Progressive Tool Design and Analysis for 49 Lever 5 Stage Tools

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Abstract: A progressive die performs a series of fundamental sheet-metal operations at two or more stations during each press stroke in order to develop a work piece as the strip stock moves through the die. The main advantage of computer-aided progressive die design and machining is ability to build precision tooling in less time and at a lower cost. In this project main steps are Design, manufacturing and FEA analysis. This design is the optimal design. By using this design we can produce accurate components. First step is manufacturing process. For manufacturing 49 lever 5 stage tool, manufacturing process is press tool design. Two tools are to be designed i.e. Punching tool and Bending tool. Punching tool is a progressive tool which is having five stages, Lancing, blanking, forming.

Keywords- Progressive tool, punching tool, bending tool, Lancing, blanking, forming, and punching force, ANSYS.

I. INTRODUCTION

Design of sheet metal dies is a large division of tool engineering, used in varying degree in manufacturing industries like automobile, electronic, house hold wares and in furniture.

There is no doubt that accuracy achieved by the new ideas in design and construction applied by the press tool designer, coupled latest development made in related fields made more productive, durable and economical.

These are

- ❖ The variety in press specification gives the liberty to the designer to think innovative.
- ❖ The latest machining process made the complex designs made easy, like wire cut, EDM, Profile Grinding.
- ❖ The Safety Provisions has reduced the accidents and the productivity has been increased.
- ❖ “Simulation Software’s” give the designer freedom from taking risky decisions.
- ❖ The use and availability of Standard Elements has reduced the design and development period
- ❖ The concept of “Flexible Blank Holder” has given the scope to control the flow of the material in a better way.
- ❖ Hardened and toughened new martial & heat treatment process made the design easy.

Four factors are essential contributions to first class presswork are

- Good operation planning
- Excellent tool design
- Accurate tool design

- Knowledge press setting

II. PROGRESSIVE TOOL

Progressive tool performs two or more operations at different stages in each stroke. The stock strip is advanced through a series of stations that form one or more distinct press working operations on the strip to get the component.

III. COMPONENT ANALYSIS

Material	: S.S-304
Thickness	: 1 mm
Temper grade	: Hard
Supply condition	: Strips

PROPERTIES

- These steel have good corrosion resistance.
- These steel have good ductility.
- These steel have non-magnetic character.
- These steel are mainly used for domestic vessel, medical equipment non magnetic character due to NI.

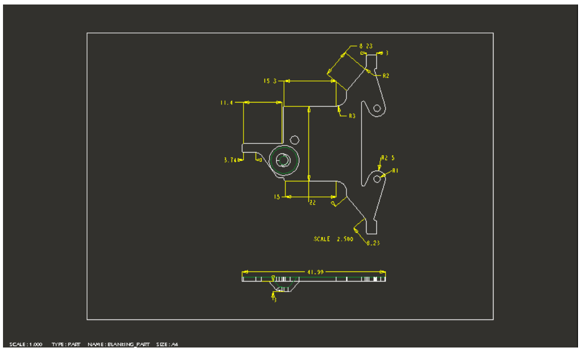
IV. DESIGN CALCULATION

Component Data

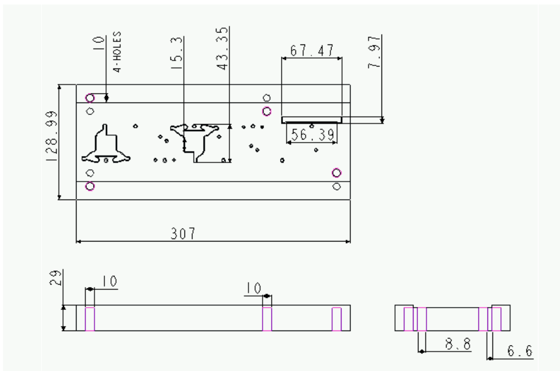
Material	: S.S-304
Thickness	: 1 mm
Temper grade	: Hard
Supply condition	: Strips

