Design and Analysis of Press Tools for a Thermostat Lever Component

T.Paramesh[1] R.SuvarnaBabu[2] S.AmithKumar[3]
[1,2,3]Department of Mechanical Engineering
[1,2,3]St. Martin's Engineering College, Secunderabad, Telangana, India

Abstract— Press devices are utilized to create sheet metals into required shape by different press activities likewise called cold stepping. A gadget is utilized for punching out sheet metal segments, for example, switches from the stock strip utilized in the switch component of thermostat. A thermostat is a gadget consequently works an electrical changing system because of detected changes in temperature in light of the remote temperature sensor controller at which the exchanging component is activated in light of a specific development of the switch instrument. The prime target of the paper is to plan dynamic and bowing devices or bites the dust that consolidates most extreme creation to deliver the part and least upkeep with "most minimal doable cost, that surpasses the desires for the client in viewpoints like Quality, Cost, for the ideal life. JDP TOOL TECH has an undertaking to configuration press instruments for thermostat switch. This paper presents CAD analysis and structure estimations for press apparatuses for the thermostat switch instrument.

Keywords: Thermostat, CAD, Sheet-Metal, Temperature

I. INTRODUCTION

Metal Stamping is the way toward taking clear sheet metal of different thickness materials and framing into various shapes by various activities. The present current innovation requests strategy to create quality items at a moderate cost to increase an edge over contenders. Sheet metal stepping assumes a significant job in satisfying the prerequisites of current innovation. The structure of press devices by PC reproduction will be exceptionally useful to dissect process appraisal abilities and consequently sparing part of uses by maintaining a strategic distance from rehashed and exorbitant tryouts currently supplanted numerous segments which were prior cast or machined. Material economy and the resultant decrease in weight and cost, high efficiency, utilization of incompetent work, and a high level of conceivable exactness have rendered presswork vital for some large scale manufacturing merchandise, for example, electronic machines, steel furniture, utensils, car and other assembling ventures. For example, the whole top of a vehicle can be done to measure from a solitary sheet metal and there is no requirement for additional machining as on account of castings or forgings.

Plan of thermostat switch includes the ideas of sheet metal cutting activities and planning dies for large scale manufacturing to create the part. It includes total investigation on kinds of activities that are performed for molding the sheet metals, dies, material and choice of springs. Molding sheet metal in to completed switch includes deciding the die cutting activities and making a succession of those tasks by considering the switch drawing, deciding dies, planning the strip spread out and structuring dies for the completed item. The structure of metal stepping dies is a complex and exceptionally specific methodology and ordinarily it takes 20% of the lead-time from the idea plan to the last stepping fabricate. The differing idea of items created by stepping die requests a significant level of information with respect to the die designer that must be accomplished through long stretches of viable experience. The information picked up by die plan specialists after long periods of experience is regularly not accessible to other people.

The Modeling and Assembly in all apparatus components are done in CATIA V5. This included creation the demonstrating, drawings of get together, drawing of individual device components and so forth. CATIA is a 3D displaying programming for demonstrating and assembling of entangled shapes and parts. Progressed and refined highlights of CATIA programming empowers to display the moment details of the parts without hardly lifting a finger. Die configuration is the starter organize in stepping die fabricating once the item configuration is finished. Die configuration organize is extremely basic, a great die configuration can create exact segments which can run for long time with less support, it includes choosing the required stepping activities, fundamental design, machining forms, kind of stepping presses to be utilized and so on. A die originator ought to have exhaustive information about these components to make a decent die plan. PC supported structure innovation has grown truly well during a decade ago to help die creators. Economically accessible CAD/CAM frameworks are giving help with drafting and analysis in die structure. With the headway in the zone of PC illustrations, CAD/CAM and Artificial Intelligence (AI), a few specialists began to misuse these strategies for the plan of metal stepping dies. Simulated intelligence is the investigation of how to cause PCs to perform savvy things for the preparing of unstructured dissipated information for the arrangement of complex issues.

