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Overview of Press Tool Design used for Sheet Metal Processes with Design Considerations

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Abstract: ***Sheet metals are generally related with cutting as well as forming operations. Mostly, the thickness of sheet metal is between ¼ inch and 1/64 inch. There are different types of metal forming operations are Bending, Shearing, Blanking, Punching, Stamping etc. For such type of applications of the material selection is major parameter. The raw material for sheet metal manufacturing processes is the output of the rolling process. Typically, sheets of metal are in the fort of flat, rectangular sheets of standard size. If the sheets are thin and very long, they may be in the form of rolls. So, by using various press tool designs and dies the complex designs of sheet metals are achieved. Punching is the most cost effective process of making holes in strip or sheet metal for average to high fabrication. It is able to create multiple shaped holes.***

Keywords: press tool designs, sheet metal operations.

1. Introduction

Sheet metal is simply metal formed into thin and flat pieces. It is one of the fundamental forms used in metalworking, and can be cut and bent into a variety of different shapes. Countless everyday objects are constructed of the material..

1.1 Sheet Metal Processes

1.1.1 Shearing Process

a. Punching: shearing process using a die and punch where the interior portion of the sheared sheet is to be discarded.
b. Blanking: shearing process using a die and punch where the exterior portion of the shearing operation is to be discarded.
c. Perforating: punching a number of holes in a sheet
d. Parting: shearing the sheet into two or more pieces
e. Notching: removing pieces from the edges
f. Lancing: leaving a tab without removing any material.

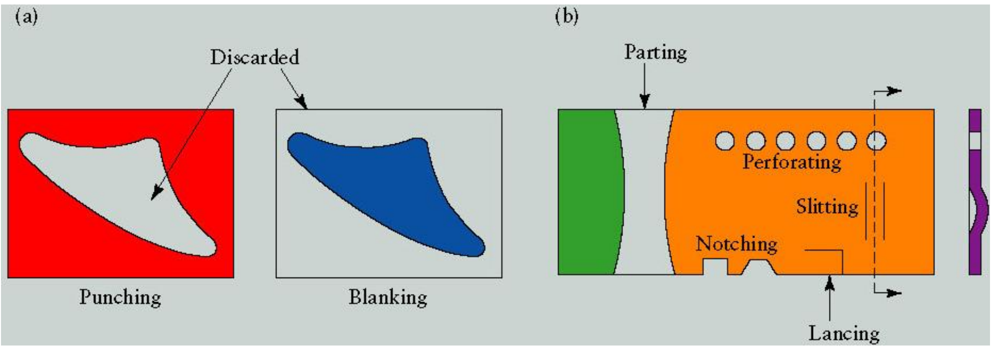

Figure 1: Shearing Operations: Punching, Blanking and Perforating

1.1.2 Forming Processes

a) Bending: forming process causes the sheet metal to undergo the desired shape change by bending without failure.
b) Stretching: forming process causes the sheet metal to undergo the desired shape change by stretching without failure.
c) Drawing: forming process causes the sheet metal to undergo the desired shape change by drawing without failure.
d) Roll forming: Roll forming is a process by which a metal strip is progressively bent as it passes through a series of forming rolls.

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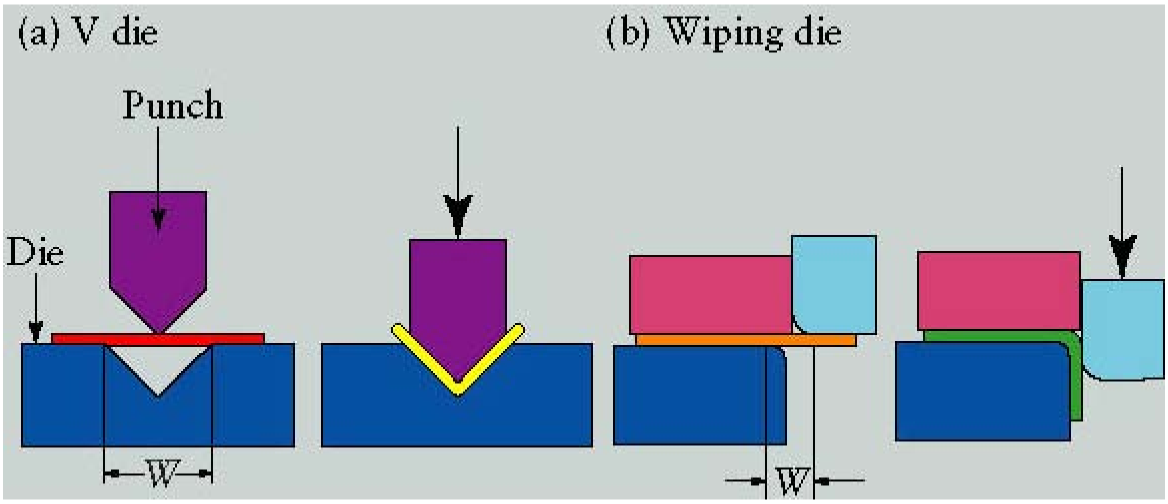

