

# **Rectification of Various Problems Associated with Hot Forging Dies (Edger, Blocker & Finisher) for Connecting Rod Forging Using DEFORM Software**

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**ABSTRACT:** This paper is an attempt to understand simulation and analysis of Connecting rod hot forging dies (Edger, Blocker & Finisher) and rectification of various problems in manufacturing of connecting rod forgings for Zero based rejections and controlling raw material wastage.

In design of a product solving of existing process problems is an important role. Product design is periodically modify to improve product performance to take advantage of the characteristics of raw material to make the products easier to manufacturing and strive for Zero based rejection and wastage. Because of the very wide variety material and manufacturing process available today.

Initially explained existing design of connecting rod forging dies using DEFORM software, then dies modified considering existing problems also explained using DEFORM Software. Explained modified design of forging dies, also compared loads, stresses and product quality with existing design

**KEYWORDS:** Connecting Rod Forging, DEFORM Software, Edger Operation, Blocker operation, Finisher operation, Chokes, Flash.

## **I.INTRODUCTION**

Forging is the name for process whereby the work piece is shaped by compressive force applied through various dies and tools. It is one of the oldest metalworking operations, dating back at least to 400B.C and, perhaps, as far back as 800 B.C forging was first used to make jewelry, coins, and various implement by hammering metal with tools made of stone. Simple forging can be done with a heavy hand hammer and an anvil, as traditionally done by black smiths.

Forging may be done at room temperature (cold forging) or at elevated temperature (hot forging depending on temperature). Because of the higher strength of material, cold forging requires greater forces, and the work piece materials must have sufficient ductility at room temperature. Cold - forged parts have good surface finish and dimensional accuracy. Hot forged requires smaller forces, but dimensional accuracy and surface finish are as not good. Forging generally required of additional finishing operations, Such as heat treating to modify properties and machine for accurate finished dimensions.

A component that may be forged successfully may also be manufactured economically by other methods, such as casting, machine or powder metallurgy. However, as you might expect, each process will produce a part having different characterizes and limitations, particularly with regard strength, toughness, dimensional accuracy, surface finish, and internal and external defects.

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## II. METHODOLOGY

- Extensive study is carried out to understand the die design
- Die 3D modeling for various values of parameters using solid works software.
- Export the model to STL format, which is used to analyze the design using Deform-3D.
- Simulate the model to study the metal flow.
- Modified die design for rectifying various die problems

**Important Dimensions of the connecting rod forging are given below**

Draft angle:	7.5 degrees
Small end thickness:	28.4 mm (+0.5, -0.0)
Big end thickness:	28.4 mm (+0.5, -0.0)
I section thickness:	16.3 mm (+0.3, -0.3)
Web thickness:	6.3 mm (+0.3, -0.3)
Big end width:	78.7 mm (+1.2, -0.6)
Small end diameter:	32.0 mm (+0.5, -0.0)
Centre distance:	137.0 mm (+0.5, -0.0)

Initially we draw the model of component by using “Solid works” software and get the following dimensions.

Volume of forging:	133758 mm cube
Plan area of forging:	8928.37 mm square
Length of forging:	200.8 mm.
Perimeter of forging:	530.461 mm
Weight of forging:	1.05 kg

Average width of component taken in three areas and decided diameter of raw material is “ø 45mm” and length of component depend on the volume of the component and volume of the flash.

Volume of the raw material = volume of the component + volume of the flash

Average width of material = 46.4 mm

Diameter of material = 45mm.

Length of material = 140.0 mm.

