Development of Forging Bolster for Quick Die Setup

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Abstract- In the forging industry, one of the main challenges is the reduction of setup change time which is non-productive time on the forging press. Long non-productive time reduces efficiency and affects profitability of the forging companies. In this thesis study, firstly setup change activities on the 1000 ton forging press of a forging company are observed and analyzed. With the help of these observations, it is seen that the new die holders with cassette holders and the new cassettes are required to reduce the setup change time radically. Different design versions of the new die holders have been studied. A new pair of die holders is designed and manufactured along with the new cassette holders and the new cassettes which hold the forging dies. The factors related to internal setup change operations, which are identified during the time and motion studies and root cause analysis, have been considered during design of the new die holder system.

Keywords: Hot Forging, Die Exchange, Die Exchange Time, Die Holder

1. INTRODUCTION

The difficulties in reducing setup time on all forging presses exist primarily in the die holder, the clamping mechanism used, the assembly sequence of the parts fitting together, and the training of workers to follow the procedure carefully. On the 1000 ton forging press, the current setup activities take approximately 2 to 3 hours while the press is kept idle, which is the time when the press is not producing acceptable quality parts. This directly increases the cost of forging and ultimately the parts being produced. Table no.1 shows the initial time study for setup change of a typical part on 1000 ton forging Press. One way to reduce the setup time is by applying the technique called Single Minute Exchange of Dies (SMED) which aims to perform setup operations within a single digit value of time in minutes. Together with quick changeover (QCO) technique, SMED significantly tackles with most of the upfront problems, thereby reducing considerable amount of setup time.

Table -1: Die Setup Time for Manual Clamping

Operation No.	Operation	press	Time in Min.
1	Dis-Mounting Previous Die-Set	Off	40
2	Mounting New Die-Set	Off	60
3	Heating Dies	Off	30
4	Total=		130

2. PROPOSED WORK

To minimize the time required for die clamping and to overcome the problem of fastening plate we are going to use hydraulic clamping.

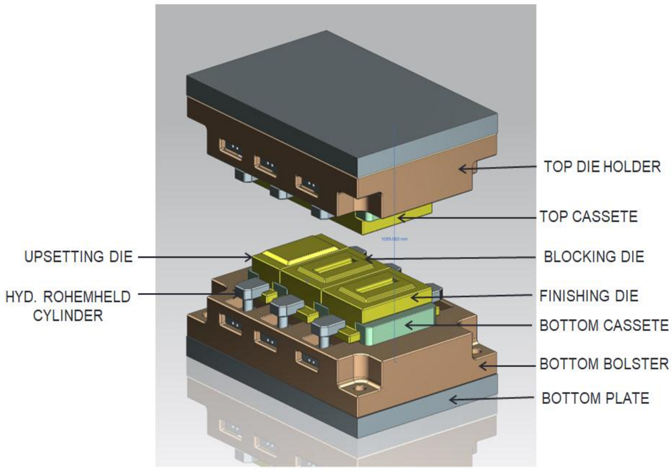

Figure 1: Modified Die Holder Using Swing Clamp For Die Clamping

1.1 Components of the Proposed System

Bottom Die Holder
Bottom Cassete
Allen Bolts for Mounting Bottom Cassete on Bottom Die Holder
Bottom Dies
Top Die Holder
Top Cassete

Allen Bolts for Mounting Top Cassete on Top Die Holder
Top Dies
Swing Clamp Cylinder for Die Clamping
Hydraulic Piping
Hydraulic Power Pack
Electric Panel

