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Design and Manufacturing of Compound Die

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Abstract: ***The work deals with the development of a combined tool for improvement of a process to be done in piaggio product manufacturing plant. Research work deals with combining two press operations done separately. This operation is done for piaggio battery support bracket, cradle assembly, Bumper cargo. In the first pressing blanking process is done. And in the second operation a hole is pierced in the same product. The objective of research is to develop a tool and process for using a single press for performing dual operation. This is also to reduce downtime, reduce operator fatigue and thereby increase production. Elimination of one operation, one operator and reduction in processing time is also to be achieved.***
Keywords: Compound Die, Metal Stampings, Blanking, Tool & Die, Precision Engineering

I. INTRODUCTION

A die is a specialized tool used in manufacturing industries to cut or shape material using a press. Like moulds, dies are generally customized to the item they are used to create. Products made with dies range from simple paper clips to complex pieces used in advanced technology. Piercing dies are typically made by tool and die makers and put into production after mounting into a press. The die is a metal block that is used for forming materials like sheet metal and plastic. For the vacuum forming of plastic sheet only a single form is used, typically to form transparent plastic containers (called blister packs) for merchandise. For the forming of sheet metal, such as automobile body parts, two parts may be used, one, called the punch, performs the piercing, stretching, bending and blanking operation, while another part, called the die block, securely clamps the w/p and provides operation.

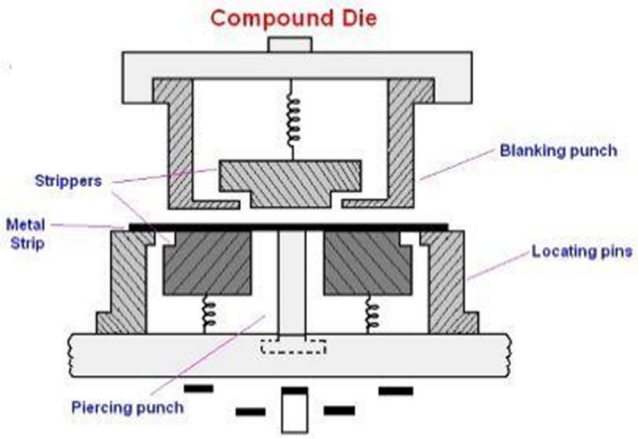

Fig – 1: Compound Die

Design of sheet metal die is a large division of tool engineering, it has a rather complex and a fascinating subject which has its own importance and pertains to the added value of the particular industry. It is by far the most exacting of all areas of the general field of tool designing. The die designer originates the design of die employed, stamped and formed part from sheet metal, assemble the parts together and perform a variety of operations.

Basics of blanking and piercing tool - A blanking die produces a flat piece of material by cutting the desired shape in one operation. The finished part is referred to as a blank. Generally a blanking die may only cut the outside contour of a part, often used for parts with no internal features. Piercing is a shearing process where a punch and die are used to create a hole in sheet metal or a plate. The process and machinery are usually the same as that used in blanking, except that the piece being punched out is scrap in the piercing process. A die, as mounted in the press, is a complex action mechanism, producing parts in predetermined sequence. The lower half of the die, mounted, on the lower die shoe, is firmly attached to the

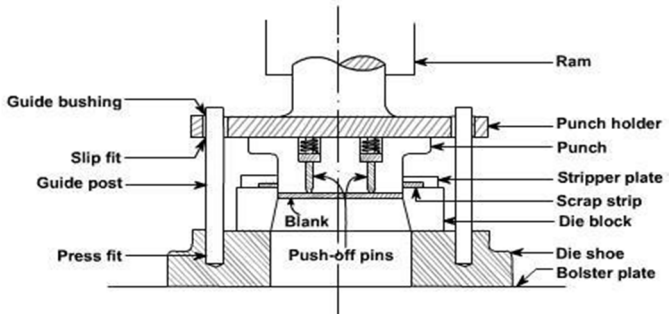

Fig – 2: Basics of blanking tool

Press bed, while the upper portion is bolted to the ram, sliding up and down along with it.
The die block contains all bushings, forming dies, or cutting inserts. It is supported by another backup plate positioned between this block and the lower die shoe. All cutting, forming, and other material-altering punches and dies are assembled into their respective blocks using two methods of attachment: Either their body diameter D is press-fit within the block, with their heads remaining loose, or their head diameter is press-fitted, while the body remains loose.

