



Design And Analysis Of Combined Extrusion Forging Die Behavior Under Thermal Structural Loads

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ABSTRACT

We all know extrusion and forging are two different processes of manufacturing but in recent past researches combined these two process to reduce the production time, production cost etc. Combined extrusion-forging processes are now getting importance for its abilities to give improved material properties, high production rate and less material waste when compared with that produced by machining, casting or by assembling the individual parts produced by different manufacturing processes. In its simplest form of combined extrusion forging process, a billet is forged by punch and dies with punch/die or both containing an opening for extrusion. This tooling arrangement permits the simultaneous lateral spread due to forging, and backward/forward extrusion or both forward and backward extrusion simultaneously through the die/punch opening(s).

In this study we are going to develop a die for extrusion-forging using knowledge from previous journals and books, we will develop a die for a flange with pipe using CAD and CAE packages. A basic die is designed and tested at maximum working conditions under thermal structural loads in simulation software ANSYS and the design of the die is further improvised to minimize the stress and improve life based on safety factor issues.

Key words: Combined Extrusion-Forging, Catia, Ansys, Heat Flux, Total Deformation etc

1.INTRODUCTION

Metal forming is one of the oldest materials processing techniques which are still playing an important role in the modern life. In metal forming, as in any other manufacturing processes, the ultimate goal is to produce components of a selected material with a required geometrical shape and a structure optimized for the proposed service environment. Of the above, production of the desired shape is a major part of the manufacturing process.

Extrusion-forging is a bulk metal forming operation in which the cross-section area of the billet is reshaped and changed into a certain shape by

forcing it through a narrow path called extrusion die and obtaining a desired shape at the end of the billet or at other locations by filling the forging die cavity. A variety of regular/irregular cross-sections and complex shape can be achieved by this process. This process has a definite advantage over other production processes used to manufacture complicated sections having re-entrant corners. Large reduction achieved even at high strain rates has made this process is one of the fastest growing metals working methods. In combined forward-backward extrusion forging process, the billet is reshaped and changed into certain shape (triangular, square, pentagon, hexagon, gear, box spanner, male female adapter) by forcing it through a narrow extrusion-forging die set up.

In this combined forward extrusion-forging process, the entire process can be divided into three stages, In the first stage, extrusion and upsetting take place simultaneously until the deformed material begins to make contact with the die wall. In the second stage, extrusion and forging takes place simultaneously until filling of the forging die cavity. In this stage, the flow of metal is restricted by the boundary wall of the forging die. In the last stage, the deformation in the head part is completed, and only steady state extrusion takes place, that the last stage of the process requires maximum load and a steady state extrusion of product taken place. This steady state maximum load is very much important for die design. The present theoretical analysis focus on this last stage steady state extrusion of the round pipe from shaped billet that already filled the forging die cavity. DIE

A DIE is a particular device utilized as a part of assembling enterprises to cut or shape material for the most part utilizing a press. Like molds, bites the dust are by and large modified to the thing they are utilized to make. Items made with passes on range from basic paper clasps to complex pieces utilized as a part of cutting edge innovation.

Framing kicks the bucket are normally made by apparatus and bite the dust creators and put into generation in the wake of mounting into a press. The

kick the bucket is a metal piece that is utilized for framing materials like sheet metal and plastic. For the vacuum framing of plastic sheet just a solitary shape is utilized, commonly to frame straightforward plastic compartments (called rangle packs) for stock. Vacuum shaping is viewed as a straightforward embellishment thermo framing process however utilizes an indistinguishable standards from bite the dust shaping. For the framing of sheet metal, for example, vehicle body parts, two sections might be utilized: one, called the punch, plays out the extending, bowing, as well as blanking operation, while another part, called the bite the dust square, safely clasps the work piece and gives comparable extending, bowing, and additionally blanking operation. The work piece may go through a few phases utilizing diverse instruments or operations to get the last frame. On account of a car segment there will for the most part be a shearing operation after the primary framing is done and after that extra pleating or moving operations to guarantee that every sharp edge are covered up and to add inflexibility to the board.

