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Design and Analysis of Progressive tool in Sheet metal manufacturing

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Abstract : *Design and development of Progressive tools for the sheet metal component is one important phase in sheet metal manufacturing. Sheet metal press working process by progressive tools is a highly complex process that is vulnerable to various uncertainties such as variation in progressive tools geometry, strip layout, die shear, material properties, component and press working equipment position error and process parameters related to its manufacturer. These uncertainties in combinations can induce heavy manufacturing losses through premature die failure, final part geometric distortion and production risk.*

Keywords *– Progressive die, FEA, Sheet metal*

I. INTRODUCTION

The progressive die performs a series of fundamental sheet metal working at two or more stages during the press running to produce a production part as the strip stock moving through the die surface. Press working from the optimum dies design and its making has been the purpose of mass production in the manufacturing field. The design and manufacture of press tools, or punches and dies, is a branch of production technology that has extended into many lines of engineering manufacture over the past seventy years. There is no doubt that the accuracy achieved by new ideas in design and construction applied by the press tool designer, coupled with increased speed and rigidity of the presses etc, used have all contributed towards maintaining this form of metal tooling well to the force as a means of obtaining pleasing, yet strong, durable articles that can withstand severe day-to-day usage. Four factors are essential contributions to first-class press work. 1. Good operation planning 2. Excellent tool design 3. Accurate tool making 4. Knowledgeable press setting According to upper factors, this paper is aimed at the optimum die design through the FE analysis, Pro-E. Furthermore the aim of least defects could be obtained mostly by revision through the tryout.

II. PROGRESSIVE TOOL AND COMPONENT ANALYSIS

Progressive tool performs two or more operations at different stages in each stroke. In a progressive tool the raw material is worked at different station to finally fabricate the component. A progressive tool is a lucrative tool for mass production of components. A lot of automobile and other transport industries develop progressive tool for the production of components. The design of tool involves lot of planning and the same amount of skill of process planning is required in the fabrication of the tool. The design also involves use of thumb rules and standard elements as per experience gained in practice. Manufacturing the press tool is a laborious task as special jigs and fixtures have to be designed for the purpose. Assembly of all the press tool elements is another task where use of accurate measuring instruments for alignment of various tool elements is important. In the present study, design and fabrication of progressive press tool for production of washer has been developed and the press tool has been tried out on a mechanical type of press. The components produced are to dimensions.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. Material: Mild Steel (St-42) Thickness: 2 mm Shear strength : 35kg/mm2 Temper grade : Hard Supply condition : Strips Geometry tolerance : IS210

PROPERTIES: - It has a bright and fine finish. It can withstand heavy loads, as it is tough. Welding of this material does not change its chemical structure. It has a scale free material. Fine or bright for electroplating.

III. METHODOLOGY

3.1 Design Calculation: -
3.1.1 Component data
Material: mild steel (St-42)
Supply conditions: strips Temper grade: hard Shear stress: 35 kg/mm^2
Geometry tolerance: IS2120

