

# Sheet Metal Shearing & Bending



## **Training Objective**

After watching the program and reviewing this printed material, the viewer will gain a knowledge and understanding of the principles and machine methods of shearing and bending sheetmetal stock.

- The principles of shearing and bending are explained
- Shearing and bending theory is demonstrated
- Machinery operation is taught
- The functions of die tooling are detailed

## **Shearing and Bending**

The two most basic and oldest metal working operations are shearing and bending. Shearing is defined as the mechanical cutting of large sheets of metal into smaller pieces of predetermined sizes. A shearing operation that completes an entire perimeter is known as blanking, with the resulting workpiece being called a blank.

Bending is defined as the creation of three dimensional shapes out of two dimensional stock. There is virtually an unlimited variety of shapes that can be produced in both sheetmetal and plate thickness' by bending.

## **Shearing Machines**

Most shearing operations are accomplished by the action of two blades, one fixed and one moving vertically, meeting progressively from one side of the material to the other much like ordinary hand shears. The angular alignment of the blades is called the rake. Also to be considered is the blade or knife clearance to each other. Both rake and clearance are a function of the type and thickness of the material to be cut.

The "slip-plane" is the final cracking from both the top and bottom of the work after the descending upper blade partially cuts through the work. This upper blade is usually inclined in relation to the bottom blade, 1/2 to 2-1/2 degrees. This concentrates cutting pressure exactly at the juncture of the blades and assures a cut exactly parallel to the blades. The slight offset also helps clean material from between the blades.

Shearing is also done on a "shearing die" mounted in a stamping press, however most shearing is accomplished with a machine designed especially for the operation and is called a "shear."

The typical shear consists of:

- a fixed bed to which one blade is attached
- a vertically moving crosshead which mounts on the upper blade
- a series of hold-down pins or feet which hold the material in place while the cutting occurs
- a gaging system, either front, back, or squaring arm, to produce specific workpiece sizes

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Shears may be operated manually, mechanically, hydraulically, or pneumatically. They can also be classified by their design. “Gap” and “gapless” shears are defined by their side frames and the maximum size sheet they can handle. “Right angle” shears have two blades set at a 90 degree angle to each other and will cut simultaneously in two directions. “CNC” shears are programmable to cut various sizes by automatically feeding material into the blades. “Ironworkers” are designed to cut angle and bar stock and to perform punching operations.

The sharpness of the knives or blades critically determine the edge quality of the cut and the accurate size of the workpiece. Dull or improperly gapped or positioned blades will create in the cut piece, either:

- a camber or deviation from a straight edge on the drop side of the shear
- a bow which is the tendency of the sheared part to arch in the center
- a twist which is the angular distortion of the part from end to end

Another common shearing operation is known as “slitting.” This operation begins with a master coil of a given width. Material from the master coil is fed through a series of rotary knives set to produce a group of more narrow stock widths for subsequent processing.

## **Bending**

Bending produces shapes in metal by the exertion of force beyond the material's yield point but below it's maximum tensile strength. During bending, the metal is stretched over it's external radius and compressed through it's internal radius. The mid-point between these points is called the neutral axis and is the location from which mathematical calculations begin.

Bending can be performed in stamping dies designed for forming, but the greater majority of bends are made in “press brakes.” Like many other machines used in metal fabrication press brakes may be mechanical or hydraulic in operation. In a typical bending operation, a piece of stock is placed between a set of upper and lower dies. Then a moving ram lowers the upper die, forcing the work into the fixed lower die. In some press brake designs, a lower die raises up against a fixed upper die.

Principle terms used in bending include:

- bend allowance refers to mathematical factors which determine the final part size
- bend angle is usually the included angle of the bent workpiece. it can also refer to the supplementary angle formed by the two bent tangent lines.
- bend radius refers to the distance from the tangents that extend from the remaining flat surfaces of the part
- springback is the tendency of the bent flange to return back to its original shape. Such springback can amount from 2 to 4 degrees depending upon the material

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Press brake operations are divided into two categories:

- air bending
- bottom bending

In the air bending mode, the male die does not force the workpiece completely into the female bottom die. Less pressure or force is required than in bottom bending. However, there are trade offs in respect to springback and bent flange accuracy.

In bottom bending, the work is completely pressed into the female die and the internal radius is accurately formed by the male die. Thus consistently accurate flange sizes are possible. However, bottom bending does have limitations in respect to maximum work thickness, usually no greater than 1/8 inch.

Dies used in press brake work are of four major types:

- acute angle dies, used mostly for air bending
- gooseneck dies, used for bending return flanges
- offset dies which produce two bends with a single press stroke
- rotary dies which, as they move upon the work, form the bend by forcing it over a die anvil

Gaging, which means positioning the work between the closing dies is accomplished by pins or stops located usually behind the dies. These devices are often computer controlled, allowing quick, repeatable set-ups for maximum press brake productivity.

Another bending operation is called "folding." A folding machine uses a bending leaf located in front of upper and lower clamping jaws. Bends can be made between zero and 180 degrees, making the folding machine sometimes more versatile than the press brake.

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## Review Questions

1. When a workpiece is sheared to shape and size in a die, it is called a:
  - a. workpiece
  - b. plug
  - c. blank
  - d. billet
  
2. Rake refers to:
  - a. a cut angle of 45 degrees or more
  - b. the vertical offset of a knife blade
  - c. the angular alignment of the blades
  - d. parallelism
  
3. Slitting is performed on:
  - a. coil stock
  - b. thinner material
  - c. hardened material
  - d. aluminum sheets
  
4. A "neutral axis" is found:
  - a. between the "V" dies
  - b. in the center of the male die
  - c. before bending occurs
  - d. between the inner and outer radii
  
5. Springback can range from:
  - a. 10 to 20 degrees
  - b. 5 to 10 degrees
  - c. 2 to 4 degrees
  - d. 1/2 to 2 degrees
  
6. A limitation in bottom bending is:
  - a. accuracy
  - b. repeatability
  - c. excessive springback
  - d. material thickness
  
7. Gooseneck dies are used for bending:
  - a. return flanges
  - b. long lengths
  - c. double right angle bends
  - d. multiple flanges
  
8. The positioning of the work in a press brake is called:
  - a. locking in
  - b. gaging
  - c. setting up
  - d. banking

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## Answer Key

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