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Productivity Increase with the Help of Press Tool

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Abstract - *In this competitive world of manufacturing, few of conventional processes are to be redesign to match with the latest technology and production rate. Here in this project we are designing a Press tool to come over the process of Horizontal Milling. This will help us to increase the productivity as well as decrease the production cost comparatively. In the horizontal milling process the method of operation is relatively slow and time consuming this will cause in less productivity and increases the cost of the product. The clamping time and operational time are high where in Press tool operation method there two are considerably reduced this will help up for increase of production and decrease in cost per component. Successful implementation of this project will help for enhance the productivity, cycle time reduction, easy to operate, cost saving, less tooling cost and lots of other benefits over present horizontal milling process. All the benefits are detailed in this report.*

Key Words*: *Press Tool, Mechanical press machine, Piercing process, Productivity, Cost saving,

1. INTRODUCTION

In this today's competitive word it is essential to reduce the cost of the product without compromising with the product quality & production rate. Different manufacturing processes are widely used in manufacturing. Now a day's sheet metals are replacing most expensive & casted components in manufacturing sector, following are some of the widely used manufacturing processes.

Casting, Moulding, Forming, Joining, Machining, Additive manufacturing etc.

Before preceding further we will have a learn in brief, What is manufacturing process?

Definition – It is a process of transforming raw material in to final / finished product.

This process begins with creation of material from which the product / design is made. Then these materials are formed or modified through different processes to become a final requirement or part. This process can include different process like machining, surfacing, heat treatment, grinding, reshaping etc. Manufacturing also includes checking for quality assurance & test during or after machining the component.

Sheet Metal - It is a metal that is formed in to thin flat plates, it is available in verities of sizes & shapes [1]. Generally the thickness of sheets is less than 20 mm. The sheet metals are widely used in various industries like Automobile, medical, Aerospace, defence products, machinery industry etc. In sheet metal working die punch tooling is a very important aspect & designing of die punch is very important [3].

Press Machine- Different types of press machines are available for machine shops. The press machines are mainly classified into two types. 1.Mechanical Press, 2.Hydraulic Press Machine. Here for this project we are using mechanical press machine for machining (piercing) operation. The mechanical press works on impact force caused using energy stored in Fly wheel where are Hydraulic press works by pump motor and oil pressure in the hydraulic cylinder.

Press Tool- The press tool is a device used to form the material from one shape to another [2]. Various operations are carried out with the help of press tool like shearing, punching, blanking, bending, trimming etc.

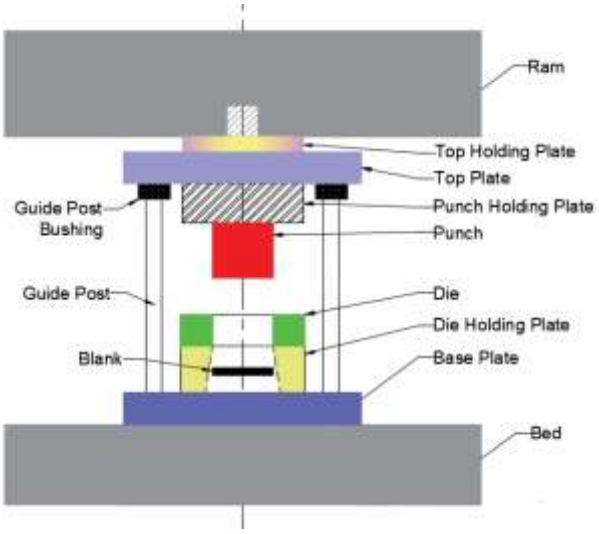

Fig -1: Schematic View of Press Tool Parts.

2. PROBLEM STATEMENT

The productivity by the Milling process is too less and where in the mass production sector there is need to be increase in the productivity with respect to time and is essential to minimize the cost of production.

The aim of this project is to increase the productivity and to reduce cycle time of existing process of milling for the component.