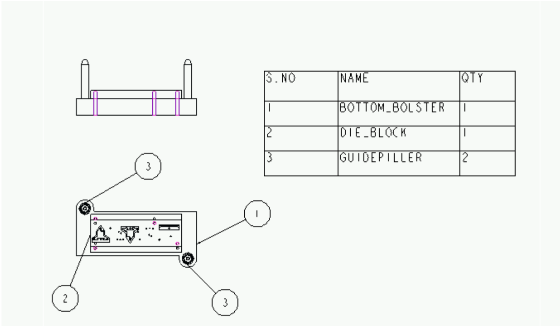
Die Assembly

Component Diagram

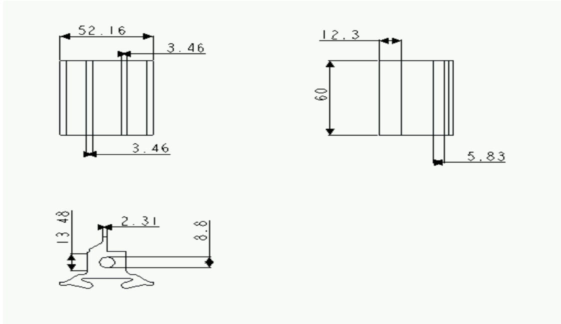


Die Block

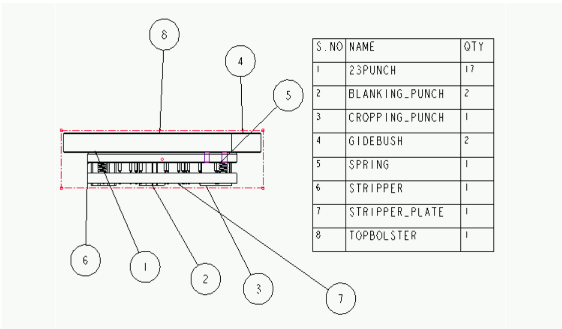




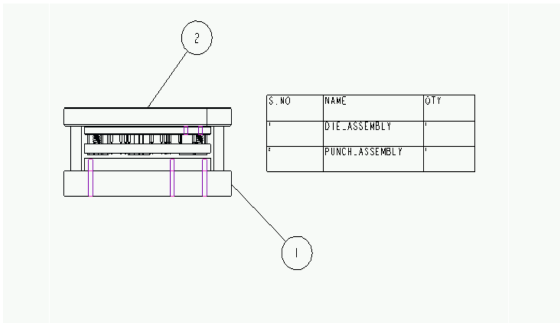
Blanking Punch



Punch Assembly



Total blanking tool assembly



TOOL SPECIFICATION	
PRESS CAPACITY	40 TONES
TYPE OF PRESS	MECHANICAL
STRIP WIDTH	30.00 MM
CLEARANCE	0.008 /SIDE
TYPE OF DIE SET	REAR AND FRONT PILLER
TYPE OF STRIPPER	SOLID TYPE
METHOD OF FEEDING	MANUAL
TYPE OF STROKE	FIXED
NO. OF SLIDE	SINGLE ACTION

V. DESIGN CALCULATIONS FOR LEVER COMPONENT

Material- S.S-304 AISI-304

Thickness of the stock= 0.2mm

Component area=1045.522 mm^2

% of strip used = (Area of component*4) (/length of strip*width of strip)

= (598.29 *4)/(117.9*30)

