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Optimization of the Process Parameters of Forging of Pitman Arm

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ABSTRACT*:Closed die hot forging process is one of the most adopted methods for forming complex shaped parts with satisfactory geometrical accuracy. Over sixty percent of the forgings are processed through this route. Forged parts, though required in many engineering sectors, play a vital role in the automotive sector. The majority of the crucial load bearing structural components as well as safety critical items are processed via the forging route. This is mainly due to the inherent strength to weight ratio and dimensional accuracy that can be combined into the components. Faster production of complex shapes with least wastage of material are some of the other benefits.*

The metal flow analysis of the process is complex due to the involvement of a large number of parameters. A number of experimental testing and production-trials are being done in the industry in order to develop a robust manufacturing process. Such practices however involve huge investments in tooling and raw materials, including a great deal of development time and effort. In recent decades, finite element method has emerged as a suitable tool for virtual process trials and simulation-based design. This would lead to an improvement in overall efficiency of the process at a lower cost.

In the present work, an attempt is made to design the finisher dies for forging PITMAN ARM and study the effects of forging and die parameters. Conventional method is used to design the finisher die. 3D-FEM (finite element method) simulations are carried out to study the effects of flash thickness, draft angle, billet temperature, die temperature and coefficient of friction on forging load, effective stress, effective strain, effective strain rate in finished product.

KEYWORDS*:Pitman Arm, Closed die forging, DEFORM 3D, Optimization, Process Parameter, Yield.*

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I. Introduction

Forging can be defined as a controlled plastic deformation of metal at elevated temperature into a predetermined size or shape using compressive force exerted through some type of die by hammer, press or an upsetting machine. Forging is one of the bulk metals forming process, involving the interactions between material behavior forging equipment, tooling, lubrication and other process conditions.

Forging leads to improvement in mechanical properties through controlled plastic deformation under impact or pressure. Forging permits the structure of metal to be refined and controlled to provide improved mechanical properties.

The present work has been undertaken with a view to optimize the material utilization in forging process of Pitman Arm. In this project, an attempt has been made to simulate a pitman arm forging process using DEFORM-3D. Different simulation trails were done to improve the yield of the forged component. The developed models are imported in the DEFORM software and analysis of each trail was done to optimize the yield.

The pitman arm is a linkage attached to steering box sector shaft, which converts the angular motion of the sector shaft into the linear motion, needed to steer the wheels. The pitman arm is supported by the sector shaft and supports the drag link or centre link with a ball joint. It transmits the motion receives from the steering box into the drag (or centre) link, causing it to move left or right to turn the wheels in the appropriate direction. The pitman arm is a steering component in an automobile or truck.

1.2. CLASSIFICATION OF FORGING PROCESSES

There are various classifications for the forging process. In general, forging processes can be classified as:

1.2.1. Based on Temperature:

a) Hot Forging: Forging is done above recrystallization temperature i.e., above 0.6 Tm, where Tm is melting temperature.

b) Warm Forging: Forging is done between 0.3 Tm to 0.6 Tm.

c) Cold Forging: Forging is carried out below 0.3 Tm.

1.2.2. Based on Die Shape:

a) Open Die Forging: Open-die forging gets its name from the fact that the dies do not enclose the work piece, allowing it to flow except where contacted by the dies. In this, the work piece is compressed between two platens. There is no constraint to material flow in lateral direction.

b) Closed Die Forging: CLOSED-DIE FORGING, or impression-die forging, is the shaping of hot metal completely within the walls or cavities of two dies that come together to enclose the workpiece on all sides. The impression for the forging can be entirely in either die or can be between the top and bottom dies.

The force required for the deformation of the billet can be applied by mechanical press, drop hammer etc., causing the metal to flow and fill the die cavities. Excess metal is squeezed out of the die cavities'; forming what is referred to as "flash". The flash cools more rapidly than the rest of the material; this cool metal is stronger than the metal in the die, so it helps prevent more flash from forming.

This also forces the metal to completely fill the die cavity. After forging, the flash is removed.

1.3. Advantage of Forging

Various advantages of forging are:

- **Direction strength**
- **Structural integrity**
- **Impact strength**
- **Uniformity**

II. Methodology

2.1.Steps:

2.1.1 Selection of Component:

First the component is selected.

2.1.2. Preparation of 3D Modeling of Component:

The preparation of CAD or 3D modeling of selected component is done by using CATIA V5R19 software.

2.1.3. Preparation of Forging Drawing:

Forging drawing is prepared by adding various allowances to the component drawing. The different allowances are machining allowances, contraction allowance etc.

2.1.4. Selection of Equipment:

Depending upon the complexity of the component and availability, suitable equipment is selected.

