material. The material used for designed component is mild steel (EN8). This is medium carbon steel. EN stands for Euro Norm. The composition of EN8 is C (0.35-0.45%), Si (0.05-0.35%), Mn (0.6-1.0%), sulphur and phosphorous is less than 0.06%.

Properties of EN8 material is-

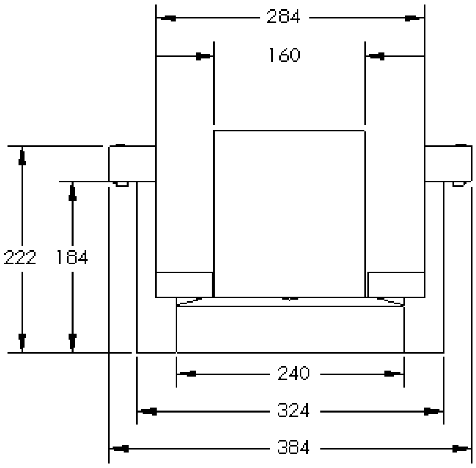
a) Poison ratio- 0.3
b) Tensile stress- 500 N/mm^2.
c) Young’s modulus-190GPa.
d) Density – 7700 kg/m^3.

6.2.4 Rotor Chute Plate

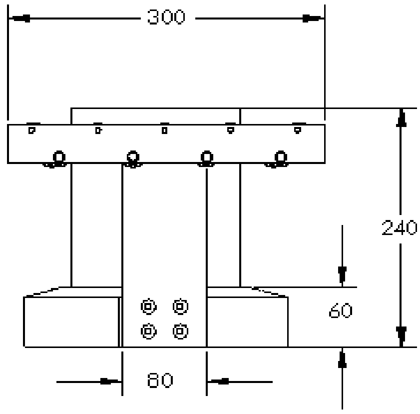
A standard rotor chute plate is designed with an interchangeable cylinder and the weight attached with chute plate is about 2 ton. The drawing, solid model and simulation results of chute plate are shown as follows-

Drawing

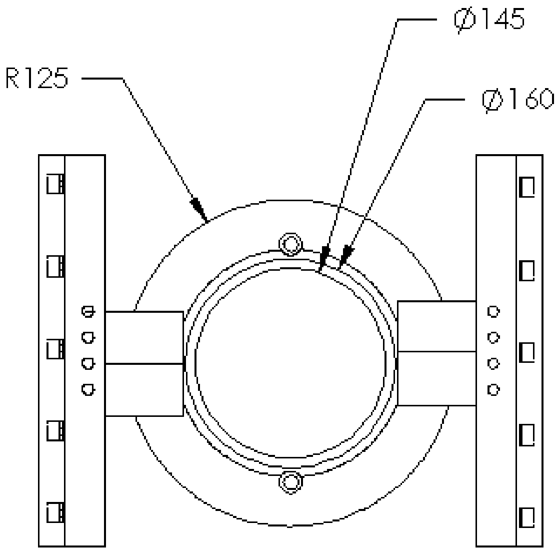
Solid works 9.0 is used for making the drawing of rotor chute plate detailed in three views as shown in Figure 6.8 a) Front view, b) Right view c) Top view.



a) Front view



b) Right view



c)Top view

Figure 6.8: Drawing detail of rotor chute plate a) Front view b) Right view c) Top view (All dimension in mm)

Solid model

The solid model of rotor chute plate is designed in Solid Works 9.0 shown in Figure 6.9. This is the fabricated assembly of component with Allen bolts and the interchangeable cylinder placed in a spigot without any clamping. The tolerance of interchangeable cylinder with chute plate is running fit and this cylinder is constrained from all direction except upward movement and no need to constrain to this direction.

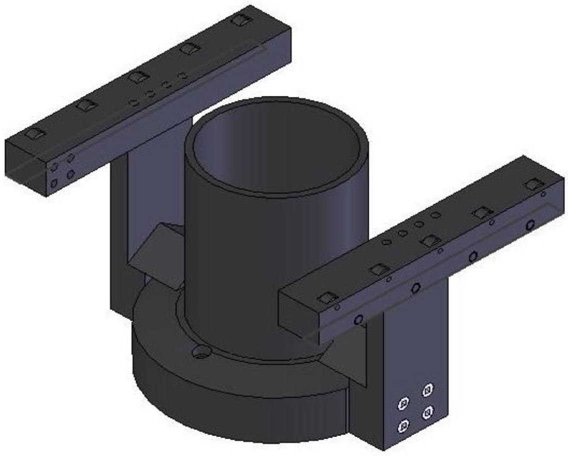


Figure 6.9: Solid model of rotor chute plate

Simulation Results

To estimate the stresses induced in the rotor chute plate a simulation is done using structural analysis module of ansys11.0 software. The solid work file saved in IGES format is imported in ANSYS followed by applying all the boundary conditions there in ANSYS. Simulation results are given in Figure 6.11. The boundary conditions are defined as 19800 N load in downward direction, sliding surface fixed, and displacement is free in y- direction as shown in Figure 6.10. The material used for simulation is mild steel (EN8) and stiffness behavior is flexible.

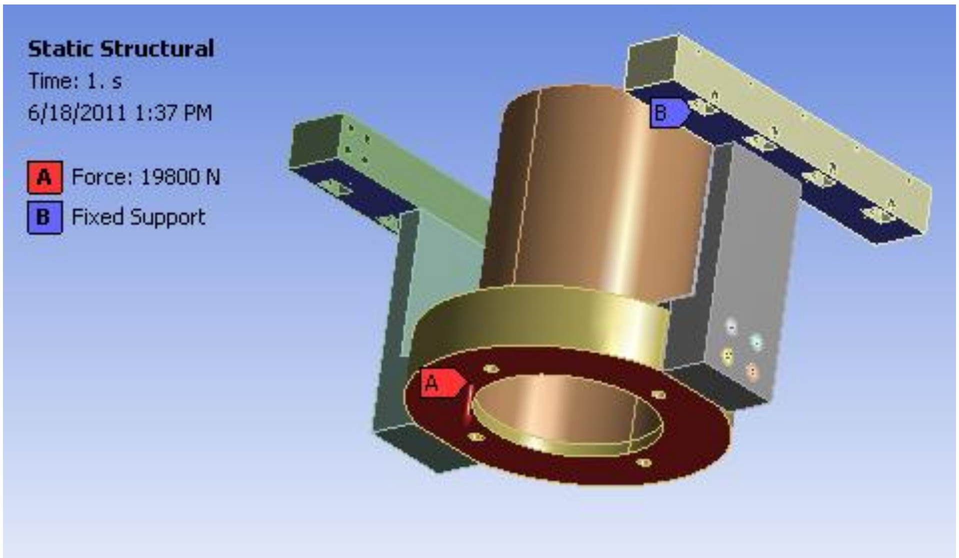
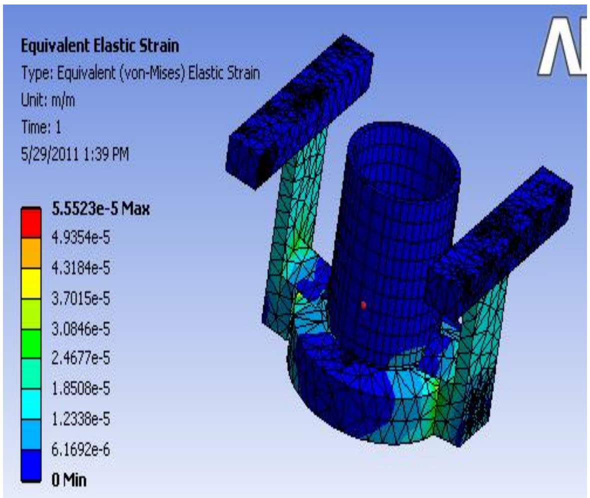


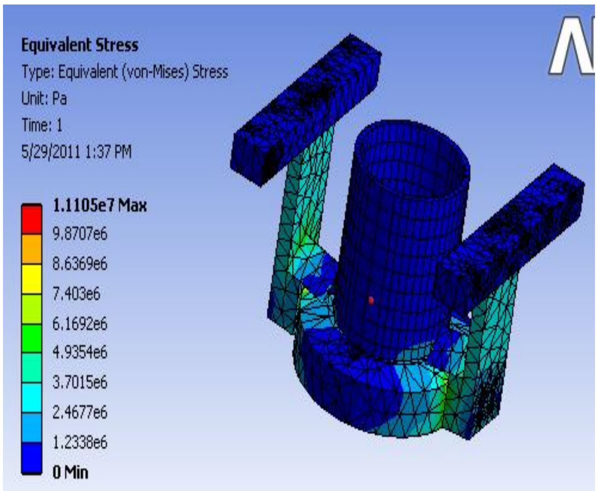
Figure 6.10: Boundary conditions of rotor chute plate in simulation