% of strip used = 0.6842*100 = 68%

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

Shear force =1.5x1032.972x0.2x40/1000

=12.39tons

Stripping force =10% of shear force

=10x12.39/100

=1.23ons

Total force=shear force + stripping force

=12.39+1.23

= 13.6293tons

Press tonnage=1.2xtotal force

=1.2x13.629

=16.35tons

=17tons

Thickness of the die plate (td) = $3\sqrt{F_{sh}}$

Where F_{sh} =shear load in tons

td = $3\sqrt{12.39}$

= 2.314cm

=24mm

Die thickness selected =24mm

Thickness of the punch holder=0.5xtd

=0.5x24

=12mm

Thickness of bottom plate (tb) = 1.5xtd

=1.5x24

=36mm

Thickness of top plate (tp) =1.25xtd

=1.25x24

=30

Thickness of top plate selected =30mm

Thickness of stripper plate (ts) =0.5xtd

=0.5x24

=12mm

Thickness of stripper plate selected=12mm

Cutting clearance =4% of sheet thickness

=0.04xo.2

=0.008mm/side

Blank punch size=size of blank die -2 c

=27.6-2x0.2x6/100

Where , c=6% of thickness of wall

=27.6-0.024

=27.576mm

Cutting force=πxDxtxfs

=3.14x29.1x0.2x40

=735.65 N

BLANKING CALCULATIONS

Clearance=C×S×√Tmax/10

Where c is constant = 0.005 for very accurate components

= 0.01 for normal component

S = Sheet Thickness in mm

Tmax = shear strength of stock material in N/mm^2

Clearance= C×S×√T_{max}/10

= 0.008×0.2×√12.39/10

= 0.00178 mm/side.

Blanking Punch Dimensions = ν27.6 – (2×0.0017)

= ν 27.59mm

Blanking Die Dimensions = ν 27.6mm

Blanking Punch Size = Blank Size – Total Clearance

= 27.59 -.00178

= 27.588mm

Cutting force = L×S×T_{max}

Where L = Length periphery to be cut in mm = 1032.97mm

S = Sheet Thickness in mm

T_{max} = Shear strength of stock material in N/mm^2

Cutting force = L×S×T_{max}

= 1032.97×0.2×12.39

= 2559.7N

Pressure = Force/Area

= 2559.7/25062.3

= 0.102 N/mm^2

BENDING CALCUALATIONS

Bending force of "U" bending

Fb = (C × bs^2×σ)/w

= 1.026×4.176×400/30

= 64.514mm

Punch radius = 2.72mm

Die punch = 2.72S

= 2.72 × 0.2

= 0.544

Where C = constant

B = width of bend

S = sheet thickness

= ultimate tensile stress

R1 = Die Radius

R2 = Punch Radius

Bending force = (C×bs^2×σ)/ 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 = $(C\times bs^2\times\sigma)/ 2(R1+Cb+R2)$

$= (1.026\times4.716\times400)/2(0.544+4.595+2.72)$

= 123.13 N

Pressure = Force/Area

= 123.13/1440

= $0.0855 N/mm^2$

VI. STRUCTURAL ANALYSIS

The objective of the analysis of the functional elements like die set, die plate, punches, stripper plate, guide pillar and guide bush are include structural analysis to estimate the deflection and stresses.

BLANKING PUNCH (DIE BLOCK)