For this there is a need of setup of die punch with a proper tool design. The monthly volume of component is about 9000 to 10000 No's.

Hence there is a need of improvements in current process or need for change of the method towards reduction in the cycle time, cost of the production and to increase the productivity of these hinges to meet the global competition.

The present cycle time of this milling operation is approximately 3 minutes. After successful implementation of this project we can reduce that cycle time up to approximately 40-60 sec.

3.ANALYSIS AND PART STUDY

Before we go for the design of press tool we need to study the raw material and process that should carry on that raw material to get the required final product. We will first study the raw material shape and size then process to be carried on that. The study of raw material will help us to select the material as well as material properties for die and punch.

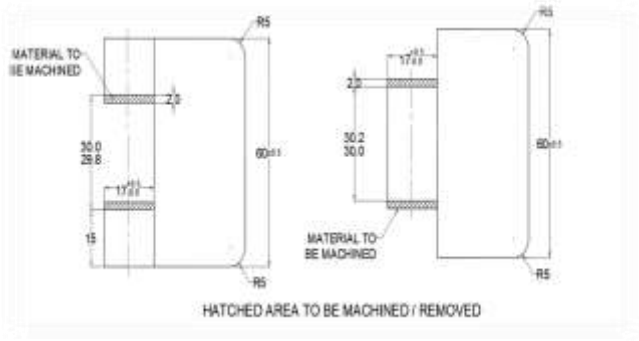

Fig -2: Raw material to Finish Size of the Part

Now will begin with the study of raw material, the raw material used for these male as well as female hinges are forged from mild steel ST 37.

Yield Strength – 320 to 350 N/mm^2

Ultimate Tensile Strength- 488 N/mm^2

For the punch and die will useHCHCr-D2 Steel application material (i.e. High Carbon High Chromium Steel) is also known as D2 material. This material has the ability to get hardened up to 55-65 HRC after heat treatment process. As the name indicates HCHCr, HC is the high carbon helps to increase the strength or hardness of the material. And HCr is high chromium helps to resist the corrosion and also increases the yield strength. This material has high toughness and high wear resistance properties due to Vanadium addition of 0.90%.

Chemical composition of HCHCr material

Table -1: Chemical Properties of HCHCr Steel

Content/ Materials	Notation	in %
Carbon	C	1.54
Silicon	Si	0.32
Magnesium	Mn	0.34
Chromium	Cr	12.0
Molybdenum	Mo	0.76
Vanadium	Va	0.91

The following Table-2 will give details of the Mechanical/physical properties of the HCHCr material.

Table -2: Properties of HCHCr Material

Properties	Value	Units
Young's Modulus	210000	N/mm^2
Shear Modulus	7900	N/mm^2
Mass Density	7700	Kg/mm^2
Comp Yield Strength	2150	N/mm^2
Tensile Strength	1736	N/mm^2
Yield Strength	2150	N/mm^2
Poisson Ratio	0.3	-
Thermal Expansion of Co-eff.	10.6 x 10e-6	w/mk
Thermal Conductivity	20.5	w/m-k
Specific Heat	460	J (Kg-K)

4. CALCULATIONS

4.1 Theoretical Calculations.

1. Cost of operation of the process.

It is essential to compare the cost of operation, when we want to change over the method of operation. It must be at least less than or equal to the existing process with having some benefit over existing process of operation.

Table-3: Cost of Tool Per Set of Operation.

Description	Milling Method		Press Tool Method	
	Qty./Units		Qty./Units	
Tooling Cost	7,500	Rs.	3,726	Rs.
Cutters /Die Punch require	3	No's	2	No's
Cost	22,500	Rs.	7,452	Rs.
No. of jobs can be machined before re-sharpening.	1000	No's	3000	No's
Possible re-sharpening to cutter/Punch	40	No's	30	No's
Total Jobs can be machined by a set of Cutters/Die Punch	40,000	No's	90,000	No's
Cost per Hinge set	0.56	Rs.	0.08	Rs.

