Multi Sliding Tool Design to Increase in Productivity of Lock Plate

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***Abstract*— Lock plate is Previously manufacture on conventional stamping power press (mechanical press).Design of multi sliding machine tool for lock plate is very critical as it includes three stages to achieve specific dimensions. Components were produce in three stages to achieve required dimensions. Due to which three machine, three tools and three operators are required. 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. 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.**

Keywords —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.Comaprison 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 finalized 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. Sawahara et al [2012] this paper shows new concept of tool design which was recommended by previous authors. Therefore, senior engineers solution in terms of education or training. As for design of steel deck floor, the designer has to choose only one category of slab with steel deck from three types. Each type of slab is different from others due to their variation according to shape and size. This solution is very effective in tool design. As steel deck floor is design in Japan, a trail was conducted on few problems with the system, following an explanation of the concept.

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.

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.

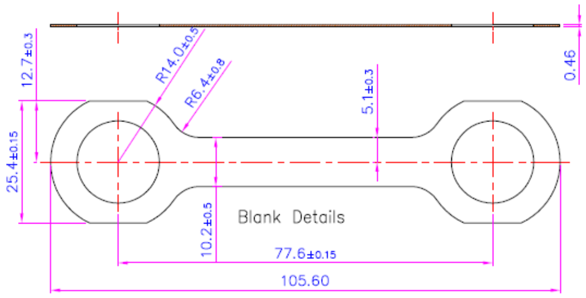

Fig. 3: Banking and Pricing

- ID Forming.

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

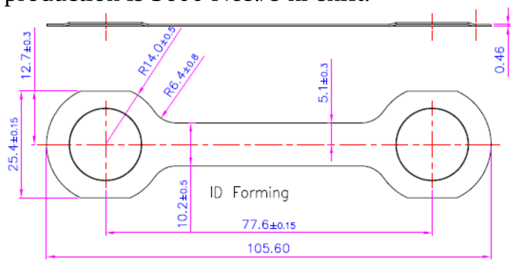

Fig. 4: ID Forming

- Bending.

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

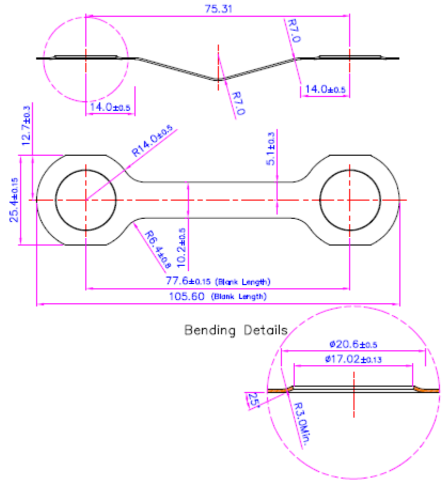

Fig. 5: Bending Operation

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.

III. 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.

IV. DESIGN CALCULATIONS

Formula used,

For Strip Layout

- Strip weight (Wo) =Strip Width x Strip Length x strip thickness x specific gravity
- Proposed coil material weight (Wn) $= \frac{(\text{Width} \times \text{pitch} \times \text{thickness} \times \text{specific gravity} \times 30000)}{1000000}$
- % 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= $\frac{\text{Raw material saving (Ws)}}{\text{Proposed coil material weight (Wn)}}$

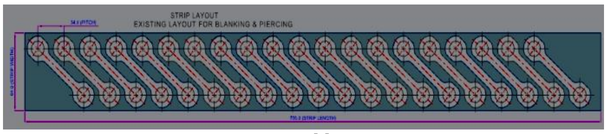

Fig 6. : Old Strip Design

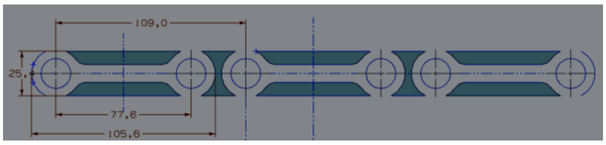

Fig 7: New Strip Design

- Clearance=5% of sheet thickness
- Shear force (Fs) = L × S ×Tmax
- Striping force for Cutting =20 % of Shear force
- Total Press Capacityfor Cutting = Total Shear Force +Stripping Force
- Press Tonnage (Tp) = 120% of Total Press Capacity for Cutting
- Thickness of Die Block (Td) $=\sqrt[3]{(Tp)}$
- Thickness of bottom plate=1.5 Td
- Thickness of top plate=1.25Td
- Thickness of stripper Plate=0.75Td
- Thickness of punch holder= 0.5 Td

Selection of material is according to thumb rule and previous experience.

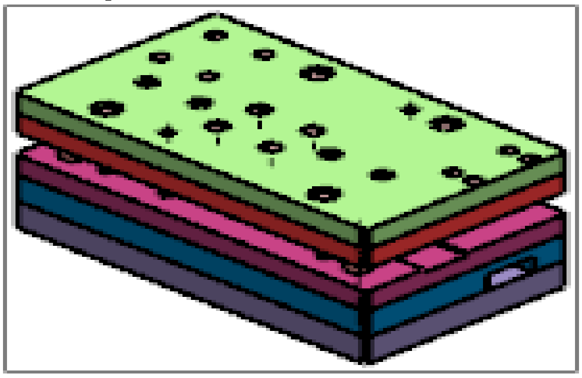

Fig.8: 3D Modeling of Progressive Tool

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.