II. LITERATURE REVIEW:

So as to grow better simultaneousness among plan and assembling of metal stepping die, a stamp capacity appraisal or assessment is vital. As an initial phase in the anticipating production of a sheet metal part, it is helpful to check its interior just as outside highlights for surveying its manufacturability on stepping die, such checks are valuable to abstain from assembling abandons, area shortcoming, and need of new dies, apparatuses or machines. De Sam Lazaro etal [1] Developed a Knowledge-based master framework utilizing standards of gathering innovation for multi-stage shaping procedure for include acknowledgment, material choice, clear assurance, ideal sequencing of tasks, device and machine choice. Nakahara et al. [2] Introduced a dynamic die structure framework that analyzes the part plan information to choose whether blanking can stamp it or not and they built up an information based framework for distinguishing configuration rule infringement to improve part manufacturability. Duffey and Sun. [3] From University of Massachusetts portrayed a proof-of idea framework for dynamic die plan for basic pivot part. The framework was actualized utilizing information gathered from manufacturability information, industry specialists and standard die parts; the framework creates level example geometry and builds up a strip design consequently. Shpitalni and Sadda.[4] Addressed the issue of programmed device choice and bowing arrangement assurance utilizing chart search heuristics. Cheok et al. [5] From National University of Singapore have answered to build up a wise dynamic die (IPD) plan framework. They utilized different AI methods, for example, include based demonstrating, rule-based methodology and spatial thinking to work piece shape portrayal, shape acknowledgment and decay, and die segment portrayal for die plan computerization. Xie et al. [6] Developed a compound cutting and punching creation technique for little and medium size sheet metal businesses. The framework utilizes simultaneous and worldwide plan and assembling conditions by coordinated information reconciliation stage dependent on Pro/INTRALINK and STEP, and an information based continuous CAPP (RTCAPP) framework into existing CAD framework. Prasad et al [7] Developed a PC helped die plan framework (CADDS).The framework is proficient to create strip-format naturally, direct structure checks for different die segments, and produce the get together perspectives and bill of materials for the blanking die. This framework is created by interfacing AutoCAD with Auto LISP. Ismail et al. [8] dealt with plan mechanization for dynamic penetrating and blanking dies. Their work depends on applying a coding system to portray the stepped part geometric highlights, which is thusly used to produce the sort and design of the die punches, and afterward built up the strip format naturally. Dequan et al. [9] introduced a complete audit of information based framework utilized in stepping arranging. They introduced a structure of CAD framework that completes mechanized procedure getting ready for penetrating activity of exactness work at a rapid and furthermore built up a coordinated framework utilizing FEM reproduction and fake neural system (ANN) to rough the elements of plan parameters and assess the exhibition of die plans before die tryout. Kumar et al [10] Developed a clever framework for determination of dynamic die segments. The framework modules are proficient to decide type and appropriate elements of dynamic die parts to be specific die square, die gages (front spacer and back gage), stripper, punches, punch plate, back plate, die-set and latches. This framework is created utilizing rule-based methodology of AI and it is coded in Auto LISP language. Gupta et al [11] depicted a procedure arranging framework for automated sheet metal twisting press. The framework consequently decides twisting arrangements, determination of punches and dies and assembling costs and so on and offers input to improve the arrangement on activity by-activity premise. Dequan et al [12] introduced an extensive audit of information based framework utilized in stepping arranging. They presented a frame work of CAD system that carries out automated process planning for piercing operation of precision work at a high speed.

III. DESIGN METHODOLOGY:

Precise system followed for die making:

1) Investigation of Basics of Die making.
2) Analysis of the subtleties of the segment gave.
3) Investigation of material qualities of the part
4) Posting the kind of apparatuses to be planned.
5) Clear opening up estimations of the part.
6) Power/Tonnage estimations
7) Structuring and deciding the elements of the individual pieces of the instrument.
8) 2-Dimensional and 3-Dimensional displaying of the considerable number of parts of the devices, collected apparatuses.
9) Setting up the last Bill of Material arrangements of the apparatuses structured.

