Reduction In Manufacturing Cost of Front Bracket Pivot And Its Cycle Time

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Abstract*- In this paper optimization of procedure to develop Blanking cum piercing die for leaf spring type suspension Front Bracket Pivot is discussed. A press is a machine tool used to used or cut metal by applying external force for producing sheet metal components at large volume. The sheet metal working processes are widely used in almost all industries like automotive, defense and mechanical. Bracket Pivot is a part which is used in suspension assembly unit of automobile. Sequence of operation for manufacture of front bracket pivot is observed and analyzed. New methods and modifications in sequence of operations are planned initially and then press tool is designed and analyzed. The purpose of carrying out analysis is to prevent the costly tryouts and thus optimize the quality and rate of production. The purpose of analysis is to save the energy for manufacturing, reduce cycle time and thus optimize the rate of production.*

Keywords- Tool Press, CAE/CAD, Analysis, Optimization

I. INTRODUCTION

bending are very widely used in the making of sheet metal parts and it assembles different processes to manufacture sheet metal parts. Piercing and Blanking are metal shearing processes in which the input sheet material is sheared to a destination shape. The sheet metal working processes are widely used in almost all industries like automotive, defense, medical and mechanical industries. The major advantage for using metal working process is to improve production rate and to reduce the cost per piece. The product formed is Front bracket pivot, which is used for mounting purpose usually in leaf spring type suspension mounting. Front Bracket Pivot has become an essential component to lead comfortable travelling and also withstand vibrations by holding the spring. This rise in use and demand for Bracket Pivot has led to increase in production. The production also demands a precise and effective workpiece which can be achieved by using advanced and appropriate manufacturing processes. Along with manufacturing and process optimization we focus on Cycle Time Reduction Approach and Cost Reduction Approach. Cycle Time does not take anything away from quality processes, it actually enhances it. It is expected to provide a different perspective that may open up significant new working capital and cost reduction opportunities in areas of a company's operations that are often missed.

II. LITERATURE SURVEY

Metal Forming Processes, By G. R. Nagpal, in this book to refer the design procedure which we used to design the combination die, (our project task), to design a combination die for the production of bearing bush. This bearing bush used in rock crusher machines rod used in the chain or belt on the wheels as a cap.

Tool design, By Cyril Donaldson, It deals with method and devices used for sheet metal operation and principle of designing sheet metal dies. Method and principle used in designing the combination dies and the forces involved during these process Catalog from J.P. Enterprises In this catalog selection of the material based on their chemical composition and the hardness number of the material used for the die design and studied various properties of die material. It also includes various materials with their physical chemical properties of the material and their application. Based on this application the material is selected.

Imperial Journal of Interdisciplinary Research (IJIR) Vol-3, Anil Parmar, Darshit Patel, Kalp Patel, Badal Patel, Maulik Patel, Process of Press Tool Design and its Manufacturing, to design a die with interchangeable die and punches and reduce the weight of the material by means of changing the materials of die sets. This paper mainly focuses on different operations done in single die set with various stations just like a progressive die.

After going through the press tool design book and with our knowledge which we gathered from our four year engineering course and with the guidance of our project guide, we were able to and a solution to a problem. We figured out that, we can reduce the time, energy supplied and the cost for the production of each part by using compound die or combination die.

III. PRODUCT DEFINITION

Product manufactured is Front Bracket Pivot which is mounted in assembly unit in the suspension mounting. The pivot acts as the crucial part is holding and absorbing the shocks and vibrations of the vehicle. Leaf spring is mainly used in commercial vehicles, In which circular ends of Leaf spring is mounted on Bracket pivot because at the time of humps, speed breakers , potholes vibrations occurs which leads to deflection in the leaf spring suspension system so to prevent the deflection and to maintain the shape of spring.

IV. PROBLEM DEFINITON

This Front Bracket Pivot was initially produced using simple dies. The production itself involves six operations to finalize. This took a lot amount of time for the production of each product, thereby increasing the cost, production time and energy supplied for the production of each part. Mass production of a mechanical part in the industry has always been deciding factor for the industry survival in the market this not only can be overcome by increasing the numbers of the order or scale of order. Thus every industry aims maximum rate of production which can be gain by high capital investment, more number of skilled labor, minimum time of production and at most the first to supply in the market for survival. As per industry`s demands, the higher rate of production by increasing the skilled labors, minimizing machining time or advancing machining processes

V. OPERATIONS USED FOR MANUFACTURING

The manufacturing of the complete front bracket pivot includes six stage working. The manufacturing includes both sheet metal processes and sheet forming processes. The sheet cutting involves blanking and piercing. Similarly sheet forming involves joggling and forming. The six stage process is sequentially performed in the following manner.

- Blanking
- Joggling
- Piercing 1
- Forming 2
- Piercing 2
- Forming 2

VI. METHODS USED IN CREATING NEW TOOLS

After making the observation and the studying the detailed process of the manufacturing the bracket pivot. A proper prescribed method is taken into make the further process minimization. The factors were taken into consideration for a proper design, calculation for a newly devised method. Also the aim to achieve the possible objectives with the help of recommended solutions.

