Design & Development of Blanking Tool for Shim

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Abstract— In this project press tools are used to produce a component in large quantity using sheet metals where component attained depends upon press tool construction and its configuration. The different types of press tool constructions are used for different operations namely blanking, bending, piercing, forming, drawing, cutting off, parting off, embossing, shaving, lancing, dinking, perforating, trimming, curling etc. the metals having less than 6mm thickness are generally called as strip. In Blanking operations we produce flat components of required shape. In Blanking process the required shape periphery is cut and cut-out piece is called blank. The press tool used for blanking operation is called as blanking tool, in piercing operation it is piercing tool and so on based on operation that we perform. Press operations are used in many industries like automobile, food processing, packing, defense, textile, aircraft and many apart from manufacturing industry. In this paper, an attempt is made on to learn the press tool design, manufacturing used for press tool, calculations involved in it & materials. The article consists of design of a simple blanking press tool and manufacturing of a prototype. The output is a circular piece having diameter of 40mm and 60mm. The press machine designed is of mechanical type.

Key words: Blanking Tool

I. INTRODUCTION

A progressive tool performs varied flat solid operations at 2 or additional stations throughout every press stroke to develop a piece because the strip stock moves through the die. Every operating station performs one or additional distinct die operations however strip should move from the primary station through every succeeding station to provide a whole half. The linear travel of the strip stock at every press stroke is termed the “progression”.

A. Metal Forming Processes

These are solid state manufacturing processes involving minimum material wastage and quicker production. During a forming method, metal is also heated to a temperature that is slightly below the solids temperature and so an outsized force is applied such material flow and takes the required formed. The required form is controlled by a group of tools referred to as dies which can be utterly closed or part closed throughout manufacture. These processes square measure usually used for big scale production rates. These are typically economical and in several cases, it improves the mechanical properties too.

B. Sheet Metal Operations

Sheet metal operations also are called press tool operations. Press operating is also outlined as a chip less producing method by that numerous elements are made up of a sheet metal. This method is additionally termed cold stamping. For a budget approach of creating these flat solid elements, we tend to presumably couldn't have even thought of getting vehicles, typewriters, mechanical toys at such a low price. A press is a machine tool used to shaped or cut metal by applying force. Sheet metal is usually thought of to be a plate with thickness less than about 5mm. The press tool operation is one of the most affordable and quickest methodology, for the whole manufacture of an element.

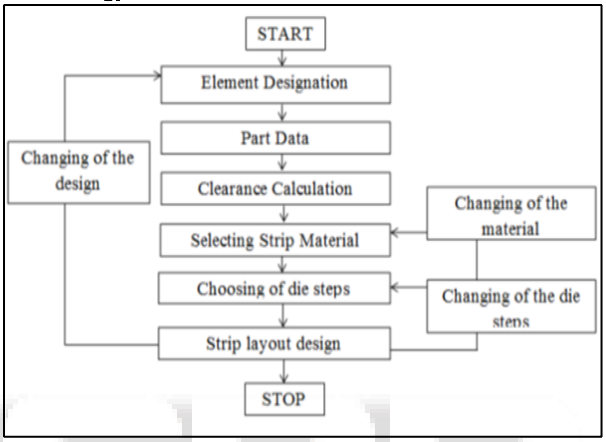

Fig. 1: Flow Chart of Design Methodology

C. Blanking Die

Blanking could be a formation tool that is designed to convert a strip of metal staple into elements that adapt to blueprint specifications. So, before continuing to the fabrication, the method of the blanking should be known initially. The knowledge of the process in the progressive die can facilitate to decide on the proper process in order that it will appropriate to the specified product that we would like to create. Dies are placed into a stamping press. When the stamping press moves up, the die opens. When the stamping press moves down, the die closes. The staple (metal that we would like to supply product) moves through the die whereas the die is open, being fed into the die a particular quantity with every stroke of the press. Once the die closes, the die performs its work on the metal and one or additional finished elements are ejected (usually by gravity) from the die.

