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Metal Extrusion

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Extrusion: is a compression process in which the work metal is forced to flow through a die opening to produce a desired cross-sectional shape.

The process can be likened to squeezing toothpaste out of a toothpaste tube. Extrusion dates from around 1800.

There are several advantages of the modern process:

(1) a variety of shapes are possible, especially with hot extrusion.

(2) grain structure and strength properties are enhanced in cold and warm extrusion.

(3) fairly close tolerances are possible, especially in cold extrusion.

(4) in some extrusion operations, little or no wasted material is created.

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However, a limitation is that the cross section of the extruded part must be uniform throughout its length.

Extrusion is carried out in various ways.

One important distinction is between:

1. Direct extrusion.
2. Indirect extrusion.

Another classification is by working temperature:

1. Cold extrusion.
2. Warm extrusion.
3. Hot extrusion.

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Finally, extrusion is performed as either:

1. Continuous process.

2. Discrete process.

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Direct versus Indirect Extrusion:

1. Direct extrusion.

(also called forward extrusion) is illustrated in Figure 12.1.

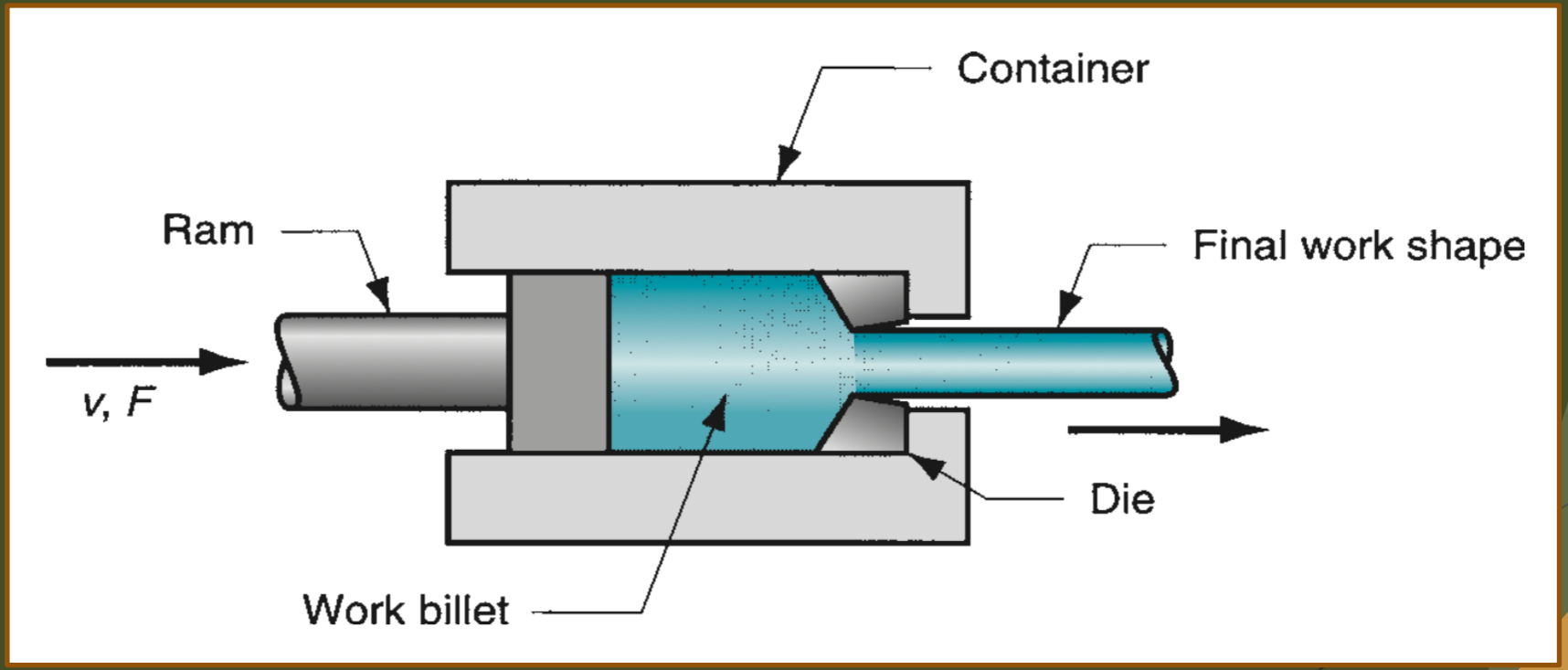

Figure 12.1 Direct extrusion.

