Modeling of Progressive Die for Chain Adjuster Bracket

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Abstract— Chain Adjuster Bracket is an automobile component used in many Bajaj bikes as the tensioning end of chain assembly. It is used to fasten the chain and to adjust the tension in the chain. It is also called as Cap Swing Arm of chain assembly. Methodology: Sahyadri Industries is situated in Waluj MIDC, Aurangabad (MS, INDIA) manufactures chain adjustor brackets and supplies it to Bajaj Auto Pvt. Ltd. The process of making chain adjustor bracket consists of use of 5 different power presses. These presses progressively produce final desired output. Process: The objective of this paper is to design a progressive die using Solid Edge V18 which can produce chain adjustor bracket with single press and progressive die set. This will ultimately reduce labors and increase productivity of industry. Conclusion: Conventionally, process consists of shearing, forming, piercing, blanking and re- striking operation. These operations require 5 different power presses, 5 different operating labors and 2-3 labors for material handling. Progressive die set and single power press will reduce labors in considerable amount, which is great achievement.

Key words: Progressive Die, Chain Adjuster Bracket

I. INTRODUCTION

A. Chain Adjuster Bracket

Chain Adjuster Bracket is an automobile component used in many Bajaj bikes as the tensioning end of chain assembly. It is used to fasten the chain and to adjust the tension in the chain. It is also called as Cap Swing Arm of chain assembly. The material used for the production of chain adjuster bracket is Cold Rolled Steel.

Fig 1: Chain Adjustor Bracket

The chain adjuster bracket has an embossed section at center for tension adjustment and perfect fitting. It has three holes, one of which is at center having 6.2mm diameter used for fitting of component in the assembly. The remaining two holes are identical having diameter 3mm. They are punched centrally at extreme ends of component on unembossed portion. These two small holes act as drainage line for chain assembly.

B. Sahyadri Industries Pvt. Ltd.

Sahyadri Industries was started in 2003 at Lt. Govindrao Dinde Udyog Bhavan D-51/39, MIDC Waluj, Aurangabad. It deals with production of many automobile components supplied to industries and general market. The main operations in the Sahyadri Industry are done by Power Presses.

One of the automobile components produced in Sahyadri Industry is Chain Adjuster Bracket or Cap Swing Arm which they supply to Bajaj Auto Pvt Ltd .They are the Sub vendor to Bajaj Auto Pvt Ltd. The material of chain adjustor bracket is Cold Rolled Steel.

The production of chain adjuster bracket at Sahyadri Industries is done on 5 different power presses and dies sets. The operations are shearing, forming, trimming, piercing, restriking. Each operation is performed on individual power press having its specific die set.

II. ACTUAL PROCESS

The operations performed for the production of chain adjuster bracket from cold rolled steel metal sheet are Shearing, Forming, Trimming, Piercing, Re-striking

A. Shearing Operation

The cutting and separating of material without the formation of chips is called as shearing. A metal strip of material cold rolled steel is cut into the desired shape by shearing operation on first power press. The tonnage of this power press is 10 ton. The rectangular strip as shown in fig.2 is cut from long metal strip. The dimensions of desired rectangular strip are 35mm×55mm and thickness of the strip is 2mm.

B. Forming Operation

Plastic deformation of metal to produce a useful shape sheet metal can be formed through operations that shear, stretch, bend, or compress the metal. The metal strip obtained by shearing operation is transferred manually to next power press for forming operation. The forming is to be performed to get an embossed portion on the strip. The forming operation is performed on the power press having tonnage of 50 ton. This operation requires more power than any other operation in this process as there is an embossed portion to be formed. The embossed portion is made 7mm below the actual strip surface.

C. Trimming Operation

This operation consists of cutting unwanted excess material from the periphery of a previously formed component. The embossed component obtained from forming operation is transferred manually to next power press for trimming operation. At trimming die the unwanted periphery of 5mm is cut and the actual product size i.e. 30mm*50mm is obtained. The extra 5mm material was for the forming operation, as the shape of the component had to be changed there. The tonnage applied for trimming operation is 20 ton.

D. Piercing Operation

It is a cutting operation by which various shaped holes are made in sheet metal. Punching is similar to blanking except

that in punching; the hole is desired product, the material punched out to form the hole being waste. The component obtained after trimming operation has to be pierced by using a punching die. There are total 3 holes to be made on the component. Out of these 1 hole is at center of embossed portion having diameter 6.2mm. Remaining 2 holes are to be made at extreme ends of bracket i.e. unembossed portion of component. The diameter of these two holes is 3mm each. These three holes are on the central line of component. The distance between centers of two extreme identical holes is 39.5mm. All the 3 holes are made on component in one stroke of punch. The tonnage required for this piercing operation is 10ton.