A. Types of Dies
1) Simple die
2) Compound die
3) Combination die
4) Progressive die
5) Transfer die
6) Multiple die

B. Types of Press Tools
1) Progressive Tool
2) Compound Tool
3) Combination Tool
4) Fine Blanking Tool

II. LITERATURE REVIEW

Metal stampings play an important part in modern day life. Together with plastic moulds, they form the most important structural components of all electronic and electrical equipment. Researchers all over the world have spent a tremendous amount of time and effort trying to develop better computer aids for the design of tools and dies required to manufacture metal stampings. Modern consumption habits demand shorter product life cycle. It is imperative that the overall die design and manufacturing lead time be reduced further to cope with the demands of the market. Conventional die design and manufacturing approaches using traditional CADCAM tools will be hard pressed to cope with these demands [1]

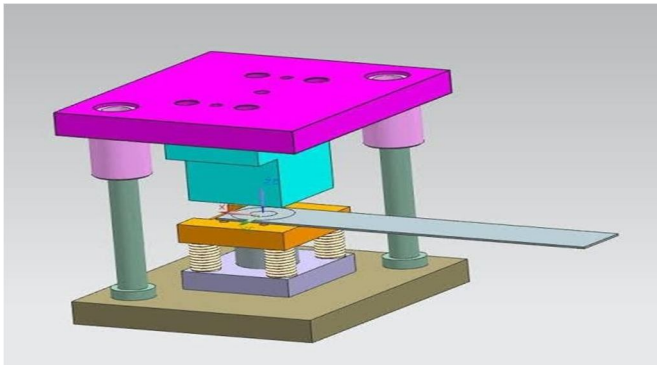
Fig – 3: 3 D View of compound Die [Example]

The fine blanking technology of cam were analysed, its blank layout was designed, the fine blanking source was calculated and stamping equipment selected. The fine blanking die clearance and rounded edge were determined. The fine blanking compound die structure was designed. The materials and heat treatment specifications of fine blanking mould work parts were selected and the gear plate structure designed. Practice shows that the process program used was reasonable [2] Due to the current trend towards lightweight design and multi-material design, the focus more than ever is on mechanical joining technologies, as thermic joining methods reach their limits with regard to joining of dissimilar materials. At the present time, the main mechanical joining technique for the realisation of innovative material mix in automotive construction is semi-tubular self-piercing riveting. [3]

The influence of the blank holder die gap size on the MDD process was investigated via experiments and FEM simulation. MDD is a typical type of micro forming technology that fabricates micro cup and box like products. The in process spring back occurs when the blank escapes from the blank holder, which is beneficial for reducing the drawing force. A small gap is preferred for reducing the non uniform distribution of the wall thickness on the drawn cup while not increasing the risk of fracture. [4]

Etsuro Katsuta and Hiroshi Morita concludes that in the dry piercing process steel sheets under nearly zero clearance is developed with use of the plasma nitride punch and die core system, High pressuring plays a key to reduce the occurrence of ductile fracture during the piercing process. The stress concentration at the punch edge corner and the core edge plays a role to make reliable micro piercing process. [5]

Based on the study of the piercing process of sheet assisted by magnetic medium, the paper puts forward that the factors such as loading speed, punch diameter, current intensity and sheet thickness are taken as the important process conditions. The traditional forming technology is difficult to meet actual needs of modern production.

III. OBJECTIVES

Aim of the project is to increase productivity, to reduce human effort, to reduce cycle time, to reduce labour cost, to design blanking and piercing die, to develop blanking and piercing die. Better product manufacturing capability in masses.

IV. METHODOLOGY

Steps involved in the entire process

1) Press selection
2) Die design
a) Design checked and approved
b) Final approval from department

3) Die manufacturing
a) Procurement of material
b) Machining of raw material type
c) Milling
d) Grinding
e) Turning
f) Material handed over to the fitting section

4) Fitting Section
a) Fitting of the top plate
b) Holder fitted on top plate and drilled, reamed and dowelled
c) Holder pocket CNC machined
d) Inserts drilling and counter boring for aligning screws
e) Holder is drilled and tap for inserts
f) Insert fitting on holders and drill reaming and dowelling
g) Top plate ready for CNC
h) Top pad manufacturing dummy plate and ready for CNC
i) Fitting of the bottom plate

j) Bearing block for guide pillar drill cutter
k) Riser block drill cutter
l) Drill tap of bottom plate for bearing block and riser block
m) Fitment of the bearing block and riser block and drill reaming and dowelling
n) Insert drill cutter
o) Riser drill taps for inserts
p) Insert fitting and drill reaming and dowelling
q) Bottom ready for CNC
r) Bottom pad ready for CNC

5) After CNC
a) *Top*
- Inserts relieving machining
- Forming punch cylinder grind and fitment

b) *Bottom*
- Insert relief drill for pierce hole and other relieve machining
- Heat treatment of inserts
- Guide pillar and bush centre grinding + die set making
- Bottom insert fit after heat treatment
- Shearing of top insert [check clearance between punch and die and pierce punch alignment]
- Do spotting or shearing and grinding if any
- Top inserts heat treatment

V. MATERIAL SELECTION

Material selection ensures the integrity at design. IN the selection process, materials will be accessed for tensile strength and modulus, flexural strength and modulus, Impact strength, compressive strength, fatigue strength, creep, and stress relaxation properties depending on the application.