Figure 2: Common Die-Bending Operations

Basic sheet forming operations involve a press, punch, or ram and a set of dies.

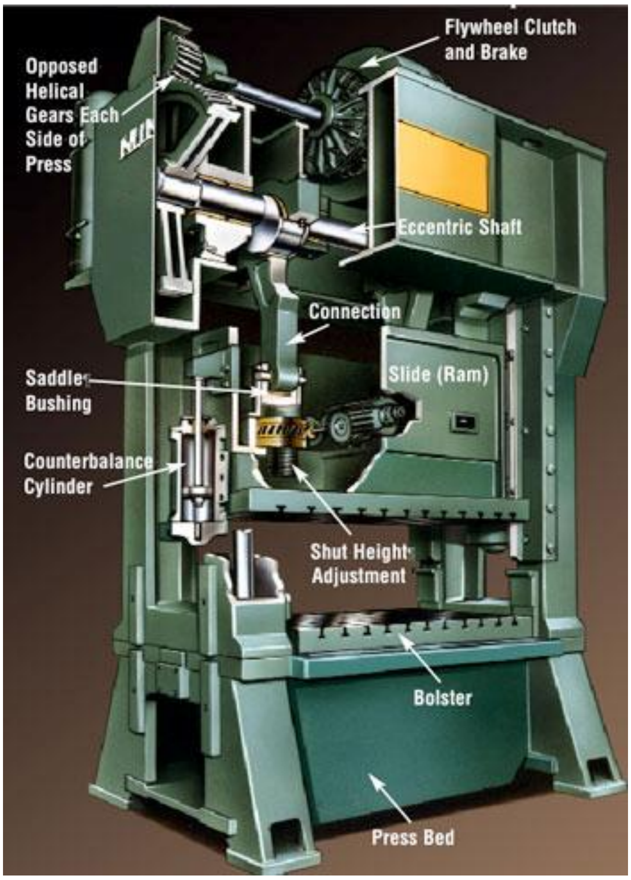

Figure 3: Mechanical Press

2. Literature Review

Knowledge for selection of materials of press tool components obtained from die designers, tool manufacturers etc. It has been analyzed, tabulated and incorporated into a set of production rules. The proposed intelligent system has been tested for variety of sheet metal components and proved to be powerful and easy to handle because of its rich knowledge base and highly interactive nature. The sample run of the system using an industrial sheet metal part has demonstrated the usefulness of the system. The system supports mainly tool steels, however its knowledge base can be modified and updated depending upon the availability of new materials and advancement in technology [1].

Sufficient research and deliberation using the proven QC tools backed up with CAE software support (HYPERFORM) has offered a feasible solution to the problem at hand. Steel material like HCHCr (High carbon High Chromium) & OHNS (Oil Hardening non Shrinkage) grade for both punch and die block to suit the components having EDD (Extra Deep Draw) is recommended per the practices found in the industries. The operating condition involving the magnitude of blank holding pressure is varied and the results analyzed [2].

The experimental investigation of the sheet metal blanking process makes it possible to study the effects of process parameters such as the material type, the punch-die clearance, the thickness of the sheet and their interactions on the geometry of the sheared edge especially the burrs height. Various methods are used in order to obtain a better understanding of the blanking manufacturing response. The investigation shows that, the blanking load increases with a reduction in the tool clearance in the case of both single and double blanking. It is observed that the diagonal angle (θ) increases linearly according to the clearance, the crack propagation angle (β) evolves nearly constant. One clear trend is that optimum clearance decreases as the material elongation increases [3].