2.1.5. Design of Dies:

The modeling of the forging drawing and dies are done in CATIA. In case of closed die forging, the production of particular component from the product design, following steps have to be taken.

a) Determination of parting plane and the axis in the product design is the factor that reflects the design skill. So the first thing is to select a suitable parting plane.

b) The next step is to give the required draft angle. If the shape of the job facilitates the use of natural draft, it will be better. Otherwise the required draft has to be found out from the chart.

c) The next step is to give the required fillet and corner radii, sharp corner radii must be avoided as they weaken both the dies and finished forgings.

d) Next step is to work out the flash and gutter design, based on hammer, press or up-setters etc.

e) Now visualize the number of steps to reach the final finishing impression and have to make drawing of product for each of these steps. These sequences are fullering, edging, blocking and finally finishing.

2.1.6. Optimization of Parameters:

Optimization of parameters is done by simulating the billet in DEFORM 3D. Different parameters like material of billet, proper die filling, forging temperature, friction factor and lubricant.

2.2. DIE DESIGN

Designing a mechanical component is essentially the process of giving shape to a component needed for performing certain useful function. In designing with metal there are alternative materials and processes, which can be used to meet the requirements. It is the designer tasks to find that single combination of material and process, which optimizes the factors of configuration, properties and costs. Forging provide the best answer to a growing list of design applications. Forging die design is influenced by the nature of metal being processed and the capabilities, and the available technology. Die cost is 15 to 20% of total cost. So, design should be economical and safe to both consumer and also producer. The materials having high forgeability, the design limits are often quite narrow. The knowledge of the material behavior is essential to the designer in planning the design of the forged parts.

2.3. TAGUCHI METHOD

The Taguchi method involves reducing the variation in a process through robust design of experiments. The overall objective of the method is to produce high quality product at low cost to the manufacturer. The Taguchi method was developed by Dr. Genichi Taguchi of Japan who mentioned that variation. Taguchi developed a method for designing experiments to investigate how different parameters affect the mean and variance of process performance characteristics that defines how well the process is functioning. The experimental design proposed by Taguchi involves using orthogonal arrays to organize the parameters affecting the process and the levels at which they should be varies.

2.3.1. Steps in Taguchi Method

Step-1: Identify the main function, side effects, and failure mode
Step-2: Identify the noise factors, testing conditions, and quality characteristics
Step-3: Identify the objective function to be optimized
Step-4: Identify the control factors and their levels
Step-5: Select the orthogonal array matrix experiment
Step-6: Conduct the matrix experiment
Step-7: Analyse the data, predict the optimum levels and performance
Step- 8: Perform the verification experiment

Bigger-the-better	$\frac{\mathrm{S}}{\mathrm{N(bigger)}} = -10 \log[\frac{\in (\frac{1}{\mathrm{yi}^2})}{\mathrm{n}}]$
Smaller-the-better	$\frac{\mathrm{S}}{\mathrm{N(smaller)}} = -10 \log[\frac{\in (\mathrm{y}^2)}{\mathrm{n}}]$
Nominal-is-best	$\frac{\mathrm{S}}{\mathrm{N(nominal)}} = -10 \log[\frac{\mathrm{Y}^2}{\mathrm{S}^2}]$

Where,
n= number of tests in a trail number.
$y_{i=}$ response value for trail condition repeated n times.

III. Experimental Work

3.1. Job Selection:.
The forging drawing is developed from machining drawing by adding machining allowance, draft allowance etc.

3.2. Product Design
Product design include design of forging drawing and the selection of proper parting line, the machining drawing is converted to forging drawing and by adding allowances to each dimension. Considering the tolerance required as mention in die design principles.

3.2.1.Parting line selection: Considering all consideration mention in literature review and using past experience of designer, parting line is selected as straight line along central line due to the symmetry of component.

3.2.2.Finishing Allowance: Addition of material in terms of dimensions. Finish allowance taken care of scale, shrinkage and machining loss. Finishing allowance is taken as 1.5mm per 200mm of surface.

3.2.3. Fillet radii and Corner radii: Sharp edge and corner are difficult to maintain in forging since sharp impression in die leads to premature failure of die due to stress cracks and erosion at high temperature. Based upon forging weight, depth of cavity and material used different levels of fillet and corner radii from 3 to 10 mm have been taken in this project work.