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A metal billet is loaded into a container, and a ram compresses the material, forcing it to flow through one or more openings in a die at the opposite end of the container.

As the ram approaches the die, a small portion of the billet remains that cannot be forced through the die opening.

This extra portion, called the butt, is separated from the product by cutting it just beyond the exit of the die.

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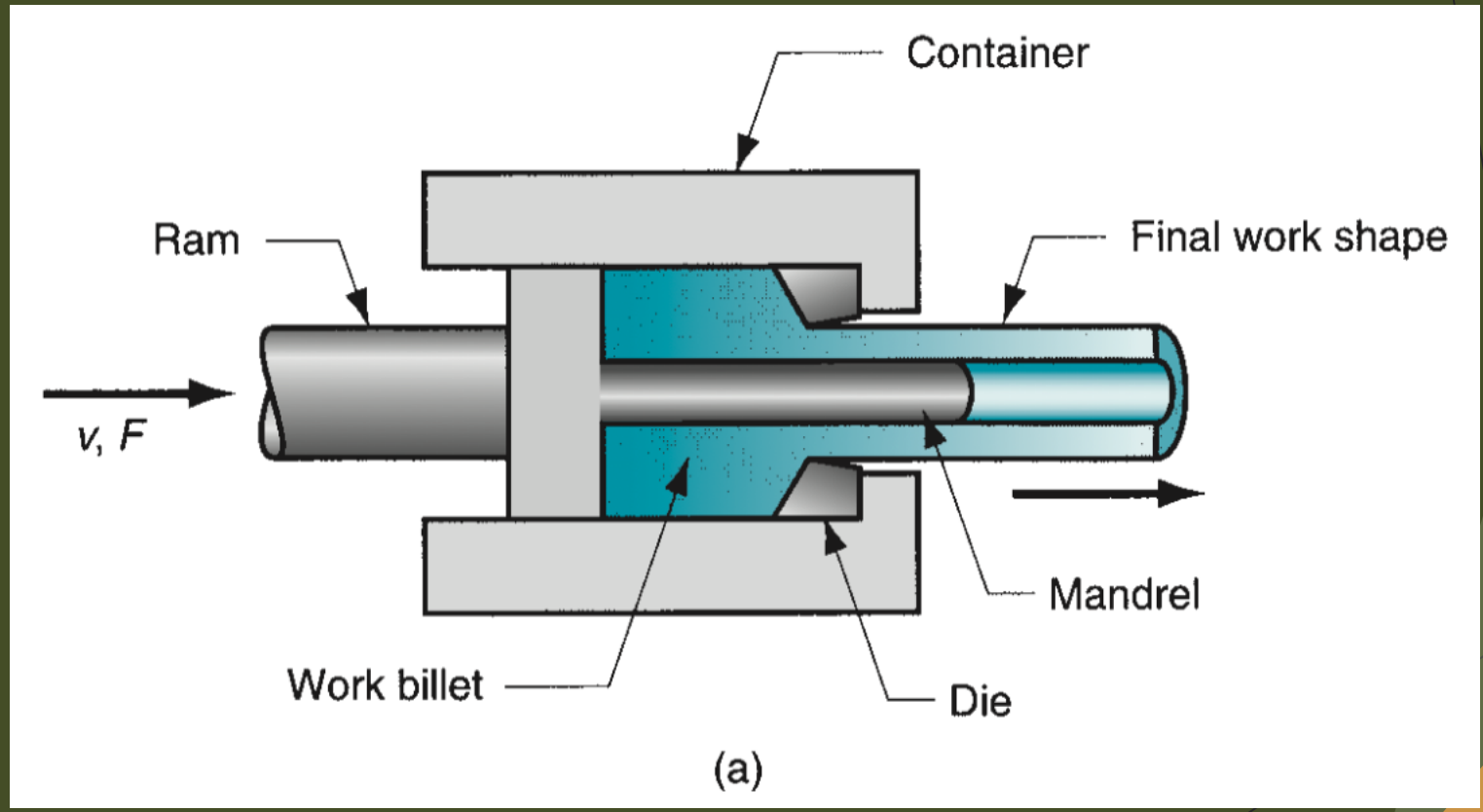
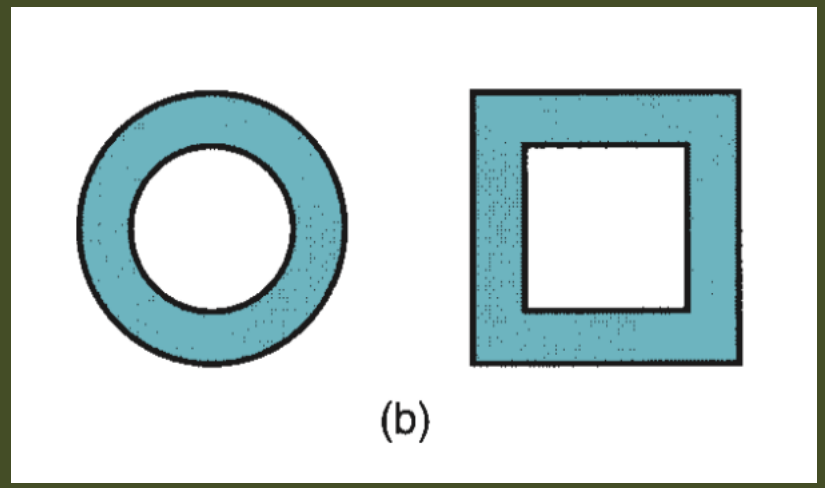
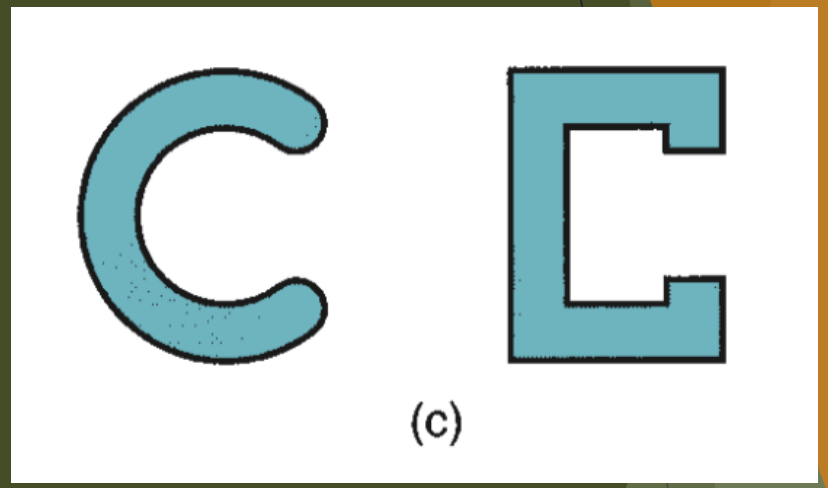
Hollow sections (e.g., tubes) are possible in direct extrusion by the process setup in Figure 12.2.