II. LITERATURE

Ms. Surabhi Sunil Bagul represented that the press tool life is major criteria in high volume production of sheet metal components. For a Progressive die, proper tool life and component accuracy are necessity for achieving higher productivity and low cost per component. This paper describes and forms a basis by accumulating factors for tool life selection. The data is based on old tool which was analyzed and its characteristics were studied closely and improvements were made which are a part of this paper. In this work, we use the software UNIGRAPHICS for modelling a progressive tool for Arc Chute plate. Here, a multiple station die with initial operation as trimming and later as parting off is performed. In each stroke, one operation is performed with four punches, thus in one stroke we get four final plates. Thus, factor selection is made easy by specific data made available and the usefulness of the system is demonstrated by sample run of Arc Chute plate analysis. It caters for obtaining the final components conforming to required dimensions and standards.

Vivek D. Barhate, Dr. Sachin G. Mahakalkar & Dr. A. V. Kale represented the die which performs two or more operation subsequently in a single stroke is known as a progressive die. This die issued for producing a finish part in a single stroke. Compound die is also use for this; but its construction more complicated than progressive die. In progressive die the strip is feed from one end and finish part take out from other end. There the strip pass over different workstations and the related operations are performed there over it. In this paper the progressive die have two work stations. First workstation performs piercing operation and second one performs the blanking operation. At first station in piercing there two holes are pierced there. These holes are used for locating the strip at the blanking operation. For locating the strip there locating pins are used on die surface and pilot pins are used on punch surface. Main objective of this paper is to design a progressive die, prepare a model of die and analyze the model using FEA technique.

U.P. Singh represents the cost of tooling in sheet metal industries contributes a considerable part to the overall cost of manufacturing a component. It is therefore imperative to keep down this cost by ensuring that the tool works for a long period in production without interruption. One way of achieving this objective is to reduce the stress on the tool during punching/blanking. This paper deals with the study of this problem by using the finite-element technique. 3-D finite element models of various type of punching/blanking tools have been developed, these models enabling the analysis of the effects of variations in tool geometry on the punching/blanking force and on the deformation of the punch, a parameter highly relevant to the assessment of tool performance in terms of the accuracy of the manufactured components. The model caters also for variation in the characteristics of the tool material, in the sense that a highly wear-resistant tool is normally composed of carbide tips around its cutting profile. Computed results by FE models are checked against design standards by American Society of Manufacturing Engineers (SME). Some suggestions are offered as to how the efficiency of a punching/blanking tool can be improved.

Subramanyam Pavuluri, B.Rajashekar & B.Damodhar represents that high rate production industries generally use press machines. Thickness can vary significantly, although extremely small thicknesses are considered as sheet and above 6mm are considered as plate. Thickness of the sheet metal fed in between is called its gauge. Sheet metal is simply fed in between the dies of press tool for any press operation to perform. The reciprocating movement of punch is caused due to the ram movement of press machine. The press machine may be of electrical type, mechanical type, pneumatic type, manual type and hydraulic type. In today's practical and cost conscious world, sheet metal parts have already replaced many expensive cast, forged and machined products. The common sheet metal forming products are metal desks, file cabinets, appliances, car bodies, aircraft fuselages, mechanical toys and beverage cans and many more. Due to its low cost and generally good strength and formability characteristics, low carbon steel is the most commonly used sheet metal because high carbon composition gives high strength to the material. The other sheet metals used are aluminum and titanium in aircraft and aerospace applications. The purpose of this paper is to examine the causes for these seemingly contradictory results. An attempt will be made here to review the previous studies to look into future possibilities of various die designs.

III. PROBLEM STATEMENT

In industry at present condition the balancer shims are produced by manual scissor cutting operation. The balancer shims produced by manual cutting operation are less accurate and create waviness in profile. The time required for manual operation was two hours for a single cutting which was costly and time consuming.