3.2.4.Draft Angles: Draft angles are used for easy release of forging from the die. Taking in consideration, all past data the draft angles are taken as, 5^{o} and 3^{o} internal and external draft respectively.
The model of Pitman Arm was generated in CATIA V5R19 and it is shown in Fig.4.1

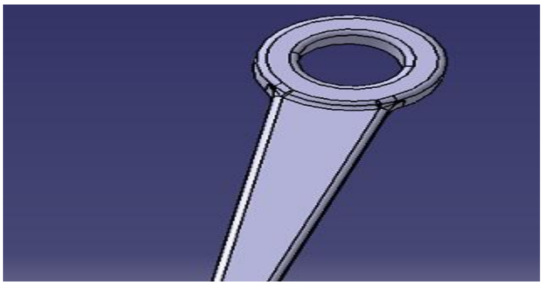
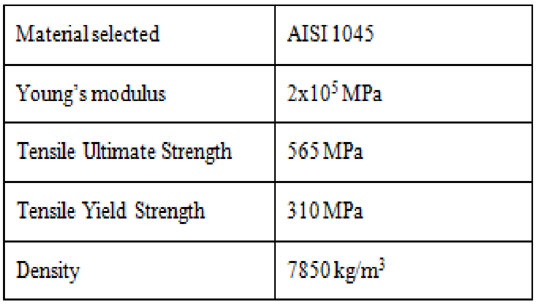
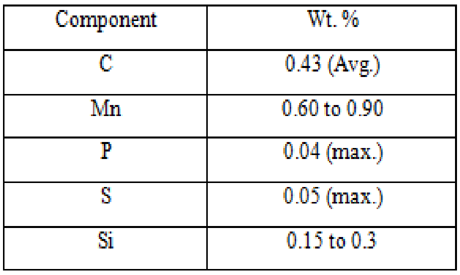


Figure.3.1: CATIA Model of Component Drawing

Table 3.1: Material Properties of Pitman Arm **Table 3.2:** Composition of material of billet



Material selected	AISI 1045
Young's modulus	$2x10^5$ MPa
Tensile Ultimate Strength	565 MPa
Tensile Yield Strength	310 MPa
Density	$7850 kg/m^3$



Component	Wt. %
C	0.43 (Avg.)
Mn	0.60 to 0.90
P	0.04 (max.)
S	0.05 (max.)
Si	0.15 to 0.3

4.2.5. Design of Flash:

As mentionin literature review flash thickness is important design parameters, the levels of flash thickness has been considered by the calculation of the conventional method of the forging process. This is given in Table 4.3.

Table 3.3: Design of flash thickness [20]

Author	Flash thickness
Bruchanov&Rebelskii	$t= 0.015\sqrt{A}$
Thomas	$t= 0.016D$
Vieregge	$t= 0.017\,D + 1/\sqrt{(D + 5)}$
Neuberger &Mockel	$t= 0.89\sqrt{W} - 0.017W + 1.13$
Teterin&Tarnovski	$t = 2\sqrt[3]{W} - 0.001W - 0.009$

Flash thickness is designed based on Neuberger &Mockel formula which gives flash thickness as:
As per CATIA,The weight of the component is found to be 0.367 Kg.
Flash Thickness $t = 0.89\sqrt{W} - 0.017W + 1.13$

$$t = 0.5391 - 0.017 \times 0.367 + 1.13$$

$$t = 1.66 = 1.6mm$$

Flash thickness is taken as 1.6 mm for the experiment.
Flash Width (b): On the basis of flash thickness, b/t = 4.5, gives the width of flash land.
Flash width is taken as 7.2mm.
Now on the basis of flash thickness and flash width, gutter thickness is taken as 4.8 mm and gutter width 21 mm.

3.3.6. Design of Preform Impression:

Preform design before the finishing operation may not be necessary and economical in case of forging components of simple shapes however, if the component has varied cross section as in case of spanner, brake pedal lever, connecting rod etc., it is necessary to reduce or increase cross sectional area of the bar at desired points with a view to improve die life and it also greatly influences the economies of the forging process.
The following procedure is used to design preform impression form the forging drawing.

- The plan and the side view of forging are laid out to full scale.
- An estimated outline of the flash of the forging preside is than laid out.
- The forging is than dived into various elements based on the geometric shape.
- Horizontal line is drawn through largest and smallest cross sectional area of each element found as above.
- The area of the above cross section is calculated and to each such area, cross sectional area of flash land is added (flash width× flash thickness).

- From the base line of the above measurement are plotted and connected with smooth line, then the cross sectional area of preform at each line is determined.
- Than the diameter "D" of the preform is evaluated at each element using the formula

$$D = \sqrt{\frac{(4\times A)}{\pi}}$$

Where D = equivalent diameter

A= total area (flash area + cross sectional area)

Thereafter, the dimension D is symmetrically plotted about the reference line. These points are finally connected with a smooth curve. [2] Using above mention steps the preform of the forging is designed as shown in Table 4.4.