Simulation results are estimated in terms of stresses and safety factor as follows-

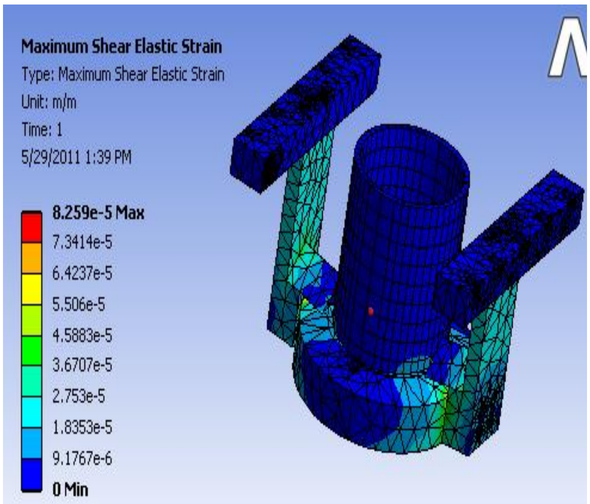
1. Maximum *Equivalent (von-Mises) stress* occurred as shown in Figure 6.11 (b) is 11.105 MPa and induced at the pillar of chute plate which are less than the tensile strength of the material. Hence the model designed is predicted to be in safe zone.
2. *Maximum shear stress* occurred as shown in Figure 6.11 (d) is 6.3531 MPa i.e. quite less than the ultimate shear strength of material which is 250 MPa.
3. The minimum factor of safety as shown in Figure 6.11 (e) is 10 and maximum is 15 which confirm that design is safe. At present no optimization is done for current design only stresses has been estimated.



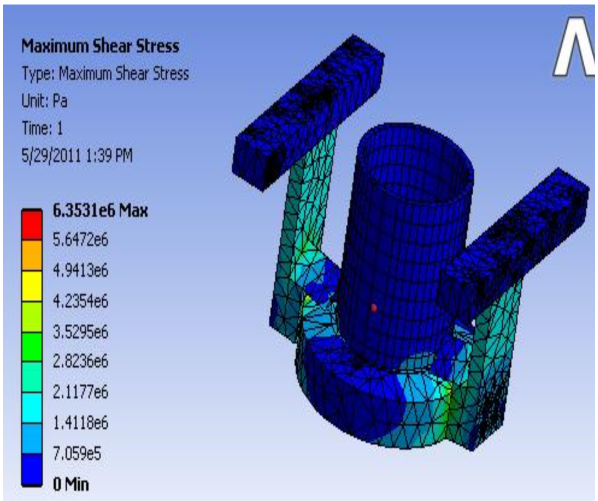
a) Equivalent elastic strain(load 19800N)



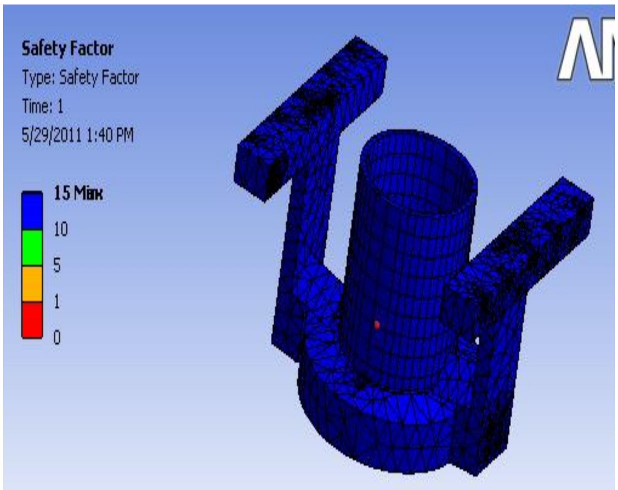
b) Equivalent stress(load 19800N)



c) Maximum shear elastic strain (load 19800N)



d) **Maximum shear stress(load 19800N)**



e) Safety factor (load 19800N)

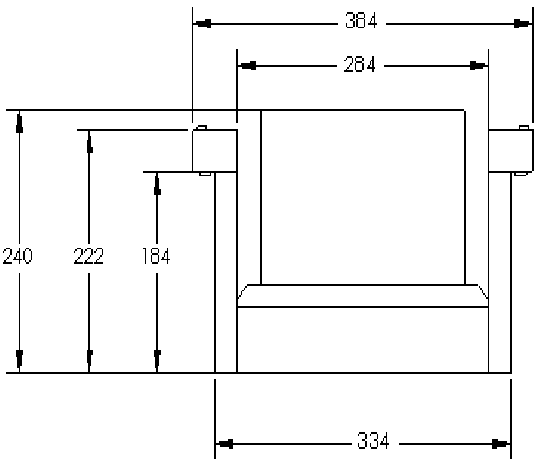
Figure 6.11: Static structural analysis results of rotor chute plate a) equivalent elastic strain, b) equivalent stress, c) maximum shear elastic strain, d) maximum shear stress, e) safety factor.

6.2.5 Stator Chute Plate

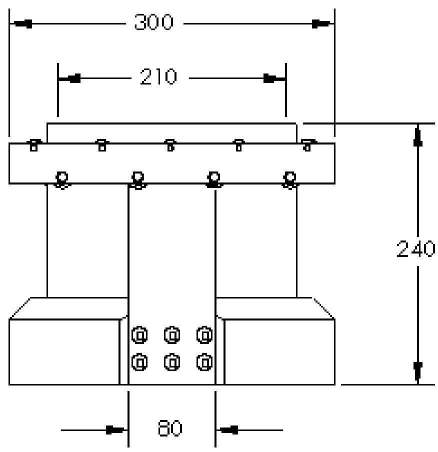
A standard stator chute plate is designed with a removable cylinder and the weight attached with chute plate is about 2 ton. The drawing, solid model and simulation results of chute plate are shown as follows-

Drawing

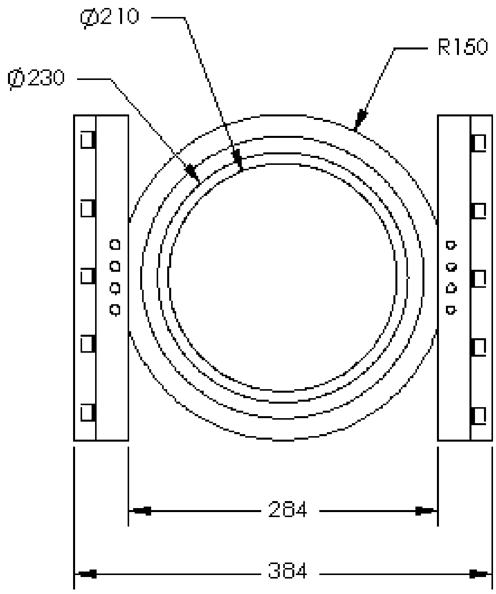
Solid works 9.0 is used for making the drawing of stator chute plate detailed in three views as shown in Figure 6.12 a) Front view, b) Right view c) Top view.



a) Front view



b) Right view



c) Top view

Figure 6.12: Drawing detail of stator chute plate a) Front view b) Right view c) Top view (All dimension in mm)

Solid model

The solid model of stator chute plate is designed in Solid Works9.0 shown in Figure 6.13. This is the fabricated assembly of component with Allen bolts and the removable cylinder placed in a spigot without any clamping. The tolerance of removable cylinder with chute plate is running fit and this cylinder is constrained from all direction except upward movement and no need to constraint to this direction.

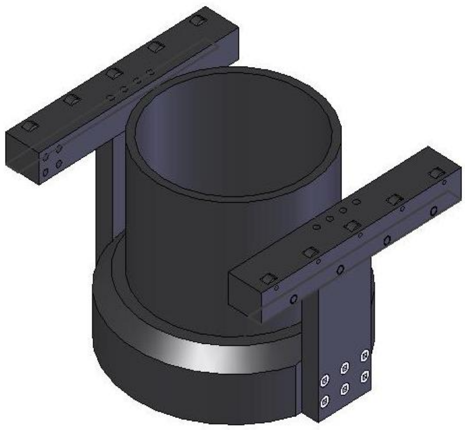


Figure 6.13: Stator chute plate

Simulation Results

To estimate the stresses induced in the stator chute plate a simulation is done using static structural analysis module of ansys11.0 software. The solid work file saved in IGES format imported in ANSYS followed by applying all the boundary conditions. The boundary conditions are defined as 19800 N load in downward direction, sliding surface is fixed, and displacement is free in y- direction as shown in Figure 6.14. The material used for simulation is mild steel (EN8) and stiffness behavior is flexible. Simulation results are given in Figure 6.15.