STEEL

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

Analysis models

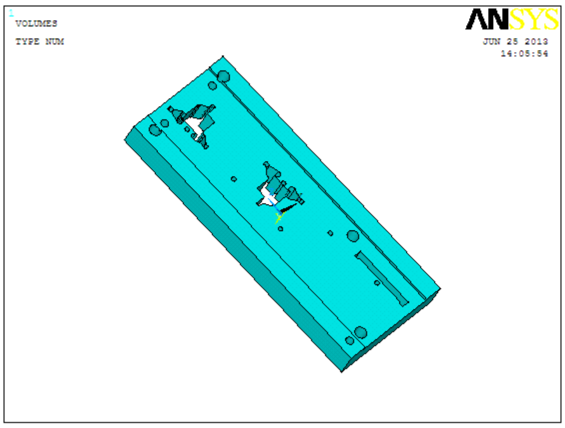


Fig: Imported model

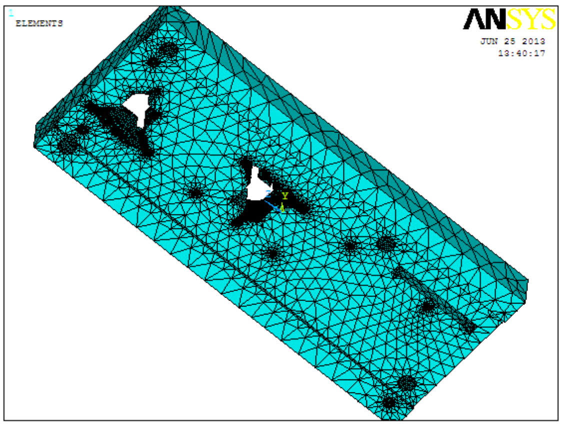


Fig: Meshed model

Loads

Select loads →Define loads→Apply loads→Structural→displacement→On areas

Select ALL DOF→Ok

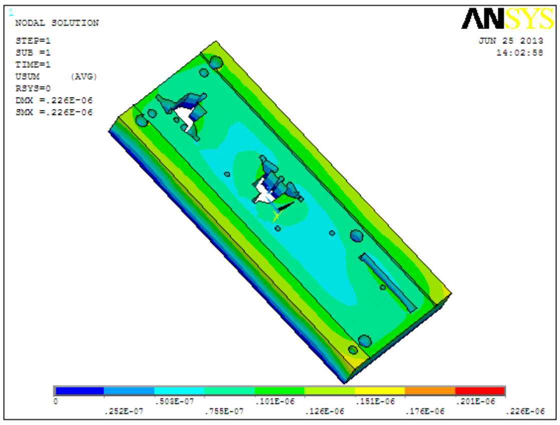
Select Pressure→On Areas→7.909N/mm^2

Solution

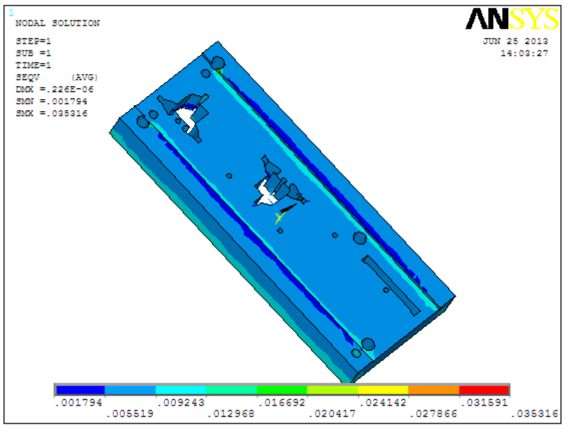
Solution – Solve – Current LS – ok

Post Processor

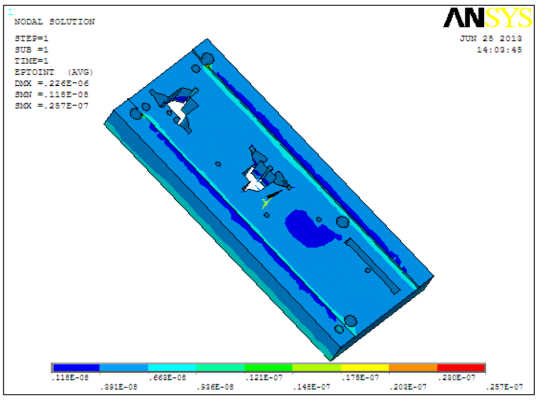
General Post Processor – Plot Results – Contour Plot - Nodal Solution – DOF Solution – Displacement Vector Sum.



General Post Processor – Plot Results – Contour Plot – Nodal Solution – Stress – Von Mises Stress.



General Post Processor – Plot Results – Contour Plot – Nodal Solution – Total Strain Intensity