By using the above dimensions the die is designed in solid works and analyzed by using DEFORM software. For manufacturing a connecting rod by using forging operation a billet of circular cross section is taken. the dimensions of billet are 140×45 mm is taken (The arrangement of billet shown in fig1). The billet is placed in blocker die first and generated a load of 555 N and it is followed by finisher die operation where the load 800N, then it followed by piercing operation. The following problems were found in the existing design and manufacturing process and the dies modified to avoid those problems are discussed below

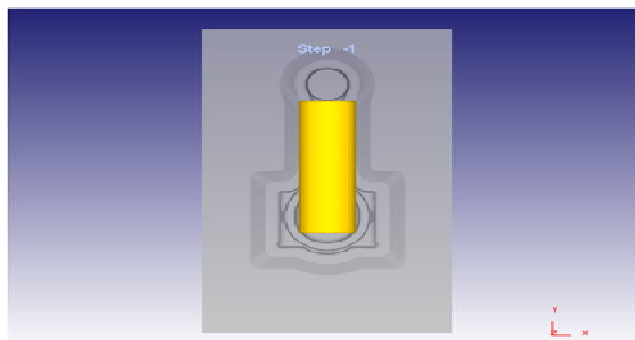


Fig1.Arrangement of billet on Die

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The Figure 1 shows the arrangement of billet inside the die before forging operation

### III.RESULTS &DISCUSSION

1) **Existing problem:** Finisher load is more than Blocker load as shown in fig2&3, so finisher dies may be damage and final finisher dimensions may be varied due to heavy load in finisher than blocker.

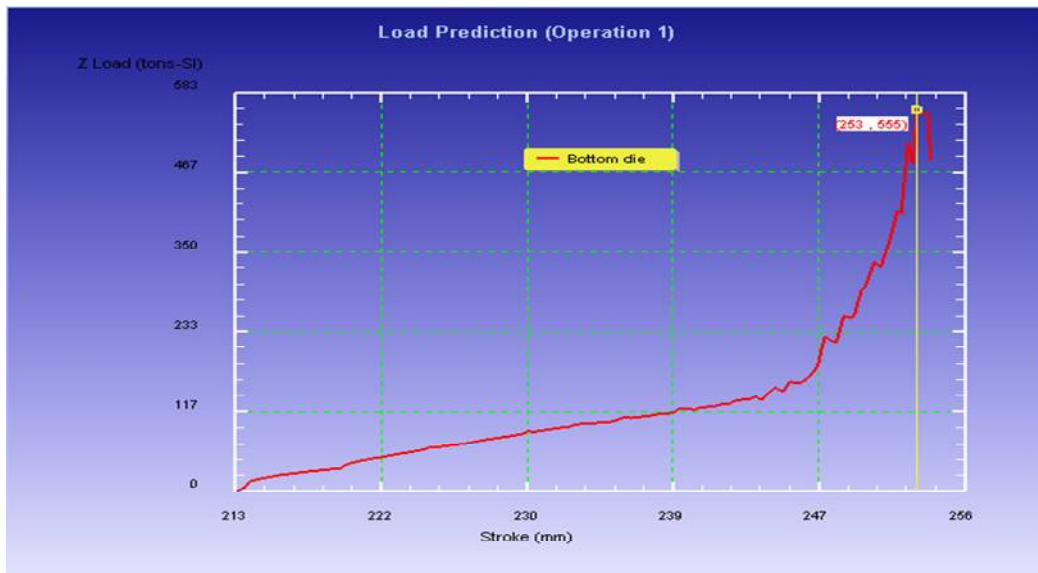


Fig2.Blocker graph, load Vs stroke length

Fig 2 shows the blocker load of the existing process which is at range of 570 tons at a 249stroke length. In blocker dies chokes provided as shown in fig4&5 .In blocker bottom die choke height projection provided and corresponding cavity is provided in to the die