(a) Direct extrusion to produce a hollow or semi-hollow cross section.



(b) Hollow cross sections.



(c) Semi-hollow cross sections.

Figure 12.2 Direct extrusion.

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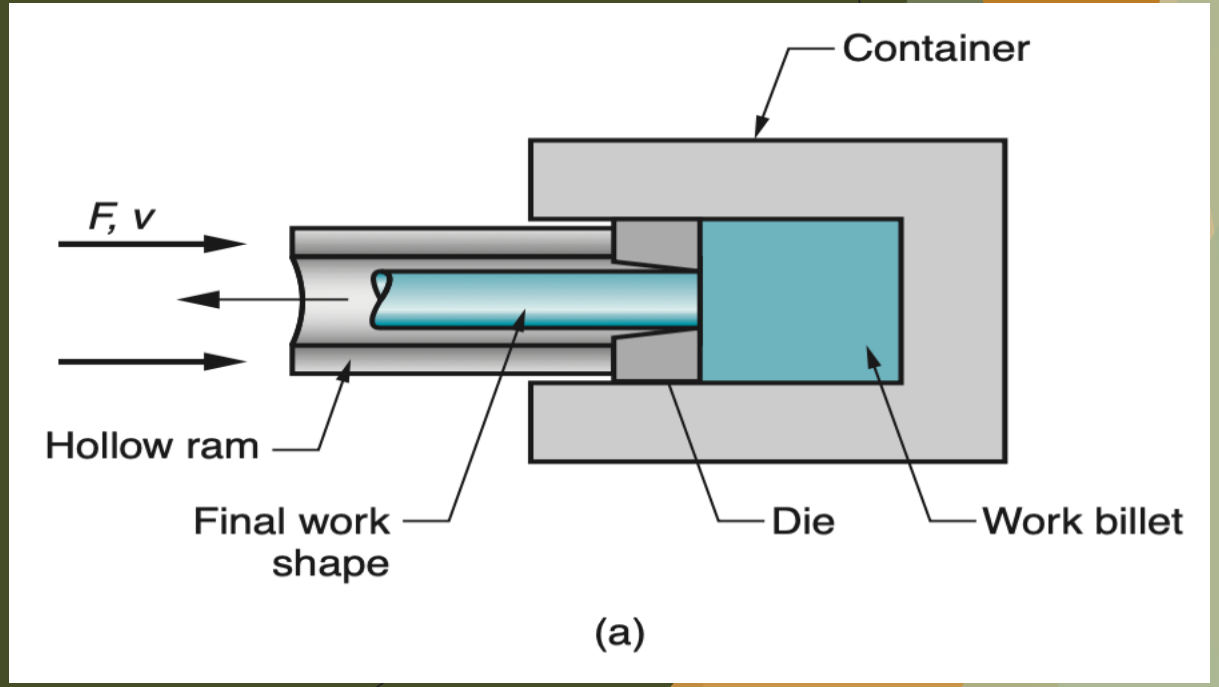
In indirect extrusion, also called backward extrusion and reverse extrusion, **Figure 12.3(a)**.

