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A PATH FOR HORIZING YOUR INNOVATIVE WORK

DESIGN AND DEVLOPMENT OF SHEET METAL DIE

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Abstract: In This Study, Sheet Metal Die has been selected as investigation topic. It essentially focuses on failure analysis of Sheet Metal Die. Saboo plastics pvt. Ltd Company is manufacturer of types of moulds, jigs, fixtures. The existing die in company induced more stresses, company requirement is that when load acts on die then less stress induced in die & less Deformation occurs. The topic represents Design and analysis of sheet metal die. Problem identified is failure of die. There are much stresses occurs in existing die of EN8 material. This problem can be analyzed by replacing existing EN8 material by HCHCR material. Considering structural analysis on die on both existing die material & suggested HCHCR die material. Several parameters which are to be considered such as Hardness of material, ultimate tensile strength, yield stress. After considering several parameters, machining process is to be done on Die. At each of the above stage, analysis is to be done on die. As well as validation of the die is also checked during the each stage. The shear force provides exact stresses which are greater than maximum allowable stress. There are analysis software which will used t and they are responsible to provide the analysis correctly, identify problems if any and resolve it. The availability of modern software tools and numerical simulation has become an important part of the design, analysis. The research presented in this thesis is to Design & Development of sheet Metal Die by using CAD and simulation technology with the goal of improving quality. Therefore in the thesis, A framework is presented based on CAD and simulation technology. With the use of CAD software and simulation technology the sheet metal die is redesigned to achieve best material properties utilization with permissible stress level. The sheet metal die imported in ANSYS 14.0(analysis software) in IGES format. The structural analysis can be carried over both EN8 & HCHCR material. Finite element analysis revealed that stresses acting are exceeding yield stress value.

Keywords: Sheet Metal Parts, Die & Mould, Invalidation Analysis, Tool Path Planning

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INTRODUCTION

Punching is a metal forming process in which the punch is forced through the work piece to create a hole by shearing action. Because of severe working conditions the punch life is invariably low. Every effort is made to enhance the life by properly selecting the punch material and design parameters. In the highly competitive manufacturing scenario of today the demands of market have changed drastically and manufacturers are trying to satisfy their customers better by reducing the cost of manufacturing and improving product quality. The die punch design selection of various parameters such as geometrical shape of punch, shear angle of punch, clearance, metallurgical composition of punch material, sheet metal thickness, cycle time of operation and the wear of die-punch for performing various operations i.e. punching blanking, piercing etc. This paper briefly reviews the efforts made for enhancing the life of die punch and describes how the parameters can be selected appropriately.

1.1] Punch Material Selection:

The punch material should have major content of tungsten, molybdenum and vanadium as they increase the amount of carbide compound and provide hard and durable cutting edge. Punches made of material containing high chromium show higher adhesiveness with the cutting material. The compatibility of metal element cause high adhesion, friction and wear rate. Material shows higher corrosion on cutting edge. The tools can be made of different metallurgical compositions having single carbide inclusion particle and cluster of The punch life depends on selected geometry [9]. It directly affects overall cost of manufacturing. Available softwares should be used for minimizing failure of tool, selection optimum tool geometry and analysis of different punch geometry. This reduces experimentation costs. Punch geometry such as flat, balanced, convex shear, concave shear, one-way shear, inverted cup shape and sintered hard metal around its circumferential cutting edge may be selected for experimentation. Punch with balanced convex shear carbides having different sized particles.

1.2] Sheet metal operations:

In order to make a sheet metal Die, there is need to make necessary operations on sheet metal to make sheet metal die mold product i.e. protection cap. To make this sheet metal die mold product (protection cap) requires several operations on sheet metal such as shear cutting to get required size of sheet metal, punching operation & bending operation which gives shape to product. Once these operations get completed on sheet metal, finishing can be done along with powder coating over the protection cap.

