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Computer Aided Design & Analysis of Press Tools for a Thermostat Lever Component

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Abstract

Press tools are the devices by which the sheet metal can be converted into required shape by various press operations. This process is also called cold stamping. It can also be defined as a device used for punching out sheet metal components from the stock strip. JDP TOOL TECH has got a project to design press tools for thermostat lever.

Levers are used in the lever mechanism of thermostat. A thermostat is a device for automatically operating an electrical switching mechanism in response to sensed changes in temperature. The position of a lever mechanism responsive to the remote temperature sensor controls the point at which the switching mechanism is actuated in response to a certain movement of the lever mechanism.

The prime objective of the paper is to design progressive and bending tools or dies that combines maximum production to produce the component and least maintenance with "lowest feasible cost, that exceeds the expectations of the customer in aspects like Quality, Cost, for the desired life.

***Keywords:** Thermostat Lever Component, Press Tools, Computer Aided Design*

I. INTRODUCTION

Sheet metal stampings have now replaced many components which were earlier cast or machined. Material economy & the resultant reduction in weight and cost, high productivity, use of unskilled labor, & a high degree of possible precision have rendered presswork indispensable for many mass production goods such as electronic appliances, steel furniture, utensils & automotives. The entire top of a car can be finished to size from a single sheet metal. There is no need for further machining as in the case of castings or forgings.

Metal Stamping is the process of taking blank sheet metal of various thickness and material, and forming it into different shapes by different operations. Today's modern technology demands technique to produce quality products at an affordable price to gain an edge over competitors .Sheet metal stamping plays a major role in fulfilling the requirements of modern technology. The design of press tools by computer simulation will be highly beneficial to analyze process assessment capabilities & thereby saving lot of expenditures by avoiding repeated and costly tryouts.

Design of press tools as a set of stage tools for lever is the subject considered for this project work. Design of press tools for thermostat lever involves the concepts of sheet metal cutting operations and designing dies for mass production to produce the component. This involves complete study on types of operations that are performed for shaping the sheet metals, sheet metal characteristics that play vital role in sheet metal operations and types of dies for shaping the sheet metal, selection of material and selection of springs for die for shaping sheet metal in to finished product.

Shaping sheet metal in to finished lever involves determining the die cutting operations and making a sequence of those operations by studying the lever drawing, determining dies, designing the strip lay out and designing dies for the finished product.

The design of metal stamping dies is a complex and highly specialized procedure and typically it takes 20% of the lead-time from the concept design to the final stamping manufacture. The diverse nature of products produced by stamping die demands a high level of knowledge on the part of the die designer that can only be achieved through years of practical experience. To check the manufacturability of sheet metal part, development of strip-layout, selection/design of die components and die modeling are some of the major activities to be carried out by die designers in stamping industries. The traditional methods of carrying out these tasks require expertise and are largely manual and therefore tedious, time consuming and error-prone . Also the knowledge gained by die design experts after long years of experience is often not available to others even within the same company. It creates a vacuum whenever the expert retires or leaves the company. The quality of die design depends to a large extent on the designer's skill, experience and knowledge.

Modeling, Assembly

All tool elements are done in CATIA V5. This involved making the modeling, drawings of assembly, drawing of individual tool elements etc. CATIA is a 3D modeling software for modeling & manufacturing of complicated shapes and parts. Advanced and sophisticated features of CATIA software enables to model the minute technicalities of the components with great ease.

OBJECTIVE OF THE PROJECT

The prime objective of the study is to design a set of tools to produce the component that exceeds the expectations of the customer in Aspects like Quality, Cost, it holds out the strong probability of achieving the following:

1) A die or set of dies that combines maximum production and least maintenance with "lowest feasible cost, for the desired or expected life".

2) Maximum utilization of the least expensive stamping material that will satisfactorily function.

3) Most efficient press working practices.

4) A stamped product that consistently meets sales and service requirements of shape, dimensions, strength, finish, style and utility.

5) The Project lays emphasis on the design of sheet metal dies for operations like piercing, blanking and forming respectively through CADD.

6) Sheet metal die design requires thorough understanding of the subject and good perception of the possible difficulties during the die manufacturing and operation.

7) Non standard parts are avoided to the maximum extent and care is taken to include design considerations for safer die operation.

8) 8.The design of press tools by CAD using catia a 3D modeling parametric software, will be highly beneficial to analyze process assessment capabilities and for detailing the die components.