Table 3.4: Design of preform calculation

S.NO	X	Y	XY	A=XY+2Wt	d/2
1.	21.2	16	339.2	362.2	10.73
2.	12.6	12	151.2	174.24	7.44
3.	14.5	12	174	197	7.91
4.	16.5	12	198	221	8.38
5.	18.5	12	222	245	8.83
6.	20.8	12	250	273	9.32
7.	22.8	12	273.6	296.6	9.71
8.	25	12	300	323	10.13
9.	37.2	16	595.2	618.2	14.02
10.	40.8	16	652.8	676	14.67
11.	35.3	16	564.8	588	13.68

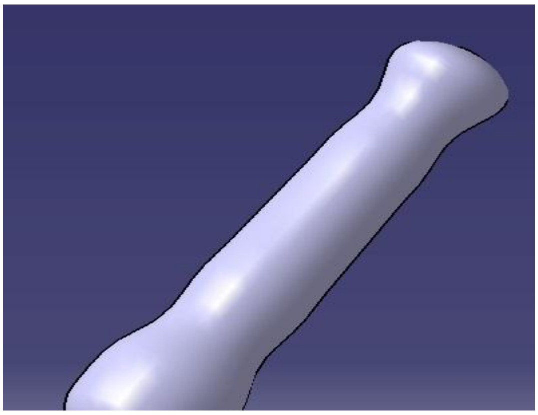


Fig.4.2: Actual Preform Design

4.3.7. Calculation and Determination of Die Block Size

As per theory, in calculation the surface area of the die block, it should be ensured that the distance between the outer periphery of the impression and die edge should be more than 1.5 times the maximum depth of the impression.

The dimensions of the die are calculating by using the empirical formula

$W \geq 1.5h + x + 1.5h$

Where

w = width of the die (mm)

h = maximum height of the component in the die (mm)

x = width of the component in the die (mm)

Width of die block (W):

$W \geq 1.5h + x + 1.5h$

≥width forging + 1.5× (depth of right + left side impression)

≥ 138.00

Length of die block (L):

$L \geq 1.5h + x + 1.5h$

≥length forging + 1.5× (depth of right + left side impression)

≥ 220

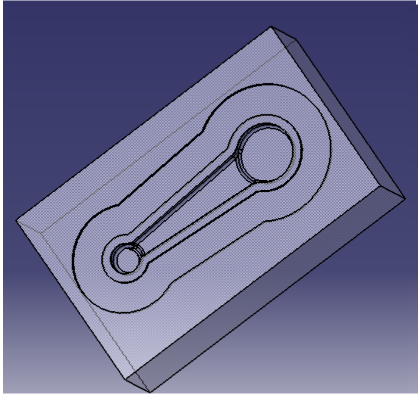
Calculation of height (H):

H ≥ 2-3 times of height

$\geq 3h$

≥ 56

After designing die block, Boolean operation is performed on the die block to get the die cavity. Then the preform and dies are imported into DEFORM to simulate the results



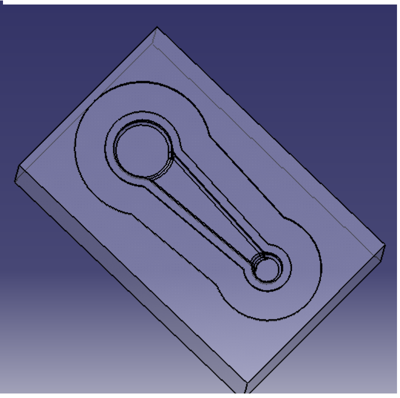


Figure.4.3: CATIA Model of Bottom Die**Figure.4.4:** CATIA Model ofTop Die

Now simulations have been run for the finisher dies.

Table 4.5: Input data for simulation

Material of Billet	AISI-1045
Material of Die	H-13
Billet Temperature	1050°,1150°,1200°
Die Temperature	150°,250°,350°
Velocity of top die	1mm/sec
Coefficient of friction	0.25,0.30,0.35
Number of meshes in preform	20000
Number of meshes in dies	20000

3.4. Design of Experiments and Experimental Details

For optimization, five parameters have been selected flash thickness, flash width, billet temperature, die temperature and coefficient of friction. The design parameters have been selected and examined each at three levels. The selected design parameters and their different levels are shown in Table 4.6.

Table 3.6: Design parameters and their levels

Parameter destination	**Design parameters**	**Level 1**	**Level 2**	**Level 3**
1	Flash thickness	1.0	1.6	2.2
2	Flash width	6.0	7.2	8.4
3	Billet temperature	1050	1150	1200
4	Die temperature	150	250	350
5	Coefficient of friction	0.25	0.30	0.35

3.5. Development of Design Matrix

The Taguchi approach enables a comprehensive understanding of the individual and combined effects of various design and process parameters to be obtained from a minimum number of experiments trails. The different levels in the form of actual values for each parameters investigated with Taguchi`s L27 orthogonal array. The Taguchi`s L27 orthogonal array along with the results of simulation is given in Table 4.7.