- Replace the simple dies with compound dies. Use of combinational die of blanking and piercing operations instead of different dies.
- To revise plant layout and introducing online inspection for better product quality. However, with the help of CAD software a combinational die of blanking cum piercing was designed in consideration of given set of requirements.

VII. DESIGN AND CALCULATIONS

Calculations for old process which incorporated one blanking operations and two different piercing operations

A. Old Process

1) Blanking Tool Calculation

Material of part to be formed → Mild Steel (Fe410)

i. Perimeter (P) = 1090.8mm (1091mm)

P = 1091mm

ii. Cutting force (CF) = Perimeter (P) x thickness of plate (t) x Shear force (Ʈ)

= 1091X5X 336.2

C.F = 1833.971 KN

Force in tonnage for blanking:

T1 = (C.F) max / (g X 103)

= 1833.971 / 9.81

T1 = 186.95 tonnes

Blank holder force (Bf)

Bf = 10% of shear cutting force

= 10% of 1833.971 X 103 N

= 183.3971 KN

= 18.69 tonnes

Blank holder force = Ram tonnage (T)

= 18.69 tonnes

Press tonnage capacity = (Shear Force + Blank Holder Force) x Factor of Safety

= (1833.971+183.3971) X 1.5

= 308.466 tonnes

Cutting Clearance allowances = (15)% of sheet thickness

= 15% of 5 mm

= 0.75 mm

2) Piercing Tool Calculation

Piercing operations are alternatively performed with forming 1 and forming 2 operations respectively after blanking and joggling operations.

Piercing operation = Piercing 1 + Piercing 2

Piercing 1

Shear Force Calculation

Cutting force (CF1) = Length of Cut x Thickness x Shear Strength …

Length of cut = $\pi D1$

= π x 16

= 50.26 mm

Cutting force (CF1) = C.F1 = 84.496 KN

Piercing 2

Shear Force Calculation

Cutting force (CF2) = (Length of Cut x Thickness) x Shear Strength

Length of cut = $\pi D2$

= π x 22.5

= 70.68 mm

Cutting force (CF2) = 118.822 KN

Therefore total cutting force i.e.

(Cutting Force for Piercing 1) +(Cutting Force for Piercing 2)

= 203.32 KN

Thus the total force needed for both operations is also the needed tonnage for piercing operations and is given as:

Force in tonnage for piercing:

T1 = (C.F) max / (g x 1000)

= 208.32 / 9.81

T1 = 20.72tonnes

Blank holder force/Stripping Force (Bf)

Bf = 10% of shear cutting force

= 10% of 203.32 x 1000 N

= 20.332 KN

Blank holder force = Ram Tonnage (T)

= 20.332 tonnes

Press tonnage / capacity = (Shear Force + Blank Holder Force) X Factor of Safety

= (203.32 + 20.332) x 1.5

= 223.652 KN

= 22.80 tonnes

Therefore the approximate tonnage is about 330 tonnes is for three processes for previous method

Thus after recommending the new method of introducing a compound die for combined operation of simultaneous blanking and piercing. So the amount of cutting done by the cutting die is the summation of combined processes .Also the new designation for new or replaced method is calculated below with possible minimization in the operation dies, parts and presses.

New Process = Blanking+ Piercing1+ Piercing 2

i. Perimeter (P) = 1091 + 50.26 + 70.68

P = 1212mm

ii. Cutting force = (Perimeter (P) x thickness of plate (t)) x (Shear force (τ))

= 1212 x 5 x 336.2

C. F = 2037.37 kN

Force in tonnage for blanking:

T1 = (C.F) max / (g x 103)

= 2037.37 / 9.81

T1 = 207.68 tonnes

Blank holder force (Bf)

Bf = 10% of shear cutting force

= 10% of 2037.37 x 103 N

= 20.7683 tonnes

Blank holder force = Ram tonnage (T)

= 20.7683 tonnes

Press tonnage capacity = (Shear Force+ Blank Holder Force) x Factor of Safety

= (2037.37 + 203.737) x 1.5

= 343 tonnes

For the previous processes there are two presses with different capacity are used thus its not only two separate station to be operated but also the there is waste of time, additional time taken to transport the blanked and joggled pieces to moved for piercing1.This leads to additional energy consumption along with storage if any in ongoing process. Again after forming 1 the pieces are sent to the same station for piercing 2 .Thus the there is total needed capacity of approximately 330 ton including other factors such as time, cost, labor, space etc.