Die Design

Die design is the preliminary stage in stamping die manufacturing once the product design is completed. Die design stage is very critical. A good die design can produce accurate components which can run for long time with less maintenance. Die design involves deciding the required stamping operations, basic layout, machining processes, type of stamping presses to be used etc. A die designer should have thorough knowledge about these elements to create a good die design. Computer aided design technology has developed really well during last decade to help die designers. Below we will discuss about the various stages involved in precision metal stamping die design.

Die Design Stages

Die design is a step by step process which includes careful evaluation of the product characteristics and operations involved. Die designer then proceed with a strip layout which involves identifying different stamping operations which are required to produce the final stamped component. Let’s discuss the stages involved in die design in detail.

Evaluate the Part design

At this stage of die design the designer does a through study of the blue print of the stamping component to understand its characteristics. The die designer has to study the product drawing carefully to understand the material composition of the stamped product, thickness of the material and complexity of the product design. This is important in identifying the material behavior against various stamping operations.

LITERATURE SURVEY

In order to develop better concurrency between design and manufacturing of metal stamping die a stamp ability assessment or evaluation is necessary. It is estimated that decisions made at the part design stage determine 70%–80% of the manufacturing productivity. Therefore, as a first step in the planning for manufacture of a sheet metal part, it is useful to check its internal as well as external features for assessing its manufacturability on stamping die. Such checks are useful to avoid manufacturing defects, section weakness, and need of new dies, tools or machines.

Nakahara et al. [3] Introduced a progressive die design system that examines the part design data to decide whether blanking can stamp it or not and they developed a knowledge-based system for identifying design rule violations to improve part manufacturability.

De Sam Lazaro et al. [4 Developed a Knowledge-based expert system using principles of group technology for multi-stage forming process for feature recognition, material selection, blank determination, optimum sequencing of operations, tool and machine selection.

Shpitalni and Sadda.[5] Addressed the problem of automatic tool selection and bending sequence determination using graph search heuristics.

DESIGN METHODOLOGY

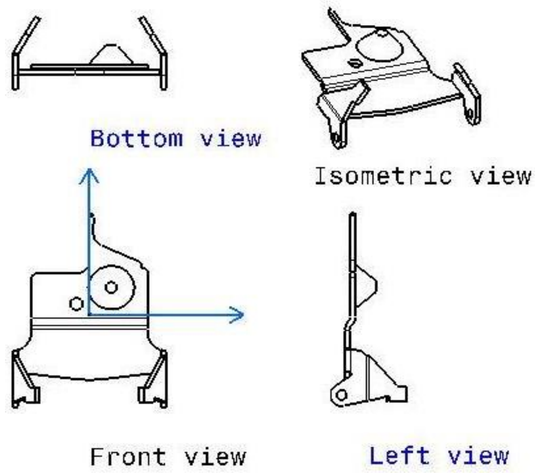

Fig.1: Thermostat Design

Levers are used in the lever mechanism of thermostat. A thermostat is a device for automatically operating an electrical switching mechanism in response to sensed changes in temperature. These devices have a sensing element positioned remotely from the electrical switching mechanism.

An example would be devices having a remote sensing element for sensing freezing conditions in a device such as a refrigerator or freezer, with switching mechanism located exteriorly of the freezing compartment.

Material characteristics of lever

This lever is made of CRCA STEEL- Low Carbon Steel Composition:

Table: 1

Carbon % - 0.35 to 0.45	Physical Properties:
Silicon % - 0.10 to 0.35	Hardness: 170HV max
Manganese % - 0.60 to 0.90	Yield Stress: 270N/mm2 min
Sulphur % - 0.05 max	Tensile Strength: 590N/mm2 max
Phosphorus % - 0.05 max	Elongation %: 30 min

Due to low carbon content, this grade of steel offers better forming & bending quality. It is used for applications, where critical bending operations are required. These steel have good corrosion resistance. This steel is of particular importance because of unique combination of strength & toughness after heat treat treatment.

Blank opening up calculations and strip layout

To determine the Blank length, bend allowance 'P' is to be determined for each bend. Estimated or Tentative Blank length =sum of lengths 'L' of the bend legs and the allowances.

B = L1 + P + L2

'P' is called the bend allowance (P = (R+C) 2*Π*N/ 360.)

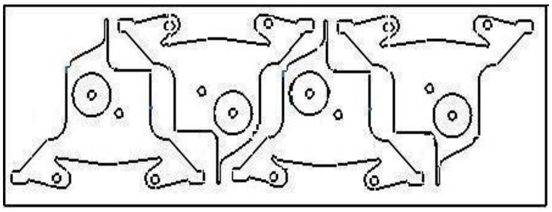

Fig.2: Strip layout

Modeling of blanking tool

Blanking is a shearing process where a punch and die are used to create a "blank" from sheet metal or a plate. The process and machinery are usually the same as that used in piercing, except that the piece being punched out in the piercing process is scrap.

