Types Of Extrusion

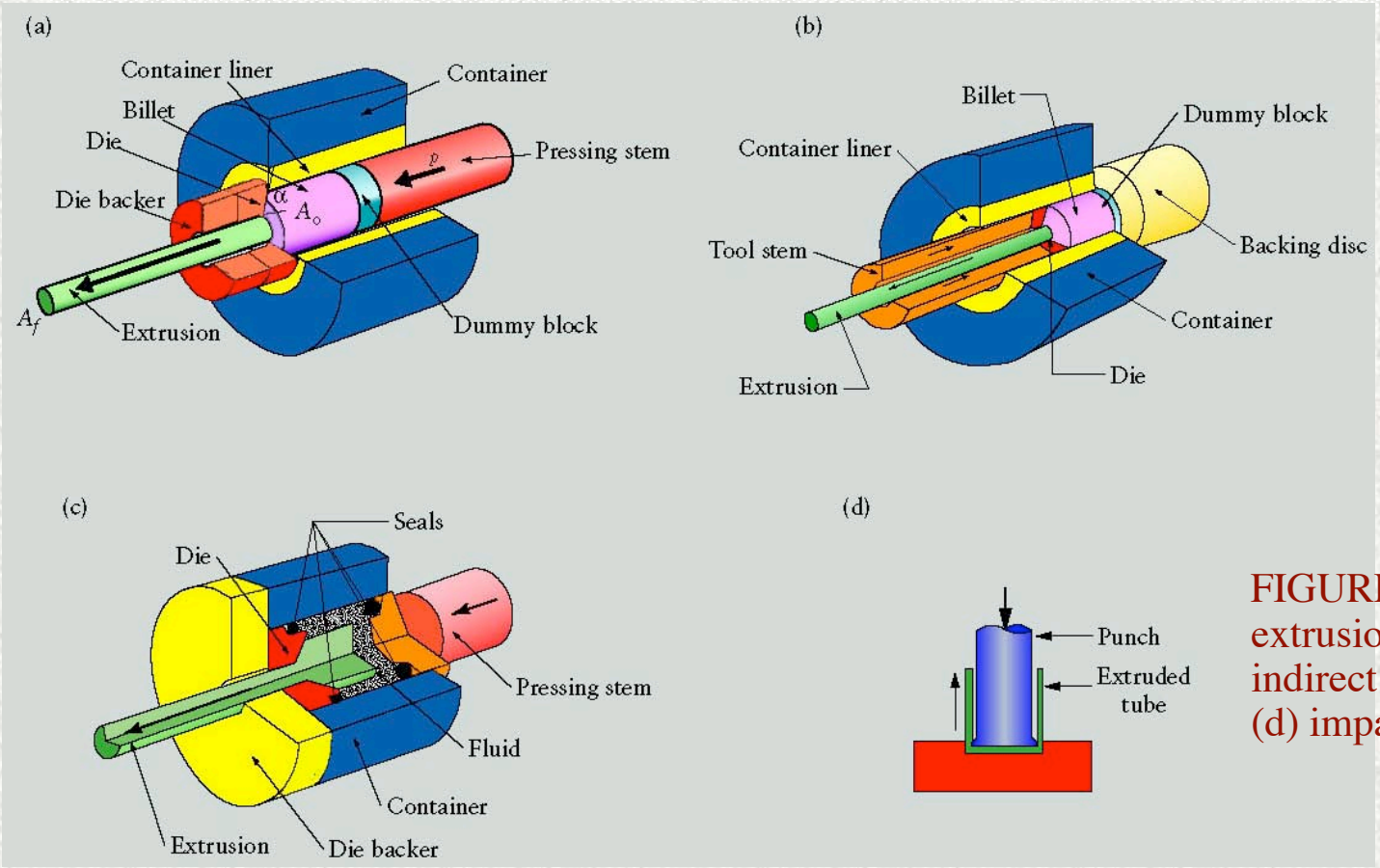


FIGURE 6.49 Types of extrusion. (a) direct; (b) indirect; (c) hydrostatic; (d) impact.