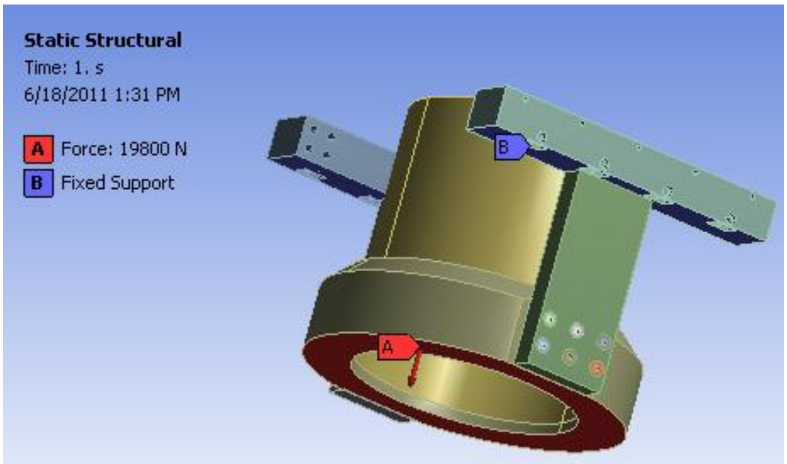
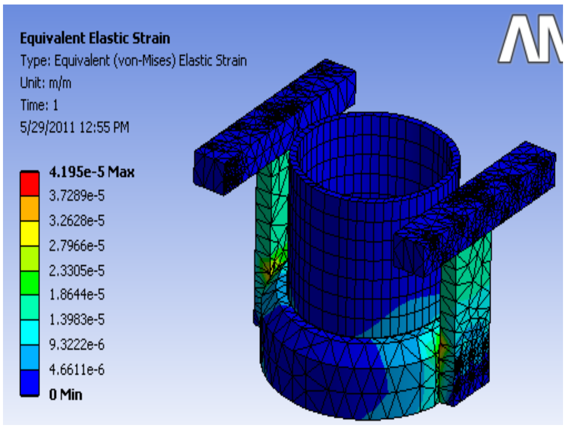


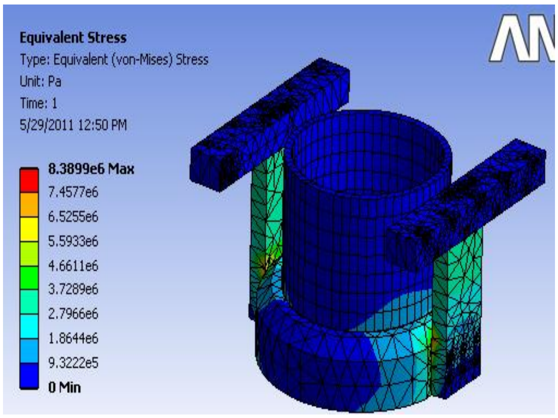
Figure 6.14: Boundary condition of stator chute plate in simulation

Simulation results are estimated in terms of stresses and safety factor as follows-

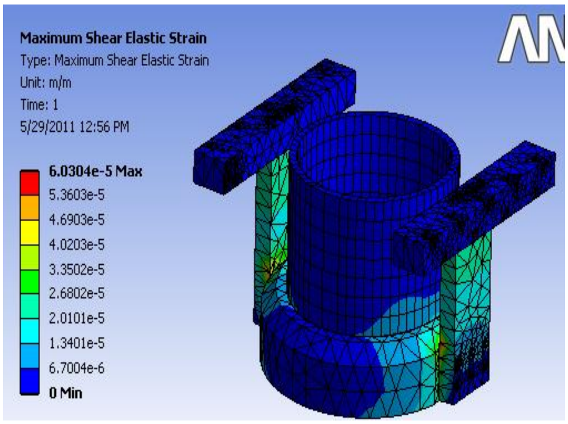
1. Maximum *Equivalent (von-Mises) stress* occurred as shown in Figure 6.15 (b) is 8.3899 MPa and induced at the pillar of chute plate which are less than the tensile strength of the material. Hence the model designed is predicted to be in safe zone.
2. *Maximum shear stress* occurred as shown in Figure 6.15 (d) is 4.6388 MPa i.e. quite less than the ultimate shear strength of material which is 250 MPa.
3. The minimum factor of safety as shown in Figure 6.15 (e) is 10 and maximum is 15 which confirm that design is safe. At present no optimization is done for current design only stresses has been estimated.



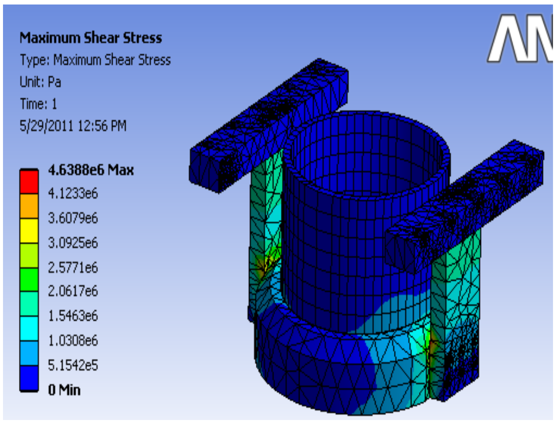
a) Equivalent elastic strain(load 19800N)



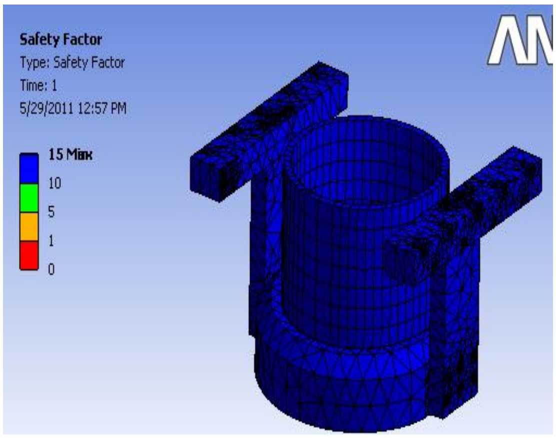
b) Equivalent stress (load 19800N)



c) Maximum shear elastic strain (load19800N)



d) Maximum shear stress(load 19800N)



e) Safety factor (load 19800N)

Figure 6.15: Static structural analysis results of stator chute plate a) equivalent elastic strain, b) equivalent stress, c) maximum shear elastic strain, d) maximum shear stress, e) safety factor.

6.3 DESIGNING OF SUPPORTING COMPONENTS OF CHUTE ASSEMBLY

A lead screw assembly attached with chute plate is used to slide the chute in horizontal direction with smooth and precise motion. The slotted bar permanently clamped at bolster plate at both side of bolster slot step. Assembled the chute plate inside the slotted bar (support bar), from this design constraint the upward and downward motion of chute plates. Now the chute plate is free to move only in horizontal direction

6.3.1 Stator Lead Screw

A lead screw also known as a power screw or translation screw is a screw designed to translate turning motion into linear motion. A square thread lead screw for stator plate is designed with the help of solid work. This lead screw is requiring for sliding the stator chute plate. The drawing, solid model and simulation results of lead screw is defined as-

Drawing

Solid works 9.0 is used for making the drawing of square thread lead screw for stator chute plate. Square threads are defined as follows by ISO standards ($Sq24 \times 5$).Where Sq designates a square thread, 24 is the nominal diameter in millimeters, and 5 is the pitch in millimeters. When there is no suffix it is a single start thread. If there is a suffix then the value after the multiplication sign is the lead and the value in the parentheses is the pitch. For example: $Sq24 \times 5LH$ would denote two starts, as the lead divided by the pitch is two. The "LH" denotes a left hand thread. The drawing details of lead screw are shown in Figure 6.16 and specification of square thread is shown in Table 6.1.

Table 6.1: Square Threads Specification of stator lead screw

Thread	Nominal diameter(D)	Minor diameter(d)	Pitch	E	R	H2	B	H1	A	H
Square	24 mm	19mm	5mm	2.5	.25	2	.5	2.5	.25	2.75

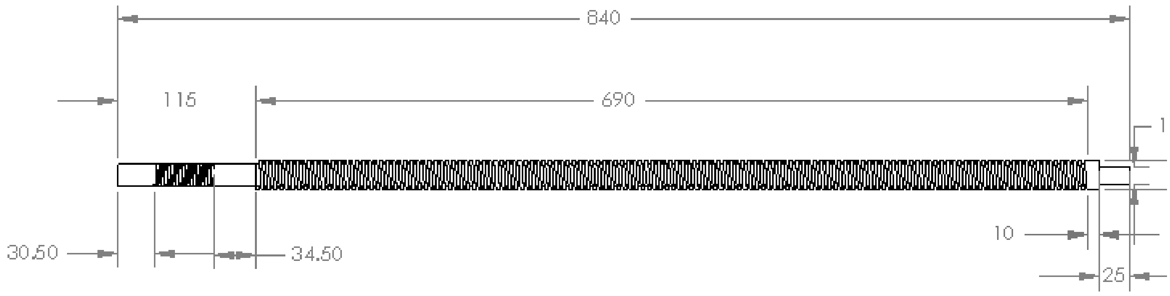


Figure 6.16: Drawing detail of stator lead screw
(All dimension in mm)

Solid model

The solid model of lead screw is designed in solid work. There are two type of thread in this lead screw first is square thread for leading the chute plate which is shown in Figure 6.17 and second is acme thread for locking nut. The lock nut is used to lock the movement of lead screw so that can fix position of chute plate. One end of the lead screw is connected to the housing and other end is connected from rotor chute plate lead screw through male and female connection. The square thread specification is given in Table 6.1.