From the structure of the component, we analyzed that we need to design a compound blanking and piercing die for getting the specified contour of the component. Therefore the blank open calculations were being done and the strip layout was being designed.

Now based on the thumb rules generally followed by the industry for the design of these tools, blanking and piercing tool is designed, modeled in 2-D and 3-D.

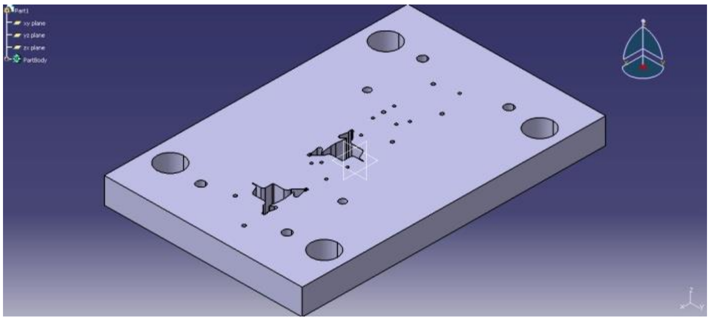

Fig.3 Bottom bolster

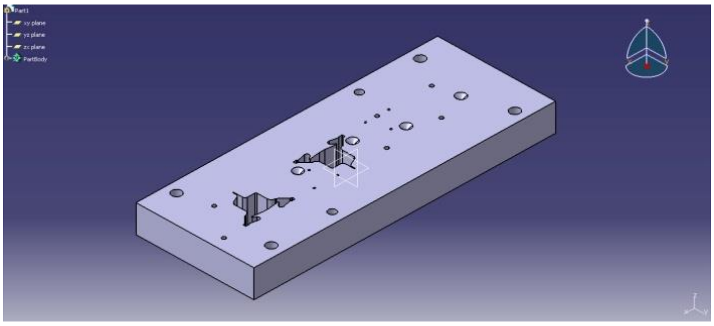

Fig.4 Die plate

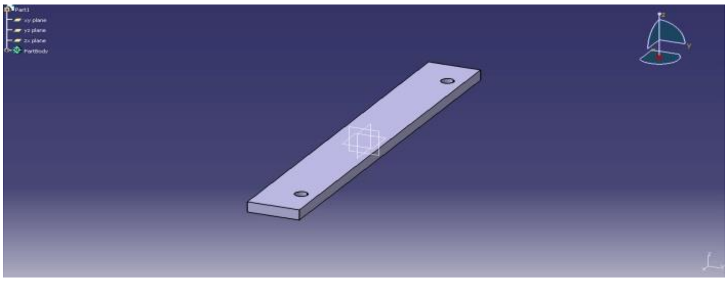

Fig.5 Guide plate

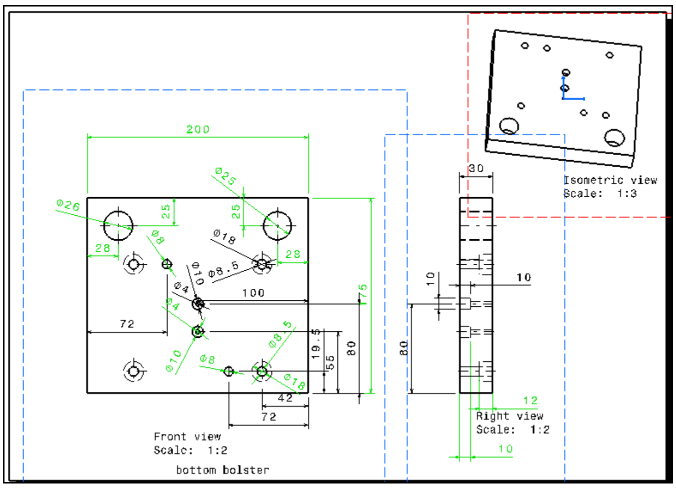

Fig.6 Bottom bolster

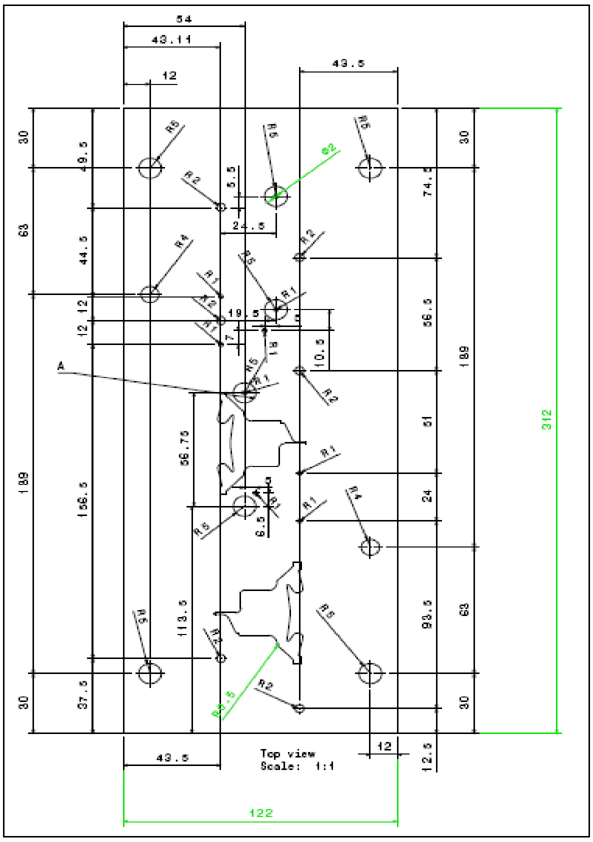

Fig.7: Die plate

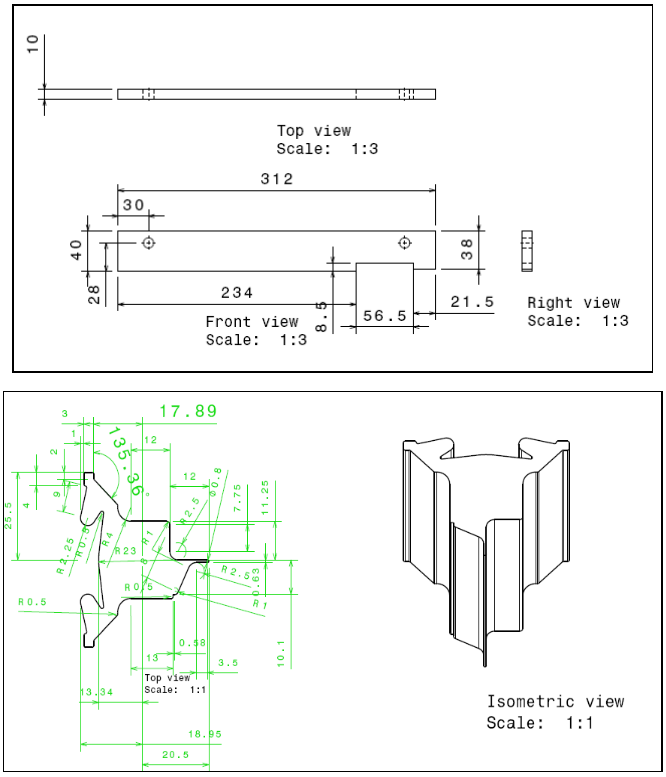

Fig.8: Blank punch

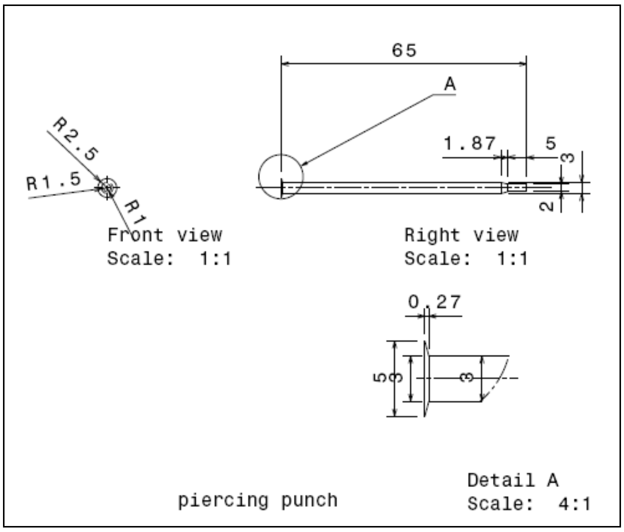

Fig.9: Piercing punch

STRUCTURAL ANALYSIS:

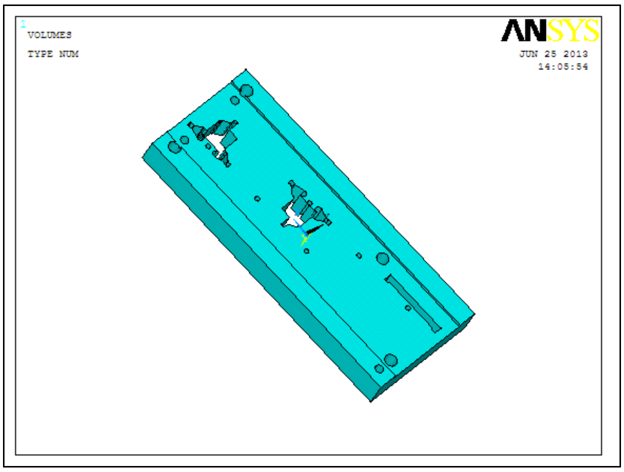

Fig.10: Imported model

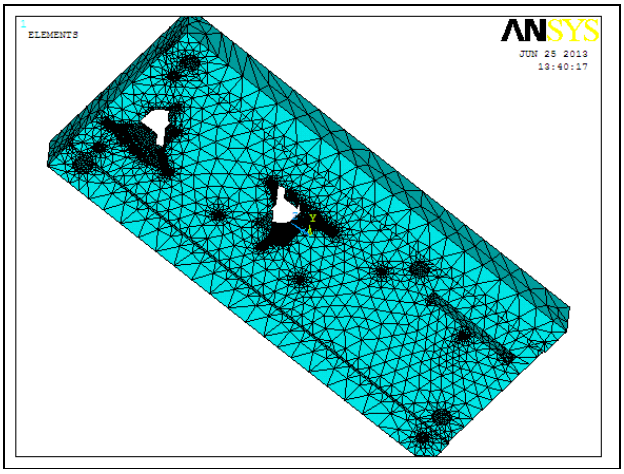

Fig.11: Meshed model

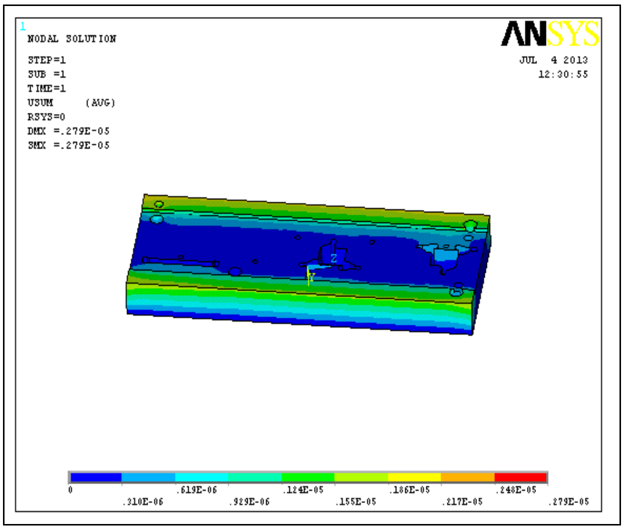

Figure: 12

RESULT AND DISCUSSION

I have successfully manufacture the designed progressive dies for the lever component of thermostat used for refrigerator as for the designed parameters which have been analyzed for deflections, stress and strain values. Comparatively both theoretical and software analysis as well at any results of stress Stress and strain.

Table: 2

Part name	**Die plate**		**Analysis result**	
	Stress(N/MM2)	Deflection(mm)	Stress(N/MM2)	Deflection(mm)
Die plate	0.1607978	0.01614e-06	0.49163	0.348e-06

Above table indicates safe design with the result of the software which is accurate as I have taken fine meshing for an analysis. But in theoretical I got the approximate values nearer to the software values and calculated press tonnage is 17 tons.

CONCLUSIONS

The individual components of progressive tool were modeled in CATIA V5-R21. Each individual file was imported to Ansys12.0 software through Initial Graphics Exchange Specification (IGES) format. The following conclusions were made.

1. The results obtained through analysis are approximately nearer to the theoretical values. This demonstrates that the analysis carried out was correct.

2. It is also observed that the design of progressive tool is safe as all the stress values were less than the allowable stress of the material.

3. Forces are calculated when blanking and bending operations are done. The press tonnage calculated is 17tons, force to shear is 12.39tons, and stripping force is 13.6293tons.

4. The pressure produced while banking is 0.102N/mm2 and while bending is 0.0855N/mm2.

SCOPE OF FUTURE WORK

Therefore, there is need to develop an intelligent system by combining some suitable AI technique and CAD system for manufacturability assessments/reasoning, concurrent planning and quick design of multi-operation dies. The system must have rich knowledge-base comprising knowledge of experienced die designers and process planners, must be interactive and user friendly and have low cost of implementation. The system finally must give its output in form of drawings of strip-layout, die components and die assembly. The authors are applying their research efforts in this direction to assist process planners and die designers of small and medium scale sheet metal industries.

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XVII. ANKYO Die design standard

XVIII. IBRO Die design standard

XIX. MISUMI Die design standard

XX. DAYTON standard