II. DESIGN OF DIE

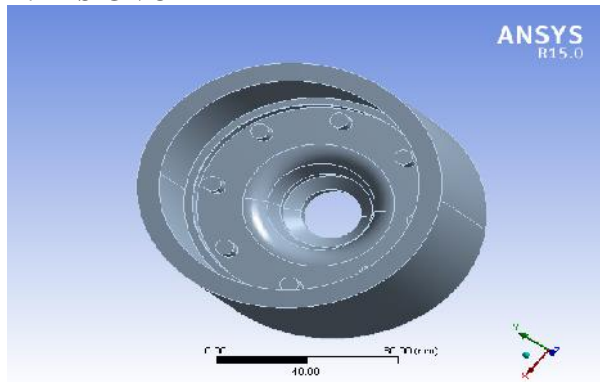


Fig-1: Geometry of extrusion forging die

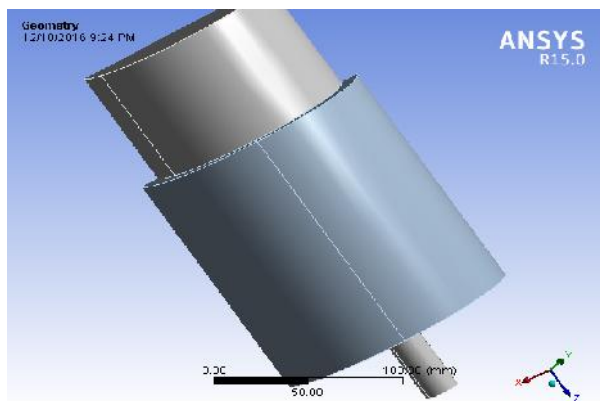


Fig-2: Geometry of extrusion forging die setup

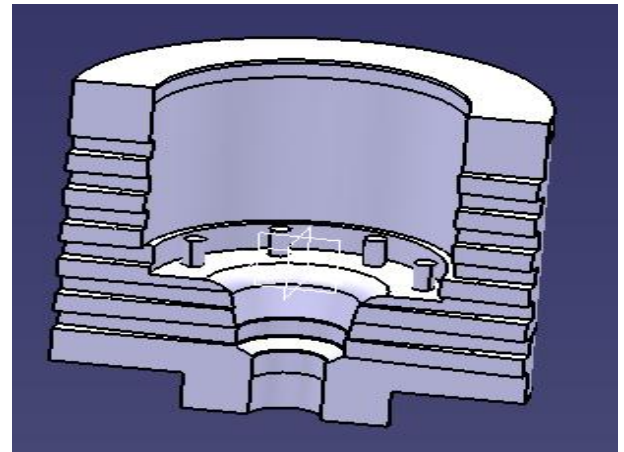


Fig -3: Cut-section of extrusion forging die

III. THERMAL ANALYSIS OF EXTRUSION FORGING DIE

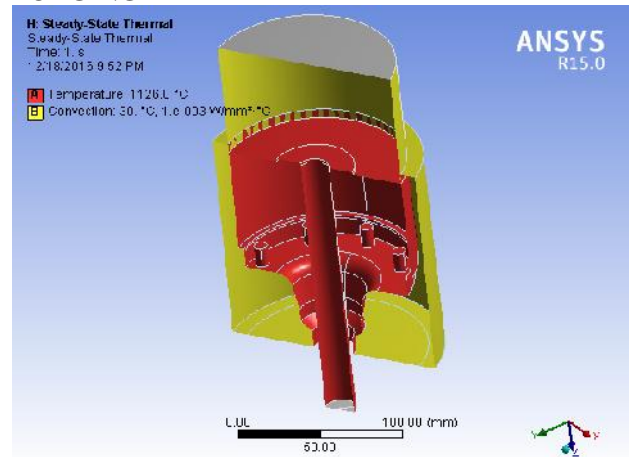


Fig-4: Applying boundary conditions for Steady state Thermal analysis on model-I, H11 Hot work tool steel