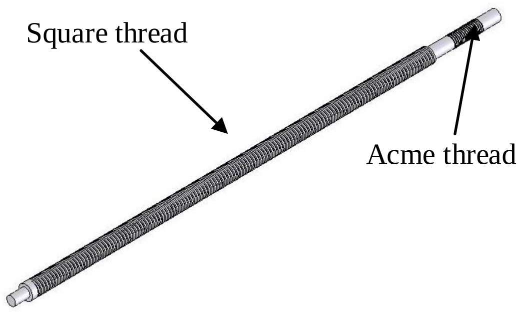


Figure 6.17: Solid model of stator lead screw

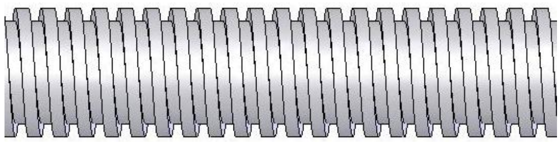


Figure 6.18: Enlarge view of square thread

6.3.2 Rotor Lead Screw

A square thread lead screw for rotor chute plate is designed with the help of solid work. This lead screw is requiring for sliding the rotor chute plate which is attached with weight. The drawing, solid model and simulation results of lead screw is defined as-

Drawing

Solid works 9.0 is used for making the drawing of square thread lead screw for rotor chute plate. Square threads are defined as follows by ISO standards ($Sq24 \times\ 5$).

Where Sq designates a square thread, 24 is the nominal diameter in millimeters, and 5 is the pitch in millimeters. When there is no suffix it is a single start thread. If there is a suffix then the value after the multiplication sign is the lead and the value in the parentheses is the pitch. For example: $Sq24 \times 5LH$ The "LH" denotes a left hand thread. The drawing details of lead screw are shown in Figure 6.19.

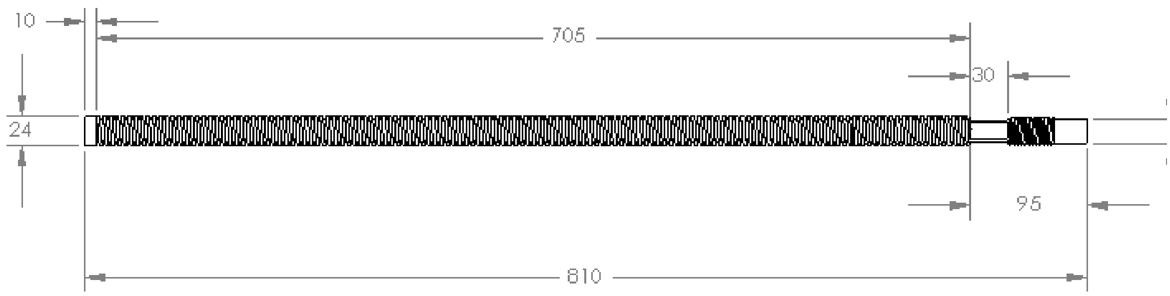


Figure 6.19: Drawing detail of rotor chute plate lead screw
(All dimension in mm)

- ***Solid model***

The solid model of stator chute plate lead screw is designed in solid work and shown in Figure 6.20. There are two type of thread in this lead screw first is square thread for leading the chute plate and second is acme thread for locking nut . The lock nut is used to lock the movement of lead screw so that can fix position of chute plate. One end of the lead screw is connected to the housing and other end is connected from rotor chute plate lead screw through male and female connection.

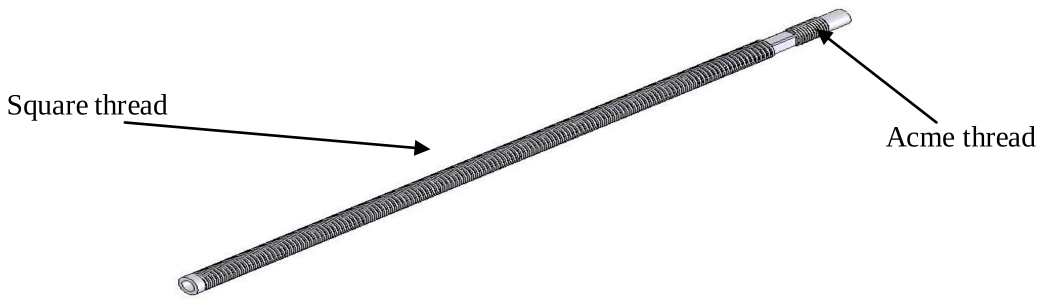
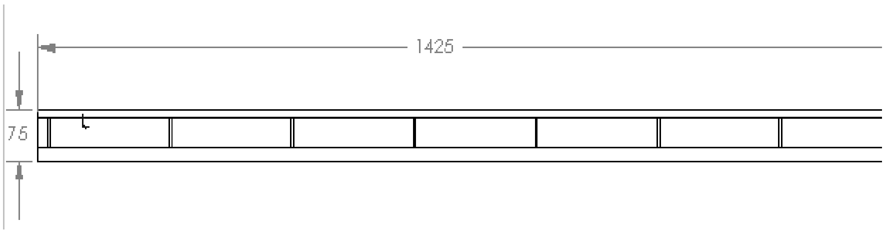


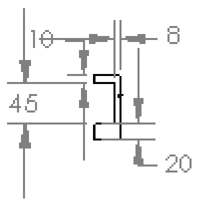
Figure 6.20: Rotor chute plate lead screw

6.3.3 Slotted Bar

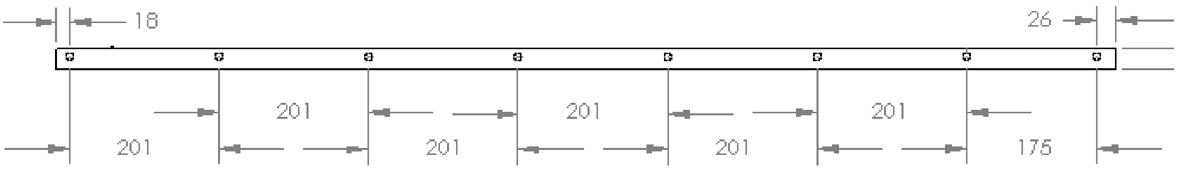
In the existing design of chute plate, four Allen bolt are required for clamping the chute plate with bolster. This process consume more time and repeated clamping and unclamping of chute plate damage the thread of tapping hole of bolster plate. To eliminate this, a slotted bar shown in Figure 6.11 is designed to hold chute plate and bolted permanently on the bolster plate. Chute plate sliding inside the slotted bar (support bar) is constrained to move in upward and downward directions. A lead screw assembly attached with chute plate is used to slide the chute in horizontal direction with smooth and precise motion. The slotted bar permanently clamped at bolster plate at both side of bolster slot step. Assembled the chute plate inside the slotted bar (support bar), from this design constraint the upward and downward motion of chute plates. Now the chute plate is free to move only in horizontal direction. The detail drawing of slotted bar is shown in Figure 6.21 and solid view is shown in Figure 6.22.



a) Front view



b) Right view



c) Top view

Figure 6.21: Detail drawing of slotted bar a) front view b) right view c) top view (All dimension in mm)