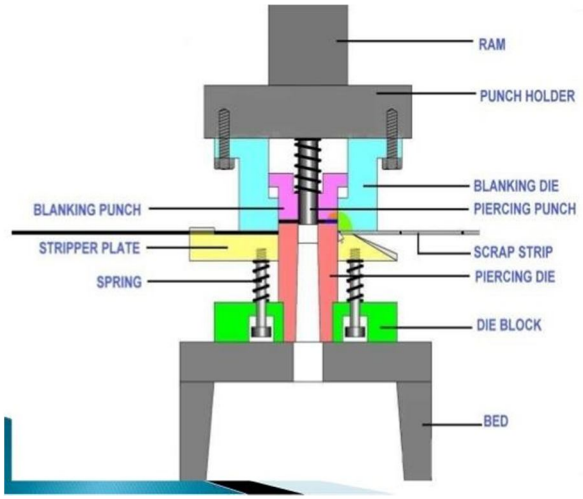

Fig – 4: Details of Compound Die

The most important criteria for selection of die steel material for forging are its resistance to wear deformation and fatigue [Mechanical and Thermal]
To provide resistance to wear and plastic deformation, the dies hardness should be as high as possible.

Table No – 1: Material Selection Chart

Sr. No.	Part Name	Material
1	Lower Plate	M.S.
2	Lower Riser	M.S.
3	Die Back Plate	OHNS
4	Die Block	HcHcr
5	Stripper Plate	M.S.
6	Punch	HcHcr
7	Punch Riser	M.S.
8	Upper Plate	M.S.
9	Guide Pillar	EN 31
10	Bush	EN 31
11	Guide Pin	EN 31

Table No – 2: Specifications of a Part

Sr. No.	Commodity	Measurement
1	Area of the Blank	20727 mm^2
2	Volume of the Blank	31090.5 mm^3
3	Thickness of the Sheet	6 mm
4	Material	MS
5	Yield Strength	250 MPA
6	Percentage Elongation	23 mm
7	Ultimate Shear Strength	410 N/mm^2
8	Clearance	10 % of Sheet Thick
9	Safety Factor	1.2
10	Hardness	65 HRB

VI. RESULT

The results are obtained in the form of completion of design process successfully, and by the successfully completion of fabrication process of the compound die, and the successful assembly of the all the parts of the compound die with Top and Bottom plate.

A. Cutting Load Calculations

We have to calculate first Cutting load, Cutting load = Perimeter x Thickness x Shear Stress = 253 x 6 X 45 = 68310 kg = 68.3 ton
Strip load = 20 % of cutting load = 0.2 x 68.3 = 13.66 ton Press load = Cutting load + Strip load = 68.3 + 13.66 = 81.96 ton.

B. Assembly

Assembling the fabricated parts plays vital role in order to accomplish the forming tool. In forming tool we can split into sub-assembly Top assembly comprises of top plate, punch plate, stopper, punch, guide bush. Punch screwed to the punch plate, subsequently screwed to top plate. Guide bush is inserted into top plate in tight fit. Also it includes stopper screwed top plate.
Bottom Assembly comprises of bottom plate, back plate, ejector, side blocks, middle block and guide pillar.

Fig – 5: Final Assembly

Back plate and side blocks screwed to bottom plate. Ejectors and middle block is screwed to back plate, while guide pillar inserted into bottom plate in tight fit.

VII. CONCLUSIONS

1) Successfully designed a blanking and piercing die operations.
2) The tool could be utilized in mass production to produce identical parts with good geometrical tolerances.
3) By choosing appropriate tool steels for die, punch and other parts, the tool life could increase for maximum range.
4) Time Saving, less movement of the part which reduces fatigue to operator.
5) Less cost of manpower and production.
6) One time investment in the requisite equipment would ensure a long term supply of superior quality products, generating huge profits for the manufacturers.