OPERATIONAL FLOWCHART

Modified Process i.e. Blanking +piercing 1+ piercing 2

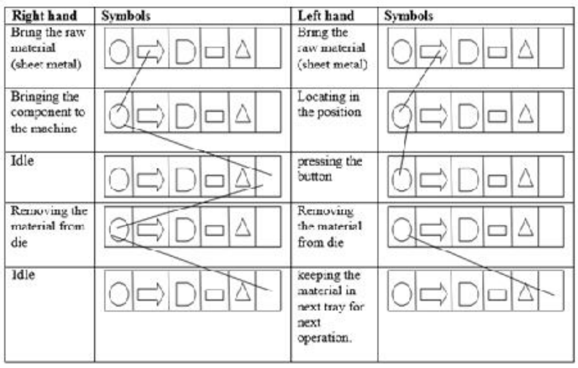

Figure 1 : Operational Flowchart of New Process

VIII. CYCLE TIME

Cycle time reduction is inherently different from traditional cost cutting approaches to profit improvement. It enables rather than diminishes an organization's ability to compete, by strengthening a company's core capabilities and by developing the dimension of time as a new strategic weapon. Slashing cycle time is the fastest and most powerful approach to profitability improvement, especially for companies who have already realized most of their core manufacturing efficiency improvement opportunities. Cycle time reductions will directly impact almost every contributor to costs within your operations. The effects after optimization of cycle time such as

- Improved Capacity
- Lower Unit Costs
- Shorter Cycle Times
- Greater Productivity
- Quicker Time to Market
- Increased Effectiveness

Overall production time taken for manufacturing the bracket pivot observed is tabulated below.

1) Old Method

Table 1: Time Taken for Old Method

Processes	Machining time (sec)
Blanking	10
Joggling	10
Forming 1	12
Piercing 1	10
Piercing 2	10
Forming 2	12
Total	64

The table 1 shows the time taken by all steps for manufacturing of a single product. Time taken for one cycle is 64 seconds**.**

2) New Method

Table 2: Time Taken for New Method

Processes	Machining time (sec)
Blanking + piercing 1 + piercing 2	10
Joggling	10
Forming 1	12
Forming 2	12
Total	44

The table 2 shows the time taken by all steps for manufacturing of a single product. Time taken for one cycle is 44 seconds. So cycle time reduced from 66 seconds to 44 seconds. It is useful for mass production and also reduced labor work and electric energy required to manufacture bracket pivot.

RESULTS

Previously,

Total stroke = (number of strokes / die) x number of dies
= 2400 x 6
= 14400 strokes

At present,

Total strokes = (number of strokes / die) x number of dies
= 2400 x 4
= 9600 strokes

Number of strokes saved = 14400-9600
= 4800 strokes

Percentage of strokes saved = (No. of strokes saved) / (Total number of strokes that were formerly used)
= 4800/14400
= 0.33
= 33%

This saving of strokes is directly proportional to the energy or power supplied for the application of stroke.

Therefore, total energy saved = 33%

Similarly, this saving of strokes is directly proportional to the amount invested or cost for the power used.

Thus total saving of energy= 33%

Similarly, this saving of strokes is directly proportional to the time saved in applying the stroke.

Thus total saving of time = 33%

IX. PRODUCT COST ESTIMATION

Strip Size = 242mm x 1250mm x 50mm
Quantity/ Strip = 06 No
Blank weight = 1.25 Kg

(**Previous) Cost Estimation:**

Manufacturing cost = 56 Rupees
Weight of Product = 1.25 Kg
Cost of Product/Kg = 1.25 x 55
= 70 Rupees /Kg
Other Charges
(Transportation, Electricity, Labor, etc.) = 3.25 Rupees
Considering a product value = 2.5 Rupees
Total cost of piece = 75.75 Rupees
GST on Total cost = 18/100 x 75.75
= 13.635 Rupees
Total Selling cost = Total value + GST
= 75.75 + 13.635
= 89.38
=90 Rupees (approximately)

New Cost:

Manufacturing cost = 55 Rupees
Weight = 1.25Kg
Cost of Product/Piece = 1.25 x 55
= 68.75
Other charges = 2.5 Rupees
Considering Product value = 5 Rupees
Total Product cost = 76.25 Rupees
GST value = 13.725 Rupees
Total Selling cost = Total Product value + GST
= 76.25 + 13.725
= 89.925
= 90 Rupees (approximately)

X. CONCLUSION

After studying all the sheet metal processes for manufacturing it was observed that the process involving the all parameters like product material, its properties, design are suitable as required yet we still we lacked by the number of productivity. Since we realized that the cycle time taken for a product taken is more. That in turn leads to more cost in productivity, thus we have to modify the manufacturing process in order to reduce the cycle time which is assumed to be more for formed product. And we hope to reduce the cycle time by adopting the prescribed suggestion and reduce cost considerably. This all together will result in increase in profit and productivity over a long period. Whole production line can be automated so as to get the maximum efficiency of the production rate these can be attained by following ways;

- Using of conveyor belt to transport the work piece from one station to another. Thus, there won't be any unproductive time as in case of human control.
- Using pick and place robot to place the work piece as the desired position without any error.
- Using robot sensors on the production line itself for inspection of the quality of the final product produced.

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