This project specifically considers the design & development of blanking tool for shim. The objective is to produce shim with varying diameter and thickness. The final part to be manufactured will be in range of thickness (0.1mm to 0.8 mm) & (1mm to 1.5mm) and diameter (40mm & 60mm).

In this paper, we will design a replaceable punch and die block for required diameter variation. The tool designed will be used to manufacture total 24 types of parts with varying thickness and diameter. This process is mechanical press which is aimed to reduce the time, cost and increase the efficiency of production of shim in comparison with manual cutting operation.

IV. DESIGN

Sheet metal is just metal shaped into thin and flat items. It's one amongst the basic forms utilized in shaping, and might be cut and bent into a spread of various shapes. Innumerable everyday objects are constructed of the material. The whole press tool isn't needed to be of high strength material. As all elements of press tool don't involve in operation. Here the additional vital members are die, punch, and touch pad. These elements are needed additional strength material. The most important principle for choosing the material for that part is given as;

1) The tool material has additional wear, abrasive or adhesive resistance than the part material. Also, its friction force is more than part material.
2) The hardness of material is more than the part material.
3) Fatigue, shear, compressive strength is more than part material strength and plastic or elastic deformation strength is less than the part material strength.

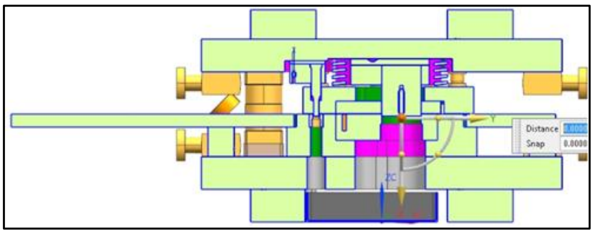

Fig. 2: Side View of Die Assembly

The material of part is mild steel. Thus, here D2 type of steel is employed for punch and die. It's a lot of hardness and strength than the mild steel. Also, OHNS, C45, SKD11 materials are used wherever there is a lot of wear and deformation occur; like guide pillar, setting ring, stacking ring, backup plate etc.

Four factors majorly affect the design of die block for any particular die. They are:

1) Part size
2) Part thickness
3) Intricacy of part contour
4) Type of die.

Small dies, like those for manufacturing business machine elements, mostly have a solid die block. Just for intricate part contours would the die block be sectional to facilitate machining. Massive die blocks area made in sections for straightforward machining, hardening, and grinding. In illustrations to follow are shown some methods of applying die blocks to small, medium, and large cutting dies. Thickness Top Plate, bottom plate and Guide pillars are the most basic part of die set and these two plates are guided by the guide pillars. This alignment is done here for improving accuracy, part quality, die life and reduce the set-up time. The lower plate support the die, die housing, raisers, etc. And the top plate supports the punch, punch backup plate, Guide pillar bush, etc.

A. Die Clearance

Die clearance is depend on the part material property. Small clearance is required If the material is ductile in nature and large clearance is required for brittle material. If the clearance is given in reverse then there for ductile material it passes through die means here it draw from die instead of cutting. Where as in ductile material it damages the cutting edges of die and punch. The die clearance for mild steel is 2.5% or 5% of thickness per side.

$$C = 5\ \%\text{ of thickness} = (2.5/100) \times 6 = 0.15\text{ mm}$$

$$\text{Or } C = 5\%\text{ of thickness} = (5/100) \times 6 = 0.3\text{ mm}$$

Large clearance increases the tool life. So here take 5% of thickness per side.

Press tools are usually created using HCHCr, Steel alloys with high carbon. However, before that based several factors like price, strength, hardness, strain and plenty of parameters choice to be made. The usually selected materials are D2, EN31. Mild cast steel is employed as supporting plate. Excluding that materials like D3, high carbide materials, high-speed steels and chromium also are used.