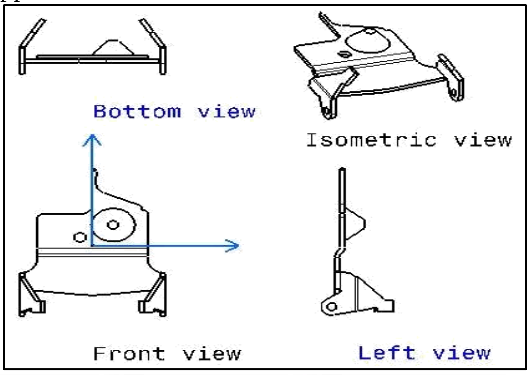

Fig. 1: Thermostat Design

A thermostat is a gadget for naturally working an electrical changing system because of detected changes in temperature. Switches are utilized in the switch instrument of thermostat. These gadgets have a detecting component situated remotely from the electrical exchanging system. A model would be gadgets having a remote detecting component for detecting freezing conditions in a gadget, for example, a fridge or cooler, with exchanging instrument found exteriorly of the freezing compartment. The switches are produced using CRCA STEEL-Low Carbon Steel Composition. The properties is seen in the beneath table.

Table I: Properties of Low Carbon Steel

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, because of unique combination of strength & toughness after heat treat treatment.

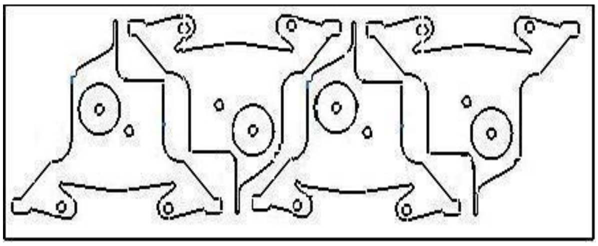
Fig. 2: Strip layout

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. 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.

