Sheet Metal Stamping Dies & Processes

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Training Objectives

After watching the video and reviewing this printed material, the viewer will gain knowledge and understanding of the stamping process and the die systems used to form sheet metal.

- the terms "ductility" and "formability" are explained
- the essential components of the stamping process are detailed
- basic stamping terms are defined
- progressive and transfer die technology is illustrated
- die lubrication is addressed
- circle grid analysis is explained

Sheet Metal Stamping

Stamping presses and stamping dies are tools used to produce high volume sheet metal parts. These parts achieve their shape through the effects of the die tooling.

Production stamping is generally performed on materials .020" to .080" thick, but the process also can be applied to foils as thin as .001" or to plate stock with thickness' approaching 1.000".

Formability is the primary attribute of sheet metal material. Formability is further defined as the materials ability to be:

- bent
- stretched
- drawn

The metallurgical term for these qualities is "ductility". Ductility is the materials ability to deform and elongate without fracture. The extent to which a stamping is subjected to such deformation is directly related to the part's overall shape and geometry. Other factors also influence the material's formability. They include:

- the die design
- the press
- the press speed
- lubrication
- sheet metal feeding mechanisms
- monitoring and control systems

The word "die" is a generic term used to describe the tooling used to produce stamped parts. A die set assembly consisting of a male and female component is the actual tool that produces the shaped stamping. The male and female components work in opposition to both form and punch holes in the stock. The upper half of the die set, which may be either the male or female, is mounted on the press ram and delivers the stroke action. The lower half is attached to an intermediate bolster plate which in turn is secured to the press bed. Guide pins are used to insure alignment between the upper and lower halves of the die set.

The most common types of dies perform cutting and forming. Cutting dies are used to shear sheet material into what is called a blank. These blanks are then exposed to blanking dies which cut the entire perimeter of the part, or to forming dies where the blank is stamped into a part. Punching is another function of cutting dies. Punching is the cutting of a slug from the sheet metal stock to produce a hole or slot. Cutting dies are also used to trim excess metal from around a formed part.

Hole punching and other cutting operations require specific and carefully maintained clearances between the punch (male component) and the die (female component). The setting of the required clearances is determined by both the stock thickness and temper. In general, die clearances increase as the stock thickness increases. The depth of punch penetration into the sheet metal stock will also increase as softer stock is used.

Forming is a general term used to describe a stamped part whose shape and contour is reproduced directly from the shape and contour of a die set. The main forming operations accomplished with press mounted dies are:

- drawing
- bending
- flanging
- hemming

Drawing, or draw forming, involves forcing a blank deeply into a die cavity and shaping it into the shape and contour of the punch face and sides. Without sufficient formability qualities, drawn blanks are subject to wrinkling, thinning, and fracturing. Draw forming requires an addition to the die set called a blankholder. The function of the blankholder, usually a ring through which the punch and ram pass, is to control the metal flow as it is forced into the die cavity. In practice, the blankholder must exert less pressure against the blank than the punch, so metal can flow into the die; yet it must exert enough pressure to prevent the material from wrinkling.

Bending is a relatively simple forming operation which provides rigidity and shape to sheet metal parts. Similar to bending is flanging. However a flange is significantly smaller in dimension than the rest of the part. The functions of a flange include:

- giving a more finished appearance
- rigidity
- edge strengthening
- providing a fastening or attachment surface

Hemming is the folding over of a short flange upon itself to form a smooth, rounded edge and to facilitate the attachment of mating parts.

Multiple stamping operations may be performed within a single die, or at a number of die stations within a die set and with a single stroke of the press.

Single station dies can be either compound dies or combinations dies. A compound die performs basic cutting operations such as blanking and hole punching to produce parts. Combination dies combine shaping and forming functions with cutting operation to manufacture parts.

Multiple station dies are arranged so that a series of sequential operations are accomplished with each press stroke. Two die types are used; progressive and transfer. With progressive dies, coil stock is fed into the press. Individual stampings are connected with a carrier strip as they progress through the various die operations and are ultimately separated and then discharged from the press. In transfer die operations individual stock blanks are mechanically moved from die station to die station within a single die set. Large stampings are done with tandem press lines where the stock is moved from press to press in which specific operations, such as drawing or trimming, are performed.

The resistance of the sheet metal stock to the forces exerted by the moving dies creates friction. For this reason, lubrication is vital for successful sheet metal forming. A lubrication's function is to minimize contact between the tooling and the work piece. This results in reduced tonnage requirements, longer tooling life, and improved product quality.

Lubricants range from light mineral oils to high viscosity drawing compounds. They may be oil base, water soluble, or synthetic materials. These lubricants may be applied in a variety of ways, including:

- manually by roller or brush
- drip
- machine roller
- spraying
- flooding

Die making is as much of an art as a science. When all the dynamics of stamping are taken into account, the resulting part may not meet all expectations. To help fine tune the stamping process and finalize die design, die makers use an analytical tool called Circle Grid Analysis, or CGA. The application of CGA involves the etching of a pattern of small circles on the surface of the blank. This pattern deforms along with the blank as it is formed, providing point-to-point calculations of the deformation that occurred. Analyzing this stamped grid pattern suggests the location and type of rework that must be performed on the dies to produce easily manufactured parts. The CGA process is repeated on the die until an acceptable part is produced.

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Review Questions

1. Most sheet metal stamping uses materials:
   a. .020 to .080 thick
   b. .050 to .125 thick
   c. .001 to 1.000 thick
   d. .010 to .100 thick

2. Ductility refers to a material's ability to:
   a. resist penetration
   b. resist corrosion
   c. bend over upon itself
   d. deform and elongate

3. A compound die is a die that performs:
   a. hemming and flanging
   b. blanking and hole punching
   c. bending only
   d. hole punching only

4.. The device(s) used to insure die component alignment are called:
   a. roller bearings
   b. ways
   c. guide pins
   d. "v" grooves

5. The terms drawing, flanging, and hemming are examples of:
   a. forming
   b. punching
   c. slitting
   d. extruding

6. A carrier strip is used with:
   a. transfer dies
   b. progressive dies
   c. tandem presses
   d. combination dies

7. The principle function of a lubricant in press stamping is to:
   a. cool the dies
   b. enable easy stack removal
   c. prevent wrinkling
   d. minimize tool contact to the work

8. Circle Grid Analysis, or CGA, is used to:
   a. calculate tonnage exerted on the work
   b. predict deformation distances
   c. finalize die design
   d. determine optimum press speed

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Answer Key

1. a
2. d
3. b
4. c
5. a
6. b
7. d
8. c