

Raw Material Yield Improvement Through Burrless Forging of Bolt Manufacturing

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ABSTRACT

In this paper, the manufacturing modification is made to minimize the manufacturing and raw material cost. This has been done by changing the die design and eliminating the additional burr removal operation. This enhances the strength and hardness of the material and also the raw material yield improvement of the manufacturing method in the bolt manufacturing system.

General Terms

This work has been carried out under the permission of the Sundram fasteners limited, Madurai. The authors thank the management and workers for the full-fledged support during the entire work.

Keywords

Bolt manufacturing, raw material reduction, design modification, cost minimization, improved strength.

1. INTRODUCTION

In the current scenario of globalization, buying and selling are emerging rapidly. The customers are demanding the suppliers for "On time delivery, with correct quantity and quality". Here even though the above things were met by the most of the suppliers, there is always one more important aspect that is to be considered by the supplier. Normally, the conventional method of fastener forging is done by trimming process. In this method, the raw material is taken more than the required volume and excess material is trimmed off from the sample and the sample is finished. Here the excess raw material that is trimmed-off from the product is called "trim burr" and is directly wasted. The trimming of excess material from the product drastically reduces the yield percentage. In mass manufacturing the wasted trim burr of raw material will give huge impact in reduced percentage of yield and in terms of money. Hence it is very much important that optimum utilization of input raw material into value added product.

In this work raw material, material cost, labour cost, are minimized by introducing an alternative design

on the method of bolt manufacturing. In this regard a burrless forging has been introduced, implemented and tested for its effectiveness.

2. EXISTING BOLT MANUFACTURING METHOD

Normally in the conventional method, forging is done by trimming process. In this method the raw material is taken more than the required amount and excess material is trimmed off from the sample and the sample is finished. Here the excess raw material that is trimmed called trim burr, and it is directly wasted as burr, which drastically reduces the yield percentage. The trim burr weight varies according to the product size and shape. The yield percentage in the trimming process is about 92% maximum. For high volume producers like Sundram fasteners, they considerably reduce the profit margin, since 4 to 5 Cr. quantity of products are manufactured in Krishnapuram (Madurai) unit alone per month in bolt segment, and 35% of the total quantity are flange screws and flange bolts only ranging from M6 to M20. For example in an average of minimum 5 grams per product goes as trim burr, for the quantity of 17500000 pieces it will be around 87500000 grams = 87.5 Metric tons. On an average the steel cost which is in increasing trend is around Rs 60000/ton. Hence for 87.5 tons the costs is around Rs. 52.5 L and are scrapped. Hence this provided us a great opportunity for yield improvement and cost reduction.

From the above value addition mapping, we can conclude that "Raw material and Forging consumes more addition of values among all other processes and the both process put together contributes 68. Since the Raw material is Basic input of the process and consumption of Raw material takes place only in the Forging process, we have chosen this process is a vital area and scope for improvement. We have selected one product among the M8 collar bolt's family and we have taken all the data's related to this part.

PART NO. : M71160 - M8 x 1.25 x 38 collar bolt.
Month Quantity: 75000 to 100000 nos.

Customer: TELCO



Fig 1. Stage Samples of Forging (trimming Version)

For forging this product input Raw material required is 23 grams/product and the after finishing the product weighs to 21.2 grams/product, balance 1.8 grams were wasted as Trimming Burr.

The product Drawing is as below. This figure 1 shows the stage wise forging from cut-off to finished blanks. We have analyzed the forging process for various contribution of cost to minimize the manufacturing cost. We have taken the forging machine and analyzed for its various contribution of cost. The loss cost bar chart is arrived with the one month data as shown in figure 2.