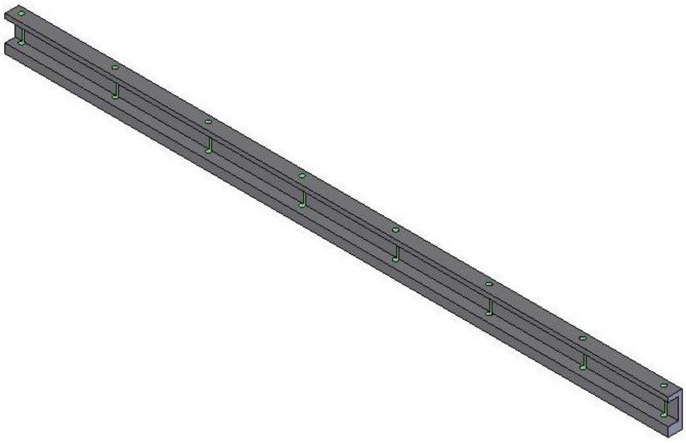
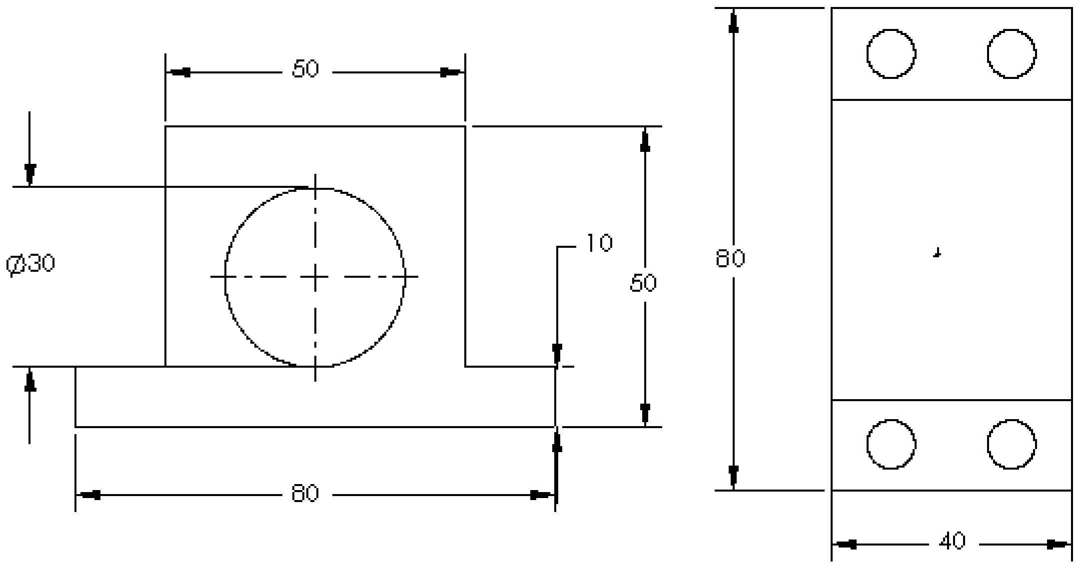


Figure 6.22: Solid model of slotted bar

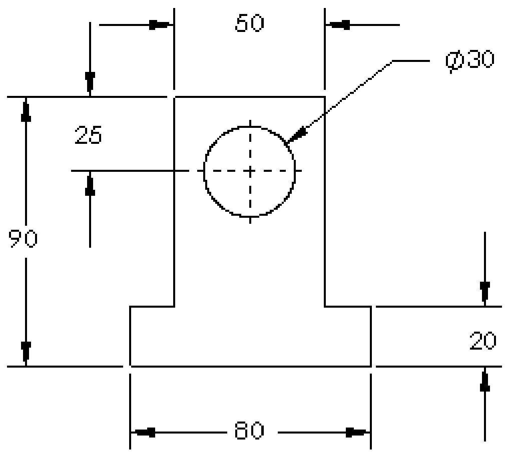
6.3.4 Housing

Housing is defined as an enclosed frame in which a shaft revolves. The housing provided the support to the lead screw, end of lead screw is inserted into the housing and that end is free to rotate. There are two housing is used for end support of lead screw. The one extreme end of lead screw is supported through housing and the other end of both lead screws is connected through male and female connection. The drawing detail of stator and rotor housing is shown in Figure 6.23 and 6.24.

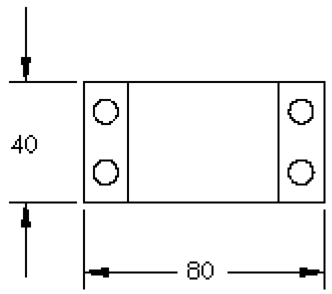


a) Front view **b) Top view**

Figure 6.23: Drawing detail of stator lead screw housing a) front view b) top view (All dimension in mm)



a) Front view



b) Top view

Figure 6.24: Drawing detail of rotor lead screw housing a) front view b) top view (All dimension in mm)

Solid model

Solid model of rotor &stator lead screw housing is shown in exploded view as shown in Figure 6.25 and 6.26. There are two components in exploded view i.e. housing and bush. The material of housing is mild steel and through continuous rotary contact between lead screw and housing, the housing material may tear off. To protect damage of housing and lead screw a gun metal bush is inserted into the housing.

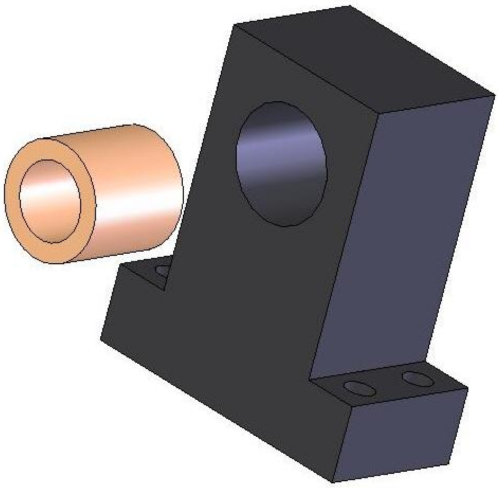


Figure 6.25: Exploded view of Rotor housing solid model with bush

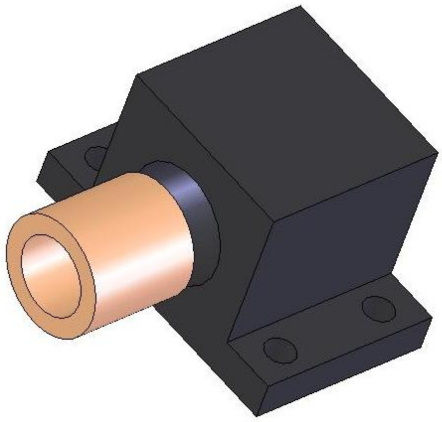


Figure 6.26: Exploded view of rotor housing solid model with bush

6.3.5 *Lead Screw Assembly with Lock Nut*

As shown in Figure 6.27 upward and downward movement is constrained from the designed slotted bar (support bar) and a lead screw assembly is attached for sliding chute plate and to position it according to new die. A lead screw also known as a power screw or translation screw is designed to translate turning motion into linear motion. There are two lead screws i.e. one attached with rotor chute plate and other one attached with stator chute plate. Both lead screws have one rotating wheel and locking nut. The lead screws are placed at one side of bolster plate and both lead screws are connected through male, female connection. A locking nut is placed at the extreme end of lead screw for locking the position of chute plate.

The square thread lead screw is used for sliding the chute plates. Square threads are named after their square geometry. These are the most efficient, having the least friction, so oftenly used for screws carrying high power. But at the same time machining of square thread is a difficult and expensive. The assembly of chute plate with lead screw is shown in Figure 6.27.

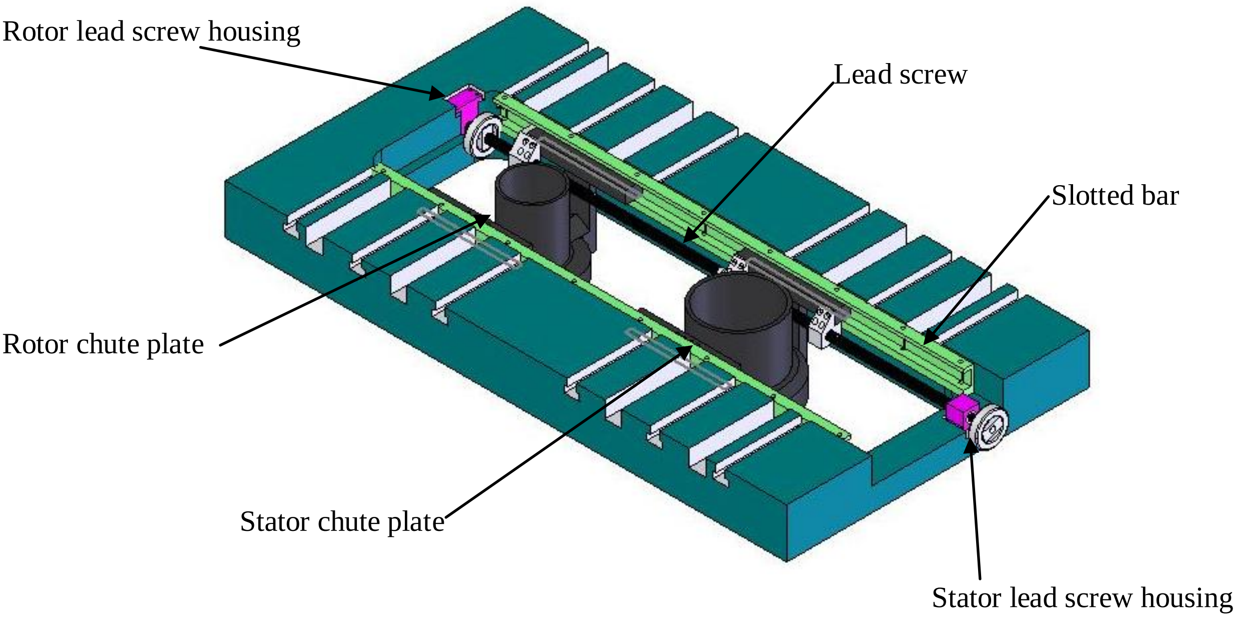


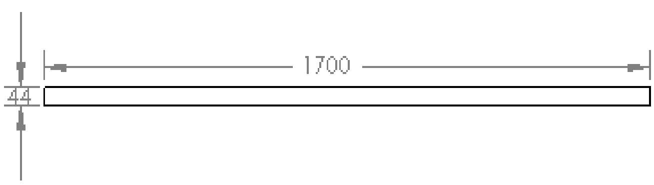
Figure 6.27: Complete assembly of chute plate with bolster