1.3] Brief Description about protection cap:

Sheet metal parts with large and complicated curved surfaces used widely for manufacturing applications for such sheet metal parts are characterized by great volume. Sheet metal parts can deform easily. The sheet metal die is designed for making a sheet metal die mould product called protection cap. This Protection cap manufactures to fix over the dynamo in tractor engine. So that electronic circuit in tractor engine prevent from dust, water Sheet metal parts with large and complicated curved surfaces used widely for manufacturing applications for such sheet metal parts are characterized by great volume. Sheet metal parts can deform easily. The sheet metal die is designed for making a sheet metal die mould product called protection cap. This Protection cap manufactures to fix over the dynamo in tractor engine. So that electronic circuit in tractor engine prevent from dust, water.

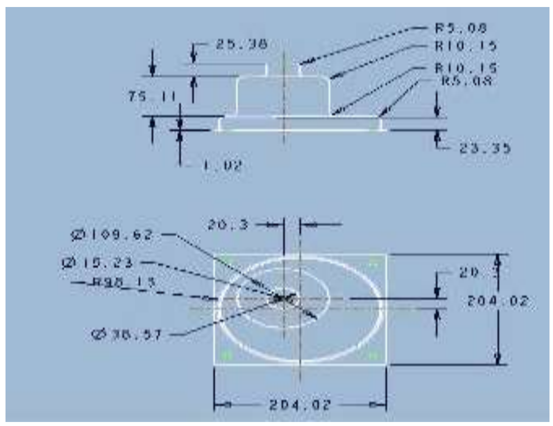


Fig: 1 Part drawing of protection cap

2] Design criteria for Die products:

Today's world places greater and greater demands on products and materials, from which they are made. Years ago, many designers never figured out stress and strain, elasticity, fatigue, or similar values. If it broke, then you just made it 2 inches thicker, or 3 inches, or 5 inches, designers are forced to economize. Demands for special alloys are continuously expanding, and they are in equal competition with all the new and increasingly better alloys that are being produced. Ferrous and nonferrous alloys, titanium and its and alloys, and alloys with traces of rare metals added for additional qualities are all available to fill that specific gap where they are needed.

Manufacturing methods are next on the list of economizing designers. Avoiding secondary operations whenever possible, designers apply cost-conscious strategies and planning not only in small shops, but in medium and large plants as well. This certainly is a good approach to any given problem, since every product has its price. If manufacturing costs become greater than the value of a product, such an item becomes unsalable.

For these reasons, manufacturability of products is extremely important

2.1] Recent Trends in Die Design:

The information is about various design parameters concerned with Sheet Metal Die design. In order to make a product of sheet metal requires measurement & analysis of sheet metal parts. Due to this range of possible errors occurring in manufacturing can be greatly reduced. Regarding the concept of Die mould design, various research work can be carried out such as Tribological simulation for invalidation analysis of mould, Quality function development, DFMA, mold delamination & die fracture analysis. Several approaches are taken into account such as virtual prototyping approach to mould design .In virtual prototype is generated by combining automated and interactive approaches. In existing die mould protection cap, There are several problems regarding selection of alloy steel, shape error of sheet metal die mould product ,so it is required to design mould for protection cap & improvement in the existing design is must. An effort is made to view various techniques of designing mould for protection cap.

As mold design is a complex process involving in many decision factors, it is difficult to insure both mold reusability and meeting manufacturing requirements without iteration of evaluating and modifying. In order to machine and assemble the moulds with required functions at first time, the mold designers should perform evaluations on their designs and modify them accordingly. While Accuracy & reliability of other sheet metal Die mould product are less. Chances of shape error occurrence are more due to poor machining. There are new methods which are developed & technology is advancing in order to improve the quality of sheet metal die mould product. This product made specifically and can be suited for customer needs and requirements. There are several problems regarding selection of alloy steel, shape error of sheet metal die mould . In order to overcome this difficulty, analysis of sheet metal Die is needed.

3] Objective:

The objective of the research presented is to Design & Development of sheet Metal Die by using CAD and simulation technology with the goal of improving quality. Therefore framework is presented based on CAD and simulation technology.

1] Objective of this project is to analyze the sheet metal die for Protection cap.