VIII. FUTURE SCOPE

Earlier, the process of die design was considered an art rather than the science. Traditionally, checking the manufacturability of sheet metal parts and process of die design require experienced die designers, involve numerous calculations, and hence time-consuming tasks. But with the advancement in the field of AI around 1980s, these are being carried out using various AI techniques. But most of the systems developed using AI techniques are having limitation in extraction and representation of part feature data in more interactive format for displaying output.

Further, most of the systems are developed for single- operation stamping dies using production rule-based Very few systems are developed for design of multi-operations dies and even these are not capable to fully automate the die design process. 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.

Further, we can reduce the number of component of the die by using the material selection method as we can eliminate the pad and use the support plate as both support and pad. We can also reduce the shut height which can optimize the production time as the ram required to travel less distance.

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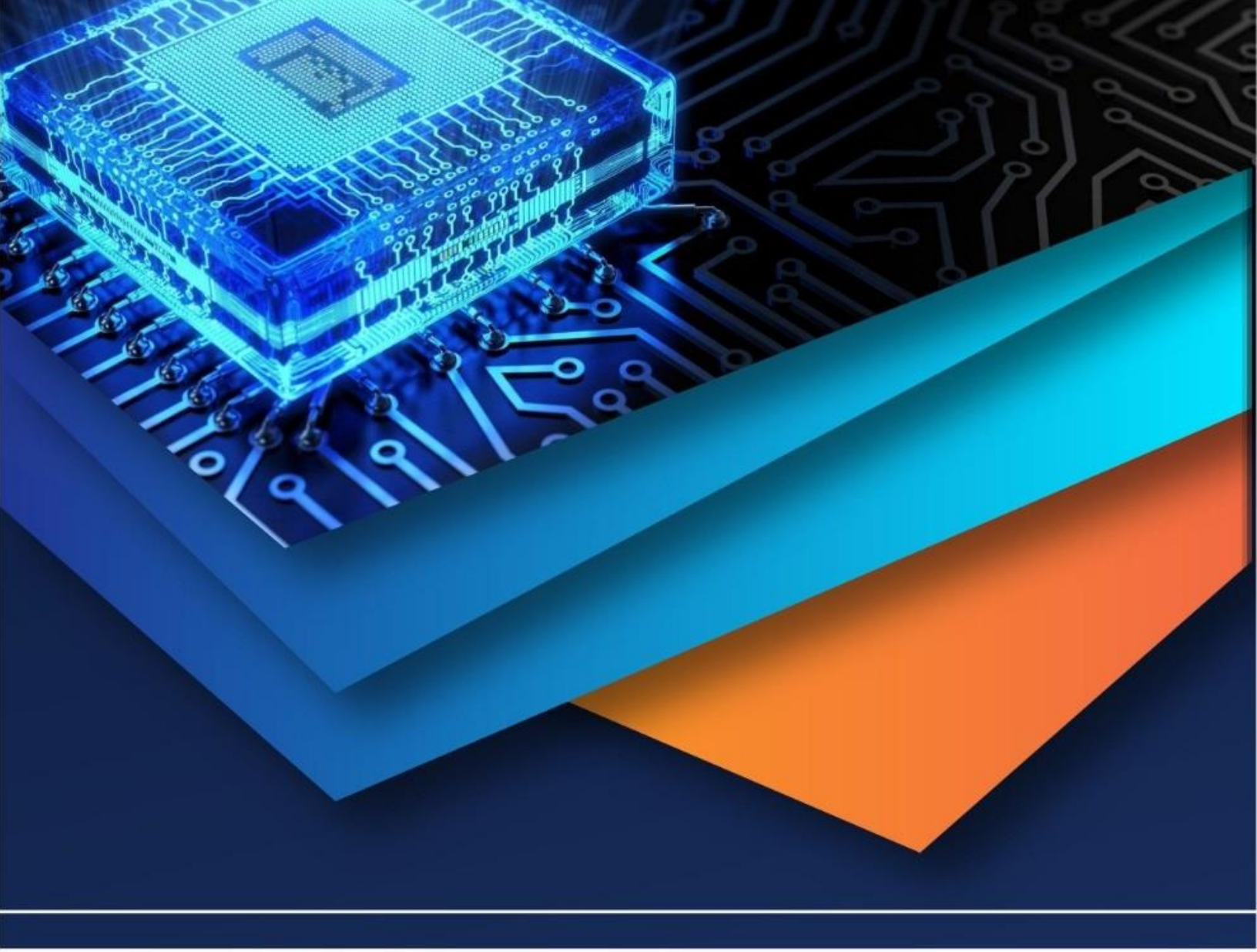

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