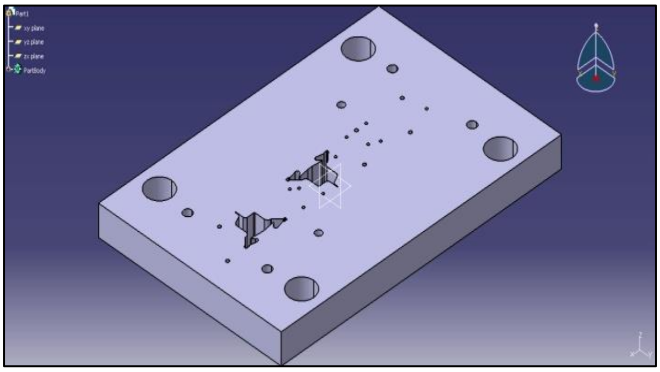

Fig. 3: Bottom bolster

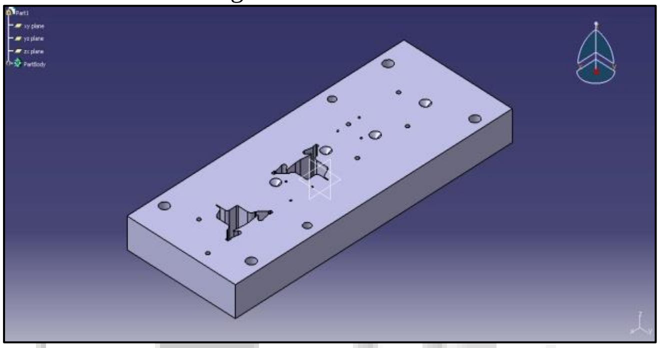

Fig. 4: Die plate

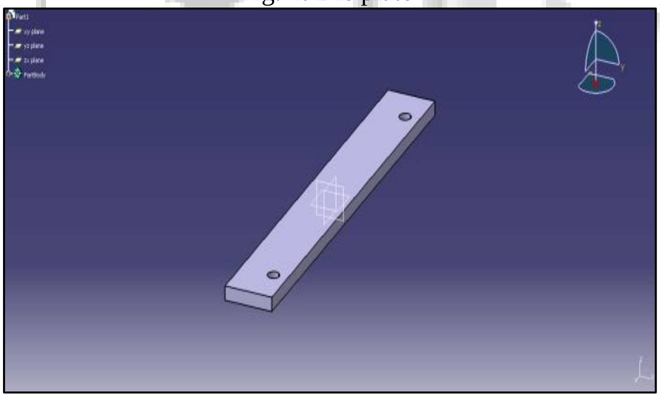

Fig. 5: Guide plate

IV. DESIGN CALCULATIONS:

To determine the Blank length, bend allowance ‘P’ is to be determined for each bend. The blank length is estimated as sum of lengths ‘L’ of the bend legs and the allowances.

B = L1 + P + L2; where ‘P’ is called the bend allowance (= (R+C) 2*Π*N/ 360).

N = angle of bend

R = Bend radius (Internal radius need to be taken)

C = Distance from the inner surface to the neutral plane.

‘C’ is a variable factor depending largely upon the Ratio of stock thickness ‘T’ to the bend radius ‘R’. Optimum value for ‘C’ may be considered to be, the dimensions of the blank obtained are always considered the tentative values and not the exact values as they may be changed as per the convenience after testing the forming tool operation on the blank which is tested.

1) Material- S.S-304 AISI-304
2) Thickness of the stock= 1.6mm
3) Component area=1045.522 mm2
4) % of strip used $= \frac{\text{Area of compound}*4}{length\ iof\ istrip*width\ iof\ istrip}$
   $= \frac{598.29*4}{117.9*30}$
   $= 68\%$
5) Shear force =K L t S_{sh} /1000 tons
   Where K is a constant =1.1 to 1.5 (based on clearance)
   L =length of cut in mm
   t =thickness of stock in mm
   S_{sh} =shear strength of material Kg/mm^2
6) Shear force = 1.5x1032.972x0.2x40/1000 =12.39tons.
   Stripping force =10% of shear force
   i. =10x12.39/100
   ii. =1.23tons.
7) Total force=shear force + stripping force
   i. =12.39+1.23
   ii. = 13.6293tons
8) Press tonnage=1.2xtotal force
   i. =1.2x13.629
   ii. =16.35tons
   iii. =17tons.
9) Thickness of the die plate (td) = 3√ F_{sh}
   Where F_{sh}=shear load in tons
   td = 3√12.39
   a. = 2.314cm
   b. = 24mm
   Die thickness selected =24mm
10) Thickness of the punch holder=0.5xtd
    a. =0.5x24
    b. =12mm
11) Thickness of bottom plate (tb) = 1.5xtd
    a. =1.5x24
    b. =36mm
12) Thickness of top plate (tp) =1.25xtd
    a. =1.25x24
    b. =30
    Thickness of top plate selected =30mm
13) Thickness of stripper plate (ts) =0.5xtd
    a. =0.5x24
    b. =12mm
    ii. Thickness of stripper plate selected=12mm
14) Cutting clearance =4% of sheet thickness
    i. =0.04xo.2
    ii. =0.008mm/side
15) Blank punch size=size of blank die -2 c
    i. =27.6-2x0.2x6/100
    ii. Where, c=6% of thickness of wall
        1. =27.6-0.024
        2. =27.576mm
16) Cutting force=Tl x D x t x fs

=3.14x29.1x0.2x40
=735.65 N

1) *Blanking die:*
Δ= FL^3 / (192E I)
F= 80%OF CUTTING FORCE = 0.8* 735.65N = 588.2 N
L=312
E=210000MPa=2.1*105N/MM2
I=bh^3 / 12 b=122mm, h=30mm.
I=122*27000 / 12 = 274500.
Δ= 588.52 * 312^3 / 192* 2.1* 10^5* 274500
=0.001614961 = 16.14µm = 0.01614* 10^-6 mm