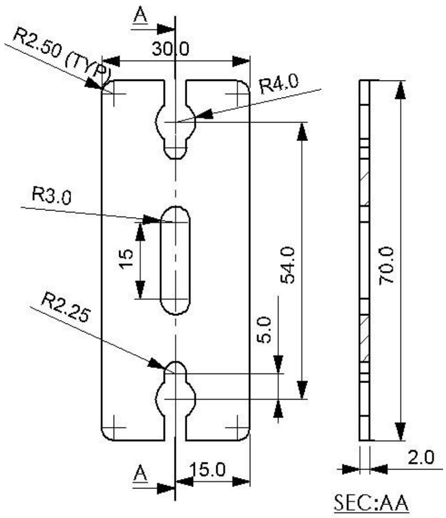

Fig. 3.1 Component Diagram

3.1.2 Progressive tool detail drawing: -

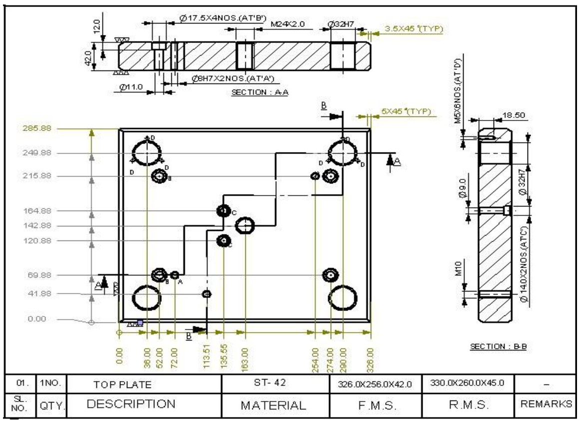

Fig.3.2 Detailed drawing of top plate

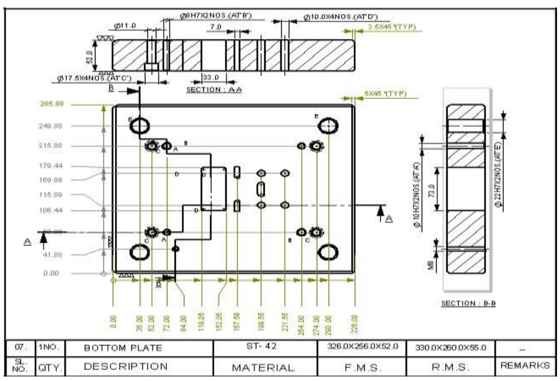

Fig.3.3 Detailed drawing of bottom plate

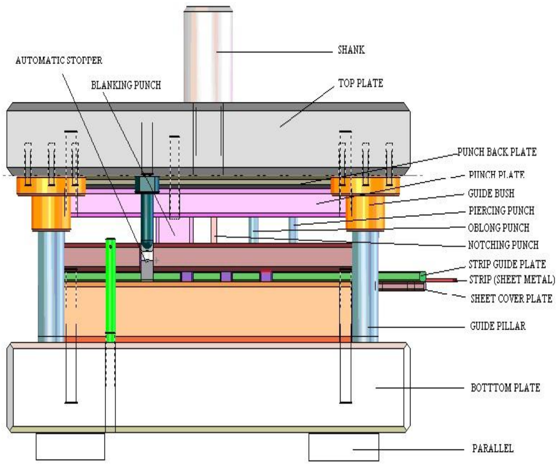

Fig.3.4 Assembly drawing of Progressive tool

TABLE. 3.1 Tool Specification

TOOL SPECFICATION	
PRESS CAPACITY	40 TONES
TYPE OF PRESS	MECHANICAL
PITCH	32.00 MM
STRIP WIDTH	74.00 MM
CLEARANCE	0.06 MM/SIDE
SHUT HEIGHT OF THE TOOL	190.00 MM
DAYLIGHT OF THE TOOL	96.00 MM
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

3.2 Theoretical deflection and stress Calculation

3.2.1 Die Block:-

Assuming that the die block (die plate) is considered to be as fixed beam. The shoe deflection is calculated using the strength of material formula for fixed supported beam,

Deflection, $\delta = FL^3/192EI$

Where, F = 80% of cutting force = 0.8 x 26177.41 kgf = 209419.3 N

L = 222 mm, $E = 2.1 \times 10^5$ N/mm^2

$I = bh^3/12 = 6.29 \times 10^6$ mm^4 Where, b = 176 mm, h = 35 mm $\delta = (209419.3 \times 222^3)/(192 \times 2.1 \times 10^5 \times 6.29 \times 10^6)$

3.2.2 Top Half:-

Top half includes as for calculation and analysis purpose as top plate, punch back plate and punch plate. Assuming that the Top plate is considered to be on parallels. The shoe deflection is calculated using the strength of material formula,

deflection, $\delta = FL^3/48EI$

Where, F = 80% of cutting force

= 209419.3 N

L = 254 mm,E = 2.1 x 10^5 N/mm^2
I=bh^3/= 6.85 x 10^6 mm^4 Where, b= 286 mm,h= 66 mm δ=(209419.3x254^3)/(48x2.1x10^5x6.85 x 10^6)
= **4.97 µm**
Stress, p=F/A
=**9.73 x 10^6 N/**

3.2.3 Bottom Plate:-

Assuming that the bottom plate is considered to be on parallels. The shoe deflection is calculated using the strength of material formula for parallels supported beam,

Deflection, δ = FL^3/354EI

Where, F=80% of cutting force = 209419.3 N
E = 2.1 x 10^5 N/mm^2
I=bh^3/12=3.35 x 10^6 mm^4 Where, b = 286 mm,h =52 mm δ = **5.26µm**

p = 209419.3 / (176 x 35) = **5.98 x 10^7 N/m^2**
Fig : 2D Diagram of Top Plate for Theoretical Calculation

Stress, p = F/A
p = 209419.3 / (326 x 52)= **4.37 x 10^7 N/m^2**

3.2.4 Guide Pillar:-

The diameter of guide pillar is = 1.1 to 1.3 x thickness of die plate = 1.1 x 35 = 38.5 mm > 22 mm. Hence the guide pillar diameter is safe dimension.

Assuming that the guide pillar as a cantilever beam vertical load. So guide pillar is as consider as a one side is fixed and other end is free column construction,

From strength of material for column construction of one end is fixed and other end is free type, crippling load as P = π^2 E I / 4 l^2

Where E = 2.1 x 10^5 N / mm^2

IV. RESULTS

Sl.No	Description	Thickness mm	Analysis result		Calculated value	
			Deflection µm	Stress N/m²	Deflection µm	Stress N/m²
1	Top half	42+8+16	5.41	8.91e7	4.97	9.73e6
2	Die plate	35 (80%)	13.6	3.44e8	13.49	5.98e7
3	Stripper plate	20	11.4	1.96e8	9.26	1.48e7
4	Guide pillar	Ø 22 X 184	7.68	3.17e6	8.02	2.63e8
5	Blanking punch	69.88 X 55 X 29.88	2.51	4.69e8	1.75	6.54e7
6	Oblong punch	55 X 21 X 6	8.43	1.37e9	7.57	2.89e8

7	Piercing punch	Ø 8 X 55	2.98	4.87e8	3.15	3.50e8
8	Bottom plate	326 X 256 X 52	4.06	3.13e8	5.26	4.37e7

V. CONCLUSION

The individual components of progressive tool were modelled in ProEngineer 4.0. 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.

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