2] Tool path generation using CAM software

4] Design Calculations:

Design of Die

For EN8 material:

Cutting operation- Punch size < die size c = optimum radial clearance0.0032 +

t = thickness of sheet

τ = ultimate sheer stress of sheet metal

= 10 % t if t > 2 mm

Load estimation

Force = τu x As

Where τu = ultimate

shear stress of sheet metal

As = Shared area

Fmax = τu x As

Area of sheet As = P x t

Where

P = Perimeter

= 2 (a+b)

= 2 (3750)

= 7500 mm

As = 7500 x 2

= 15000 mm

Work done = Force x distance

W.D. = Fmax x k.t

Where k = % penetration required for completing shear action

= 0.2 for hard Material

W.D. = 1555 x 0.2 x 2

= 622 Nm

Method of Reducing Punch force

1) By providing shear

Punch Force

F =

Where F = Force required with provision of shear

I = amount of shear to provide on punch

Imax = t = thickness of strip

F = I = 1

= 444. 28 KN

2) Stagging of punches

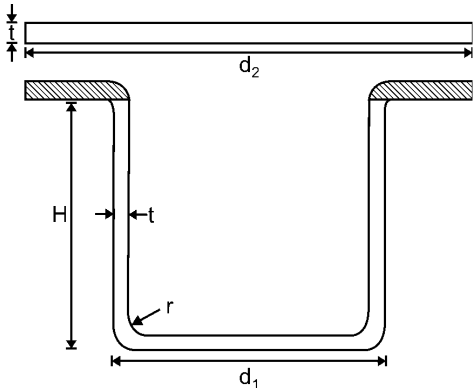
σcp = compressive stress in duced

Acp = C/S area of punch

Deep Drawing

depth/dia < 0.5 Shallow drawing

Depth/dia > 0.5 deep drawing



Total surface area of blank = total surface area of component

D2 = d2 + 4 dh

= 15 < < 20 Outer radius

= 10 < < 1.5 Inner radius

In case of punch & Die,

= optimum clearance matter

& In case of Deep Drawing,

Sheet Metal thickness considers

P = Load reqd. for deep drawing operation

P =

P1 =

P2 =

P3 =

Where D = Blank Dia

t = sheet thickness

c = const for friction = 0.6 to 0.7

If C = 0

P1 =

= π t σy (D0) = 3.14 x 2x 25 (116) N/mm

= 1832 N/mm

111y, P2= π t σy d1

= 3.14 x 2 x 250 (109.62) = 1721 N/mm

P3 = π t σy d2

= 3.14 x 2 x 250 (38.57)

= 605.54 N/mm

workdone = Forcex distance

WD1 = P1 x H1

= 1832 x 23.5 = 43052

W. D2 = P2 (H2-H1)

= 1 x 21 - (98.5 - 2.35) = 29198

W.P3 = P3 (H3 -H2)

= 605.54 - (123.84 -98.5)

= 15344 = 153 KN

No of Draws required for Deep Drawing operation

1) Draw ratio Method

LDR - DR1 = DR2 = DR3

LDR = 1.6 Hard Steel

2) Draw Reduction Ratio

DRB4 = 16 %

= d1 = DC (1 - DRR1) < d ; n =1

= d2 = d1 (1 - DRR2) < d ; n =2

= d3 = C (1 - DRR3) < d ; n =3

= d4 = d3 (1 - DRR4) < d ; n =4

5] Product design

Product design is the process of creating a new product to be sold by a business to its customers. It is the efficient and effective generation and development of ideas through a process that leads to new products.

In a systematic approach, product designers conceptualize and evaluate ideas, turning them into tangible products. The product designer's role is to combine art, science, and technology to create new products that other people can use. Their evolving role has been facilitated by digital tools that now allow designers to communicate, visualize, and analyze ideas in a way that would have taken greater manpower in the past. Product design is sometimes confused with industrial design, and has recently become a broad term inclusive of service, software, and physical product design. Industrial design is concerned with bringing artistic form and usability, usually associated with craft design, together to mass produce goods

5.1] Trends in Product Design:

Product designers need to consider all of the details: the ways people use and abuse objects, faulty products, errors made in the design process, and the desirable ways in which people wish they could use objects. Many new designs will fail and many won't even make it to markez. Some designs eventually become obsolete. The design process itself can be quite frustrating usually taking 5 or 6 tries to get the product design right. A product that fails in the marketplace the first time may be re-introduced to the market 2 more times .If it continues to fail, the product is then considered to be dead because the market believes it to be a failure Most new products fail, even if it's a great idea. All types of product design are clearly linked to the economic health of manufacturing sectors. Innovation provides much of the competitive impetus for the development of new products, with new technology often requiring a new design interpretation. It only takes one manufacturer to create a new product paradigm to force the rest of the industry to catch up - fueling further innovation.