Table-4: Cost per Piece and Cycle Time Difference.

Description	Milling Method		Press Tool Method	
	Qty./Units		Qty./Units	
Machine Hour Rate	170	Rs/Hr	130	Rs/Hr
	2.83	Per/min	2.17	Per/min
Hours per Shifts	8	Hr	8	Hr
Shifts per Day	2	No's	2	No's
Cost of machine per day	2720	Rs.	2080	Rs.
Cycle time of operation	2.7	Min	0.6	Min
No of jobs can be machined/Shift	180	No's	823	No's
	360	No's/Day	1646	No's/Day
Cost per piece	7.56	Per Set	1.26	Per Set
No of days per month (Avg.)	25	Day's	25	Day's
Qty. can be machine per month	9000	No's	41143	No's

Table-5: Cost Saving per Year.

Description	Milling Method		Press Tool Method	
	Qty./Units		Qty./Units	
No of quantity to be machined approx	9000	No's	9000	No's
Cost of Operation	7.56	Rs/Set	1.26	Rs/Set
Machining Cost	68,000	Rs.	11,375	Rs.
Cost Difference	56,625	Rs.		
Cost Saving per Month by Press tool	56625	Rs.	Press tool method is cheaper than Milling Process	
Cost Saving per Annum	679500	Rs.	Can be saved per year by press tool operation method	

The following Table- 5 gives the details of the cost saving benefits of press tool method over milling process.

2. cutting force or shear force required

The cutting force / shear force required is given by below formula

Shear force = l x t x τ

Where,

l= Blanking perimeter length

t = Material thickness

τ= Shear strength of the material (ST 37) to be cut.

3. Fatigue life of Punch -

Fatigue life is a mechanical and logical term that identifies with to what extent an object or material will last before totally failing in view of concentrated stresses [4]. Or The aggregate number of cycles for which an model supports before failure is called "fatigue (cyclic) life", denoted by N.

Fatigue life is given by,

$$\tau = P/A$$

Stress applied on the Punch tip =N/mm^2

Where,

P= Punching force, N

A= area of contact on punch, mm^2

4. Clearance between Die and Punch-

To obtain the good surface finish and the tool life of the die and punch, the proper allowance to de defined [5]. The allowance should not be more as it will cause the work piece to bend and then cut, so that will create burr on the object. And if the clearance is very small, then there is possibility of punch failure due to impact on die or due to friction between die and punch as both materials are hard. In this case another chances are of punch gets stuck in work piece as allowance is very small. This will let to punch failure or the life of punch will be impacted.

Clearance can be given from 5% to 25% percent depending on operation we are carrying, finish required, job geometry, strength of work piece and other factor are also involved.

5. 3D MODELING

3D modeling is the way toward building up a mathematical or scientific, wireframe portrayal of any three-dimensional object or surface, called a "3D model", by means of particular programming or manually. Models might be made automatically or physically; the manual modelling procedure of planning geometric information for 3D Computer illustrations is like plastic sculpture expressions, for example, chiselling. 3D models might be made utilizing different methodologies.

The below Fig-.3 Assembly view of the Press Tool.

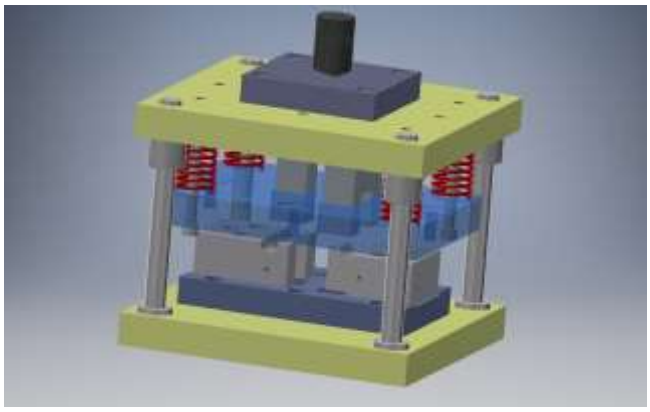

Fig -3: Assembly View of Press Tool.

