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Forging Die Design for Gear Blank

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Abstract - *Forging is one of the most adopted manufacturing processes, in which raw material is plastically deformed in to desired shape and size of component. The majority of the crucial load bearing structure component as well as safety critical item are processed through forging process. This is mainly due to the strength and dimensional accuracy of component can be achieved in forging process. Faster production of complex shapes with the less wastages of material can be manufacture with the help of forging process. This benefit cannot be achieved by any other manufacturing process.*
The maximum strength of component can be achieved by forging process. Especially components used in automobile section are manufactured by the forging process. Components such as shafts, connecting rod, and planetary gear blank

Key Words: Hot close die forging, Planetary gear, Auto CAD, 3D modelling, Manufacturing.

1. INTRODUCTION

1.1 Project Idea

Nowadays forged components are commonly found at points of shock and stress such as wheel spindles, kingpins, axle beams and shafts, planetary gear blank, etc. So it is needed to manufacture different forging dies for different components. We are manufacturing forging die for planetary gear blank with the help of CAD/CAM software.

1.2 Forging

It is defined as a metal working process by which metal or alloy are plastically deformed to the desired shape by a compressive force applied with the pair of dies. One die stationary and to other has in motion.

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Among all manufacturing processes, forging can be considered as one of the most adopted metal forming process. The properties generated in the product by the process, such as acceptable dimensional accuracy, higher strength to weight ratio, superior micro structure etc., make the forging process attractive. Other attributes such as faster processing and low material wastage, push down the cost of production of complex shaped parts. The application of forged parts, include most of the engineering sectors including automotive. The automotive sector is a major user of mass produced precision forging components. Their primary aims, is to manufacture reliable vehicles that can support load carrying at relatively higher speed; simultaneously should be lighter in construction to support fuel economy.

2. LITERATURE SURVEY

"Forging Die Design and Simulation", Nilkanth Velhal; IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 2, Issue 6, Dec-Jan, 2015
In this study he had designed connecting rod on CAD software and simulated it on software. It results to determine defect in die and also failure of the die manufacturing and thus reduced the financial loss. [4]

"Perform Design For Near Net Shape Close Die Gear Forging Using Simulation Technique",Mohommad Haider, K.KPathak; Archives of Applied Science Research, 2010, 2 (6):317-324
In this study they have made the design to perform for near net shape upsetting of gear forging using simulation techniques which is based on the filling of the material during closed die forging. They have tried various perform. Using this parametric study, best die and process parameters are suggested for near net shape gear forging. [3]

"Analysis Of Process Parameters Towards Improving Efficiency Of Closed Die Hot Forging Process". M.Mercy Lydia Joshua, T.L Rakesh Babu. International Journal of Engineering Research vol.3, 2015
They had studied a sample case a real life automotive driveline component, a flange yoke, which is taken for investigation. A simulation-driven approach using a commercial package (DEFORM), based on finite element method, was adopted. Trials were conducted using an industrial press, data generated were validated against those predicted. The correlation was found to be satisfactory. This would lead to an improvement in overall efficiency of the process at a lower cost. [2]
"Designing a Forging Die to Improve Productivity in Forged Front Axle",Amar H.Mane R.K.Kawade; IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 06, 2015.

They have studied under fill which occurs in die cavity of front axial beam due to improper ventilation, sticking and dies wear out problem. It can be easily visualize and measure with the help of gauge. The presence of under fill will scrap the job. This is one of the different methods for correcting under fill problem of front axle beam with the help of up setter die. They are designing a new die for rework of forged front axle beam on up setter machine, which is different than forging die of front axle beam. [5]

3. PROBLEM DEFINITION AND OBJECTIVE

3.1 Problem Statement

The planetary gear blank is used to transmit the high power. According to its function it requires more strength. Forging component has more strength than casting components. It is needed to manufacture a forging die for producing those component.

3.2 Objective

To manufacture a forging die for planetary gear blank with better accuracy by using CAD/CAM software like creo, feature cam.

4. METHODOLOGY

The broad objective of this chapter is to deal with some of the design guidelines, appropriate to the intended component, including die design, so that the prerequisite steps can be performed for the analysis of the process. The manufacturing route for the component is finalized as closed die hot forging based on the complexity of the geometry, tolerance requirement for the component, the extent of deformation required to form the shape, and mass production requirement of the component. The project consists of steps from design to manufacturing. The involved design phase can be broadly divided into two stages: Product Design Stage and Die Design Stage.

4.1 Product Design Stage

The engineering design team finalize the geometry, dimension, tolerance and material requirement for the final component. This is based on intended application in service, including the desired performance characteristic for the particular part. The typical output is a machine drawing of the final required part which includes post forging operations such as machining, tolerance and surface finish requirements.