2) *STRESS: DIE BLOCK*
σ = F/A = 588.52 / 122*30 = 0.1607978 N /MM^2
Bending punch:
S cn=cutting force / cross sectional rea of punch
P b= 123.1 N
A=28*60*53 mm^2 E=2.1*10^ N/mm^2
L=60 mm.
Depth =53, breadth=28
S cn=123.1 / 89040. =0.00138=13.8*10^
Δ= FL^3 / (192E I)
L=60 mm.
Δ=0.18364 mm

3) *Stress: Bending Punch*
σ = F/A = 588.52 / 28*53 = 588.52 / 1484 =0.3976486 N /MM^2

4) *Bending calculations:*
Bending force of "U" bending
$F_b = (C \times bs^2 \times \sigma)/w$
$= 1.026 \times 4.176 \times 400/30$
= 64.514mm
Punch radius = 2.72m
Die punch = 2.72S
$= 2.72 \times 0.2$
= 0.544
Where
C = constant; B = width of bend; S = sheet thickness; σ = ultimate tensile stress; R1 = Die Radius; R2 = Punch Radius;
Bending force = $(C \times bs^2 \times \sigma)/ 2(R1+C_b+R2)$
C_b= bending clearance
$W/2 = R1+R2+C_b$
$30/2 = 2.72+.544+ C_b$
$C_b = 4.595$
Bending force = $(C \times bs^2 \times \sigma)/ 2(R1+Cb+R2)$
$= (1.026 \times 4.716 \times 400)/2(0.544+4.595+2.72)$
= 123.13 N
Pressure = Force/Area
= 123.13/1440
= $0.0855 N/mm^2$

V. STRUCTURAL ANALYSIS:

1) *Blanking punch (die block):*
Material S.S-304
Material properties:
E=210000Mpa
Poisson's Ratio= 0.33
Density = $7850 Kg/m^3 = 0.00000785\ Kg/mm^3$
Analysis Procedure:
Set Units - /units, si, mm, kg, sec, k
File- change Directory-select working folder
File-Change job name-Enter job name
Select element-Solid-20 node 95

2) *Bending Punch*
Material S.S-304
Material properties:
E=210000Mpa
Poisson's Ratio= 0.33
Density = $7850 Kg/m^3 = 0.00000785\ Kg/mm^3$
Analysis Procedure:
Set Units - SI, mm, kg, sec, k
File- change Directory-select working folder
File-Change job name-Enter job name
Select element-Solid-20 node 95

Structural Analysis of Blanking Die:

Material	Displacement(mm)	Stress(N/mm^2)	Deflection(mm)
S.S	0.279E-05	0.491673	0.348E-06

Structural Analysis of Bending Punch

Material	Displacement (mm)	Stress(N/mm^2)	Deflection(mm)
S.S	0.157e-05	0.213643	0.149e-06