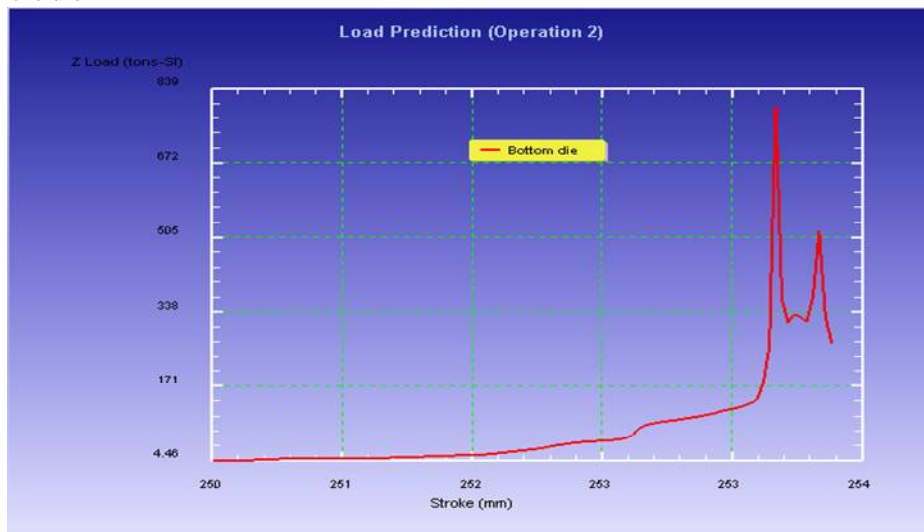


Fig3.Finisher graph, load Vs stroke length

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Fig 3 shows the finisher load of the existing process which is at range of 683 tons at a 253stroke length, which is very high value and undesirable. **Action taken:** In blocker dies chokes provided as shown in fig4&5. In blocker bottom die choke height projection provided and corresponding cavity is provided in to the die

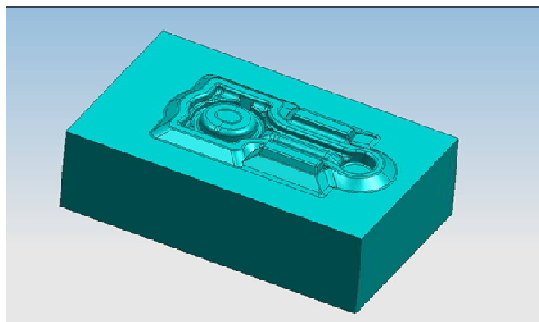


Fig4. Modified Blocker bottom Die

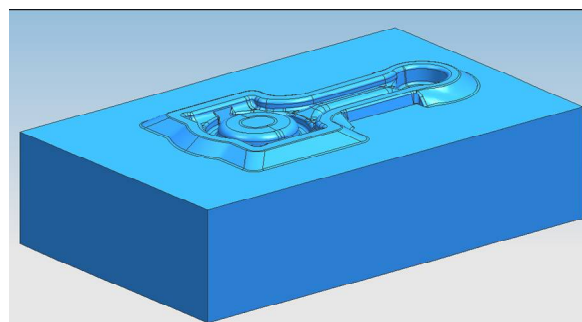


Fig5. Modified Blocker top Die

Blocker die load increased and Finisher dies load reduced from 800tons to 415 tons. As shown in graph fig6&7.in blocker load increased due to chokes. Chokes stopped material and avoided underfilling problem in finisher and also load reduced in finisher die

