Design and analysis of progressive tool for moving contact holder

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*Abstract-***Before converting raw materials to a finished product we need an accurate design of the product and also data required for manufacturing. If the design is not accurate then defects will occur in the manufactured product; small mistakes in designing a product makes the manufactured product useless so more amount time is allotted for designing a new product (or) for modifying the existed design.**

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.

Identification of these uncertainties and quantifying them will facilitate a risk free manufacturing environment, which goes a long way to minimize the overall cost of production. Finite element method based modeling of press working process is a very effective tool to overcome the above uncertainties.

This project involves designing a progressive tool for moving contact holder component and also analysis of the critical parts of the progressive tool for their better functioning during the production of the component

Index terms **–strip layout, failure, progressive tool**

I. INTRODUCTION

Sheet-metal parts are usually made by forming material in a cold condition, although many sheet metal parts are formed in a hot condition because the material when heated has a lower resistance to deformation.

Strips or blanks are very often used as initial materials, and are formed on presses using appropriate tools. The shape of a part generally corresponds to the shape of the tool. Sheet metal forming is a plastic deformation process in which, a work piece (billet or a sheet blank) is plastically deformed between the tools (dies) to obtain the desired final configuration stored in the tool.

Sheet-metal forming processes are used for both serial and mass-production. Their characteristics are: high productivity, highly efficient use of material, easy servicing of machines, the ability to employ workers with relatively less basic skills, and other advantageous economic aspects. Parts made from sheet metal have many attractive qualities: good accuracy of dimension, adequate strength, light weight, and a broad range of possible dimensions, - from miniature parts in electronics to the large parts of airplane structures as shown in fig 1.

Figure1. Different sheet metal components

II. COMPONENT ANALYSIS

Component	:MovingContactHolder
Material	:CRCA
Thickness	:0.8±0.03mm
Tool to beloadedon	:AmteepG’63Ton Press
Typeoffeed	:RollFeed

Clearanceperside :0.03mm/side
ShearStrength :360N/mm^2

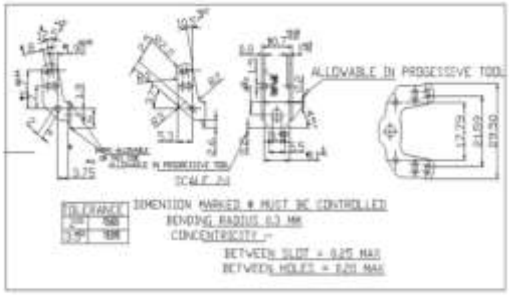


Figure2. Geometry of component in 2D

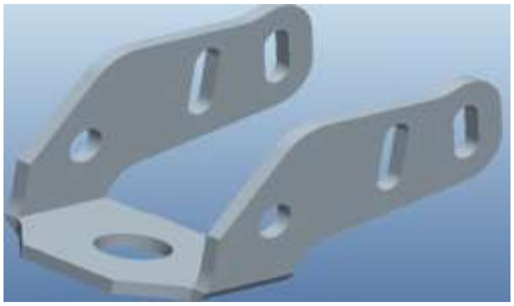


Figure3. Geometry of component in 3D

Strip Layout

Strip-layout design has an extreme importance during the planning stage of progressive die design as the productivity, accuracy, cost and quality of a die mainly depends on the strip-layout The die is constructed from the die drawing, the die drawing is made around the strip[1-6], and the strip represents the sequence of the logical, workableoperations,which is to say a sequence of ideas. If this sequence of operation has error, the error will surely emerge in the tryout press and so it behaves the designer to make certain, that his strip is cent percent sound. Fig 4 shows the detailed strip layout of the component to be produced

Figure4. Strip Layout for the required component

III. DESIGN CALCULATION

The various force calculations has to be done in order to estimate the amount of press force required to get the final desired component [7].The forces required to form the component are given below in the table 1

Table 1: force calculation of various operations

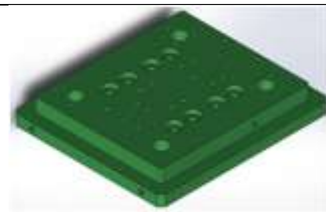
Operation	Force equations	Force value in N
Blanking	Cutting Force $= L \times s \times \tau max$	91525.9
Stripping	Stripping Force=20%of Cutting Force	18305.19
Embossing	Max Embossing Force $= Kr \times Ae$	6000
U-Bending	Bending Force $= \frac{C}{3} \times B \times s \times \sigma_s$	3874.2
Wipe Bending	Bending force $= \frac{0.33 \times B \times \sigma_s \times s^2}{W}$	703.71
Total Force :		120409.21