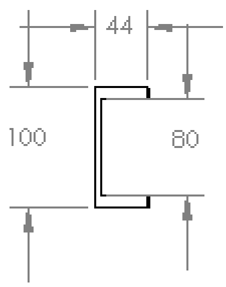
6.3.6 Sliding Support of Chute

Chute is an inclined, passage through or down which things may pass. It is in curvature form first down the material and then inclined. One side of the chute is connected with chute plate and other is free for collecting the lamination. The chute is made by steel rod due to curvature profile it is flexible so it is require to provide a support to the free end of chute. To providing end support of chute design a sliding support. This sliding support is consisting from one channel beam and two sliding jack one for stator chute and other one is for rotor chute.

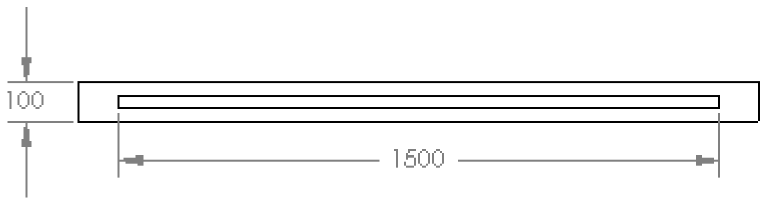
Channel

A structural member is subjected to axial load and bending moments simultaneously produced by lateral forces or eccentricity of the longitudinal load. Channel beams are made of steel and they have a specific lengths and shapes. A beam is defined as which transmit axial load as well as transverse load. The free end of chute is attached with a sliding jack and this jack is slide at a channel. This channel transmits the axial load of chute in axial direction. The drawing detail of channel is shown in Figure 6.28 and solid model is shown in Figure 6.29.





a) Front view **b) Right view**



c) Top view

Figure 6.28: Drawing detail of channel beam a) front view b) right view c) top view (All dimension in mm)

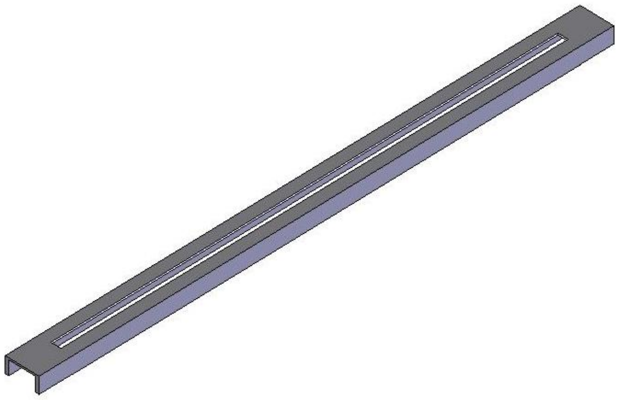


Figure 6.29: Solid model of channel

Sliding Jack

Because chute is flexible, in existing design chute is tied up with wires and supported with channel and wooden block for maintaining the height of chute from the pit base. The operator has to open the tied wires and lift the chute with overhead crane during every chute setting. Once the chute plate setting is done, chute is tied up with wires and a support is given with some wooden block and channel. To eliminate this operation a sliding support shown in Figure 4.14 is designed for hanging the chute. In this design two sliding jacks are placed for rotor and stator chute and a needle roller bearing is placed at the sliding contact for easy sliding of chute plate. To maintain the height chute is hanged up with lead screw attached with wheel at top.

At one side of sliding support a lock nut is placed for locking the position of chute. While positioning the chute plate with lead screw, the complete chute slide with chute plate and locked after positioning followed by locking of free end of chute with lock nut of sliding support. Final assembly of sliding support attached with chute is shown in Figure 6.31.

Sliding jack is an assembly of component which slides on channel beam placed at the top of the pit at some distance from the chute plate in front of machine. This sliding jack can be used for both to lift and lower chute and to move horizontally. The lowering and lifting operation is performed manually with the help of lead screw in jack. There are two pins which come in contact with channel, at the contact surface of pins needle bearings are placed for easy sliding. There are two sliding jacks at this Channel one for rotor chute and other for stator chute. The exploded view of sliding jack is shown in Figure 6.30 and sliding support assembly is shown in Figure 6.31. The modeling and assembly of sliding support is done using solid work. The final assembly of sliding jack after manufacturing is implemented at press shown in Figure 6.32.

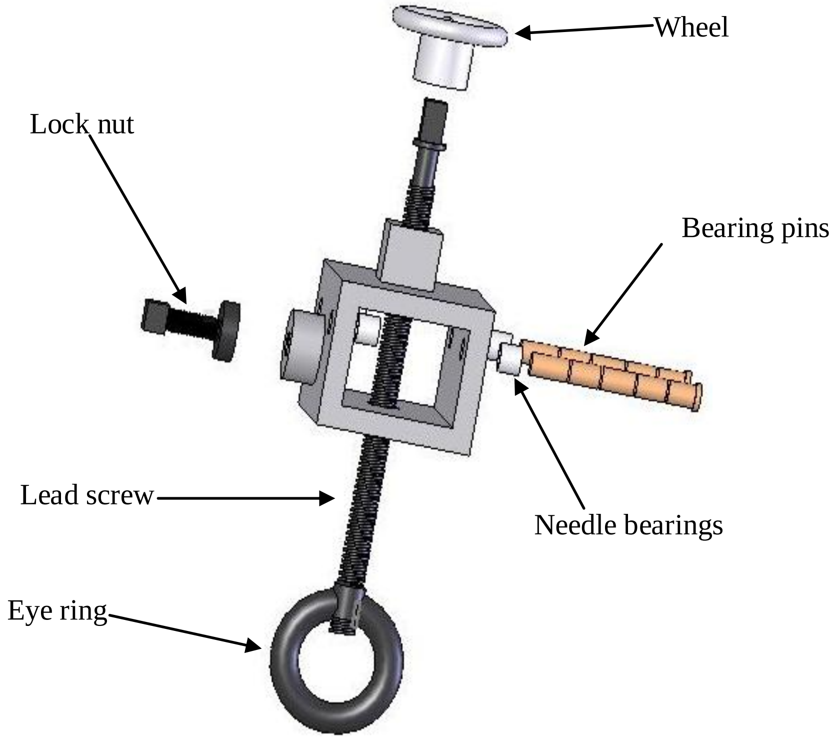


Figure 6.30: Exploded view of sliding jack

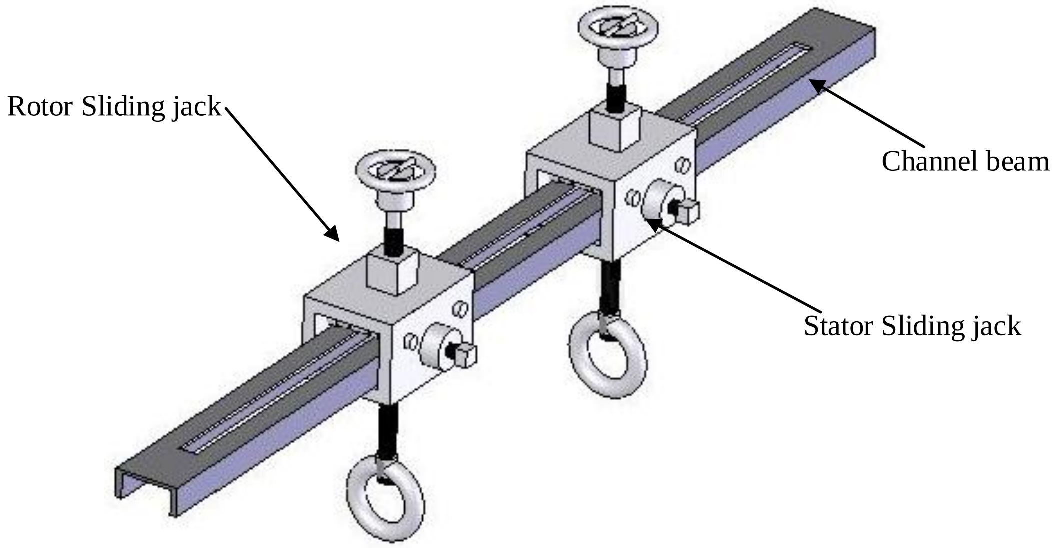


Figure 6.31: Sliding support assembly of chute

Figure 6.32: Final assembly of sliding support attached with chute [Crompton Greaves, Ahmednagar]

6.4 Implementation Results

In the existing setup process the chute setting usually took 60 minute. In existing process of chute setting, the operator had to change the chute plate because there was no standard chute plate for all model of die. To eliminate this long setup time a standard chute plate is designed for all models of tool die and attached with a lead screw assembly for easy sliding the chute plate. The chute setting process is done semi automatic. After this improvement complete chute setting takes only 2 minutes which is far more less than the previous time taken by the earlier existing designs. The time duration of chute setting before and after improvement is shown in Table 6.2.