Table 3.7: Taguchi`s L27 Orthogonal Array with results of simulation

RUN	**A:Flash thickness**	**B:Flash width**	**C:Billet temperature**	**D:Die temperature**	**E:Coefficient of friction**
1	1	1	1	1	1
2	1	1	2	2	2
3	1	1	3	3	3
4	1	2	1	2	3
5	1	2	2	3	1
6	1	2	3	1	2
7	1	3	1	3	2
8	1	3	2	1	3
9	2	3	3	2	1
10	2	3	1	1	2
11	2	3	2	2	3
12	2	3	3	3	1

13	2	1	1	2	1
14	2	1	2	3	2
15	2	1	3	1	3
16	2	2	1	3	3
17	2	2	2	1	1
18	2	2	3	2	2
19	3	2	1	1	3
20	3	2	2	2	1
21	3	2	3	3	2
22	3	3	1	2	2
23	3	3	2	3	3
24	3	3	3	1	1
25	3	1	1	3	1
26	3	1	2	1	2
27	3	1	3	2	3

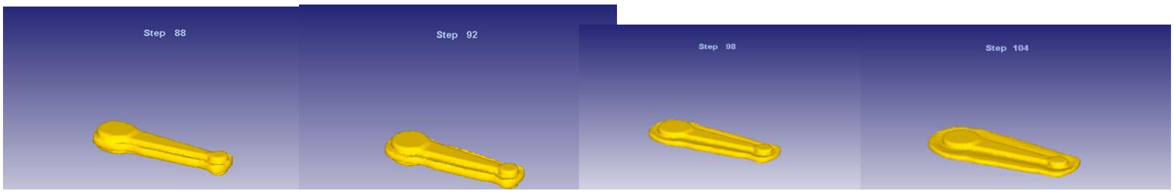


Fig.3.5: Different stages of deformation of preform in finisher die

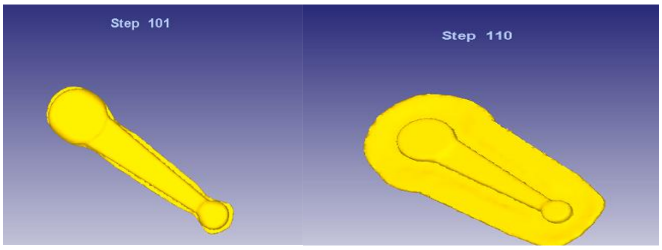
Table 3.8: Results of simulation

Run	**Equivalent Diameter (mm)**	**Fill / incomplete Fill**	**Billet Temperature (°)**	**Friction Coefficient**	**Load (tons)**
1	18	Incomplete fill	1200	0.3	323
2	21	Fill	1200	0.3	480

Now from the Table 4.8, it has been observed that billet having diameter 21 mm shows complete filling of the finisher dies, which is shown in Fig.4.6 and Fig.4.7. Therefore numbers of simulation trails has been made on this billet and simulation results for the billet along with Taguchi`s L27 orthogonal array, is shown in Table 4.9.

Table 3.9: Results of simulation for billet having 21 mm diameter

RUN	**A**	**B**	**C**	**D**	**E**	**Flash thickness**	**Flash width**	**Billet temperature**	**Die temperature**	**C.o.F**	**Load (tons)**
1	1	1	1	1	1	1.0	6.0	1050	150	0.25	769
2	1	1	2	2	2	1.0	6.0	1150	250	0.30	681
3	1	1	3	3	3	1.0	6.0	1200	350	0.35	409
4	1	2	1	2	3	1.0	7.2	1050	250	0.35	594
5	1	2	2	3	1	1.0	7.2	1150	350	0.25	396
6	1	2	3	1	2	1.0	7.2	1200	150	0.30	691
7	1	3	1	3	2	1.0	8.4	1050	350	0.30	428
8	1	3	2	1	3	1.0	8.4	1150	150	0.35	459
9	2	3	3	2	1	1.6	8.4	1200	250	0.25	371
10	2	3	1	1	2	1.6	8.4	1050	150	0.30	500
11	2	3	2	2	3	1.6	8.4	1150	250	0.35	452
12	2	3	3	3	1	1.6	8.4	1200	350	0.25	321
13	2	1	1	2	1	1.6	6.0	1050	250	0.25	424
14	2	1	2	3	2	1.6	6.0	1150	350	0.30	343
15	2	1	3	1	3	1.6	6.0	1200	150	0.35	413
16	2	2	1	3	3	1.6	7.2	1050	350	0.35	411
17	2	2	2	1	1	1.6	7.2	1150	150	0.25	409
18	3	2	3	2	2	2.2	7.2	1200	250	0.30	536
19	3	2	1	1	3	2.2	7.2	1050	150	0.35	661
20	3	2	2	2	1	2.2	7.2	1150	250	0.25	410
21	3	2	3	3	2	2.2	7.2	1200	350	0.30	367
22	3	3	1	2	2	2.2	8.4	1050	250	0.30	502
23	3	3	2	3	3	2.2	8.4	1150	350	0.35	487
24	3	3	3	1	1	2.2	8.4	1200	150	0.25	306
25	3	1	1	3	1	2.2	6.0	1050	350	0.25	414
26	3	1	2	1	2	2.2	6.0	1150	150	0.30	302
27	3	1	3	2	3	2.2	6.0	1200	250	0.35	325