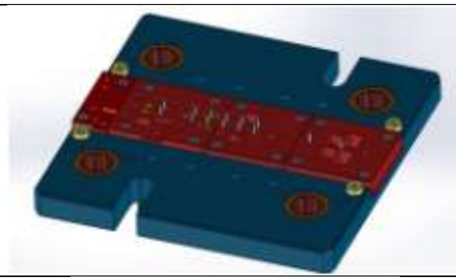
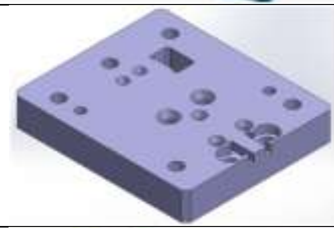
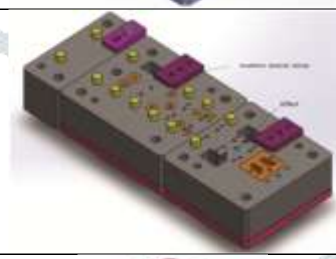
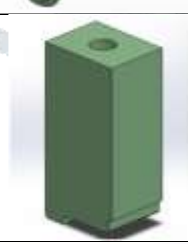
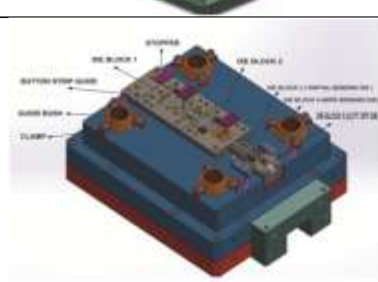
IV. COMPONENTS OF PROGRESSIVE TOOL

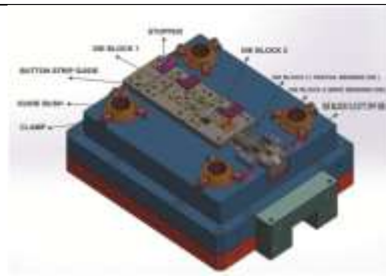
There are various components (parts) involved in manufacturing of the progressive press tool, some critical components are described in table 2

Table 2: major parts of the progressive tool

Components	Figure	Size(mm)

Top Plate		1025×625×56
Bottom Plate		1025×625×75
Guide Pillar		50×250
Guide Bush		38×50
Spring		20×50
Die block 1		250×300×26

Stripper plate		1025×625×32
Punch Plate		250×300×18
Strip guide		250×600×50
Cutting Punch		30×20×100
Embossing Punch		20×100
Bending Punch		30×20×100
Bottom Assembly		---------------

Tool Assembly		---------------

V. THEORETICAL MODEL ANALYSIS OF DIE ELEMENTS

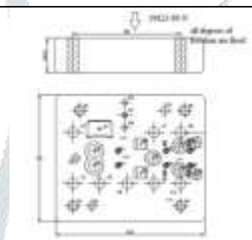
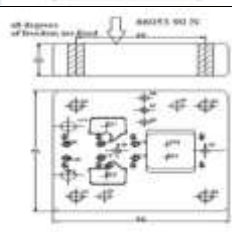
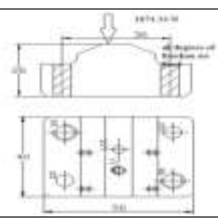
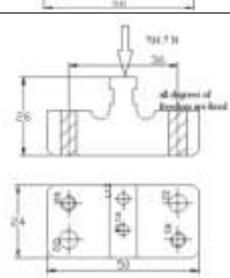
All the components undergo deformation in the application of load so it is necessary to calculate the deformation and stress induced in the components. The Eqn 1 and 2 can be used for the calculations.

