

Design of Multi sliding Tool to Increase in Productivity of Lock Plate

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Abstract: Multi sliding machine tool is design and manufacture lock plate in mass production, reduce raw material consumption, eliminate various operations, increase in productivity and reduce labor cost. Such never produce in bulk by conventional stamping power press. Design of multi sliding machine tool for lock plate is very critical as it includes three stages to achieve specific dimensions. Previously lock plate is manufacture on conventional stamping power press (mechanical press). Components was produce in three stages to achieve required dimensions. Due to which three machine, three tools and three operators are required. We have design new tool which include progressive tool, bending slides and cams in UG NX 9.0 and conducted analysis to evaluate our design will withstand a given load condition on ANSYS 14.5 for Von Mises stresses and deflection which are also verified by mathematical calculations.

In new design we have converted all three operations at single workstations. By designing new multi sliding tool we can increase productivity by 6.20 times as converted on single workstation, raw material handling is eliminated, reduces raw material consumption by 13.77% and reduce labor cost for manufacturing by 7400 Rs.

Index Terms—Productivity, Raw material consumption, Progressive tool design, Bending Slides, Cams, Labor cost..

I. INTRODUCTION

A stamping press, most widely small press, is a machine tool that is used to change shape of sheet by applying pressure on it. Classifications of presses are according to

- ❖ Mechanism: pneumatic, mechanical, hydraulic.
- ❖ Function: stamping presses, punch press, forging presses, press brakes etc.
- ❖ Structure, e.g. Knuckle-joint press, screws press.
- ❖ Controllability: servo-presses vs conventional.

A stamping press is a machine tool used to shape or cut metal by deformability it with a die. A four-slide, also known as a multi slide or four-way is a metalworking machine having application for in the high-production of small stamped components from bar or wire stock. A four-slide is different than other conventional presses. The key of the machine is its moving slides that have tools attached which move forward as well as reverse on work piece to give appropriate shape. Slides are moved due to help of forward and reverse cams. The cams are attached to bevel gears so that one shaft take motion from electric motor and this motion is used to move other shaft which is used to move slides. The material strip used in four-slides is usually having limitation of forming. The most commonly used materials are

Low-carbon steel, steel, stainless spring steels, Copper alloys, copper alloys.



Fig.1:-Power Press Fig.2:-Multi sliding Machine

II. LITRATURE REVIEW

If Literature review shows that considerable amount of researches have been reported in progressive tool design, V.Dinesh et al [2015], This project consist of design and analysis of Compound Tool, by High carbon high chromium D2 Tool steel material with hardness 38 HRC and 58 HRC. Comparison on two tool with same hardness has given for soft material like aluminium. For 38 HRC tool die having less life as punch and die become weak during continuous operation but for 58 HRC hardness tool having much more life which is also studied with help of ANSYS. The stress values are compared. Thus compound tool is work without any effect on heat treated sheet metal. V. Kumar et al [2015] In sheet metal component manufacturing most important phase is to design and development of component.

The process includes are sharing blanking forming pricing etc. Due to criticality of manufacturing leads to various failures. Solid works is used for modeling of progressive tool with considering few dimensions are given in 2D. Results of stress are obtain by ANSYS which are verified by mathematical calculations. Khosa et al [2014], This project includes design and development of progressive tool to manufacture chain link. The raw material used for chain links is MS which is having application in conveyer belt. Thickness of the sheet is 2 mm. The manufactured parts are inspected and assembly of component is made. V. Bhajantri et al [2014] Cost reduction is main aim of progressive die without compromising on the quality of components. Using the optimum available of resources results in designing the progressive dies frame which reduces progressive die cost. One way of doing it will be optimizing the volume of material utilized for building the structure. Commercial software COSMOS is used for this analysis which uses finite element method. The methodology used for this work is compared stresses used to finalize the frame of the progressive dies. These stresses are used to compare with yield stress with factor of safety 2, frame thickness is used to reduce material volume for manufacturing die which ultimate result in to cost reduction. A. Prabhakar et al [2013] In bending process pressure is applied on sheet to achieve required shape used two methods to prove spring back effect for different thickness which includes analysis and actual model results are compared He major spring back, percentage of spring back, on mises stress, contact pressure, residual stress, plain stress for four different thickness. Paper states that by increase in thickness spring back effect, von mises stress, contact pressure, residual stress, plain stress are reduces.