E. Restriking Operation

This operation may be called as the finishing stage of the process. Restriking is to be done because the burrs are formed during the piercing operation at the edges of the holes. Also during the piercing operation the component gets bent near the portion of holes. So to remove these burrs and bending of component restriking is done by using a die set and plain punch identical to the component size. This operation requires a power press having tonnage 20ton.

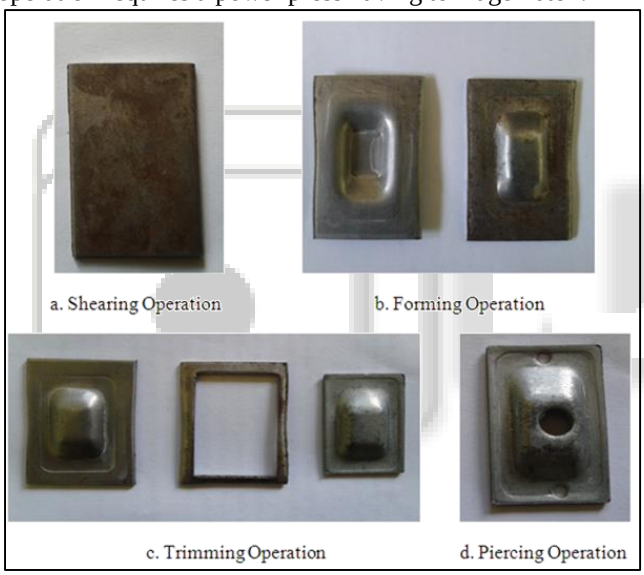

Fig. 2: Actual Processes for production of chain adjuster bracket

Study of the above operations performed for the production of chain adjuster bracket has been carried out. Each of the above operation is individually performed on separate power press having different die set and different tonnage. These operations were performed manually. The component has to be operated on each machines and then transferred manually to next machine. Here each power press or machine is acting as a work station during the process. The component cannot be passed to next station until its operation on previous station is completed. So the transportation of component from one work station to another is time consuming and increasing the labor cost. This makes the process lengthy and time consuming causing to require more manpower.

Another problem during this process is formation of burrs and bending of component because of striking of punch on it. Due to these problems we have to perform a re-striking operation on the component. So it also increases the cost of operation likewise labor cost, assembly cost. And it also increases the process time.

III. Conventional Costing of Component

Costing of single component of chain adjuster bracket consist of

A. Raw Material Cost

The material cold rolled steel costs Rs.50 per kg. A single chain adjuster bracket component requires 32 grams of raw material. Therefore for a single component,
Raw material cost = 0.032 x 50.
= 1.6 Rs.

B. Operation Cost

The operation cost for a single component of chain adjuster bracket is as follows,
Shearing operation cost = 10 paise.
Forming operation cost = 20 paise.
Trimming operation cost = 20 paise.
Piercing operation cost = 10 paise.
Restriking operation cost = 10 paise.
Therefore the total operational cost = 70 paise.
Material handling cost = 10 paise
Packing cost = 10 paise
Transportation cost = 10 paise

Cost of component = Raw material cost + Operational cost +Material handling cost + Packing cost + Transportation cost.
= 1.60 + 0.70 + 0.10 + 0.10 + 0.10
= 2.60 Rs.
Administrative Profit = 10% of cost
= 2.60 x 0.1
= 0.26 Rs.
Final cost of component = 2.60 + 0.26
= 2.86 Rs.

The production rate of component in Sahyadri Industry is 4000-4500 in a general shift per day. In the total production of this component 1-1.5% components are found to be defective.

IV. Progressive Die

A progressive die is also called as follow on die and has a series of operations to be performed in stroke. At each station, an operation is performed on a work piece during a stroke of press. Between strokes, the piece in the metal strip is transferred to the next station. A finished work piece is made at each stroke of the press.

A. Design Procedure of Progressive Die

Progressive die also known as cut-and-carry die, is a multisession die that performs several operations in succession in a single stroke of press die. The various operations may be all cutting operation or a combination of cutting and forming operation. The first step in the design of die is development of a blank. For this, the direction of metal gain is kept in mind. Normally, the gain of coil strip is parallel to its length.

For establishing the sequence of operation for progressive dies, the following guideline should be considered.