The materials used for making blocks are mild steel and HCHCr. The material for the punch and the die block is HCHCr (EN31 and P20) whereas for base plate and guide block it is mild steel (H13 and EN8). Punch and Die block should have high strength compared to base plate and Guide block. So, high strength materials are used for punch and base. By comparison on many factors like strength ability, Machinability, thermal properties, load factor and cost factor EN31 and EN8 suits best. So we selected EN31 for base and punch, EN31 for die and guide block.

a) Punch and Die Block: the main function of punch is to strike the sheet metal that is connected to the hub of the power press machine. The striking power relies on tons capability of machine. The punch is fitted by tapering at its top and bolted by a nut. The form and dimensions of the output to be achieved depends on design of Die block. The product is of coin kind form with 20mm dia. Clearance is required between punch and Die block, otherwise we cannot perform the operation. Clearance is given depending on the thickness of sheet and it's regarding 10% of sheet thickness. If we tend to take the sheet thickness as 2mm then positive tolerance should be as 0.2mm for die block.
b) Guide Block and Base Plate: The Guide block is simply block that supports acts as intermediate between the punch and the Die block. The main function is to oppose the Shear force and perform sheet operation. The drawing and dimensions is shown for the guide block. Here the punch moves down with high force, thus to stop the breakage of Die. High strength material is employed and placed as bottom plate. Thus, base plate and punch are used of same material.

Die sets are manufactured in three accuracy groups:

1) Commercial die sets, with tolerances between guide posts and bushings from 0.0004 to 0.0008 in. (0.010 to 0.020 mm). Commercial die sets should be used for dies where no piercing, blanking, or any other cutting is performed, such as forming and bending dies.
2) Precision die sets, where the alignment between guide posts and bushings is further perfected by precision grinding of the bushing's inner opening, as well as its outer diameter, which is press-fitted into the die shoe. The alignment of these dies is excellent, and they should be specified for cutting, piercing, blanking, and perforating dies.
3) Ball-bearing die sets with ball-bearing arrangement in place of plain sleeve bushings. These die sets are very tight-fitting, and they completely eliminate the possible development of thrust stresses or so-called side-play. Die sets with ball bearings are recommended for materials over 0.015 in. (0.38 mm) thick; pin sets may be used for all sheet stock under 0.015 in. (0.38 mm) in thickness.

B. Die Plate

The die block constitutes the female half of the two mated tools, which carry the cutting edges. A vertical opening extending through the block determines the size and outline of the blank. The exact opening is provided in the die to obtain a predetermined clearance between punch and the die. The quantity of angular clearance and vertical land within the die opening is critical so as to stop the chance of a blank or slug jam within the passage.

C. Die Set Mounting

Each die set comes equipped with a mounting arrangement. In many cases this consists of a shank which is either welded or screwed to the upper die shoe. With semi-steel die sets the shank is cast along with the upper shoe and machined to size afterward. The size of the shank depends on the mounting dimensions of the press the die is intended for. With die sets of greater weight, an additional holding provision is added in the form of socket cap screws inserted through the upper die shoe to the underside of the ram. The upper half of the die shoe is always firmly mounted to the ram of the press while the lower half is attached to the press bed. However, the attachment of the die's lower half should never be firm and tight, as the die needs some minute space to move around, if necessary. The bottom attachment should therefore be snug, but never rigid.

Many may question the die's "moving around," but there are indeed many instances when the die arrangement changes. This may be due to the variation in temperature, introduction of stresses during the production cycle, relaxation of such stresses at the end, to name a few. These changes may produce some minimal variations in size or location, often almost microscopic, but as with everything else they do add up and if a die would be firmly tightened at both ends, damage to the tool may result.