Industrial design is the use of a combination of applied art and applied science to improve the aesthetics, ergonomics, and usability of a product, but it may also be used to improve the product's marketability and production. The role of an industrial designer is to create and execute design solutions for problems of form, usability, physical ergonomics, marketing, brand development, and sales.

CAD Model of Protection Cap:

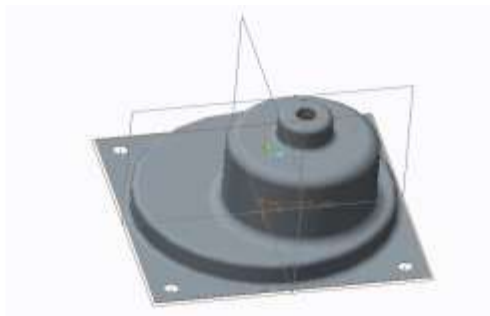


Fig 2 Protection Cap

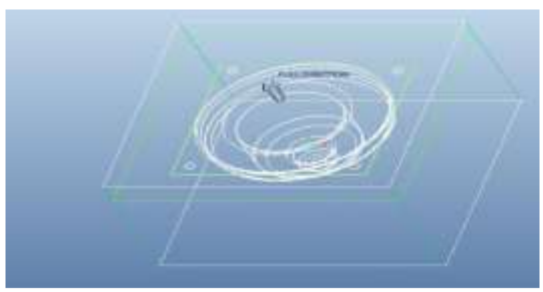
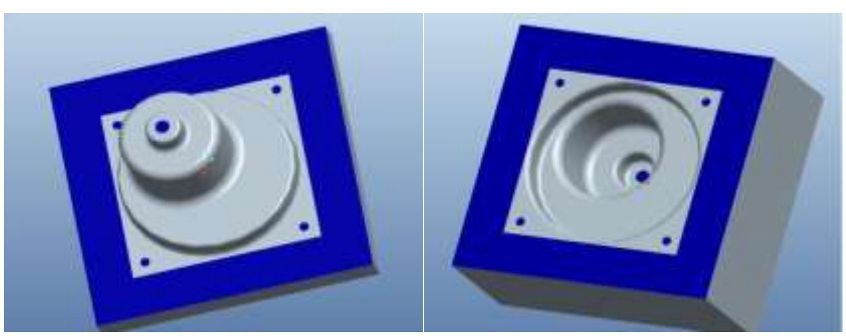
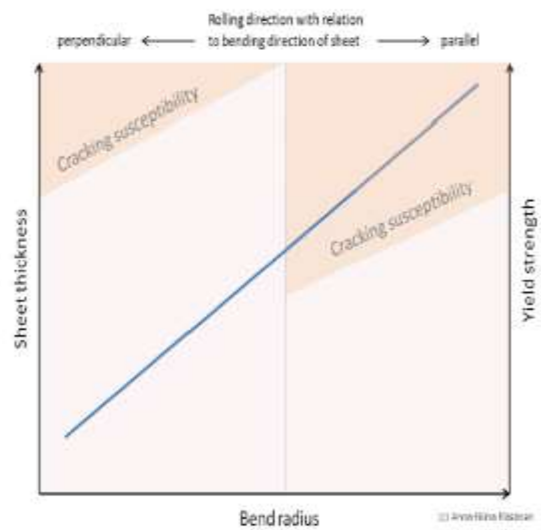


Fig3 Cavity Extraction:



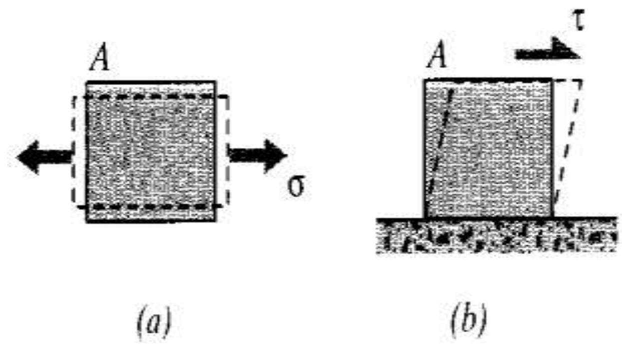
6] Low cost strategy for sheet metal product:

This is illustration of real sheet metal product, which manufacturing is really challenging and many problems occur in production. In this paper given some point of views, which should be take into consideration before the part can be produced without or some minimal problems. The frame of this work is a cost-oriented DFMA-approach which aims to control and manage both the product design and manufacturing process together with its costs[4]. The purpose of this paper is to study variables which should be considered when manufacturing of a certain demanding product is transferred successfully in global networks accordingly low cost strategy.



7] Shearing Stresses and Strains:

Not all deformation is elongational or compressive, and we need to extend our concept of strain to include “shearing,” or “distortional,” effects. To illustrate the nature of shearing distortions, first consider a square grid inscribed on a tensile specimen as depicted . Upon uniaxial loading, the grid would be deformed so as to increase the length of the lines in the tensile loading direction and contract the lines perpendicular to the loading direction. However, the lines remain perpendicular to one another. These are termed normal strains, since planes normal to the loading direction are moving apart. Now consider the case illustrated in Fig., in which the load P is applied transversely to the specimen. Here the horizontal lines tend to slide relative to one another, with line lengths of the originally square grid remaining unchanged.



8] General Die Design Guidelines:

Most of the die design rules established for conventional metal dies are applicable, as they are based on the forming of the workpiece rather than the deformation and failure of the die. However, there are several factors to consider when designing with composite dies. One of the most important issues is determining the optimal run-off. It goes without saying that the larger run-off provides greater resistance to hoop stress and reduces the likelihood of fracture failure. However,from the material handling and economics standpoints, the run-off can be optimized, that is, it can be selected to be large enough to prevent fracture and small enough to minimize cost. The experimental results showed that the die undergoes fracture when the maximum tensile principal stress reaches the vicinity of the flexural strength of the tooling material. Therefore, the FEA with an axisymmetric model should be performed to obtain the hoop stresses, which are equal to the maximum tensile principal stresses, and these stresses should be compared to the flexural strength. However, care must be taken, as this method can be used only as a rough guideline. It is desirable to apply the largest punch–die clearance allowable, as long as the final drawn part meets the geometric tolerances. A large clearance is beneficial in both fracture and wear prevention, as it reduces normal stresses on the die surface. Another design parameter to consider is the punch corner radius. Therefore, the part should be designed such that the punch corner radius,. The experiments have shown that a small corner radius tends to increase the pressure on the punch surface leading to deformation under compression.

9] CONCLUSIONS:

This paper developed and verified a method for predicting the failure mode of a drawing die fabricated from and The stress states in the die, which govern the failure, are not intuitive, and thus require computational simulations. The simulations were performed by constructing a FE model and obtaining the stress–strain responses. The possible failure modes in drawing dies are fracture, wear, and deformation. The damage parameters used were the maximum tensile principal stress for fracture and the maximum normal component of a traction vector on the die surface for wear. Deformation occurs primarily due to the wrinkles in the sheet metal when no blank holder is used. The drawing die fails when the maximum principal stress reaches the flexural strength of the die material. One important observation is that the peak in the drawing force curve does not correspond to the maximum stress, which necessitates the FEA of the process prior to selecting process parameters. A statistical analysis of the two-level fractional factorial design showed that sheet strength and thickness are the most dominant parameters, followed by draw ratio, punch–die clearance, and run-off. The analysis also revealed that several influential two factor interactions exist, including the punch corner radius-draw ratio, sheet strength-thickness, and die corner radius-run-off interactions. The experimental study showed that the punch corner radius must be selected carefully to prevent premature deformation failure of the die.

10] ACKNOWLEDGMENT:

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