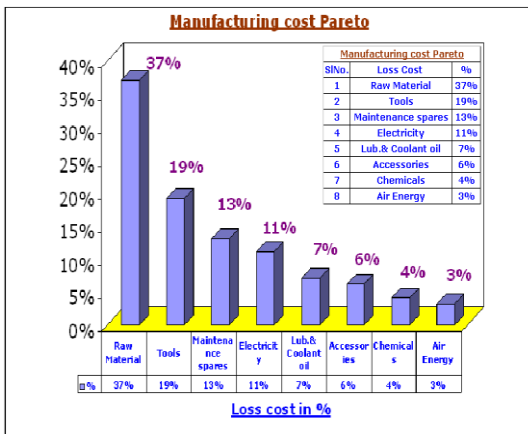


Fig.2 Manufacturing Cost Pareto

Here the major manufacturing loss cost is 37% of Raw material and all others are comparatively lesser in percentage of cost.

3. PROPOSED METHODOLOGY AND IMPLEMENTATION

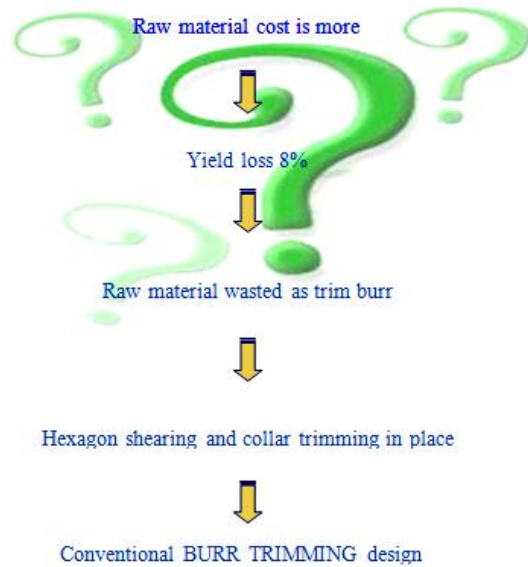
To minimize the form error and the manufacturing cost the existing method of manufacturing is replaced by the new method. This has been done by implementing the changes in the die design.

3.1 Evolution of Idea

Root cause analysis is made on the problem identified and an effective idea has been sparked which is explained as follows:

The above problem is process related and we thought of process which would considerably reduce the burr weight by referring various sources. On analyzing the net shape forging of gears we thought of forming of fasteners.

3.2 Route Cause Analysis



Further we have done analysis for the higher Raw material cost during the forging process and which is as follows:

Fig.3 Value addition graph

Hence from the above analysis, it is concluded that the final root cause is Trimmed version process that reduces the Raw material yield since Trim burr is wasted and scrapped. This will contribute to the company as reduction in profit.

3.3 Feasibility study

In this phase, the feasibility of adopting the collar bolts in Formed version (Burr less Forging) has been arrived and the general template made for the Formed version process.

From the below available templates, we have checked for the trial of

M8 collar bolts and the following are concluded.

- Length / Diameter ratio: L / D within limits.
- Upsetting ratio : Within Limits.
- Extrusion ratio : At maximum limit.

The Design modification starts from the 2nd station of both punch and Die side assembly. The Process flow chart for both Trimmed version and Formed versions are described hereunder

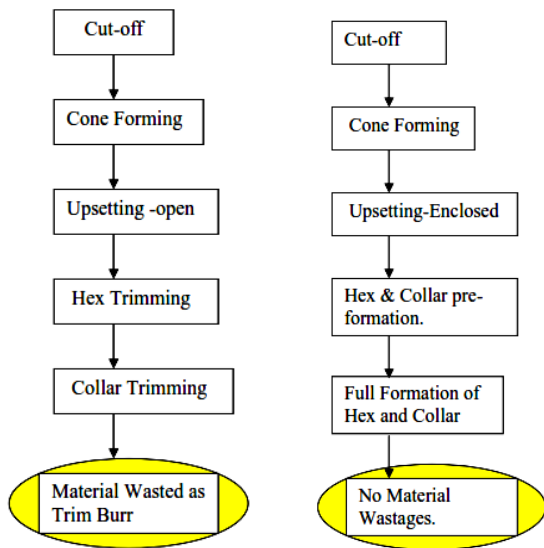


Fig. 4 Comparison of old and new methods

3.4 Design Modification of Die and Tool

In order to successfully implement our proposed idea, we are in need of some change in tool design which are as follows. In trimmed version process the Die K.O pin face was flat and circular, which was used to eject the product from die bore. In formed version this K.O pins are performs in two ways.