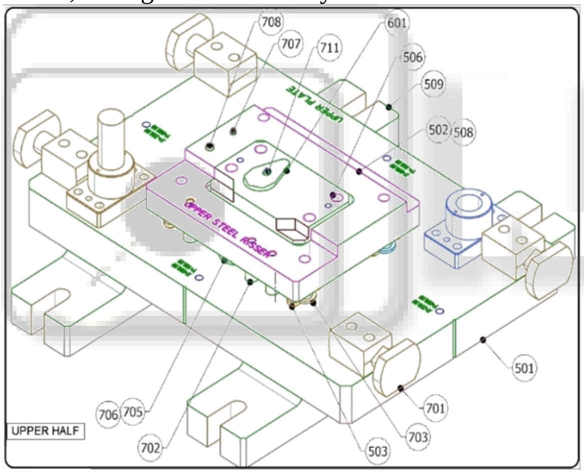

Fig. 3: Upper Half Part of Die

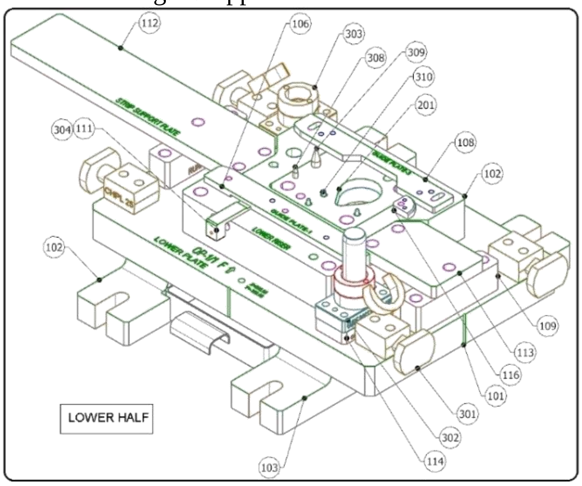

Fig. 4: Lower Half Part of Die

V. CALCULATION

Design Calculation of Stripper Force
Cutting Length = 540 Mm
Sheet Thickness = 1.5 Mm (Maximum Consider)
Strip Material = Mild Steel
Shear Strength = 44 Mpa
Cutting Force = Cutting Length X Sheet Thickness X Shear Strength
= 540 x 1.5 x 40/1000
= 35.64 Ton
Stripping Force = 12% of Cutting Force
= 12% x 35.64
= 4.3 Ton
For Press Selection
Press Tonnage = 3 X Cutting Force
= 3 x 35.64
= 107 Ton
We required more than 110 ton press but available press is 160 tons which can also be used for required operation.

1) Design of Punch

Punch is made part of the press tool. The cutting operation is carried out here. So the material required for manufacturing the punch is harder than the part material. So d2 material is used for the punch manufacturing. The hardness of this material is 52-56 HRC.

2) Punch Calculation for Diameter

Punch diameter taken 80 % of tolerance of punch size in design there are + 0.5 tolerance.
Clearance = 0.5 x 80/100 = 0.4 mm
Punch size = Ø 10.4 mm
Die button diameter calculation
= 16 % of sheet thickness
Clearance = 16/100 x 2 = 0.32 mm
Die button diameter size = punch size + clearance
= 10.4 + 0.32
= 10.72 mm

