07 Sheet metal forming (blanking & piercing)

Shearing operation

Shearing is the mechanical cutting of materials without the formation of chips or the use of burning or melting. It is often used to prepare materials between 0.025 and 20 mm in thickness for subsequent operations, and its success helps to ensure the accuracy and precision of the finished product.

When the two cutting blades are straight, the process is called shearing. When the blades are curved, the processes have special names, such as blanking, piercing, notching, and trimming.

In terms of tool design and material behavior, however, all are shearing-type operations.

A simple type of shearing operation is illustrated in **Figure 7.1**. As the punch pushes on the workpiece, the metal responds by flowing plastically into the die.

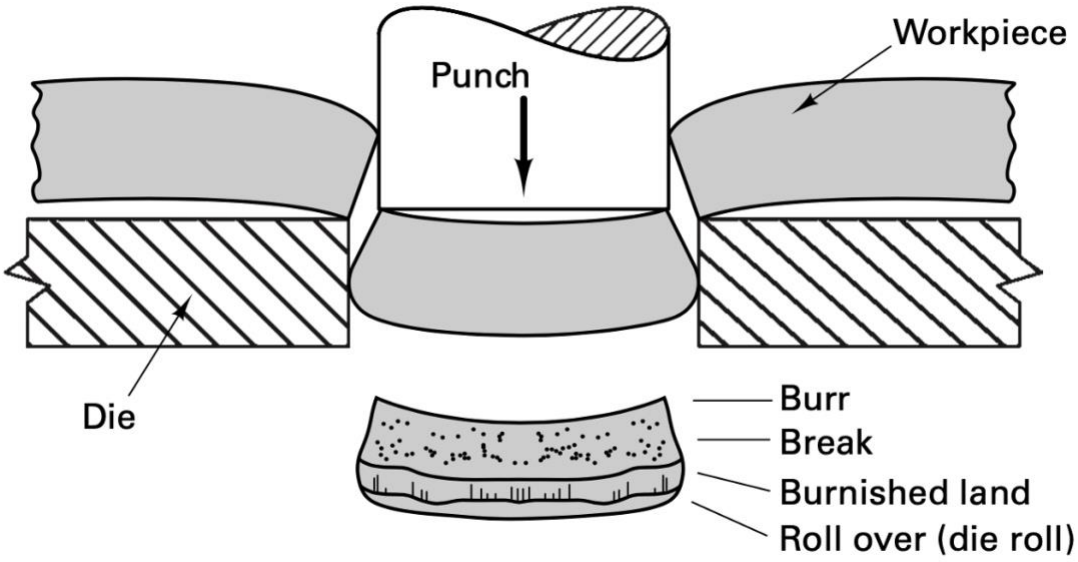
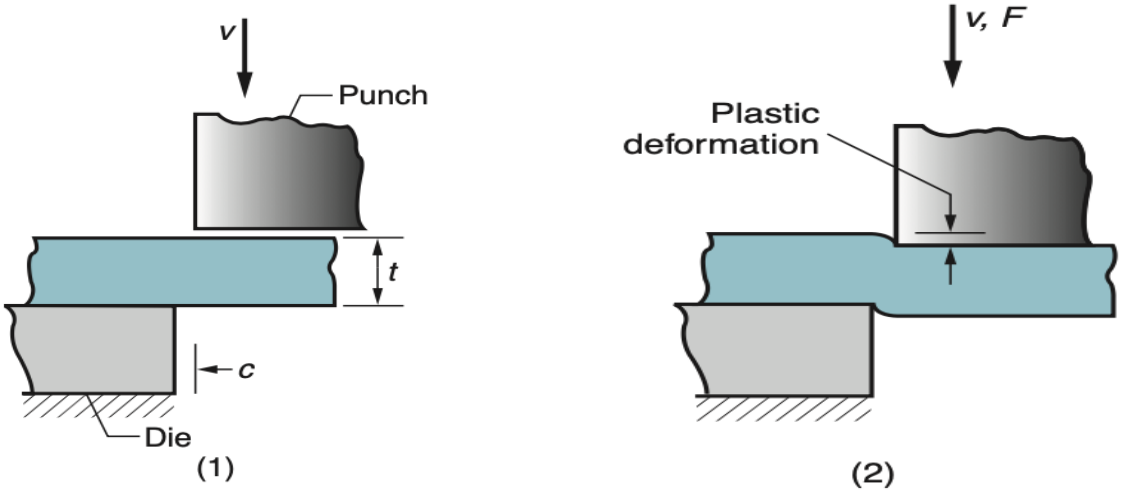