The die is mounted to the ram rather than at the opposite end of the container. As the ram penetrates into the work, the metal is forced to flow through the clearance in a direction opposite to the motion of the ram.



(a) Indirect extrusion to produce a solid cross section

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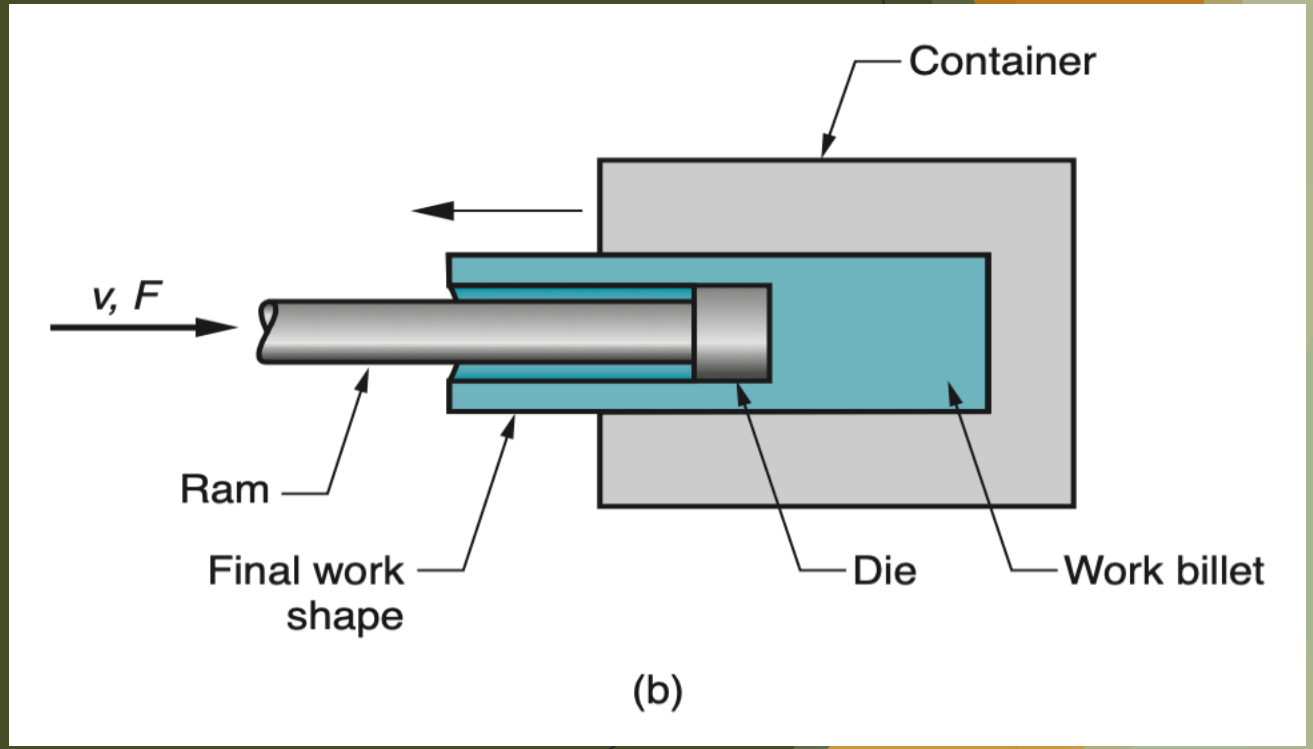
Indirect extrusion can produce hollow (tubular) cross sections, as in Figure 12.3 (b).