BENDING PUNCH

MATERIAL-STEEL

Material properties

E=210000MPa

Poisson's Ratio= 0.33

Density = 7850Kg/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

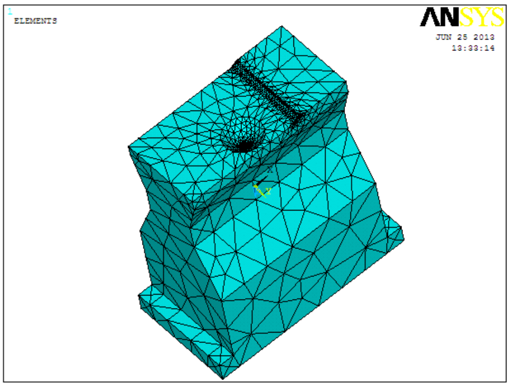


Fig: Meshed model

Loads

Select loads →Define loads→Apply loads→Structural→displacement→On areas

Select ALL DOF→Ok

Select Pressure→On Areas→0.0855N/mm^2

Solution

Solution – Solve – Current LS – ok

Select element-Solid-20 node 95

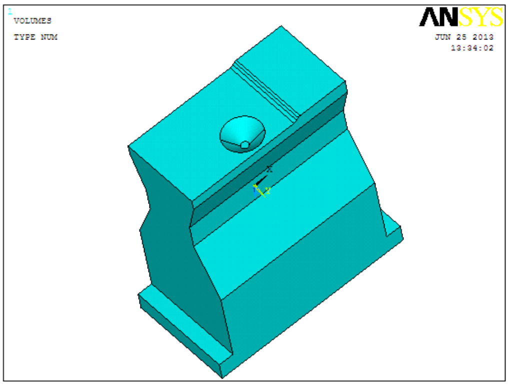
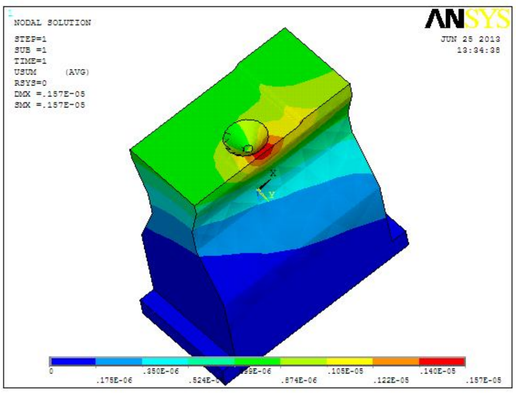


Fig: Imported model

Post Processor

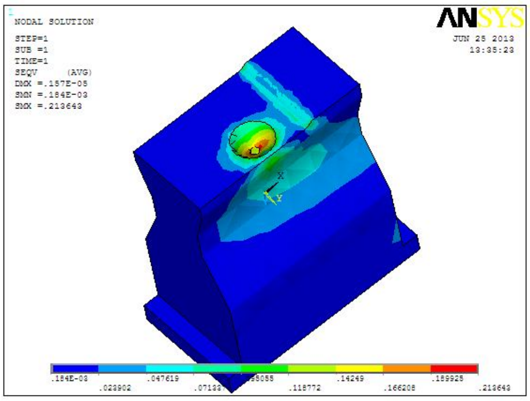
General Post Processor – Plot Results – Contour Plot - Nodal Solution – DOF Solution – Displacement Vector Sum.

DISPLACEMENT VECTOR SUM



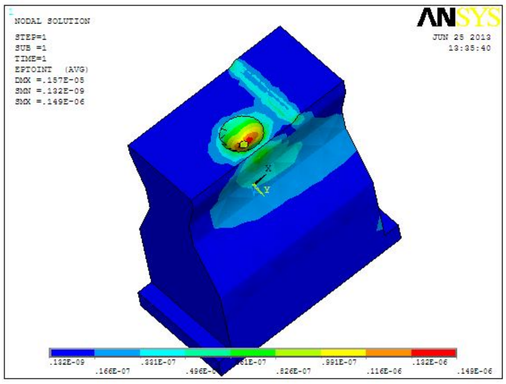
General Post Processor – Plot Results – Contour Plot – Nodal Solution – Stress – Von Mises Stress.

VON MISSES STRESS



General Post Processor – Plot Results – Contour Plot – Nodal Solution –Total Strain Intensity

TOTAL STRAIN



VII. RESULTS

STRUCTURAL ANALYSIS OF BLANKING DIE

	Displacement(mm)	Stress(N/mm^2)	Total Strain	Permissible Yield Stress (N/mm^2)
STEEL	0.226e^{-06}	0.35316	0.257e^{-07}	450

STRUCTURAL ANALYSIS OF BENDING DIE

	Displacement(mm)	Stress(N/mm^2)	Total Strain
STEEL	0.157e^{-05}	0.123643	0.149 e^{-06}

VIII. CONCLUSION

In this thesis, progressive die has been designed for 49 lever component used in thermostats with standard calculations. The modeling of progressive die is done using Pro/Engineer package. The component can be produced with accurate dimensions.

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

The pressure produced while banking is 0.102N/mm^2 and while bending is 0.0855N/mm^2.

Every step has taken to distribute the stresses evenly so as to provide the set with adequate strength to resist cutting force.

Structural analysis is done on the blanking punch and bending punch to determine the strength of the progressive die.

By observing the results, the stress values for both are less than the respective yield stress value of steel. So our designed safe is under given load conditions.

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