The 3D models of the die and punch of the press tool are designed with the help of AutoCAD Inventor. And analyzed in ANSYS Workbench 14.0.

The following figures shows the results of the ANSYS.

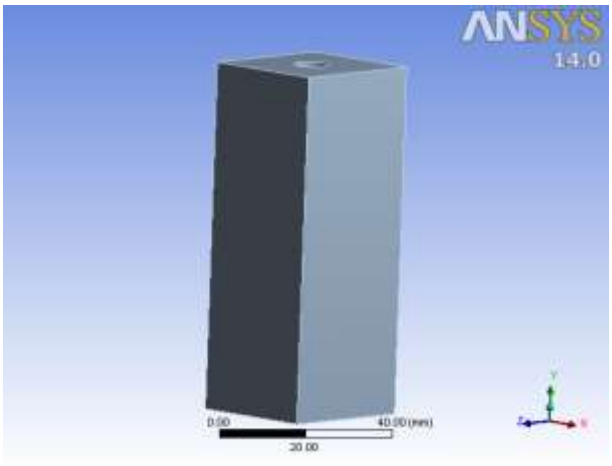

Fig -4: 3D model of Female Punch

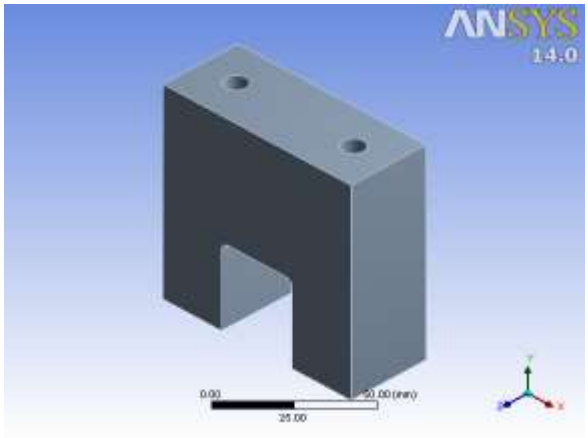

Fig -5: 3D model of Male Punch

Once the 3D models are ready and imported to ANSYS workbench will conduct the buckling and fatigue load trials on the punched, to check whether the design is safe and to know the life of the punch.