Extrusion of Seamless Tube

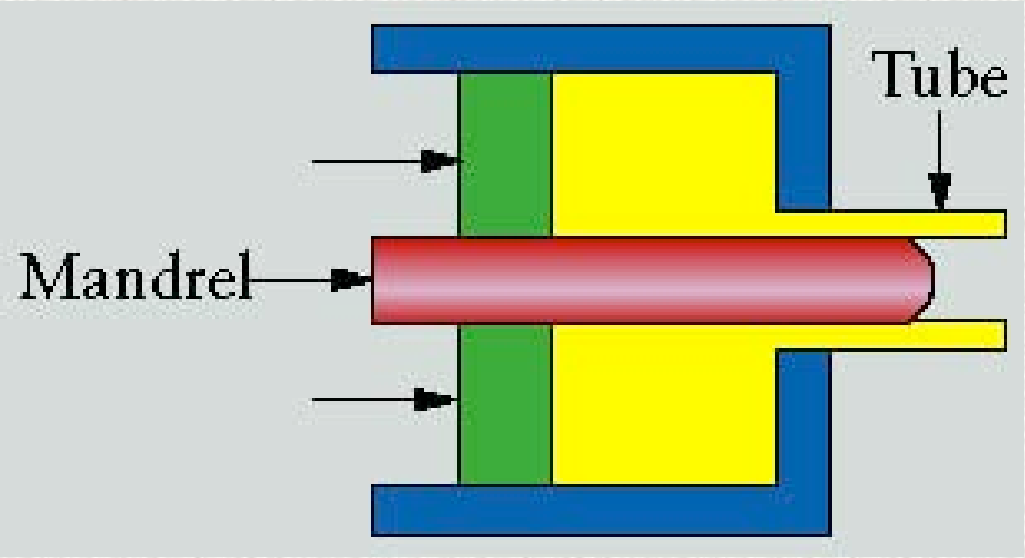


FIGURE 6.60 Extrusion of a seamless tube. The hole in the billet may be prepunched or pierced, or it may be generated during extrusion.;

Cold and Impact Extrusion

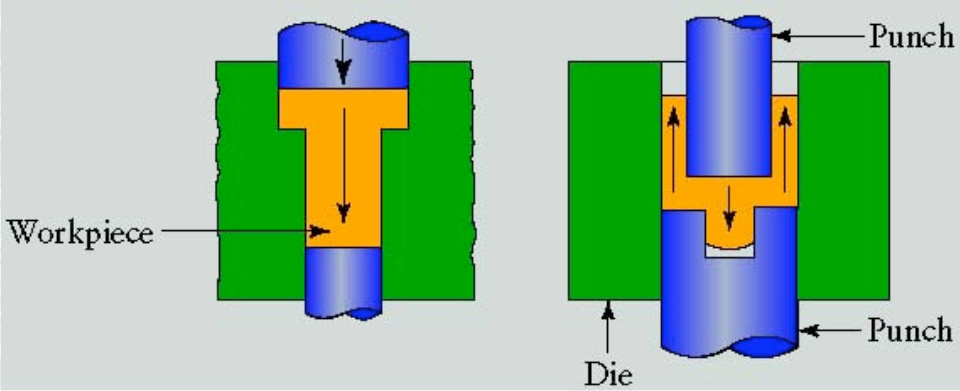
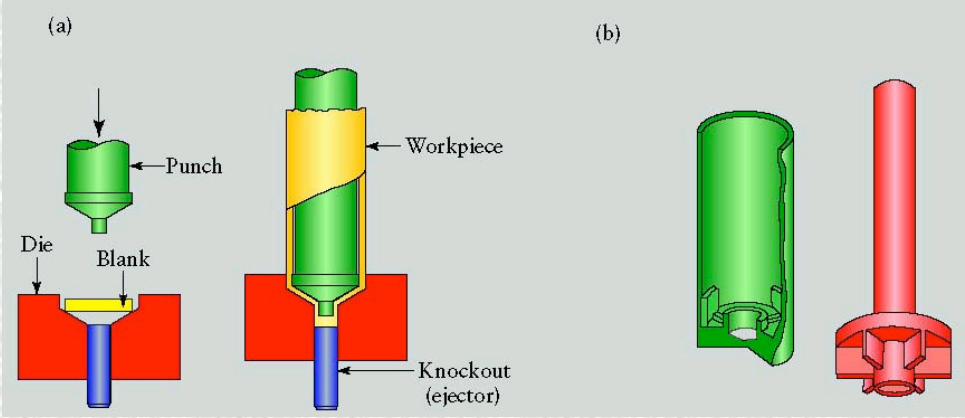


FIGURE 6.56 Examples of cold extrusion. Arrows indicate the direction of material flow. These parts may also be considered as forgings.