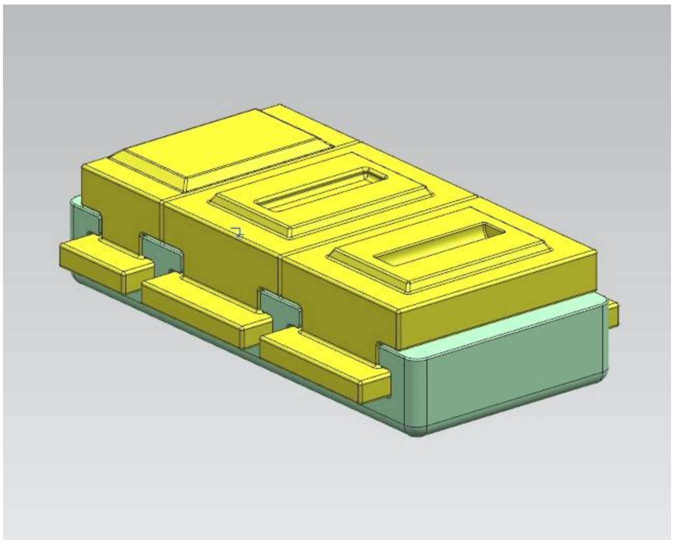

Figure 2: Cassete & Die Assembly

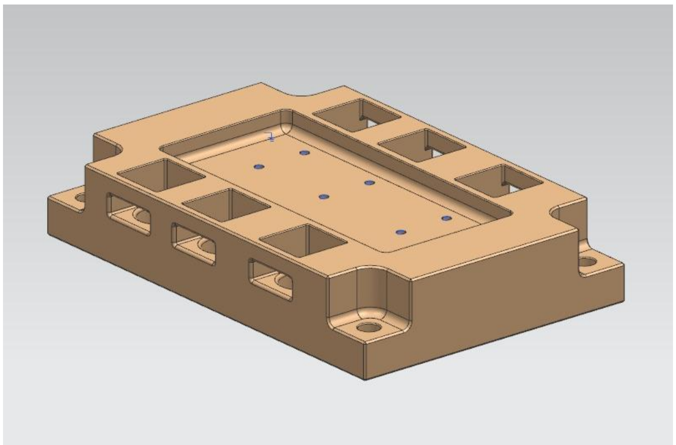

Figure 2: Die Holder for Top & Bottom Die Cassete

1.2 Working Principle

The bottom die holder is a part which is fixed to the bed of the forging press with the application of the Allen bolt. These degrees of freedom of bottom die holder are locked in all the sides. Because while forging it should not be moved from its fixed position.

On the bottom die bolster cassette is mounted with the application of Allen bolt. The degrees of freedom of bottom cassette must be locked from all the sides. The function of bottom cassette is to hold the bottom dies in bottom bolster.

Similarly top die holder is a part which is fixed to the ram of the forging press. This part is fixed to the ram of the press by the application of Allen bolt. The all degrees of freedom of top die holder are locked because it must not be moved from its fixed position while forging.

Top cassette is mounted on top die holder with the application of Allen bolt. Degree of freedom of cassette is locked from all the sides to lock the moment while forging. Top cassette is used to mount the top dies on top die holder.

There are three top and three bottom dies for upsetting, Finishing, & blocking operation. These three dies are mounted in a bottom cassette on bottom die holder and three dies are mounted in a top cassette on a top die holder.

The rohemheld cylinder is a hydraulic operated cylinder. These main advantages of these cylinder it consist clamp which is swing operated. This is used to save the area and material in top & bottom die holder.

These cylinders are connected to the hydraulic power pack by the application of steel piping.

The electric panel connection is established to the hydraulic power pack which is then operated by electric switch provided on electrical panel.

To load dies in the bolster. The operator first lifts the dies from ground along with cassette and put it into a bottom die holder with the application of trolley or forklift.

When operator press the button on electric panel to clamp the dies the hydraulic power pack increases the oil pressure in the rohemheld cylinder fixed at the front of top & bottom dies.

The swing clamp of this rohemheld cylinder is then clamping the dies mounted in a cassette at a hydraulic pressure of 350bar. This pressure is necessary and calculated to clamp the dies on 1000Tone forging press

Similarly when operator has to de-clamp the dies. He or she presses the button on electric panel. As soon as the operator presses the button the pressure in hydraulic cylinder is dropped and clamp release the dies.

2. CALCULATION

2.1 Bottom & Top Dies Holder:

Due to impact loading stress is generating in bottom die holder

To calculate stress caused by impact loading we have formulae

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To calculate stress caused by impact loading we have formula,

$\partial max = \frac{P}{A} + \sqrt{(\frac{P}{A})^2 + \frac{2EPh}{AL}}$

Where,

P= Load falling down N/mm^2

A= Cross sectional area mm^2

E= Young's Modulus of material N/mm^2

h= Height from object fall mm

Given:

P = $9806.65 * 10^3\ N/mm^2$

A = L*W
= 1200*800
= 960000

E = 205Gpa

h = 250 mm

Material Used = Din 2714

$$\partial max = \frac{9806.65 * 10^3}{960000} + \sqrt{\left(\frac{9806.65 * 10^3}{960000}\right)^2 + \frac{(2 * 205 * 9806.65 * 10^3 * 250)}{(960000 * 1200)}}$$

$$\partial max = 10.21 + \sqrt{10.21^2 + 872.55}$$

$$\partial max = 10.21 + \sqrt{104.24 + 872.55}$$

$$\partial max = 10.21 + 31.25$$

$$\boldsymbol{\partial max = 41.46\ N/mm^2}$$

Factor of Safety = $\frac{Ultimate\ stress}{Working\ Stress}$

= $\frac{1270}{41.46}$

FOS = 30.63

Hence design of bottom die holder as well as top die holder is safe.