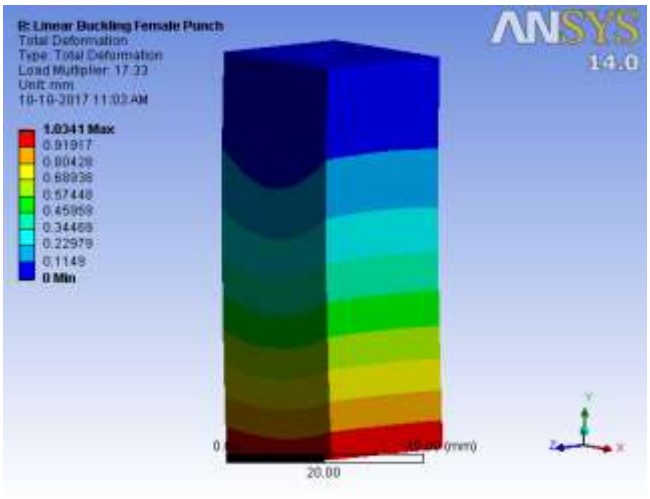

Fig -6: Buckling Load Test of Female Punch

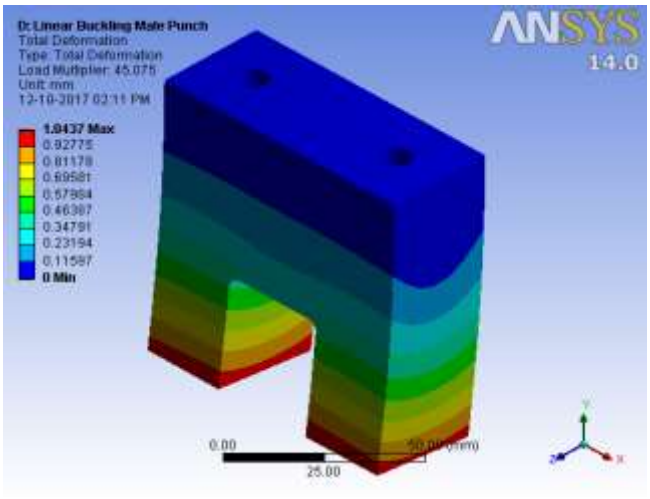

Fig -7: Buckling Load Test of Male Punch

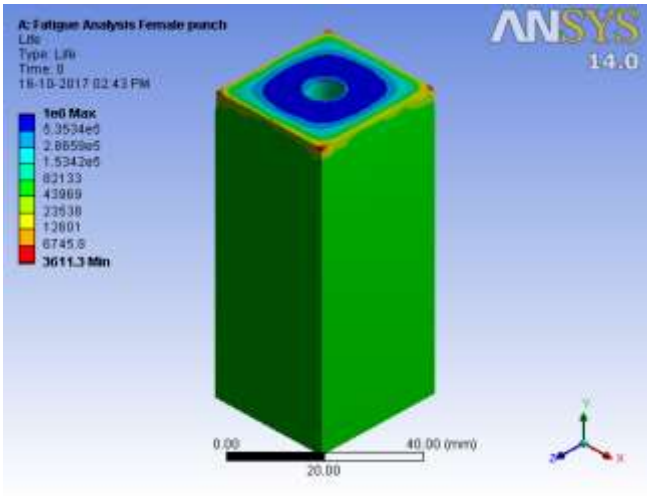

Fig -8: Fatigue Test of Female Punch

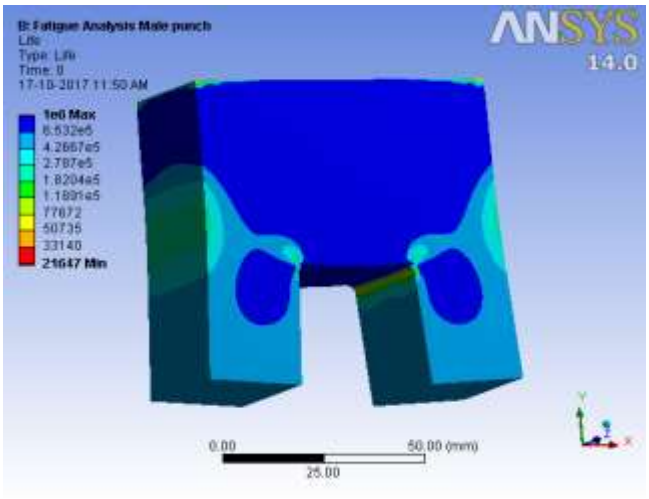

Fig -9: Fatigue Test of Male Punch

6. RESULTS

Referring to the Calculation the comparison and cost of production and other calculation for both processes. The cycle time, cost of existence process of milling can be reduced by implementing the press tool. There is a total saving of 2.1 min's which costs Rs.6.29 per hinge set. The total difference of Rs.56,625/- at the month over 9000 No's. If tanking these average of 9,000 no's per month will have saving of Rs-6,79,500/- annually.

The Following graphs shows the clear difference in above said processes.