- While evolving the strip design, the positioning and proper location of the stock in each station is of prime importance. For this, pilots are incorporated in the die. Advantages should be taken by any required holes in the work piece for piloting.
- Distribute pierce area over several stations if they are close together or are close to the edge of die opening.
- Check, if the blanked area can be dividing into simple shapes, so that commercially available punches of simple contours may be used. A blanked area may be partially cut at one station and the remaining area will be cut in later station.
- Use of Ideal Station. They help the designer to distribute the total load uniformly over the complete length of die. They also strengthen die blocks, stripper plates and punch etc. and facilitates strip movements.
- Bending and forming operation must be at last station.
- Cutting and forming areas should be located to provide uniform loading of the press slide.
- While designing strip layout, try for minimum scrap. Use a multiple layout if possible.
- Design the strip so that scrap and work piece can be ejected without interference.
- The next step is to design the die. The design of various die elements like die block, punches, stripper etc.

V. DESIGN FEATURES OF PROGRESSIVE DIE

Conventional process consists of operations in order of shearing, forming, trimming, piercing and re-striking. For progressive die, we need to set different sequence of operations for obtaining desired output in single die and single press. Modified sequence of Operation is as follows.

A. Guide Punching

When strip is fed to progressive die, first operation which is done on the strip is punching of guide hole of 2.5 mm diameter. This hole is punched on horizontal axis of strip. This hole guides strip and also holds the strip while other operations are performed on the strip. Due to this guide hole, strip is kept at its position which facilitates flawless operation of die.

B. Initial Forming

After first operation, die performs forming operation on the strip. In conventional process desired forming was obtained in single stroke of punch because size of strip was small but in modified method, strip is not cut yet to its final layout and thus we need two strokes for achievement of final desired forming. First stroke is done at this stage which partially forms a cup on the strip.

C. Final Forming

Second stroke of forming process is done in this process which gives us final formed strip.

D. Piercing of Side Holes

After forming operation if performed, we need to punch holes on the strip. Two of side holes are pierced in this process. Piercing diameter is 3 mm. These holes are at a distance of 39.5 mm on vertical central axis of chain adjustor bracket.

E. Piercing of Central Hole

Guide hole which was produced in first process is now enlarged and pierced in this operation to diameter of 6.2 mm. This is final desired hole shape of chain adjustor bracket which is used for fastening the chain.

F. Blanking

Strip is not yet cut into its final stage till process 5. This cutting of strip into final desired shape of (50 x 30) mm is done in this process. This process is called blanking process. This final product is ejected through cavity and scrap strip passes further.

Now modelling of various parts of die is discussed in this section. Following diagram shows different views of final assembly of progressive die set.

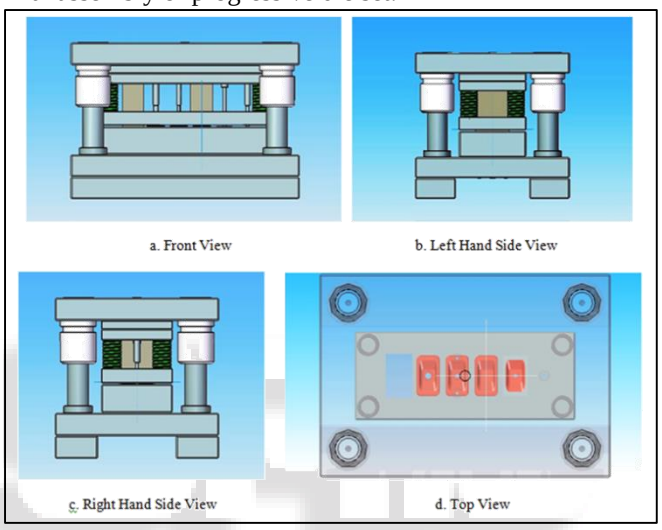

Fig. 3: Assembly and various views of progressive die set

VI. CONCLUSION

From the above discussion all the 5 operations viz. Shearing, Forming, Trimming, Piercing and Re-striking were done by five different dies. These operations require separate labor to handle these operations. But the combination of these operations in to one single progressive die will be beneficial to the industries. The progressive die manufacturing is a great alternative to improve the productivity and also to reduce labor cost. This progressive die was designed using Solid Edge V18 Computer Aided Design (CAD) software. Total 28 parts were modeled and then they were assembled to produce final progressive die.

The designed die was very effective and reduced manpower from 7-8 workers to 2 workers only. This reduced labor cost. This also reduced effective cycle time and thus increasing production. Ultimately, Productivity of the industry is increased. The manufacturing cost of chain adjuster bracket with progressive die is reduced up to 2.46 paisa as the previous cost was 2.86 paisa. So there is a reduction in overall manufacturing cost per component is up to 40 paisa. This progressive die have very high initial cost and complicated design but it can make up with time and ultimately will be profit making for the industry.

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