Table 6.2: Activity duration of chute setting before and after improvements

Activity	**Activity duration before improvement (min.)**	**Activity duration after improvement (min.)**
Chute setting	60	2

CHAPTER 7

DESIGN IMPROVEMENTS FOR OTHER SETUP OPERATIONS

Along with chute design there were some other setup operations causes for more changeover time. These operations need some design improvement, which can reduce setup time.

7.1 HYDRAULIC CLAMPING

Reduction of downtime is an important factor in increasing productivity and maximizing capacity utilization. Positional accuracy and the repeatability of clamping force also make an essential contribution to efficiency and quality improvement. The aim of Flexible machining centers is to reduced production cycle times. The placing and clamping of die on one bolster, and later removing them, was often a major time factor in the process. In order to be productive and efficient, it is important that procedures such as positioning, clamping, support and release be rapid, straight forward and safe. This is more important for larger work pieces such as tool die with relatively brief processing intervals making semi-automatic or fully automatic clamping in one fixture a profitable option. Hydraulic positioning and clamping is an extremely reliable and efficient technique.

In existing setup operation threaded bolts were used to clamp the die with manual clamping and eight bolts required for clamping the die takes 35 minutes. This was also a time consuming process and required more labor fatigue. Manual clamping is to be replaced with hydraulic clamp shown in Figure 7.1 to reduce the clamping time, and standardize the clamping slot dimension give in Table 7.1 of tool die so that can be used hydraulic clamp for all die run at CHING FONG machine.

Figure 7.1: Hydraulic clamp with spacer[Crompton Greaves, Ahmednagar]

When a decision is made to develop a hydraulic clamping system a logical plan will provide the best chance of success. The plan should include the following choices.

1. The clamping force and the clamping stroke of the cylinders;
2. The power source;
3. The control of the clamping system (accessories and valves)

7.1.1 Clamp Force

Maximum weight of die= 3 ton

No. of clamp= 4

$$Force\ require\ per\ clamp = (maximum\ die\ weight \times 4) \div No. of\ clamp \qquad (7.1)$$

$$= (29700N \times 4)/4$$

$$=29700N$$

Displacement of hydraulic clamp= 8mm.

7.1.2 Power Source

Hydraulic machinery is operated by the use of hydraulics, where a liquid is the powering medium. In this type of machine, hydraulic fluid is transmitted throughout the machine to various hydraulic motors and hydraulic cylinders and which becomes pressurised according to the resistance present. The fluid is controlled directly or automatically by control valves and distributed through hoses and tubes.

The popularity of hydraulic machinery is due to the very large amount of power that can be transferred through small tubes and flexible hoses, and the high power density and wide array of actuators that can make use of this power. The component of power source are hydraulic pump, control valve, actuator, reservoir, hydraulic fluid, filter, tubes pipes and hoses ,seals , fitting and connections. The image of hydraulic clamp power source is shown in Figure 7.2.

Figure 7.2: Power source of hydraulic clamping[Crompton Greaves, Ahmednagar]

Figure 7.3: Control panel of hydraulic clamping[Crompton Greaves, Ahmednagar]

7.1.3 Control System

The hydraulic valves are usually very heavy duty to stand up to high pressures. Some special valves can control the direction of the flow of fluid and act as a control unit for a system. Classification of hydraulic valves in terms of function and method of activation is defined as-

a) Classification based on function:
   1. Pressure control valves
   2. Flow control valves
   3. Direction control valves

b) Classification based on method of activation:
   1. Directly operated valve
   2. Pilot operated valve
   3. Mutually operated valve
   4. Electrically actuated valve
   5. Open control valve

Table7.1: Clamping slot dimension after standardization

S. No.	Tool name	Clamping slot size in mm (bottom)	Clamping slot size in mm (top)	Clamping slot after improvement (bottom)	Clamping slot after improvement (top)
1.	Super 91	118	80	90	90
2.	Euro 160-Ex	100.6	65.7	90	90
3.	Euro 160- 4p	114.6	58	90	90
4.	S 100-SQ	86.3	70	90	90
5.	BC 90-4p	100	67	90	90
6.	ND 132-4p	90	64	90	90
7.	Nema 112-4p	89.2	46.2	89.2	90
8.	Nema 132-4p	90	45.7	90	90
9.	BC132-4p	90.2	42.9	90.2	90
10.	BC 132-2p	89.5	44.8	89.5	90
11.	BC 112-4p	88.4	68.7	88.4	90
12.	B 50-2p	67.6	92.1	90	92.1
13.	Yash fan-12p	92.2	50.9	92.2	90

7.1.4 Implementation Results

The major benefit of hydraulic clamping is the enormous time saved in clamping and unclamping the components. When we compared the time required for hydraulic clamping with that required for manual clamping the gain is no less than 90 to 95%. The used of hydraulic clamping reduced cycle time’s thereby increased manufacturing capacity significantly and reduced costs. Equally as important as the time advantage was the positional accuracy of hydraulic clamping systems. The clamping forces are constant resulting in very precise positioning and clamping. This ensures identical processing procedures and guaranteed quality. Rejection rates due to distortion will be insignificant. A third advantage offered by hydraulic clamping is optimum use of clamping space due to compact standard components and the ability to clamp in manually inaccessible areas. This can increase the number of components that can be clamped and processed simultaneously on one fixture.

There are many significant benefits achieved with hydraulic clamping systems. The major advantage of hydraulic clamping is that it significantly reduced the load and unloads times as shown in Table 7.2 compared to conventional manual clamping. This results in higher capacity utilization on all types of machines. Hydraulic clamping also offers improved quality due to consistent and repeatable clamping forces being applied. Clamping operation is done totally automatic with hydraulic clamping.

Table 7.2: Activity duration before and after placing the hydraulic clamping

Activity	Activity duration with manual clamping (minute)	Activity duration with hydraulic clamping (minute)
Tool clamping	30	4

7.2 SLIDE SETTING

Die shut height is defined as the height of the die in the shut or closed position. This height may be greater when measured on the shop floor than in the press because the die might not close completely because of die pressure systems. The press shut height for die setting purposes is the distance from the top of the bolster to the bottom of the ram or slide at bottom dead center, (BDC). It is not necessary to use a common shut height throughout the pressroom. The press shut height varies according to die. So due this reason every time while changing tool die, press shut height has to be changed according to die. A pneumatic gun is used for shut height setting. Three operator performed this operation and it took time about 15 min. For reducing this time and labor fatigue a motor and reduction gear box assembly is attached with slide. The attachment of motor assembly with slide is shown in Figure 7.4.

7.2.1 Motor Specification

Torque required for slide movement is 100 lb-in. A formula given in Equation 7.1 is used to determine required horse power motor. A 2 hp induction motor of 4 poles is used to lift the slide. The RPM of motor is 1400 which are not appropriate to move the slide. A reduction gear assembly of 20:1 reduction ratio is attached with motor to reduce the RPM. The output RPM of reduction gear is 70 attached with slide through a chain connection.

$$horse\ power\ require\ for\ rotating\ object\ HP = T \times N \div 5252 \quad (7.2)$$

T= torque (lbft)

N= RPM

Length of slide= 2m, height of slide=1m, width of slide= 0.7m;

Volume=1.4 m^3.

Density of material=7.86×10^3 kg/m^3.

Mass of slide = volume × density =11004kg.