III. PROBLEM STATEMENT

Sheet metal parts are manufactured by stamping root, because of complexity and functional requirement of part, designer has to introduce number of tools which result into more time for manufacturing, high labor cost and low productivity.

We have taken the one part to study following parameters:- Part Name-Lock Plate

- ❖ Lock plate is manufacture by stamping root in three stages which is explain as below,
- ❖ Blanking of outer profile and inner diameter piercing.
- ❖ ID forming.
- ❖ Bending.

IV. OBJECTIVES

- ❖ To reduce raw material consumption.
- ❖ To increase productivity more than stamping.
- ❖ To reduce material handling and eliminate operation.
- ❖ To reduce labor cost.
- ❖ To reduce manufacturing time.

V. NEED OF INVESTIGATION

Currently lock plate manufacturing is done in three stages.

❖ *Blanking and Piercing.*

For Blanking and piercing one machine of 50 Ton, one operator, one tool and production is 4400 Nos./8 hr shift.

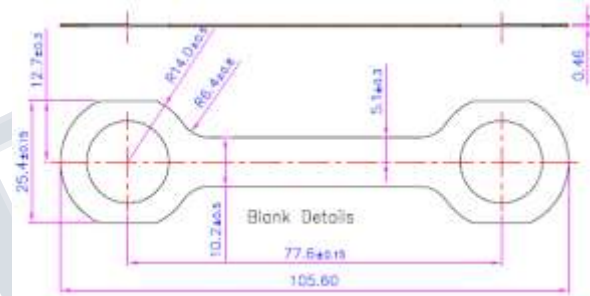


Fig. 1.4: Blanking and Pricing

❖ *ID Forming.*

For ID forming one machine of 40 Ton, one operator, one tool and production is 3600 Nos./8 hr shift.

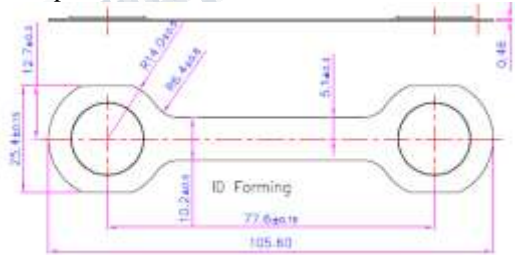


Fig. 1.5: ID Forming

❖ *Bending.*

For bending one machine of 40 Ton, one operator, one tool and production is 3600 Nos./8 hr shift.

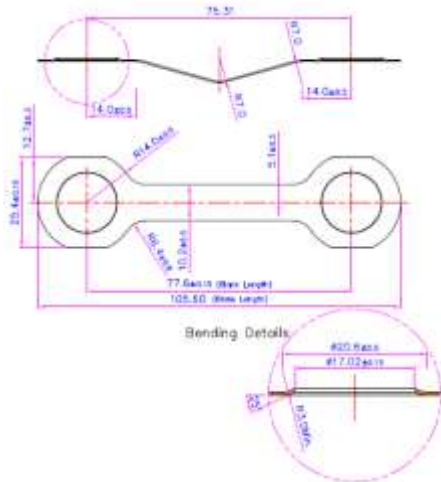


Fig. 1.6: Bending Operation

Monthly consumption of component is 30000 Nos. As requirement is high and productivity is very slow. To eliminate above three operations and cover in single workstation.

VI. METHODOLOGY

The methodology adopted would be studying and identifying with the existing tool design of lock plate, as it is manufacture in three stages on mechanical press. Studying tool material, component material and tool design. Identification of critical parameters which are consider in tool design for multi sliding machine. New Lock plate tool design is Carrying out various with help of UGNX software. Stress analysis would be carried out by static structure model on ANSYS software. If design is fail in analysis then modification is to be done in tooling design and again analysis of component. Same procedure will be followed till design will not safe in analysis. Manufacturing best output tool design and comparing with existing process with experimental results. Only critical areas of concern would be studied for the work and suitable recommendations can be find out while concluding the work. Practically recommended solutions pertaining ease of development would be considered while suggesting the variants of design.