(a) Billet having 18mm diameter (b)Billet having 21 mm diameter

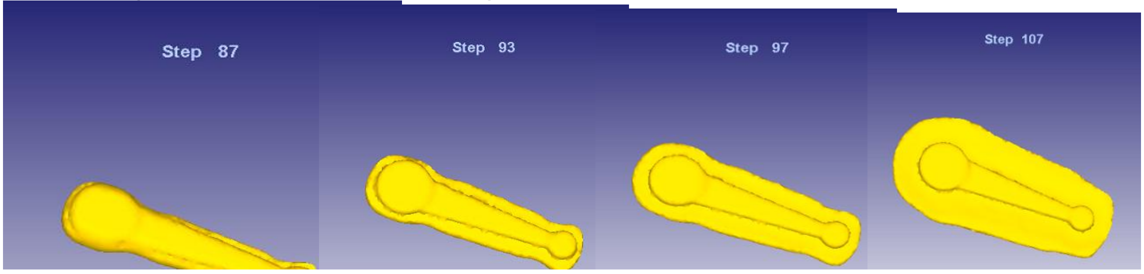


Figure.3.7: Different stages of deformation of billet having 21 mm diameter in finisher die

IV. Analysis Of Experimental Work

4.1. A preform has been forged in the finisher dies.

4.1.1. Analysis of load for preform

Taguchi method is used to determine the most desirable combination of parameters along with the significance of each. There are three methods available for calculating the S/N ratio, and the appropriate method is decided based on end objective or outcome desired.

Here forging load as response, minimization criteria (Smaller is better) is selected. The load is a “small is better” type of quality characteristics. The different levels in the form of actual values for each parameters has been investigated with Taguchi`s L27 orthogonal array. The Taguchi`s L27 orthogonal array is given in Table 5.1. The S/N ratio for the load (response) is shown in Fig.5.1

Table 5.1: Taguchi`s L27 orthogonal array with results of S/N ratio

RUN	A	B	C	D	E	Flash Thickness (mm)	Flash Width (mm)	Billet Temp (°C)	Die Temp (°C)	C.o.F	Load	S/N Ratio
1	1	1	1	1	1	1.0	6.0	1050	150	0.25	769	-57.434
2	1	1	2	2	2	1.0	6.0	1150	250	0.30	681	-55.288
3	1	1	3	3	3	1.0	6.0	1200	350	0.35	409	-51.806
4	1	2	1	2	3	1.0	7.2	1050	250	0.35	594	-56.160
5	1	2	2	3	1	1.0	7.2	1150	350	0.25	396	-52.402
6	1	2	3	1	2	1.0	7.2	1200	150	0.30	691	-56.528
7	1	3	1	3	2	1.0	8.4	1050	350	0.30	428	-52.227
8	1	3	2	1	3	1.0	8.4	1150	150	0.35	459	-53.781
9	2	3	3	2	1	1.6	8.4	1200	250	0.25	371	-52.076
10	2	3	1	1	2	1.6	8.4	1050	150	0.30	500	-54.664
11	2	3	2	2	3	1.6	8.4	1150	250	0.35	452	-53.932
12	2	3	3	3	1	1.6	8.4	1200	350	0.25	321	-49.869
13	2	1	1	2	1	1.6	6.0	1050	250	0.25	424	-53.801
14	2	1	2	3	2	1.6	6.0	1150	350	0.30	343	-51.250
15	2	1	3	1	3	1.6	6.0	1200	150	0.35	413	-53.008

16	2	2	1	3	3	1.6	7.2	1050	350	0.35	411	-51.993
17	2	2	2	1	1	1.6	7.2	1150	150	0.25	409	-50.860
18	3	2	3	2	2	2.2	7.2	1200	250	0.30	536	-54.155
19	3	2	1	1	3	2.2	7.2	1050	150	0.35	661	-56.002
20	3	2	2	2	1	2.2	7.2	1150	250	0.25	410	-52.800
21	3	2	3	3	2	2.2	7.2	1200	350	0.30	367	-51.982
22	3	3	1	2	2	2.2	8.4	1050	250	0.30	502	-53.730
23	3	3	2	3	3	2.2	8.4	1150	350	0.35	487	-52.376
24	3	3	3	1	1	2.2	8.4	1200	150	0.35	306	-49.286
25	3	1	1	3	1	2.2	6.0	1050	350	0.25	414	-53.025
26	3	1	2	1	2	2.2	6.0	1150	150	0.30	302	-50.371
27	3	1	3	2	3	2.2	6.0	1200	250	0.35	325	-49.976