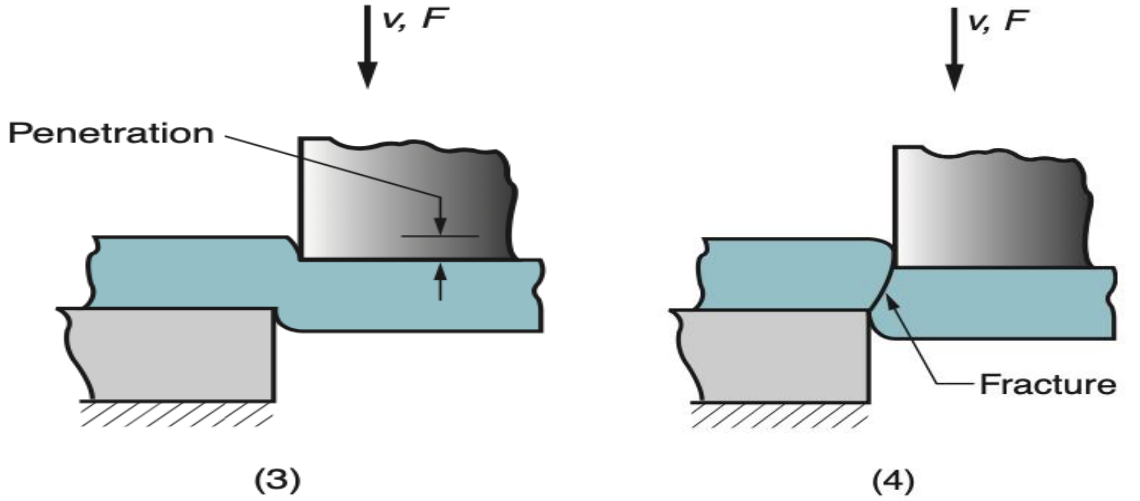
Figure 7.1 Simple blanking with a punch and die.

Because the clearance between the two tools is small, usually between 5 and 20% of the thickness of the metal being cut, the deformation occurs as highly localized shear.



(1) just before the punch contacts work.

(2) punch begins to push into work, causing plastic deformation



(3) punch compresses and penetrates into work causing a smooth cut surface

(4) fracture is initiated at the opposing cutting edges that separate the sheet.

Figure 7.2 Shearing of sheet metal between two cutting edges

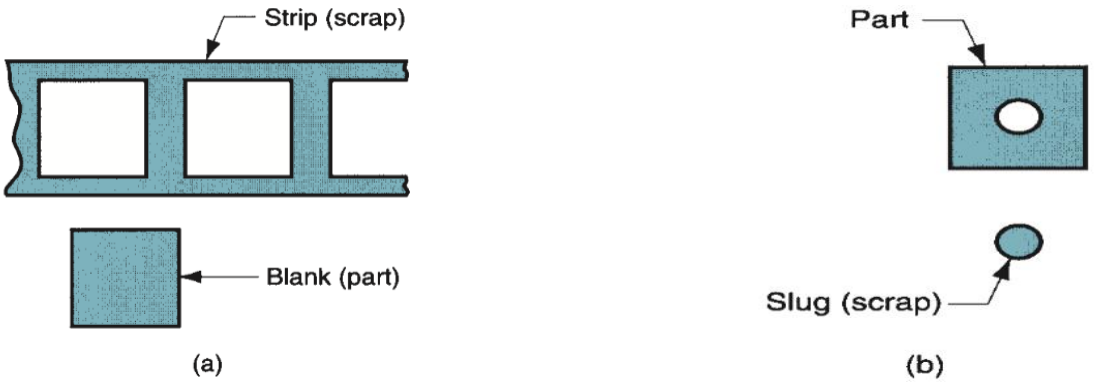
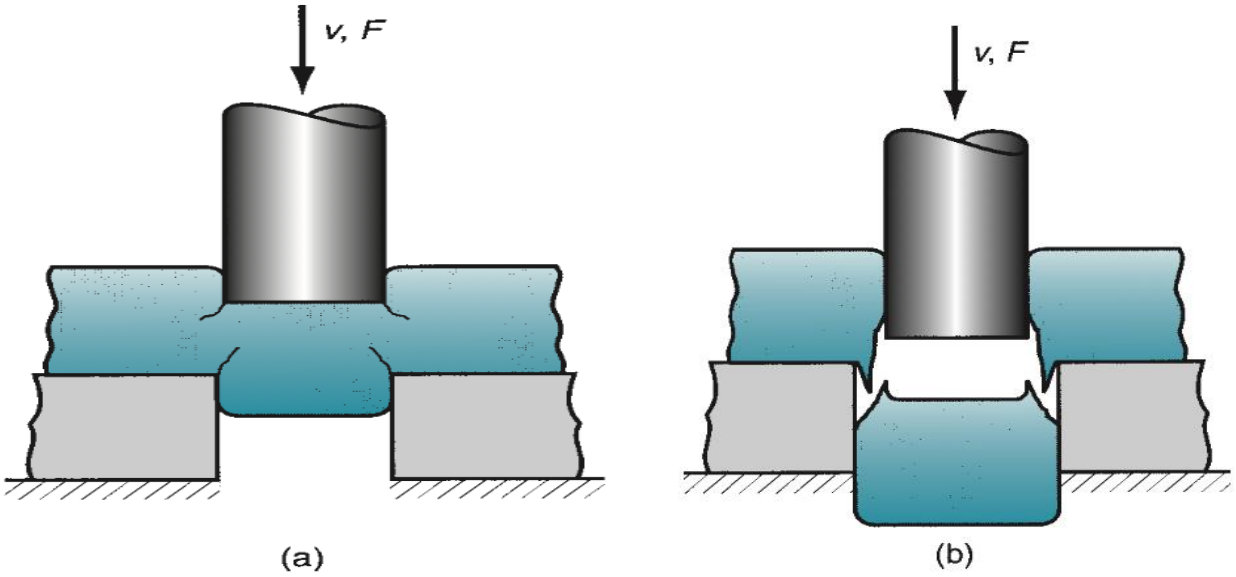