FIGURE 6.57 (a) Impact extrusion of a collapsible tube (Hooker process).(b) Two examples of products made by impact extrusion, these parts may also be made by casting, forging, and machining, depending on the dimensions and materials involved and the properties desired. Economic considerations are also important in final process selection.



Cold Extruded Spark Plug

Figure 15.12 Production steps for a cold extruded spark plug. *Source*: National Machinery Company.

Figure 15.13 A cross-section of the metal part in Fig. 15.12, showing the grain flow pattern. *Source*: National Machinery Company.

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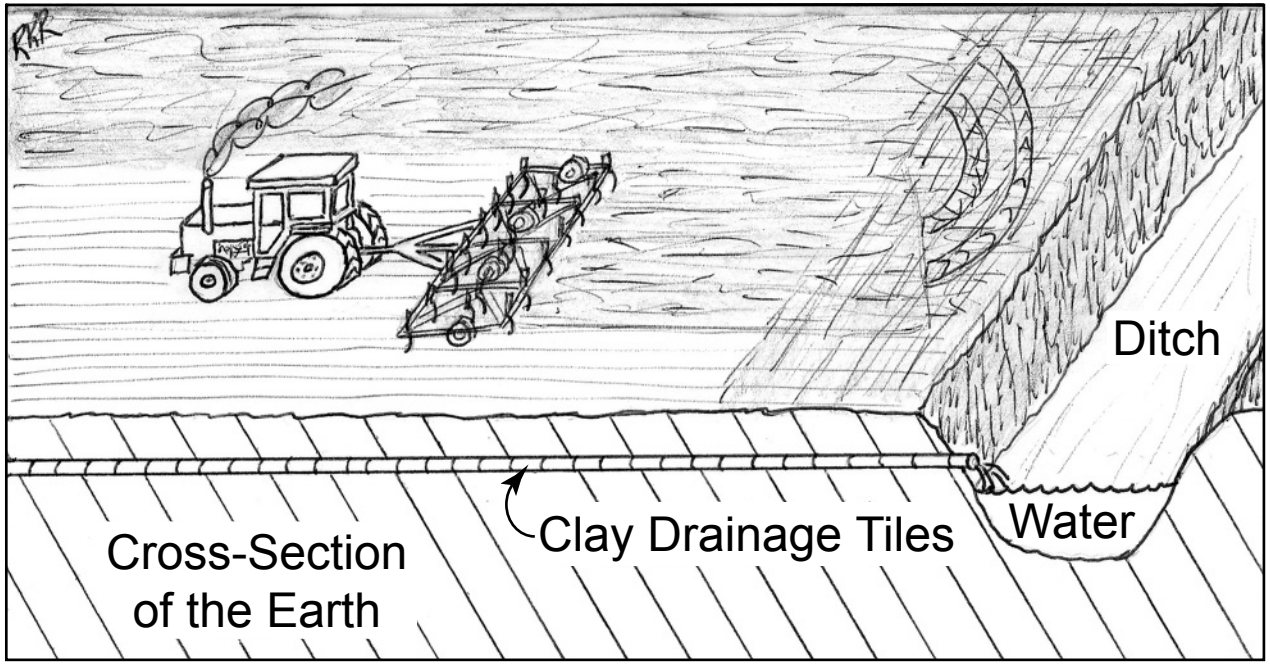
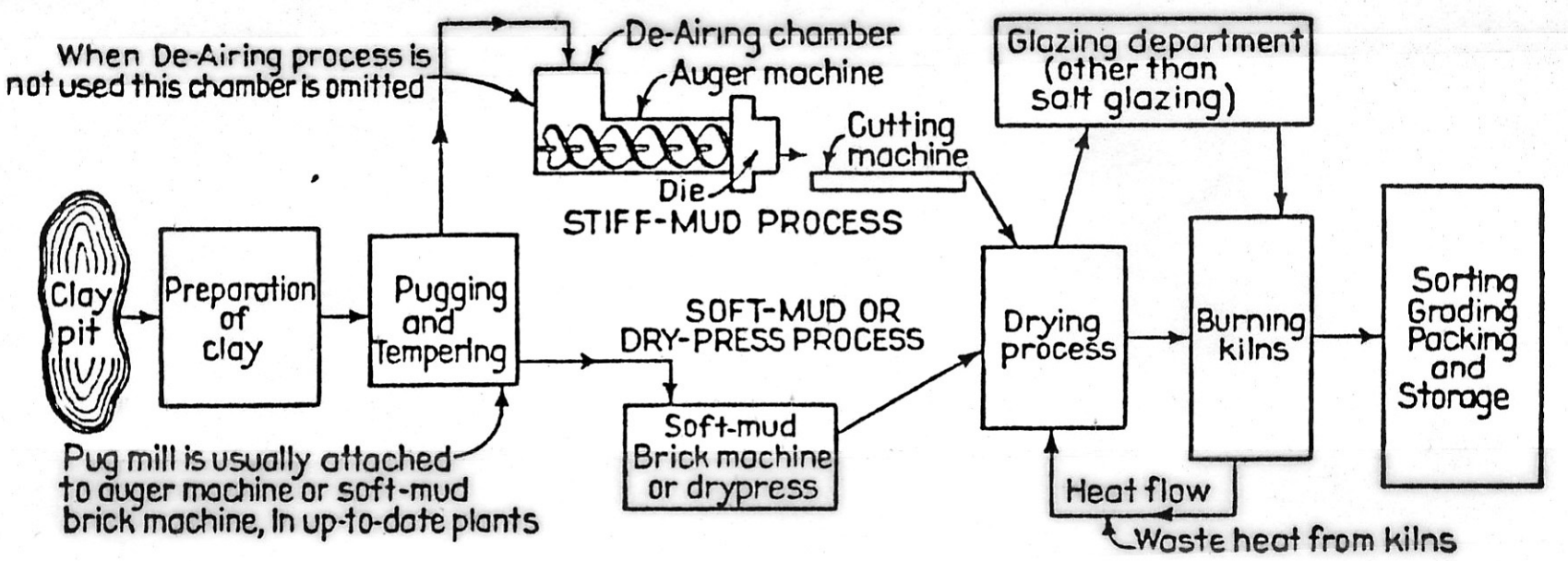
Clay Drainage Tile