VII. DESIGN CALCULATIONS

Formula used,
For Strip Layout

- ❖ Strip weight (W_o) = Strip Width x Strip Length x strip thickness x specific gravity
- ❖ Proposed coil material weight (W_n) = $\frac{(\text{Width} \times \text{pitch} \times \text{thickness} \times \text{specific gravity} \times 30000)}{1000000}$
- ❖ % Area of utilization = $\frac{(\text{Area of blank} \times \text{No. of rows})}{(\text{Pitch} \times \text{width})}$
- ❖ Economy factor = $\frac{(\text{Area of Blank} \times 100 \times \text{No. of Rows})}{(\text{pitch} \times \text{strip width})}$
- ❖ Percentage of raw material saving = $\frac{\text{Raw material saving (W}_s\text{)}}{\text{Proposed coil material weight (W}_n\text{)}}$



Fig.: Old Strip Design

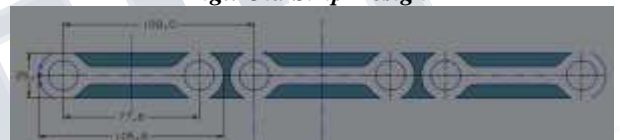


Fig.: New Strip Design

- ❖ Clearance = 5% of sheet thickness
- ❖ Shear force (F_s) = L × S × T_{max}
- ❖ Stripping force for Cutting = 20 % of Shear force
- ❖ Total Press Capacity for Cutting = Total Shear Force + Stripping Force
- ❖ Press Tonnage (T_p) = 120% of Total Press Capacity for Cutting
- ❖ Thickness of Die Block (T_d) = $\sqrt[3]{(T_p)}$
- ❖ Thickness of bottom plate = 1.5 T_d
- ❖ Thickness of top plate = 1.25 T_d
- ❖ Thickness of stripper Plate = 0.75 T_d
- ❖ Thickness of punch holder = 0.5 T_d
- ❖ Selection of material is according to thumb rule and previous experience.

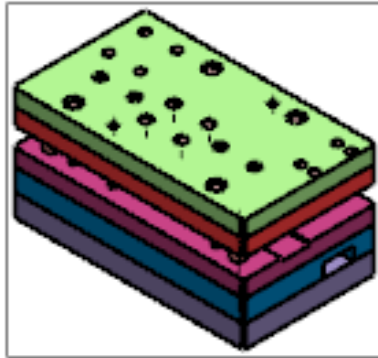


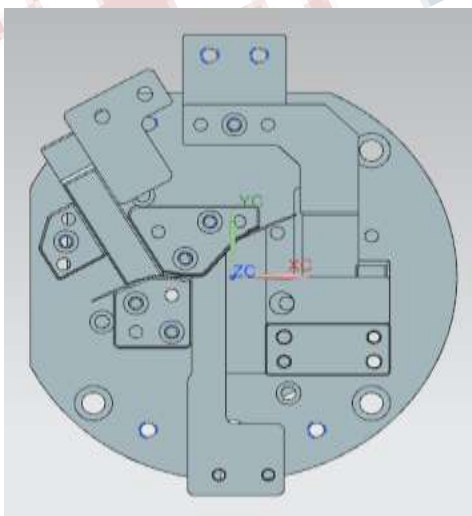
Fig.4.11: 3D Modeling of Progressive Tool

Design of Slides and Cams

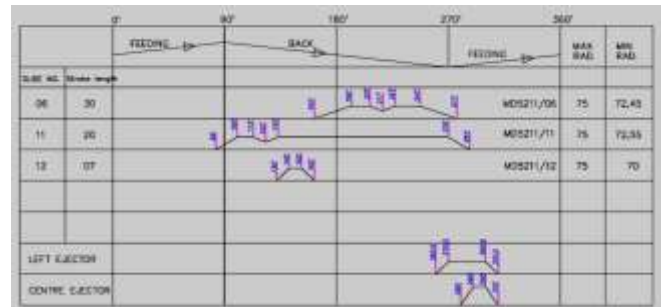
For design of slides we have taken finish 3D component which is drawing with help of software. This is in line with feeding strip. All below design are based on thumb rule of design and practical experiences.



Finish Component Drawn In 3D Software



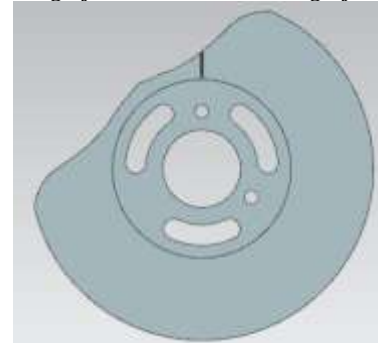
3D Modeling Bending and Cutting Operation Assembly Motion diagram is used to finalize movement of slides and distance of slides. Slide count from counter clockwise slide 06, slide 11 and slide 12 respectively. After that we have design cams which are used to move side forward and reverse. Thus two cams are design for each slide.