- Ejecting product from the Die bore,
- Orienting the product from 3rd station to 4th station.

The 3rd Hex trim die assembly which was the tool, used in Trimmed version process. Now in the Burr less forging process this tool was design modified as 3rd Hex pre-forming tool (P.K.O assembly). In 4th station 4th collar trim die was replaced with 4th PKO Assembly. Similarly in the die side 3rd and 4th dies design were changed. Transfer fingers – which are used to transfer the products from one station to another.



Fig.5 Bolt Formed production from the new method

The above figure. 5 shows the stage wise samples of Formed version process.

3.5 Tests and Analysis

Further analysis made for the produced formed version product, and they are explained below. We have compared grain flow of trimmed version and formed version products through destructive testing, and the results shows that there is an improved strength in the case of formed version of the product. The grain flow of the products are given below.

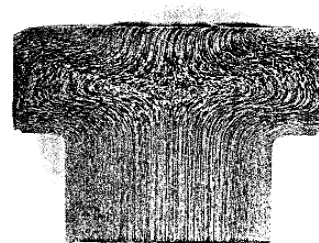


Fig.6 Grain flow in the trimmed version of product

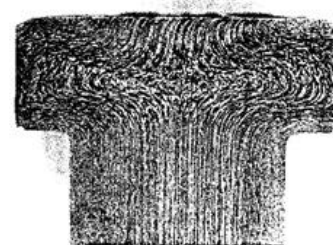


Fig.7 Grain flow in the formed version of product

The hardness of the both trimmed and formed products are tested and the tests show that the

formed version of the product has improved hardness at their formed necks.

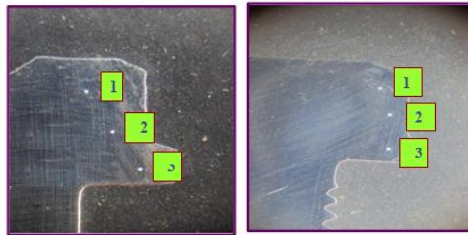


Fig.8 Hardness tested locations on the bolt

Table 1 Harness of the products

Location	Trimmed (BHN)	Formed (BHN)
1	284	286
2	291	289
3	288	292

4.1 RESULTS AND DISCUSSIONS

The proposed method is being implemented in their premise and the following results were obtained which depicts the success of our proposed methodology.

4.2 Yield improvement

RM yield is improved from 92% to 100%

In January month M71160 - part forged and dispatched quantity was 93,510 nos. Input Raw material used to forge this quantity was: 2.019 MT 100% of input raw material used. Hence Dispatched Material is same as that of 2.019 MT. If it was forged with Trimmed version the required Raw material may be of 2.18140 MT. RM savings for the month of January 2014 is 0.162401 MT. Input RM cost: (procuring cost): Rs.52, 000/MT. Cost savings due to RM savings: Rs.8444.85 for January 2014. Considering the same quantity for the whole year, then the Cost savings / year will be: Rs.1, 01,338.224

5 CONCLUSION

A detailed analysis of the most important processes affecting the raw material yield improvement is carried out and the results and the conclusions obtained are discussed below:

- Raw material yield is improved from 92% to 100% for collar bolt (M71160) through Burr less forging method (Formed version).
- Thus full utilization of raw material is obtained through this process.
- The bolts manufactured by forming method have good surface finish when compared with

that of the one manufactured by trimming method.

- The hardness of the bolt manufactured by forming method is higher than that of the one manufactured by trimming method.
- The sharp corners found in trimming method have been replaced by reduced corners in forming method.
- The stress concentration area in the bolt head is increased in the formed method which in turn increases the tool life.
- The process of trimming is eliminated in forming which in turn reduces the operation time and also the labor cost for processing trim burr

Hence, Burr less forging (Formed version) process is the best process for manufacturing collar bolt (M71160-M8) which ensures "No wastage of raw material".

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