A new Blank Holder Force System (BHF) device with six-bar linkage mechanism has been designed and manufactured. Whole control system of the new BHF technique was developed, and the basic structure of the hardware configuration of the system was given. Software analysis, implementation and division of the functional modules have been done. Also, the control software in data acquisition and processing module has been developed in the relevant technology of the BHF control system for the requirements of real-time, stability and accuracy [4]. Tool design of oval punching was carried out by following three steps:

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Step1. Identify the type of wear:
Factors Considered:
1) Type of sheet material
2) Hardness of sheet material
3) Presence of hard particles in the sheet material.

Step2. Occurrence of chipping or plastic deformation:
1) Type of operations to be performed on press tool.
2) Thickness and hardness of sheet material
3) Geometrical complexity of parts to be produced.

Step3. Risk of cracking:
1) Type of operations to be performed on press tool
2) Geometry of part to be produced
3) Die design and die size
4) Thickness and hardness of sheet material.

This was accomplished to identify the factors influencing the selection of materials of press tool components [5].

This paper investigates the realization of two sensing methods to create a tooling-integrated sensing system: mutual inductance-based displacement measurement for sheet draw-in, and distributed contact pressure measurement at the tool–work piece interface. The two sensing systems are complementary in nature, and together, they significantly enhance the on-line observability of the stamping process. The performance of the draw-in sensor was evaluated using numerical simulations and experiments in a small-scale and a large-scale lab setup, and its effectiveness has been confirmed under the presence of wrinkled sheet Real-time monitoring of local draw-in amount and local contact pressure in a deep drawing process is highly desirable for effective process control and for the time reduction needed for die trial out. Two tooling-integrated sensing methods were quantitatively evaluated using experimental setups [6].

A greedy algorithm to form part family using a bottom-up approach that makes use of the mixed integer linear programming formulation for generating shared setups for each part family. Secondly, mixed integer linear programming formulation to generate a shared setup for a given set of parts if such a setup exists. We expect that by producing many different types of parts on the same setup, we can significantly reduce the number of setup operations, improve machine tool utilization and enable cost-effective small-batch manufacturing [7].

3. Strip Layout Flow Chart

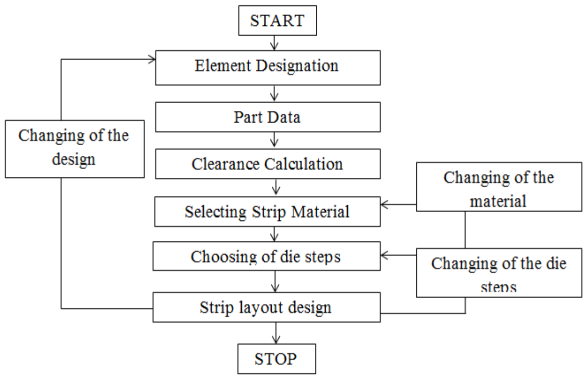

Figure 4: Flow Chart of Strip Layout

Process planning of the sequential steps sheet metal strip layout is based on classical methods is a "time and cost" consuming. A considerable knowledge collected to achieve an intelligent system in strip layout design. Sometimes the system is constructed based on Visual-LISP and AutoCAD customization tools. The usefulness of the proposed system can be demonstrated through a sample run using an example of an industrial component.

4. Characteristics of Metals Used in Sheet-Forming

Sr. No	Characteristic	Importance
1.	Elongation	Determines the capability of sheet metal to stretch without necking and failure
2.	Yield Point Elongation	Typically observed with mild steels, flame like depressions on the sheet surface
3.	Residual stresses	Typically caused by non-uniform deformation during forming, results in part distortion when sectioned, can lead to stress-corrosion cracking
4.	Spring back	Due to elastic recovery of the plastically deformed sheet after unloading, causes distortion of part and loss of dimensional accuracy can be controlled by techniques such as over bending and bottoming of the punch.
5.	Wrinkling	Caused by compressive stresses in the plane of the sheet, can be objectionable, depending on its extent, can be useful in imparting stiffness to parts by increasing their section modulus, can be controlled by proper tool and die design.

5. Design Considerations for Stamping tools

1) Type of material used and its thickness
2) Tool surface finish and use of Lubricant
3) Blank size and shape
4) Blank Holding Force
5) Punching speed
6) Draw radius
7) Draw Bead Height and Shape
8) Defects
9) Hydroforming

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