In this method, the ram is pressed into the billet, forcing the material to flow around the ram and take a cup shape.



(b) Indirect extrusion to produce a hollow cross section.

Figure 12.3 Indirect extrusion.

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Hot versus Cold Extrusion

Extrusion can be performed either hot or cold, depending on:

1. Work metal.

2. Amount of strain to which it is subjected during deformation.

Metals that are typically extruded hot include aluminum, copper, magnesium, zinc, tin, and their alloys. These same metals are sometimes extruded cold.

Steel alloys are usually extruded hot, although the softer, more ductile grades are sometimes cold extruded (e.g., low carbon steels and stainless steel).

Aluminum is probably the most ideal metal for extrusion (hot and cold), and many commercial aluminum products are made by this process (structural shapes, door and window frames, etc.).

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Hot extrusion involves prior heating of the billet to a temperature above its recrystallization temperature. This reduces strength and increases ductility of the metal, permitting more extreme size reductions and more complex shapes to be achieved in the process.

Cold extrusion and warm extrusion are generally used to produce discrete parts, often in finished or near finished form.

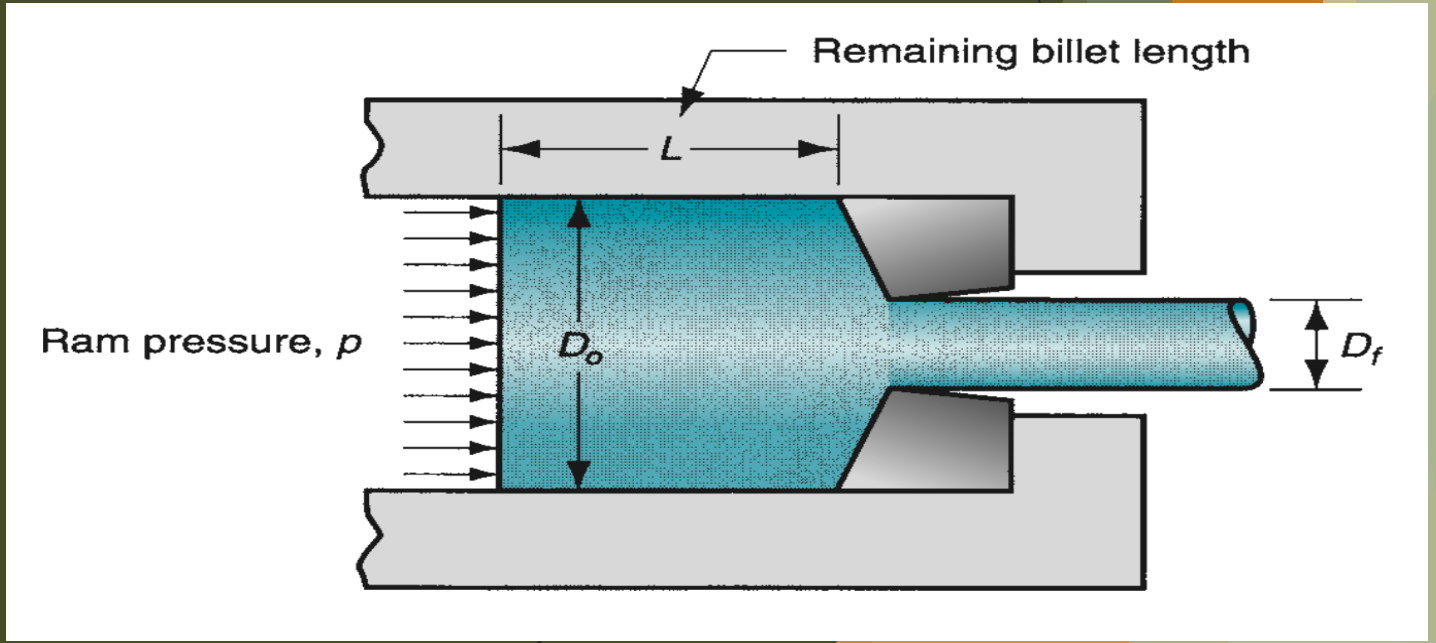

Figure 12.4 Pressure and other variables in direct extrusion.