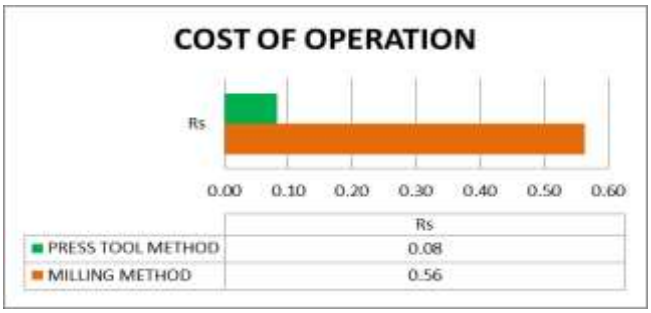

Chart -1: Cost of Operation of the Process

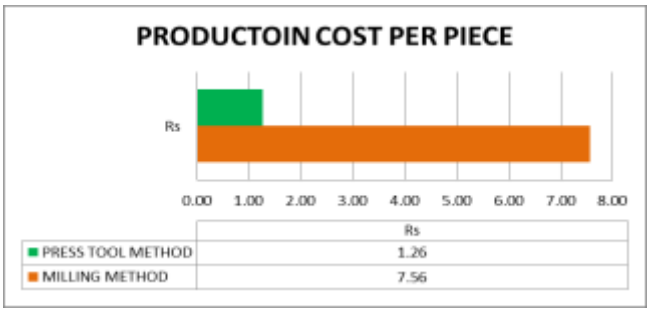

Chart -2: Cost per Piece

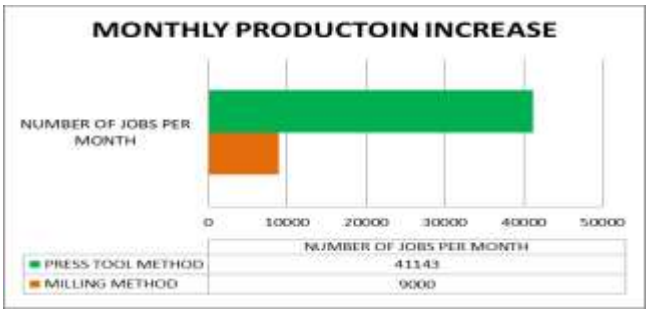

Chart -3: Difference in Productivity

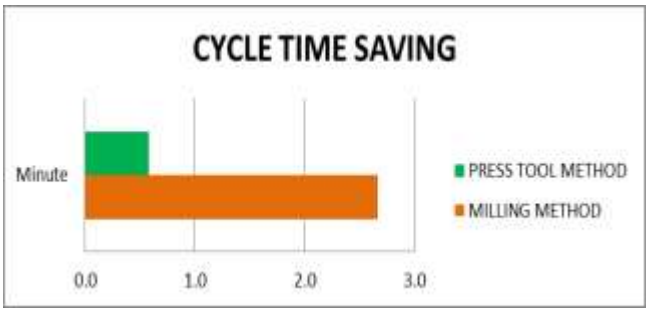

Chart -4: Cycle Time Difference

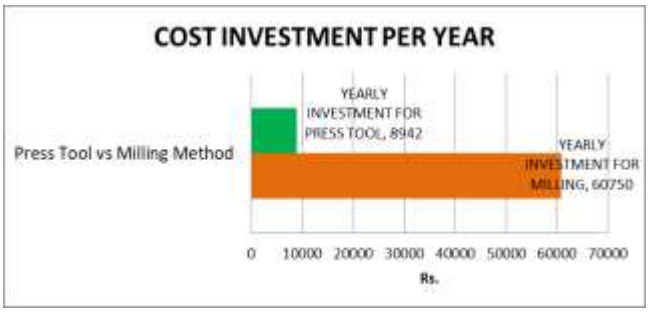

Chart -5: Cost Investment per Annum

7. Conclusion

From the above calculations is can be conclude that, by successful implementation of the press tool project to the Production will increase the production as well as reduction in the cycle time of the current process. The production can be increased by 4.5 times the existing production. Also the total production increase is of 32143 No's per month and Total Saving of Rs. 6,79,500/- per Annum.

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