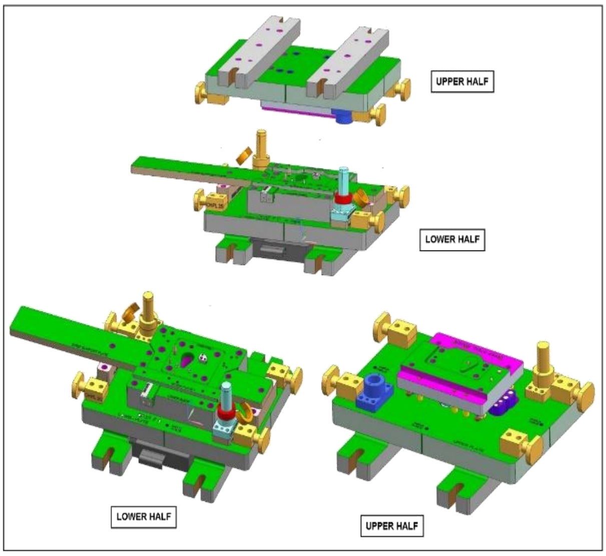

Fig. 5: Final Parts of Die Assembly

VI. RESULTS & DISCUSSION

A. Advantages

1) The nature of the process allows you to create more parts in a shorter period when compared with traditional fabrication or machining. For high volume parts, progressive stamping provides the lowest cycle times per part.
2) Less Scrap Material – Stamping is a metalworking method that can encompass punching, coining, bending and several other ways of modifying metal to produce your desired end part shape. Most of material is used, hence, less scrap is produced. Progressive Die Metal Stamping may provide the most cost-effective material option for manufacturing your parts.
3) Quicker Setup – When compared to traditional fabrication or machining, the setup time may be much less for the progressive stamping process. What is achieved in multiple Setups and processes during traditional fabrication and machining, may be performed in one operation if Progressive Die Stamping is utilized. This reduction in Setup and processing will result in a more cost-effective piece part.
4) High Repeatability – The hard tooling die designs allow for high volume runs without die degradation. This means that part quality remains high and there are fewer failed parts.
5) Longer Runs – The continuous material feed used in the progressive die stamping process allows for long runs. Longer runs between material changes and tooling adjustments mean your parts can be produced in a much shorter time.
6) Lower Cost per Part– All of the factors above contribute to reducing the overall cost of your part. Using progressive die stamping allows you to create robust parts in the most cost effective and expeditious manner.

VII. FUTURE SCOPE

A number of other issues related to this present research would be new avenues for further research. In the progressive die there should be some error of burr problem of blank. So there is some problem in die clearance. Also there is problem in guiding the strip over the die surface. This can done by introducing coil feeding system to make complete automation of blanking operation which will increase accuracy, save time and labor cost.

Interchangeable punch and holder can be developed to obtain various different size and shapes of shim. Which will reduce requirement of design and manufacturing of complete die set. Total cost of tooling and material for tool will be saved.

VIII. CONCLUSION

We can see that all the industry wants low production cost and high work rate which is possible through the design and manufacturing of blanking tool for shim which will require less manpower as well as less time, since this tool provides working with different sizes it really will reduce the time consumption up to appreciable limit. In an industry a considerable portion of investment is being made for manufacturing.

So we conclude in this project, proposed tool which can able to perform operation like manufacture total 24 different types of parts with varying thickness and diameter. Which implies that industrialists have not to invest in more manpower for performing above tasks and can manufacture the parts with varying thickness and diameter.

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REFERENCES

[1] Ms. Surabhi Sunil Bagul1, Nishant Surendra Dhadiwal2, Jayesh Rajendra Chopda, 'Experimental Study for Improvement of Press Tool Life and Component Accuracy', International Journal of Modern Trends in Engineering and Research, 2005, pp. 3-5.
[2] Hakan Gürün, Mustafa Göktaş, Abdulmecit Güldaş, 'Experimental Examination Of Effects Of Punch Angle And Clearance On Shearing Force And Estimation Of Shearing Force Using Fuzzy Logic', International Journal of Mechanical and Industrial Technology ISSN 2348-7593 (Online) Vol. 4, Issue 1, April 2016 - September 2016, pp. 6-12.
[3] Ketan Kapse, Ajinkya Jadhav, Sagar Pawar, Gajanan Gaikwad, 'Design of Blanking Die for Stiffening Rib: A Case Study', International Journal of Innovative Research in Science, Engineering and Technology, 2017, pp.4-12.
[4] Rupali Chavan, Navneet Patil, 'Design, Development and Analysis of Press Tool for an Industrial Part', International Journal of Mechanical and Industrial Technology, 2016, pp.4-9.
[5] Vivek D. Barhate, Dr. Sachin G. Mahakalkar & Dr. A. V. Kale, 'Design and Analysis of Progressive Die for an Industrial Part', International Journal of Science and Research (IJSR) ISSN, 2013, pp.3
[6] Vishwanath M.C., Dr. Ramni , Sampath Kumar L, 'Design of Progressive Draw Tool', International Journal of Scientific and Research Publications, Volume 3, Issue 8, August 2013, pp.2-5.
[7] U.P. Singh, 'Design study of the geometry of a punching/blanking tool' Journal of Materials Processing Technology, 33 (1992) Elsevier, pp. 5-12.
[8] Subramanyam Pavuluri, B.Rajashekar, B.Damodhar, 'Process of Press Tool Design and its Manufacturing for Blanking Operation', International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) Vol. 5, Issue 5, May 2016, pp.4-6.
[9] Anudeep S, 'Design and Analysis of Blanking and Bending Press Tool to Produce Anchor Bracket.Component, International Journal of