2.2 Bottom Cassete & Top Cassete:

Due to impact loading crushing stress is generating in bottom die holder.

To calculate stress in cassete due to impact loading.

∂max =

$$\frac{P}{A} + \sqrt{(\frac{P}{A})^2 + \frac{2EPh}{AL}}$$

Given

P = $9806.65 * 10^3\ N/mm^2$

A = 860*400
= 344000mm^2

E = 205Gpa

h = 250mm

$$\partial max = \frac{9806.65 * 10^3}{344000} + \sqrt{\left(\frac{9806.65 * 10^3}{344000}\right)^2 + \frac{(2 * 205 * 9806.65 * 10^3 * 250)}{(344000 * 860)}}$$

$$\partial max = 28.50 + \sqrt{(28.50)^2 + 3397.72}$$

$$\partial max = 28.50 + \sqrt{812.25 + 3397.72}$$

$$\partial max = 28.50 + 64.88$$

$$\boldsymbol{\partial max = 93.38\ N/mm^2}$$

Factor of Safety = $\frac{Ultimate\ stress}{Working\ Stress}$

= $\frac{1270}{93.38}$

FOS = 13.60

Hence cassete for top and bottom is safe.

2.3 Bottom Dies & Top Dies:

$\partial max = \frac{P}{A} + \sqrt{(\frac{P}{A})^2 + \frac{2EPh}{AL}}$

Given material = H11

P = $9806.65 * 10^3 \; N/mm^2$

A = 400*200
= $80000 mm^2$

E = 190Gpa

h = 250mm

$$\partial max = \frac{9806.65 * 10^3}{80000} + \sqrt{\left(\frac{9806.65 * 10^3}{80000}\right)^2 + \frac{(2 * 190 * 9806.65 * 10^3 * 250)}{(80000 * 400)}}$$

$$\partial max = 122.58 + \sqrt{(122.58)^2 + 29113.49}$$

$$\partial max = 122.58 + \sqrt{15025.85 + 29113.49}$$

$$\partial max = 122.58 + \sqrt{44139.34}$$

$$\partial max = 122.58 + 210.09$$

$$\boldsymbol{\partial max = 332.67 \; N/mm^2}$$

Factor of Safety = $\frac{Ultimate\ stress}{Working\ Stress}$

$= \frac{1190}{332.67}$

FOS = 3.57

Hence die design is safe for both top and bottom die.

3. CONCLUSIONS

In this study, die holder designed to suit hydraulic die clamping system which reduces idle time of the forging press has been designed, produced and tested. The die changing and adjustment operations with the proposed modular die system have been much simpler, much quicker and more systematic than the old changeover methods. The current problems encountered during die changing. In this thesis, applicability of SMED System to 1000 ton forging press has been studied.

The internal die changing times, which are the unproductive times of the press, were generally 2 hours (130 minutes) by the old system. In the time study for the particular case, the total time spent for internal die changing operations was 130 minutes by the system of the company. It has been reduced to 40 minutes by the new system. A saving of 90 minutes has been obtained. Therefore the reduction is 70 %.

Table -2: Die Setup Time for Hydraulic Clamping

Operation No.	Operation	press	Time in Min.
1	Dis-Mounting Previous Die-Set	Off	05
2	Mounting New Die-Set	Off	05
3	Heating Dies	Off	30
4	Total=		40

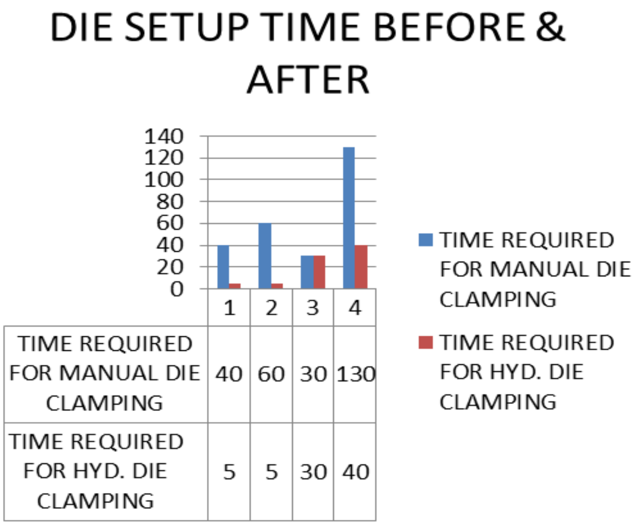

Chart-1: Die Setup time comparison for manual & Proposed System

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