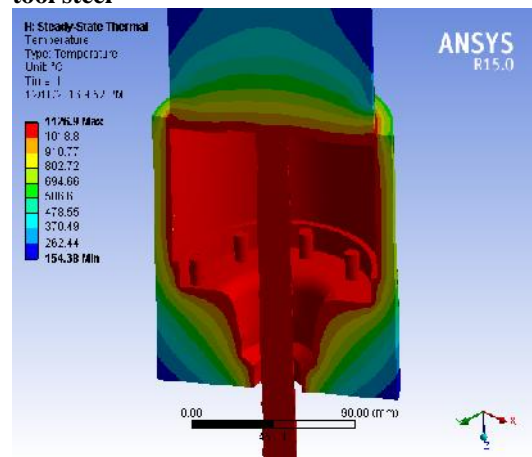


Fig-5: Steady state thermal analysis (Temperature) on model-I

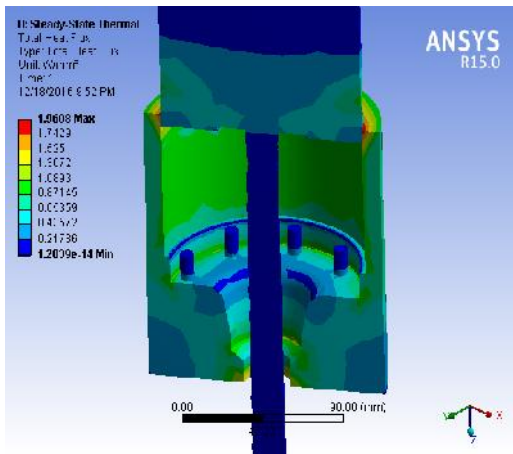


Fig-6: Steady state thermal analysis (Total Heat Flux) on model-I

IV. STRUCTURAL ANALYSIS OF EXTRUSION FORGING DIE

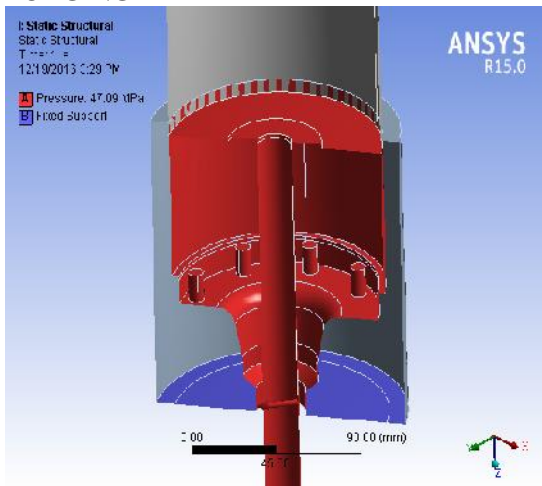


Fig-7: Applying boundary conditions for static structural on model-I, H11 Hot work tool steel

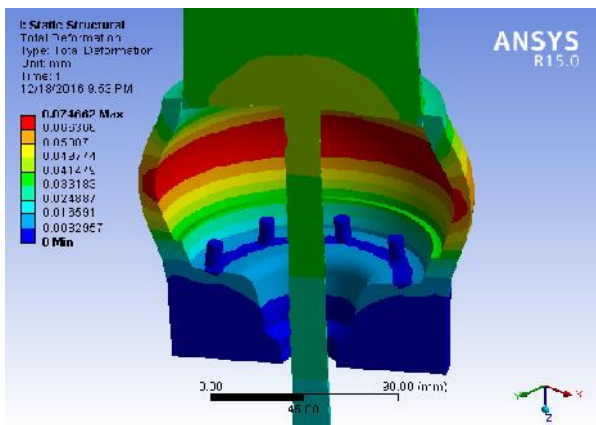


Fig-8: Static structural analysis(Total deformation) on model-I

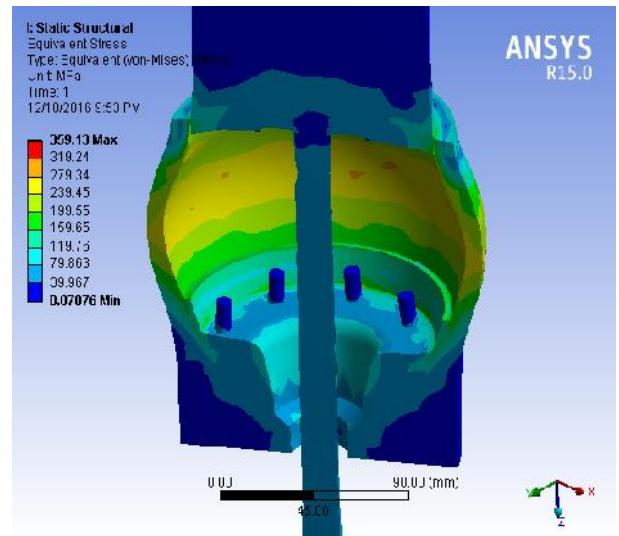


Fig-9: Static structural analysis Equivalent (von-mises) stress on model-I

V. RESULTS AND DISCUSSIONS

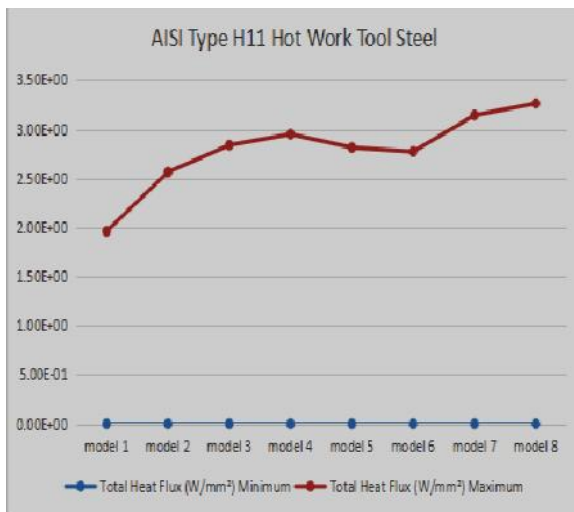
STEADY STATE THERMAL ANALYSIS OF EXTRUSION FORGING DIE ALL 8 MODELS

AISI Type H11 Hot Work Tool Steel,	Temperature (°C)		Total Heat Flux (W/mm ²)	
	Min	Max	Min	Max
model 1	154.38	1126.9	1.20E-14	1.9608
model 2	75.387	1155.7	7.23E-16	2.5631
model 3	124.63	1146.4	7.23E-16	2.8388
model 4	61.657	1148.6	7.23E-16	2.9503
model 5	109.34	1146.1	3.49E-16	2.8136
model 6	99.388	1132	9.04E-16	2.7724
model 7	99.268	1132.4	8.89E-16	3.1437
model 8	73.562	1146.2	6.15E-16	3.2638