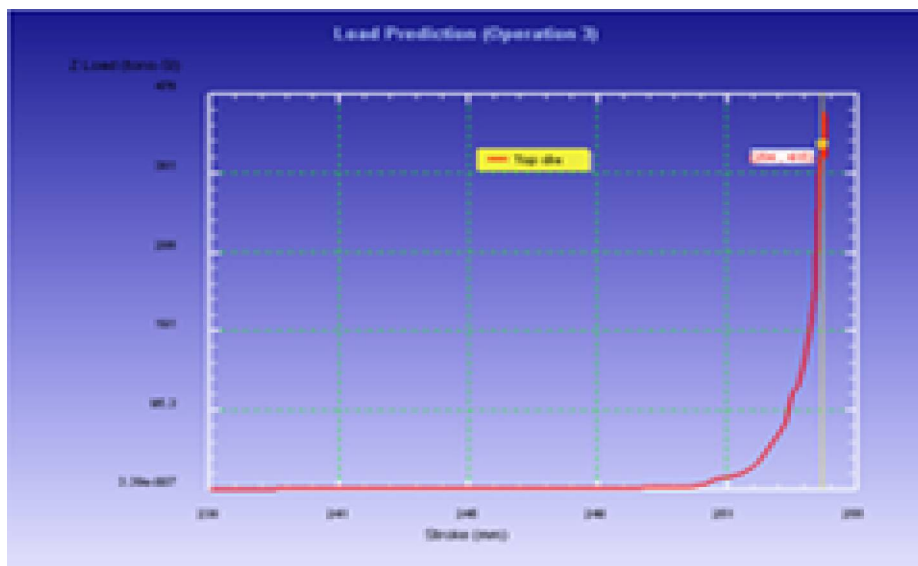


Fig6. Modified blocker dies graph, load Vs Stroke length

Fig 6 shows the blocker load of the modified process which is at range of 693 tons at a 249stroke length in blocker load increased due to chokes. Chokes stopped material and avoided underfilling problem in finisher and also load reduced in finisher die

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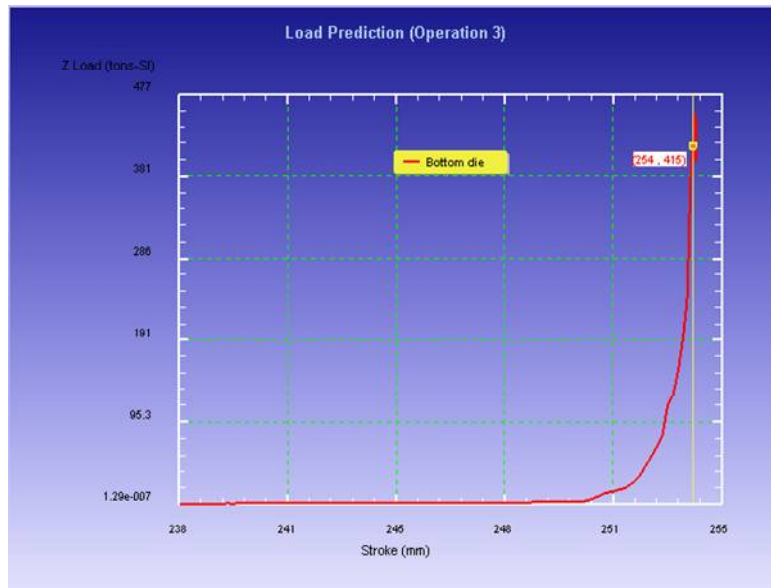


Fig7. Modified Finisher graph,load Vs Stroke length

Fig 7 shows the Finisher load of the modified process which is at range of 440 tons at a 253stroke length in blocker load increased due to chokes. Chokes stopped material and avoided underfilling problem in finisher and also load reduced in finisher die

**2) Existing problem:** Under filling problem in finisher & blocker dies (Connecting rod small end area observing less flash volume) as shown in fig8&9

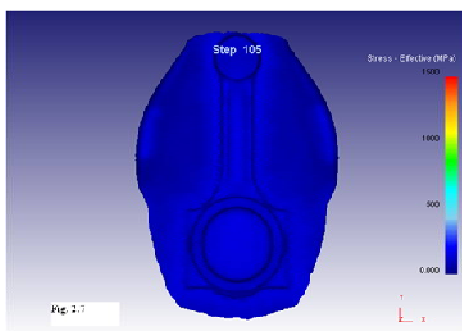


Fig 8. Blocker Forging

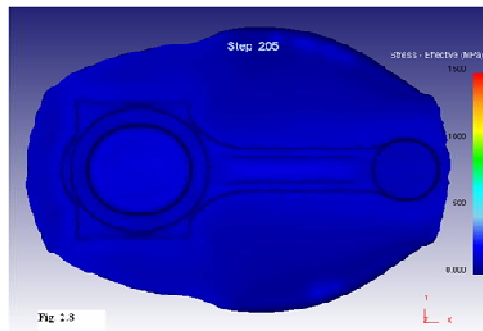


Fig 9. Finisher Forging

**Action taken:** Before the Blocker operation “Edger” operation arranged as shown in fig10&11, blocker under filling problem solved. And also blocker dies chokes provided as shown in fig 12so Blocker under filling problem solved as shown in fig12 and finisher under filling problem solved