Figure 7.3 (a) Blanking and (b) Punching.



(a) clearance too small causes less-than- optimal fracture and excessive forces.

(b) clearance too large causes oversized burr.

Figure 7.4 Effect of clearance.

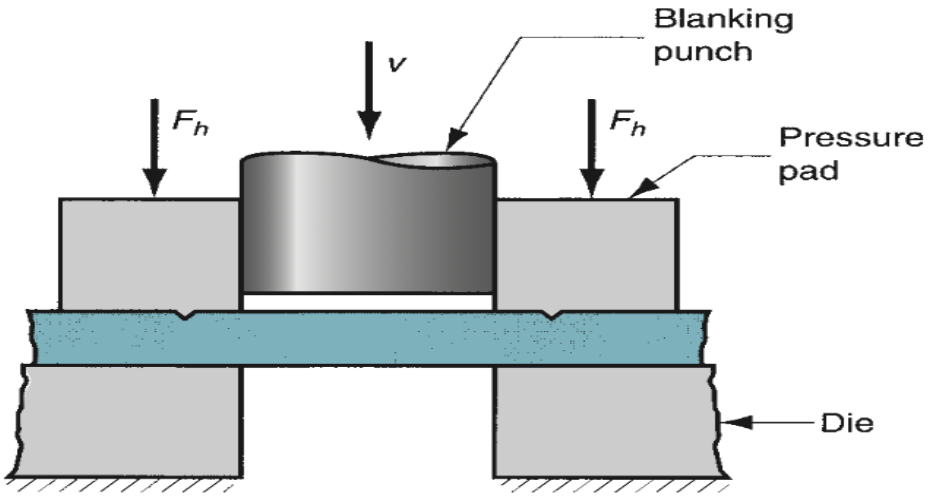


Figure 7.5 Fine blanking.

TABLE 7.1 Clearance allowance value for three sheet-metal groups.	
Metal Group	**Ac**
1100S and 5052S aluminum alloys, all tempers	0.045
2024ST and 6061ST aluminum alloys; brass, all tempers; soft cold-rolled steel, soft stainless steel.	0.060
Cold-rolled steel, half hard; stainless steel, half-hard and full-hard.	0.075

Example 7.1

A round disk of 150-mm diameter is to be blanked from a strip of 3.2 mm thickness, half-hard cold- rolled steel whose shear strength = 310 MPa. Determine (a) the appropriate punch and die diameters, and (b) blanking force.

Solution:

(a) From Table 7.1, the clearance allowance for half-hard cold-rolled steel is:

Ac = 0.075. Accordingly,

$(clearance)\ c = 0.075 \times 3.2 = 0.24\ mm$

The blank is to have a diameter = 150 mm, and die size determines blank size. Therefore,

Die opening diameter = 150:00 mm

Punch diameter = 150 – 2(0.24) = 149:52 mm

(b) To determine the blanking force, we assume that the entire perimeter of the part is blanked at one time. The length of the cut edge is:

$$L = \pi D_b = 150\,\pi = 471.2\ mm$$

$$F = 310\ (471.2)(3.2) = 467.4\ kN$$