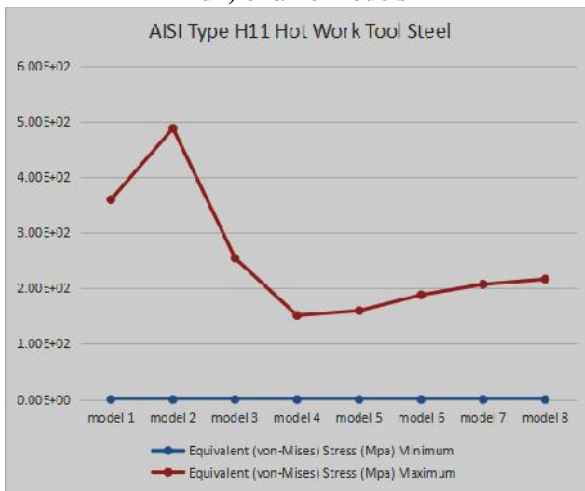
STATIC STRUCTURAL ANALYSIS OF EXTRUSION FORGING DIE ALL 8 MODELS

AISI Type H11 Hot Work Tool Steel,	Total Deformation (mm)		Equivalent Elastic Strain (mm/mm)		Equivalent (von-Mises) Stress (Mpa)	
	Min	Max	Min	Max	Min	Max
mod 0	0	7.47	6.47	1.71	7.08	359.

el 1		E-02	E-07	E-03	E-02	13
mod el 2	0	7.89	7.32	2.37	6.92	487.37
mod el 3	0	3.56	5.78	1.21	3.43	254.16
mod el 4	0	2.49	6.30	7.88	1.99	151.15
mod el 5	0	2.82	6.60	7.60	4.12	159.66
mod el 6	0	2.91	5.97	9.05	4.08	187.97
mod el 7	0	3.08	5.92	9.95	1.43	207.11
mod el 8	0	2.92	6.20	1.05	2.68	216.37



Graph-1: Steady state thermal analysis (Total heat flux) of all 8 models



Graph-2: STATIC STRUCTURAL ANALYSIS (EQUIVALENT VON-MISES STRESS) OF ALL 8 MODELS

VI CONCLUSIONS

In this study we developed a die for extrusion forging using knowledge from previous

journals and books. We developed a die for a flange with pipe using catia and analysis has done using Ansys. A basic die is designed and tested at maximum working conditions under thermal structural loads in simulation software ANSYS and the design of the die is further improvised to minimise the stress and improve life based on safety factor issues.

1. The maximum stress induced in model 1 is 359.13 MPa which is less than allowable limits of 1990 MPa. Hence the factor of safety is 5.541.
2. The maximum stress induced in model 2 is 487.37 MPa which is less than allowable limits of 1990 MPa. Hence the factor of safety is 4.083.
3. The maximum stress induced in model 3 is 254.16 MPa which is less than allowable limits of 1990 MPa. Hence the factor of safety is 7.829.
4. The maximum stress induced in model 4 is 151.15 MPa which is less than allowable limits of 1990 MPa. Hence the factor of safety is 13.165.
5. The maximum stress induced in model 5 is 159.66 MPa which is less than allowable limits of 1990 MPa. Hence the factor of safety is 12.463.
6. The maximum stress induced in model 6 is 187.97 MPa which is less than allowable limits of 1990 MPa. Hence the factor of safety is 10.586.
7. The maximum stress induced in model 7 is 207.11 MPa which is less than allowable limits of 1990 MPa. Hence the factor of safety is 9.608.
8. The maximum stress induced in model 8 is 216.37 MPa which is less than allowable limits of 1990 MPa. Hence the factor of safety is 9.197.

The model 4 is having less stresses when compared with other models. So it is concluded that is the preferred model for manufacturing the die.

VII. FUTURE SCOPE

The present work will inspire the future investigators and have a wide scope for to explore many aspects of combined extrusion-forging processes. Some recommendations for future research include:

- This method can be extended to analyse section extrusion-forging of other solid and hollow shapes.
- Experiment can extend to hot combined extrusion-forging process other materials.
- The analysis can be extended for the extrusion of sections through converging, curve dies and taper die.
- The flange can be modelled with different dimensions and analysed for optimised design.

VIII. REFERENCES

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