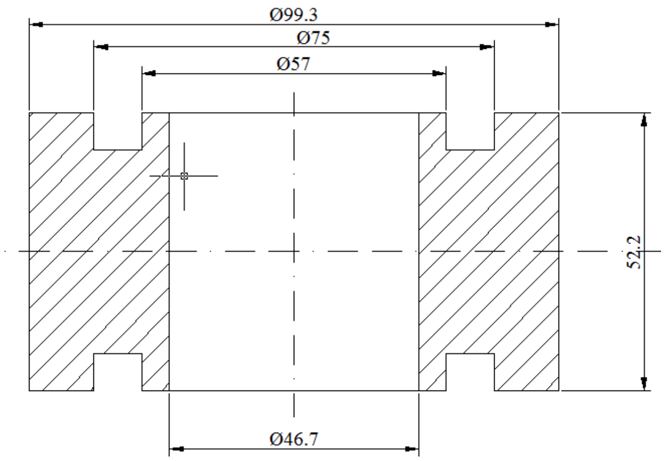

Fig -1: Machining Drawing

4.2 Determination of Stock/Billet Size

1. Part Weight

Weight = volume x density

Volume =

$V1 = \pi/4 \times [(99.3)^2-(46.7)^2] \times 52.2$

$= 314846.589\ mm^3$

$V2 = \pi/4 \times [(75)^2-(57)^2] \times 7$

$=13062.742 \times 2$

$=26125.48\ mm^3$

Total volume = v1-v2

$V = 288721.1\ mm^3$

$V = 288.72\ cm^3$

Density = 7.81 gm./cm^3

Weight = 288.72 x 7.81

= 2254.90 gm.

= 2.254 kg

≈ 3 kg

According to thumb rule,

01-03 kg → 1 Ton hammer

04-10 kg → 2 Ton hammer

2. Raw Material Size –

According to buckling ratio,

Buckling ratio = (R) = length/diameter

= 2.5 max

Consider,

Φ 65 mm = 6.5 cm

Weight = Area x length x density

Area = $\pi/4 \times D^2$

$= \pi/4 \times 6.5^2$

$=33.1830\ cm^2$

3000 = 33.1830 x L x 7.81

L = 3000/259.15

= 11.57 cm ≈ 11.6 cm

= 116 mm

R = 116/65

= 1.78

Φ70 mm = 7 cm

Area = 38.4845 cm^2

3000 = 38.4845 x L x 7.81
L = 3000/300.56
= 9.9812 cm ≈ 10 cm
= 100 mm
R = 100/70
= 1.42

4.2Die Design Stage

There are no fixed rules for designing the dies for forging. The design method adopted is majorly dependent on the geometry of component and the processing conditions. There are, however, a set of recommended guidelines and principles for design, which can be adopted based on a particular situation. They are mostly empirical, and are developed from years of practical experience.

1. Determination of Parting line

A parting plane is the in plane in which the two die halve of the forging meet. It could be a simple or irregular bent, depending on the shape of forging. The choice of proper parting plane greatly influences the cost of the die of the die as well as the grain flow in the forging.

2. Incorporating the Draft Angle in Design

Draft refers to the taper generated in the internal and external sides of a closed die forging to facilitate easy removal of components from the die cavity. The draft angle value is decided as 30 for external 50 for internal surface.

3. Design Considerations for Fillet and Corner Radii

Design of fillet and corner radii affect grain flow, forging load, die wear, grain flow and the amount of metal to be removed during machining. All possible sharp corners must be avoided in forging design as they tend to weaken both the dies and finished forgings.

4. Flash and Gutter Design

Flash refers to the excess metal normally attached at the periphery of the workpiece that is subsequently trimmed in a separate die.

Flash Calculation:

Flash Thickness (T) = 0.015 $(A)^{1/2}$ To 0.018 $(A)^{1/2}$
Where, A = Plan Area of Forging
D = Diameter of Plan Area

Flash Width (W) = $63t/D^{1/2}$

Plan Area of Component (A) =$\pi/4$ X $(D)^2$
A = $\pi/4$ X (99.3)2
=7744.41
D = $(4A/\pi)^{1/2}$
= 99.3
T = 2 mm
W =10 mm

Gutter Calculation:
Tg = 4 X T
= 8 mm
Wg = 3 X W
= 30 mm

5.Shrinkage allowance

The forging are generally made at a temperature of 1150^0c to 1300^0C. At this temperature, the material gets expanded and when it is cooled to the atmospheric temperature, it dimension would reduce. Therefore to precisely control the dimension, a shrinkage allowance is added.

6.CAD Drawing of Die

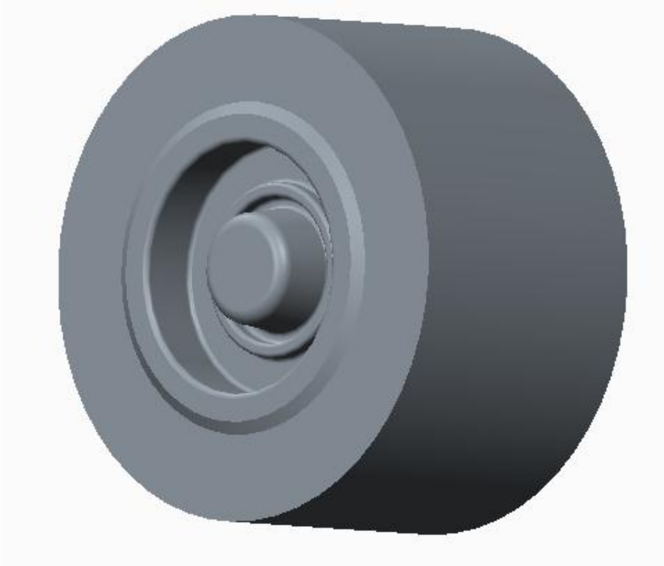

Fig -2: 3D CAD Model

5. CONCLUSION

We have manufacture a forging die for planetary gear blank by using [IS 3469] standard table with better accuracy with the help of tables, design parameters can be controlled such as draft angle, fillet , corner radius and allowances etc. Because of this the forging components can be easily removed from forging die. Also the grain flow is better so strength obtained is more.

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