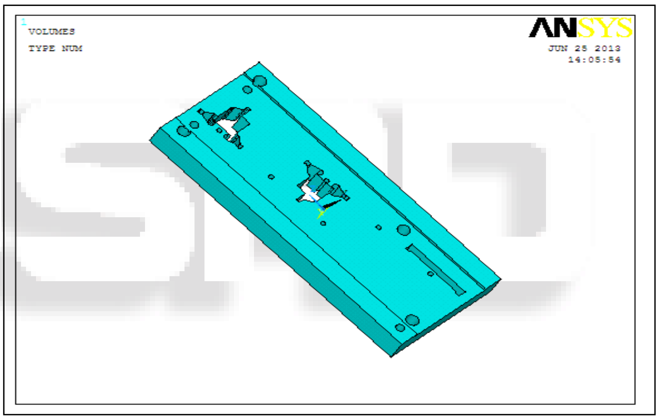

Fig. 6: Imported model

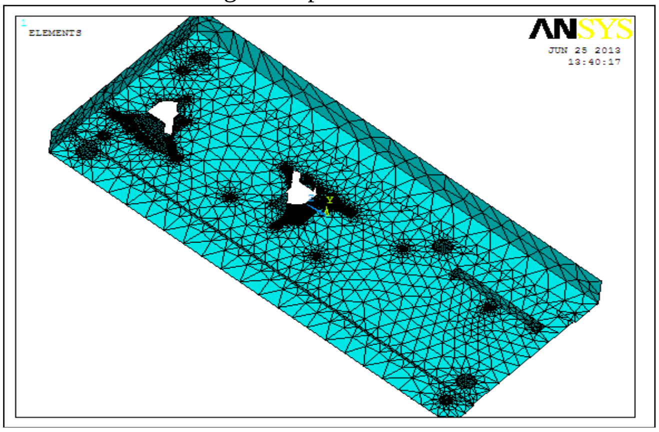

Fig. 7: Meshed model

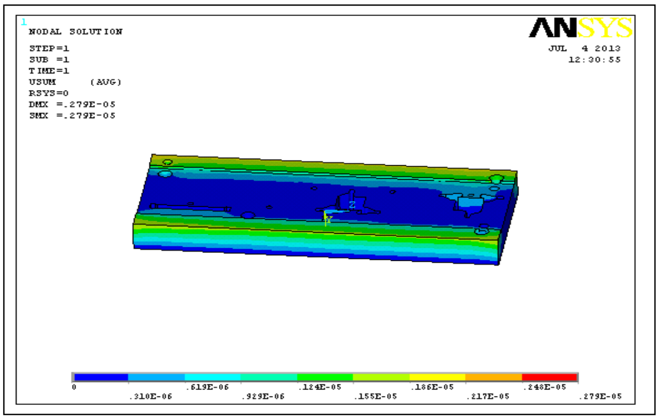

Fig. 8: Finished model

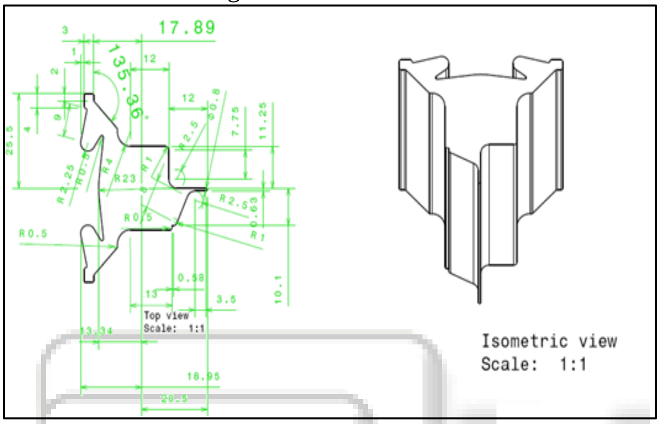

Fig. 9: Blank punch

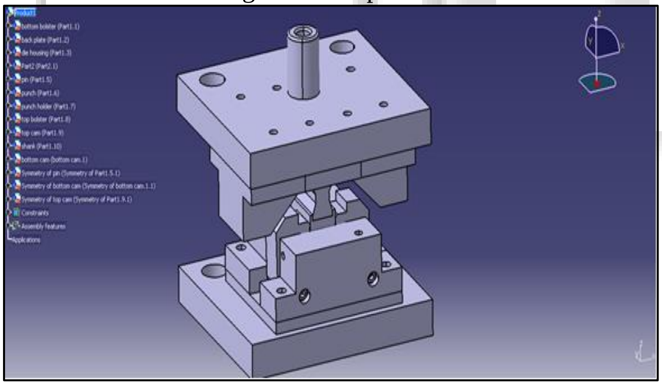

Fig. 10: Bending die assembly

VI. RESULT AND DISCUSSION

The successful manufacture of 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 for both theoretical and software analysis as well at any results of stress and strain.

Part Name	Die Plate		Analysis Result	
	Stress	Deflection	Stress	Deflection
Die plate	0.1607978	0.016e-06	0.49163	0.348e-06

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

VII. CONCLUSIONS

The individual segments of dynamic instrument were demonstrated in CATIA V5-R21. Every individual record was imported to Ansys12.0 programming through Initial Graphics Exchange Specification (IGES) group. The accompanying ends were made.