Motion Diagram for lock plate



3D Modeling of Forward Cam Design for Slide 06



3D Modeling of Reverse Cam Design for Slide 06
Increase in productivity of lock plate= Multi sliding tool process production/ Stamping process production (Avg. of all operation)

Saving in labor cost = Addition of all three process Operator cost- Operator of multi sliding machine process.

VIII. ANALYSIS

The analysis is done for die by using the ANSYS software. The below figure initially modelling is done then boundary conditions and suitable material is applied. The below figure shows the stress distribution of die under the applied loading condition. The orange and blue colour in the plot indicates the maximum and minimum stress distribution respectively. This gives the comparison between analytic and numerical value. Part is drawn in CAD software and this part is call to ANSYS in (.step) format. For CAD part there is UG NX 9.0 software is used.

Table No. 5.1: Mechanical Properties for D2/OHNS Material

| Properties | Values | Units |
|----------------------|--------|--------------------|
| Elastic modulus | 210000 | N/mm ² |
| Poisons ratio | 0.3 | |
| Mass density | 7700 | kg/mm ³ |
| Tensile strength | 1736 | N/mm ² |
| Compressive strength | 2150 | N/mm ² |
| Yield strength | 1532 | N/mm ² |
| Thermal conductivity | 20 | W/(m-K) |
| Specific heat | 460 | J/(kg-K) |

Table No. 5.2: Mechanical Properties for MS Material

| Properties | Values | Units |
|-----------------|--------|--------------------|
| Elastic modulus | 210000 | N/mm ² |
| Poisons ratio | 0.3 | |
| Mass density | 7700 | kg/mm ³ |

| | | |
|----------------------|-----|-------------------|
| Tensile strength | 470 | N/mm ² |
| Compressive strength | 410 | N/mm ² |
| Yield strength | 400 | N/mm ² |
| Thermal conductivity | 12 | µm/(m-K) |
| Specific heat | 450 | J/(kg-K) |

Type of Meshing=Tetradehron (Default)
 Type of Element=3D Solid 187
 Element Size=Default
 Relevance Center=Coarse
 For Stress calculation on components,

$$\text{Stress}(\sigma) = \frac{\text{Force}}{\text{Surface Area}}$$

Table No. 5.2: Analysis results and Mathematical Results

| Sr. No. | Name Of Component | Stress analysis By Ansys in N/mm ² | Stress analysis By Mathematical calculations in N/mm ² | Design Remarks |
|---------|-------------------|---|---|----------------|
| 1. | Die Block | 5.6567 | 5.00065 | Design is Safe |
| 2. | Top Plate | 7.0541 | 7.152 | Design is Safe |
| 3. | Bottom Plate | 7.7843 | 7.152 | Design is Safe |
| 4. | Blanking Punch | 27.083 | 26.352 | Design is Safe |
| 5. | Piercing Punch | 85.159 | 85.17 | Design is Safe |
| 6. | Slide 06 | 0.2735 | 0.2389 | Design is Safe |
| 7. | Slide Insert 06 | 0.23152 | 0.2026 | Design is Safe |
| 8. | Slide 11 | 0.36289 | 0.3574 | Design is Safe |

| | | | | |
|-----|---------------------|---------|---------|----------------|
| 9. | Cutting Die Support | 10.37 | 10.8010 | Design is Safe |
| 10. | Cutting Die | 4.752 | 4.382 | Design is Safe |
| 11. | Cutting Punch | 76.998 | 71.38 | Design is Safe |
| 12. | Slide Guide 11 | 0.13708 | 0.1220 | Design is Safe |
| 13. | Forming Insert 01 | 0.19841 | 0.18569 | Design is Safe |

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IX. CONCLUSION

Due to design of multi sliding tool we can increase productivity of lock plate by 6.20 times. Design of multi sliding tool also helps to reduce raw material consumption by 13.77 % and 4000 Rs. aprox. It also helps to eliminate various operations by converting on one workstation, which will also reduce material handing cost. Due to implementation of new tool labor cost saving is by 7400 Rs and three machines as well as three operators are available for another work.

Future Scope

We can modify strip design form single column to double column and slide motion which results into increase in productivity.

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