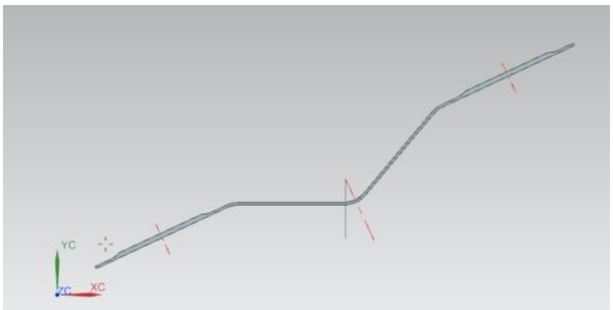

Fig.9: Finish Component Drawn In 3D Software

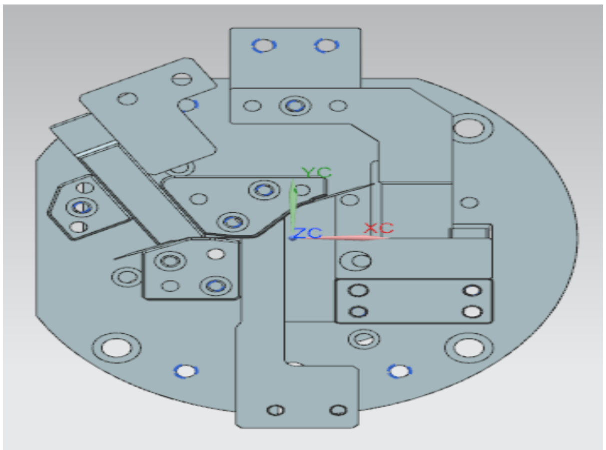

Fig.10: 3D Modeling Bending and Cutting Operation Assembly

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.

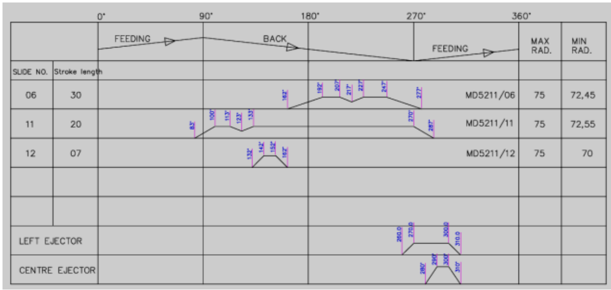

Fig.11 Motion Diagram for lock plate

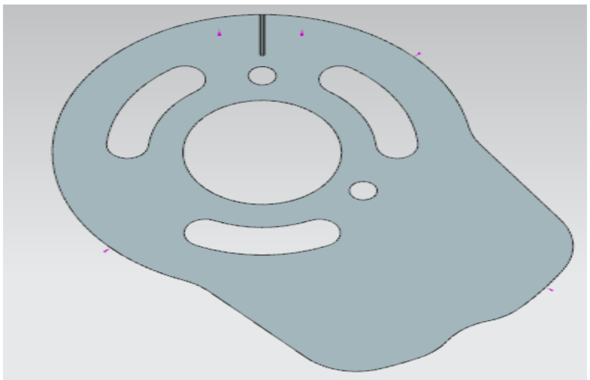

Fig.12: 3D Modeling of Forward Cam Design for Slide 06

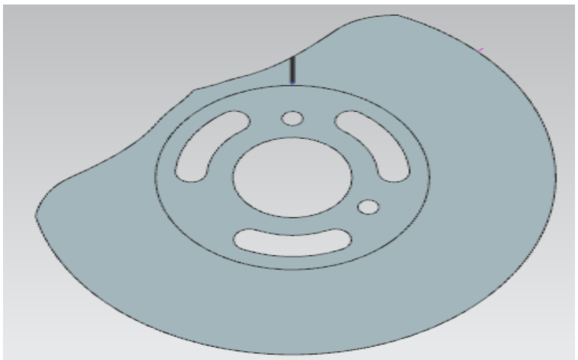

Fig.13: 3D Modeling of Reverse Cam Design for Slide 06

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.

V. 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.. 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. 1: Mechanical Properties for D2/OHNS Material

Properties	Values	Units
Elastic modulus	210000	N/mm²
Poisons ratio	0.3	
Mass density	7700	kg/mm³
Tensile strength	1736	N/mm²
Compressive strength	2150	N/mm²
Yield strength	1532	N/mm²
Thermal conductivity	20	W/(m-K)
Specific heat	460	J/(kg-K)

Table No. 2: Mechanical Properties for MS Material

Properties	Values	Units
Elastic modulus	210000	N/mm²
Poisons ratio	0.3	
Mass density	7700	kg/mm³
Tensile strength	470	N/mm²
Compressive strength	410	N/mm²
Yield strength	400	N/mm²
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,

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

Table No. 3: 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

VI. 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.

VII. 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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