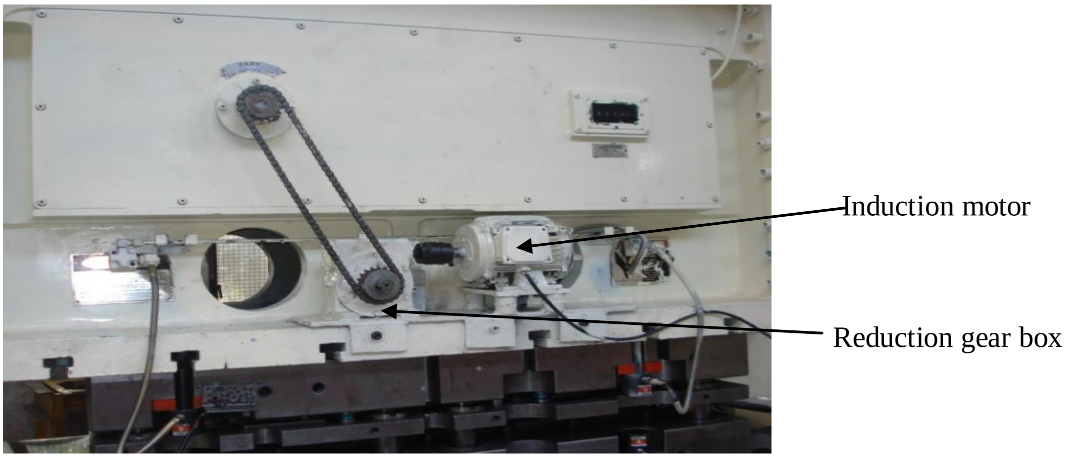


Figure 7.4: Motor and reduction gear box assembly attached with slide [Crompton Greaves, Ahmednagar]

A reduction gear box is used to reduce an input speed to a slower output speed and more output torque. It is a wheel work consisting of a connected set of rotating gears by which power is transmitted or motion or torque is changed. The assembly of reduction gear with motor is shown in Figure 7.5. The motor and gear box are attached through a coupling.

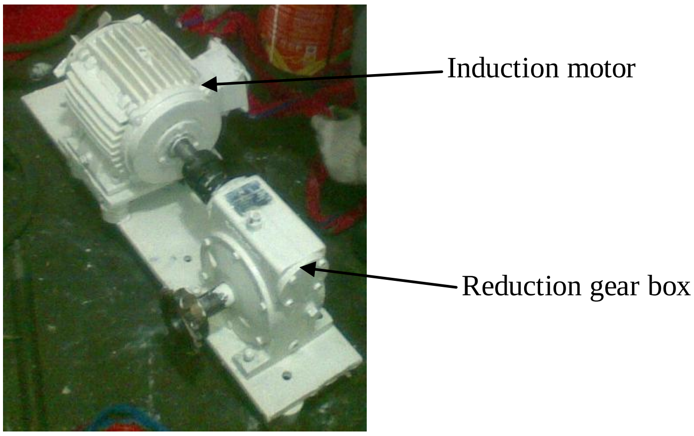


Figure 7.5: Motor and reduction gear box assembly [Crompton Greaves, Ahmednagar]

7.2.2 Implementation Results

In existing setup process a pneumatic gun was used for slide setting, it required more number of operator and labor fatigue. After this improvement only one operator could perform this operation in less time. Also the operation time with new design has been reduced to 2 minutes than with existing design i.e. 15 minutes. The improvement before and after is shown in Table 7.3.

Table 7.3: Activity duration before and after attachment of motor with slide

Activity	Activity duration before improvement (min.)	Activity duration after improvement (min.)
Slide setting	15	2

7.3 FEEDER GEAR BOX SETTING

A feeder is used to feed the sheet with desired pitch according to strip layout of tool die. This feeding pitch is varying for all tool die. To change the feeding pitch a gear box is attached with the feeder. The gear ratio is to be changed for changing the pitch. There are four gears (driver, driven and transmission gears) and 25 Allen bolt in this assembly. Two Transmission gears are mounted on a single shaft and 12 Allen bolt are required for mounting the gears on transmission shaft.

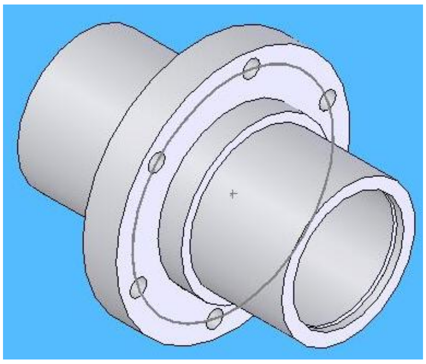


Figure 7.6: Transmission gear shaft

Figure 7.7 : Transmission gear assembly [Crompton Greaves, Ahmednagar]

To avoid opening and closing these 12 Allen bolt different transmission gear shafts (equal to number of dies running at CHING FONG) have been manufactured and preassembled for all dies. Solid model of transmission gear shaft is shown in Figure 7.6 and transmission gear assembly is shown in Figure 7.7. Using this new approach operation time has been reduced to 13 minutes from the 35 minutes. The activity duration after this process innovation is shown in Table 7.4.

Table 7.4: Activity duration before and after this process innovation

Activity	Activity duration before improvement (min.)	Activity duration after improvement (min.)
feeder setting	35	13

CHAPTER 8
RESULTS AND CONCLUSION

8.1 RESULTS

Due to implementation of new design of chute plate and supporting components, hydraulic clamping, design improvement of slide setting operation, SMED methodology, the changeover time is reduced from 228 min to 15min. The results of this proposed method application has improved the machine flexibility and increased the different part production capacity due to reduced tool exchanges in controlled time period. The results before and after improvement in terms of time and machine capacity increased in terms of strokes are shown in Table 8.1. The existing time of complete changeover was 228 minute after all improvement is reduced up to 15 minutes and saving of time in one setup is 213 minutes. The minimum changeover required per month is 16 according to past production record of plant and average speed of machine is 120 SPM .The machine strokes per month is increased 4.08 lacs shown in table 8.1 and machine availability in terms of monthly basis is increased 21% while the average stroke per month of machine from the past recorded data is 19.30 lacs.

Table 8.1: Results after implementation of design modifications in setup operations

Condition	Time for one setup(minute)	Total no. of setup/month	Total time lost /month (minute)	Strokes/ month (lacs)
Before	228	16	3648	19.30
After	15	16	240	23.38
Saving	213	16	3408	4.08

8.2 CONCLUSION

The chute plate setting was the critical problem it takes maximum time in one complete changeover. There were separate chute plates for every tool die and needed to be replaced every time die is changed. So a standard chute plates was required to design for rotor and stator chute to overcome this problem. This new design of chute plate has helped reduced the multiple chute plates to only one standard chute plate. A lead screw and slotted bar was attached with chute plates for easy sliding at bolster. The static structural analysis of this newly designed chute plate is done and it is found safe at maximum load (2 ton). To eliminate wires tie operation of free end of chute a sliding support was designed for hanging the chute. As a conclusion it has been observed that design of new chute plate and supporting components of chute plate assembly have reduced the critical time period of about an hour to few minutes. The design concept of this chute developed is so versatile that it can be implemented not only on this particular press but also on other high speed presses improving the efficiency of production rate. A QDC hardware hydraulic clamping was implemented that benefited the process as it significantly reduces the load and unloads times compared to conventional manual clamping and also reduces the manpower needed to clamp the die resulting in higher capacity utilization of press. Hydraulic clamping also improved quality due to consistent and repeatable clamping forces being applied. An induction motor and a reduction gear assembly attached with the slide for improving this setup operation. SMED methodology was also involved along with the new designs and improved the setup time reduction.

8.3 FUTURE SCOPE

Present improvements are not final one, since implementation of new and innovative tool gives the space for further improvement. Besides, this new approach uses methods independent of industry field which make them applicable to other complex technological processes. The target of this project was to complete the all setup operation less than 10 minute or in single digit of minute. We could achieve up to 15 minute with the integration of SMED and QDC still more scope in time to reduce setup time less than 10 minutes. Beside of SMED a new technology is arose OTS (one touch exchange of die), the target of this technology is to perform the complete changeover less than one minutes. Feeder setting still take 13 minute to eliminate this time replace the mechanical feeder gear box with servo feeder.

In the conventional clamping system, the actual clamps go where they make a sense to hold the range of dies on the press. The mechanical clamping require more time and labor fatigue and hydraulic clamping require more maintenance, if the pressure of clamp is drop down due to some reason the break down may take place. To overcome this problem can use a magnetic clamping technology. This technology is based on the principle of electro-permanent magnet. It provides the safely clamping while the power failure. Electric power is needed only 2-3 second to magnetize and demagnetize the die. There is no modification requiring in die and machine directly bolted the plates in the existing holes of machine bed. The benefits of this technology are that if the smallest movement in the die will cause stop to machine so greater safety of machine and die.

In the present design there is no optimization is done. There is a wide scope of optimization in designed chute plate to reducing material cost and weight.

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