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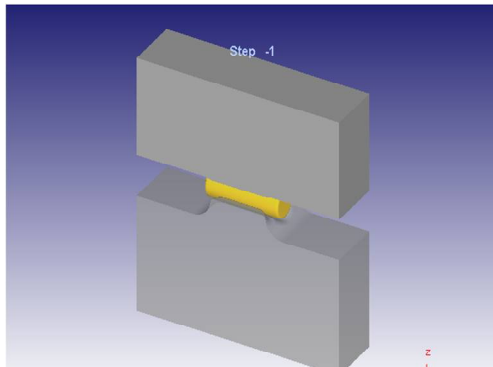


Fig10. Edger operation

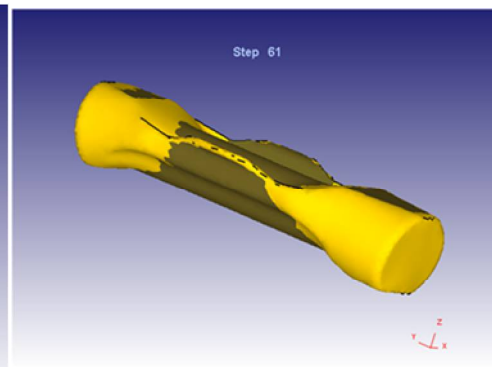


Fig11. Eger Forging

Fig 10&11 shows the die arrangement and billet shape after the first operation of forging process .the heated billet placed in blocker dies to get perform shape of connecting rod forging

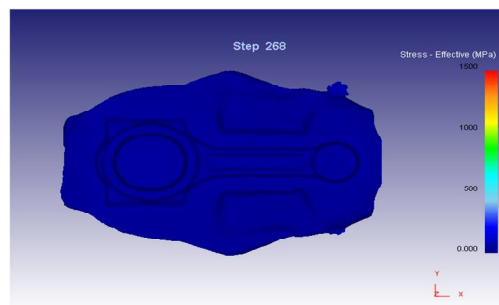


Fig12. Modified Blocker Forging

Fig 12 shows the modified blocker die and which was analyzed by DEFORM Software the results shows that the die is with the safe limits

**3) Existing problem:** More raw material wastage as a flash. (Section  $\phi 45 \times 140$  mm)

Volume of raw material = 222.660 cubic cm (100%), Weight of material = 1.75 kg

Volume of component = 133.758 cubic cm (60%), Weight of component = 1.05 kg

Volume of flash = 88.902 cubic cm (40%), Weight of flash = 700 grams

**Action taken:** Developing of edger and blocker dies so raw material section used  $\phi 45 \times 126$ mm.

Volume of the material = 200.394 cubic cm (100%), Weight of material = 1.55 kg.

Volume of component = 133.758 cubic cm (67%), Weight of component = 1.05 kg

Volume of the flash = 66.636 cubic cm (33%), Weight of the flash = 400 grams

200 grams flash controlled in each piece, and also forging defects eliminated in all components.

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S.NO	PARAMETER	EXISTING RESULTS	NEW DESIGN RESULTS
1	Raw material section	Ø45 × 140 length	Ø45 × 126 length
2	Weight of the raw material	1.75 kg	1.55 kg
3	Volume of raw material	222.660 cm cube	200.394 cm cube
4	Volume of the flash	88.902 cm cube	66.636 cm cube
5	Edger dies load	--	125 tons
6	Blocker dies load	555 tons	693 tons
7	Finisher dies load	800 tons	415 tons

## IV.CONCLUSION

The design and manufacturing of connecting rod forging is successfully completed. The solid modeling and drafting of the dies and component are done by using UNIGRAPHICS, AUTOCAD software.

The dies have been constructed as per design parameters and considering existing problems. Initially all the existing problems and rectification of problems have been seen by using “DEFORM software”.

Product qualities are follows:

- Finisher Load reduced to 415 tons
- Material wastage is reduced by employing the chokes in blocker dies and introducing edging operation before blocker

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