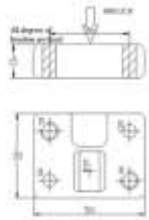
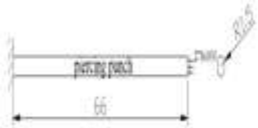
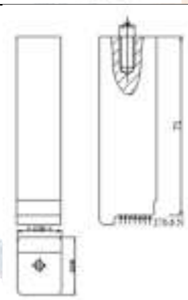
$$\text{Deflection} = \frac{FL^3}{192EI} \quad (1)$$

$$\text{Stress} = \frac{\text{Load}}{\text{Area}} \quad (2)$$

By considering these above equations the calculations has been done for various die and punches which are reflected in the table3

Table 3: Stress and displacement values for various punch and die

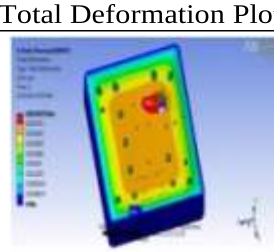
Component	Figure	Stress (N/mm2)	Displacement ×10-3 mm
Die Block 1		15.95	3.73
Die block 2		26.46	3.66
Die block 3		3.72	7.652×10-6
Die Block 4		1.127	2.316×10-2

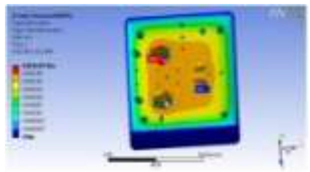
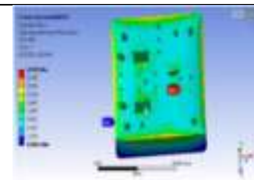
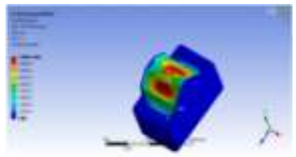
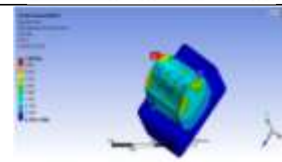
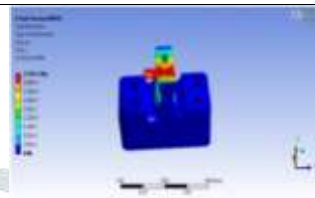
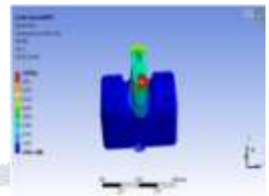
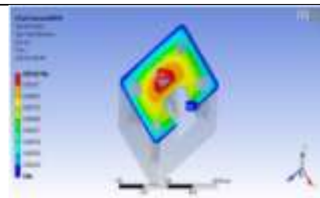
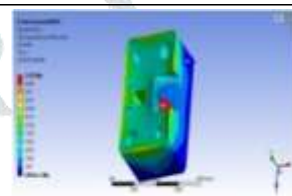
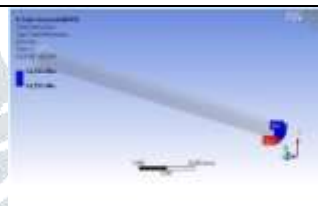
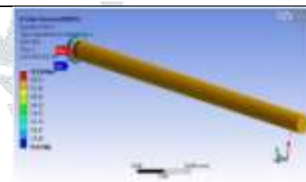
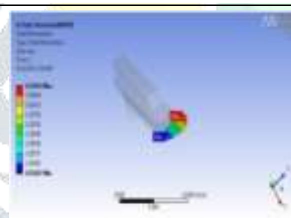
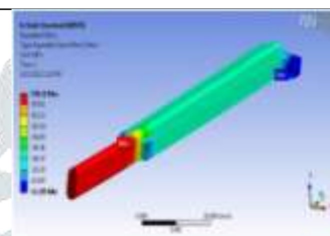
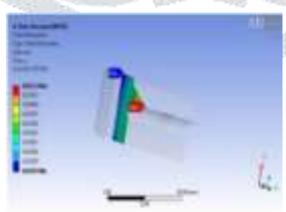
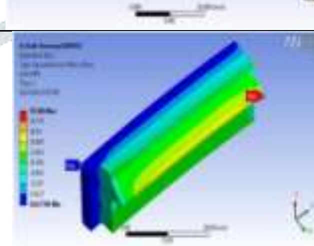
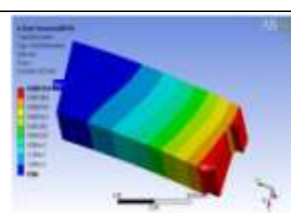
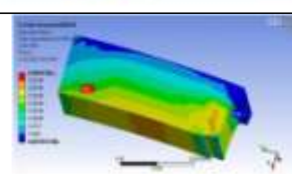
Die Block 5		17.46	1.07
Piercing Punch		384	120
Oblong Piercing Punch		535.91	168
Blanking Punch		60.85	21
Bending Punch		0.515	24