Table 5.2: Response Table of Signal to Noise Ratios for load

Level	Flash thickness	Flash width	Billet temp	Die temp	Coefficient of friction
1	-54.25	-52.80	-54.40	-53.50	-52.50
2	-52.60	-53.60	-52.60	-53.50	-53.50
3	-51.00	-52.50	-52.00	-51.50	-53.20
Rank	1	2	3	4	5

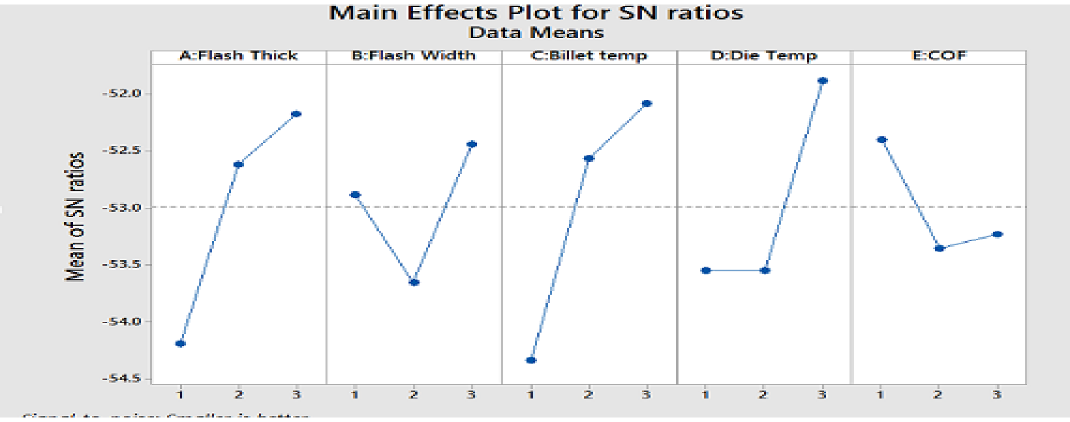


Figure.5.1: Main effect plot of SN ratio for load

The graphical representation of above SN ratio shows that the combination (3,3,3,3 and 1) is the best combination for getting smallest forging load. This corresponds to forging at 2.2mm flash thickness,8.4mm flash width, billet temperature 1200^{o}C, Die temperature 350^{o}C with 0.25 coefficient of friction.

5.1.2 Yield of Forging:

Yield of forging = net weight/ gross weight
= weight of component/ weight of preform (forging)
= (0.301/ 0.420) ×100
Yield = 71.66%

V. Results And Discussion

Considering Taguchi`s orthogonal array L27 , the corresponding data are noted down.

5.1. A preform has been forged in the finisher dies

The optimized parameter levels that have been established for effective load are illustrated in Table 6.1.

Table 6.1: Optimum levels of various forging parameters for optimum load effective

Parameters	Values	Preferred level
Flash thickness	1.0,1.6,2.2	3(2.2)
Flash width	6.0,7.2,8.4	3(8.4)
Billet temperature	1050,1150,1200	3(1200)
Die temperature	150,250,350	3(350)
Coefficient of friction	0.25,0.30,0.35	1(0.25)

From the analysis of result, optimum forging load is achieved and the value obtained is 473 tons.

Effective load distribution:

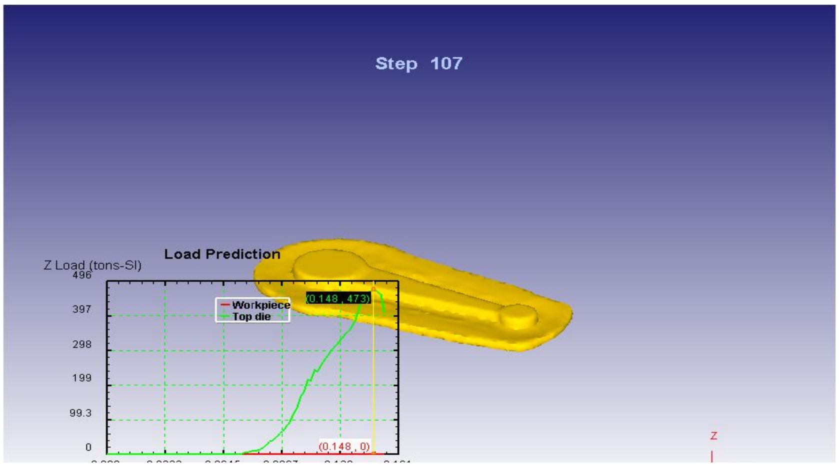
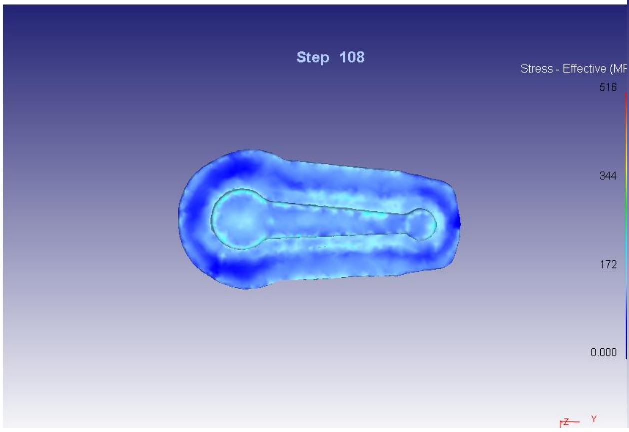


Figure.6.1: Optimum result for load effective

The above graph shows that load increases gradually after the flash formation and increases sharply near the end, after the filling of die cavity.

Effective Stress Distribution:Effective Temperature Distribution:



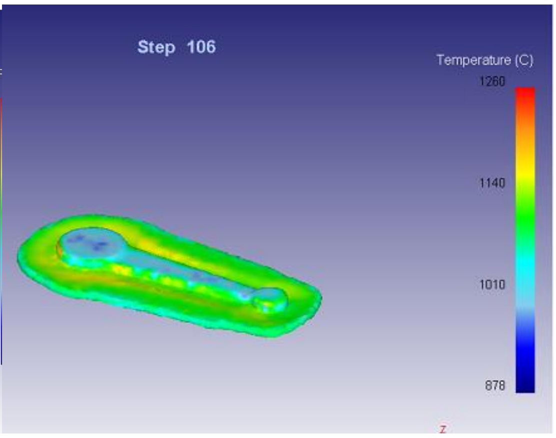


Figure.6.2: Effective stress plot for finisher die**Figure.6.3:** Temperature distribution plot

Effective Damage Distribution:

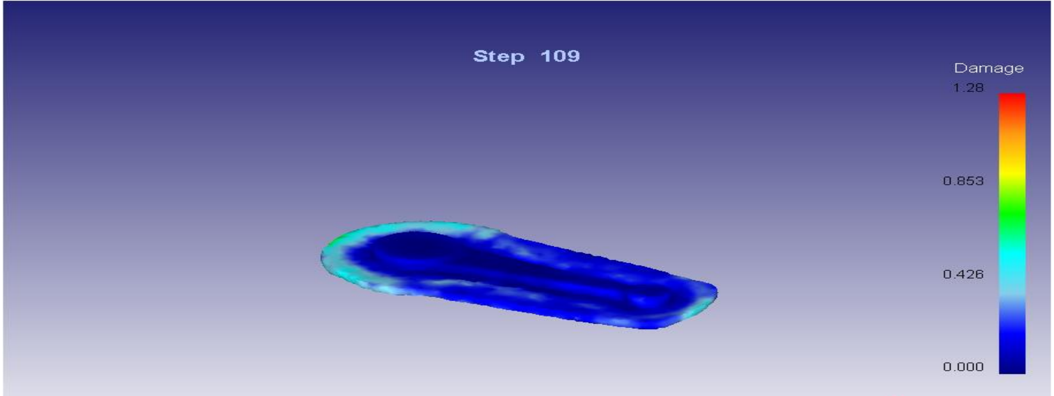


Figure 6.4: Damage Distribution Plot

VI. Conclusions

Forging load is used as the objective function. The analysis for optimum result has been made by Taguchi design and the optimum value for forging load is 473 tons; when preform is used in the finisher die. The optimum value of stress, when preform has been forged in the finisher die is 516 MPa.The optimum value of Temperature, when preform has been forged in the finisher die is 1260°C.The optimum value of Damage, when preform has been forged in the finisher die is 1.28. The optimum value of flash thickness 2.2 mm, flash width 8.4mm, billet temperature 1200ºC, die temperature 350°C and Coefficient of friction 0.25 have been obtained at the optimum forging load. Yield of the forging, that has obtained is 71.66%.In this project, parameters for forging of pitman arm has been optimized by changing the design and process parameters using finite element based simulation software (Deform 3D). With the help of this simulation software optimization has been achieved efficiently and effectively.

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