Engineering Research & Technology (IJERT) ISSN: 2278-0181 Vol. 4 Issue 04, April-2015 pp.3.
[10] Vyshakh, Sannamani L G & Dr Ramegowda D, ‘Design, Analysis of Punch and Die for Blanking, Piercing and Forming tools to Produce Chain Guide Mounting Bottom Bracket’, International Journal for Ignited Minds (IJIMIINDS), pp.5-9.
[11] S. B. Tor, G. A. Britton, and W. Y. Zhang, ‘Functional Modeling in Conceptual Die Design, Singapore-MIT Alliance (SMA) Fellow, SMA-NTU Office, N2-B2C-, pp-78.
[12] Guoying Ma and Binbing Huang, ‘Optimization of Process Parameters of Stamping Forming of the Automotive Lower Floor Board’, Hindawi Publishing Corporation Journal of Applied Mathematics Volume 2014, Article ID 470320, pp-7-9.
[13] Khushee Ram, Sanjeev Kumar and D. P. Singh, ‘Study and designing of new chute plate for single minute exchange of die (SMED) in sheet metal industry on high speed presses’, Pelagia Research Library Advances in Applied Science Research, 2015, pp-54-72.
[14] J. R. Paquin, ‘Die Design Fundamentals A step- by-step introduction to the design of stamping dies including material, plJnches, die sets, stops, strippers, gages, pilots and presses’ Library of Congress Cmalog Card Number: 62- 19251, pp-188-196
[15] Kumar Shailendra, An Intelligent System for Selection of Materials for Press Tool Components, pp.7-12.
[16] Ulhas K Annigeri, Y P Deepthi, Raghavendra Ravi Kiran K, ‘Design, Development And Analysis Of Forming Tool For Side Panel Of An Automobile, International Journal of Mechanical And Production Engineering, ISSN: 2320-2092, Volume- 2, Issue- 6, June-2014, pp. 2-4.
[17] Sei-Hwan Kim and Kye-Kwang Choi, ‘Research on Improvement of Blank Precision and Life Span Extension of Nail Clipper Die with Uneven Shear Area, International Journal of Advanced Science and Technology Vol. 54, May, 2013 pp. 1-7.
[18] Vyankatesh B. Emche and Rajesh R Kandalkar ‘Efficient Method of Producing Oval Punching holes on Sheet Metal’Journal of Applied Mechanical Engineering, pp. 3-6.
[19] Pawan Kumar Rai, Dr. Aas Mohammad, Hasan Zakir Jafri, ‘Causes & Preventation of Defects (Burr) In Sheet Metal Component’, Pawan Kumar Rai, Dr. Aas Mohammad, Hasan Zakir Jafri / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622,Vol. 3, Issue 4, Jul-Aug 2013, pp. 42-44.
[20] B. F. Satpute, M. S. Harne, ‘Design and Development of Compound Die for Bearing Cap’ International Journal of Recent Engineering Research and Development (IJRERD) Volume No. 02 – Issue No. 01, ISSN: 2455-8761 June- 2016, pp. 50-61.
[21] Khushee Ram, Sanjeev Kumar and D. P. Singh, ‘Study and designing of new chute plate for single minute exchange of die (SMED) in sheet metal industry on high speed presses’, Pelagia Research Library Advances in Applied Science Research, 2015, pp.5-17.