VI. MODELING AND ANALYSIS USING ANSYS

The objective of the analysis of the functional elements like die plates, punches (piercing punch, oblong punch, notching punch and blanking punch, bending), are include structural analysis to estimate the deflection and stresses. The stress values determined through Ansys is given in the table 4 below

Table 4: Stress and displacement values for various punch and die through Ansys

Component	Total Deformation Plot	Von-Mises Plot
Die Block 1		

Die block 2		
Die block 3		
Die Block 4		
Die Block 5		
Piercing Punch		
Oblong Piercing Punch		
Blanking Punch		
Bending Punch		

VII. RESULTS AND DISCUSSION

In post processing section of the Ansys the results of stress analysis are reviewed. The different results obtained by using Ansys are as follows, table 4 shows the comparison of stress by analytical method and by using Ansys, and table 5 shows the comparison of deformation by analytical method and by using Ansys

Table 4: Comparison of stress values of analytical and Ansys

Component	Theoretical Stress	FEA Stress	Error %
Die Block 1	15.95	15.95	0
Die block 2	26.463	26.58	0.44
Die block 3	3.72	3.46	6.98
Die Block 4	1.127	1.128	0.08
Die Block 5	17.46	17.43	0.98
Piercing Punch	384	373	
Oblong Piercing Punch	535.91	538.4	0.46
Blanking Punch	52.35	53.7	2.51
Bending Punch	8.92	10.29	13.31

Table 5: Comparison of deformation values of analytical and Ansys

Component	Theoretical Deformation×10^{-3} mm	FEA Deformation×10^{-3} mm	Error %
Die Block 1	3.73	3.6	0
Die block 2	3.66	3.61	1.36
Die block 3	7.62×10^{-3}	7.48×10^{-3}	1.83
Die Block 4	2.316×10^{-2}	2.73×10^{-2}	15.38
Die Block 5	1.07	1.6	33.12
Piercing Punch	120	125	4
Oblong Piercing Punch	168	159	5.35
Blanking Punch	16.7	16.2	2.99
Bending Punch	24	24.1	0.419

VIII. CONCLUSION

Designing

a. By the implementation of computer in design field accuracy of design is improved and design field accuracy of design is improved and design process time is reduced drastically than by traditional method.

b. In the process of creating the documentation for the product design much of required data base to manufacture the product is also created.

c. Many design problems which are complicated to estimate by traditional methods are eliminated by using CAD system, as the designs have more standardization they can be imported to any other software and also CAD provide better functional analysis to reduce prototype testing Regarding progressive die design of progressive die is simple.

Analysis

The individual components of progressive tool were modeled in solidworks2012. Each individual file was imported to Ansys12.0 software through Initial Graphics Exchange Specification (IGES) format. The following conclusions were made

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

b. 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.

IX. BIBLIOGRAPHY

[1] K. Park, S.Choi, " Finite element analysis for the lamination process of a precision motor core using progressive stacking dies" Journal of Materials Processing Technology(2002)

[2] K.Park, D.Y. Yang,Y.S.Kang," Precision forging design and analysis in electronics parts manufacturing ",Proc. Inst. Mech.Eng. B.213(1999).

[3] S.Kumar, R.Singh," An automated design system for progressive die Expert Systems with Applications", Journal of Materials Processing Technology (2011)

[4] S.Kumar,R.Singh,"Automation of strip-layout design for sheet metal work on progressive die" ,journal of materials processing technology(2008)

[5] A.C. Linand D .K.Sheu, "Computer-aided sequence planning of shearing operations in progressive dies",World Academy of Science,EngineeringandTechnology(2010)

[6] Paquin,J.R. &Crowley,R.E., "Die design fundamentals" ,Industrial Press Inc. Second edition,NY1987

[7] A.C.Rao, A.Srinath–"Planar linkages: structural influence on mechanical advantage and function generation "Mechanism and Machine Theory(2007)

[8] S.Kumar,R. Singh."Alowcost knowledge base system frame work for progressive die design "Journal of MaterialsProcessingTechnology10November2004,

[9] Dieter,G.," Engineering Design ",McGraw-Hill International Editions, Mechanical Engineering Series,ISBN0-07-366136-8,USA2000.