- The outcomes acquired through analysis are around closer to the hypothetical qualities. This exhibits the analysis did was right.
- It is additionally seen that the plan of dynamic device is protected as all the pressure esteems were not exactly the passable worry of the material.
- Powers are determined when blanking and bowing activities are finished. The press tonnage determined
- is 17tons, power to shear is 12.39tons, and stripping power is 13.6293tons.
- The weight delivered while banking is 0.102N/mm2 and keeping in mind that twisting is 0.0855N/mm2.

VIII. FUTURE SCOPE:

In this way, there is have to build up a smart framework by joining some appropriate AI method and CAD framework for manufacturability evaluations/thinking, simultaneous arranging and fast plan of multi-activity dies. The framework must have rich information base involving information on experienced die fashioners and procedure organizers, must be intuitive and easy to use and have ease of usage. The framework at long last should give its yield in type of drawings of strip-design, die segments and die get together. The creators are applying their exploration endeavors toward this path to help process organizers and die originators of little and medium scale sheet metal businesses.

REFERENCES

[1] Prabhakar Purushothaman, Prashanth Thankachan. Design and Analysis of Piercing Tool with Special Purpose Hydraulic Press. American Journal of Mechanical and Industrial Engineering. Vol. 1, No. 3, 2016, pp. 31-37. doi: 10.11648/j.ajmie.20160103.11
[2] Prof. Dr.-Ing. Dr. h.c. Klaus Siegert and Dipl.-Ing. M. Vulcan "Tool and Die Design for Deep Drawing AHSS"IFU Stuttgart University Institute for Metal Forming Technology available athttp://www.autosteel.org/~/media/Files/Autosteel/Great Designs in Steel/GDIS 2005/13 - Tool and Die Design for Deeping Drawing AHSS.pdf.
[3] Prabhakar Purushothaman"ypes of press tools"ikipedia article available at
[4] https://www.researchgate.net/publication/264982108_Types_of_press_tools.
[5] Online Formula for press Tool Design, available athttp://www.wisetool.com/formular/formula.htm.
[6] Dheeraj Gunwant and Anadi Misra"Topology Optimization of Sheet Metal Brackets Using ANSYS"MIT International Journal of Mechanical Engineering Vol. 2, No. 2, Aug. 2012, pp. (120-126) ISSN No. 2230-7680 © MIT Publications.

[7] Dr. Prashanth Thankachan Mr. Prabhakar Purushothaman"Optimum Material and Process Modification to Reduce Lead Time of Pedestal Manufacturing Used in Gearbox Assembly"International Journal of Engineering Research and Technology (IJERT) Vol. 3 issue 02, February 2014, ISSN 2278–0181.
[8] Fluid Power Formulaavailable at
[9] http://hydraulicspneumatics.com/site-files/hydraulicspneumatics.com/files/archive/hydraulicspneumatics.com/Content/Site200/ebooks/01_01_2006/80281Ch22IFPBFo_00000052653.pdf.
[10] Prabhakar Purushothaman"Design, Analysis and Simulation of Hydraulic Circuit"technical report DOI: 10.13140/2.1.3202.2404 Add to Citavi project by DOI available at https://www.researchgate.net/publication/265048287_Design_Analysis_and_Simulation_of_Hydraulic_Circuit.
[11] Gashaw Desie, Yonas Mitiku, Progressive Die Design for Self Explosive Reactive Armor Holder (Case Study at Bishoftu Motorization Industry-Ethiopia), the International Journal of Engineering and Science (IJES),Volume 3, Issue 3 Pp 75-86, 2014.
[12] Joti Bhaskar, G Sathya Prakash, "Die design and analysis of progressive tool for can lid lever," International Journal of Research in Engineering & Advanced Technology, Vol. 1, Issue 4, Aug-Sept. 2013