- In agricultural drainage systems many clay tiles remain in use after up to 100 years.
- New drainage systems use corrugated PVC piping.

Clay Drainage Tile Manufacturing

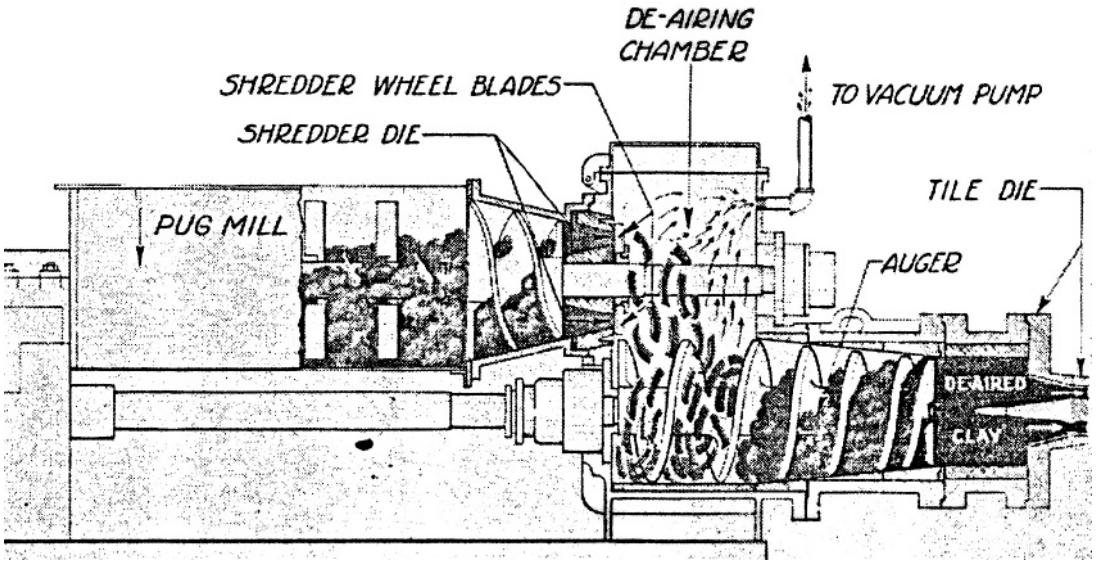
- Earliest drainage tile shaped on a potter's wheel (4000 BC).
- The first American mass production was in 1875 (New Jersey), reaching Indiana by 1885.

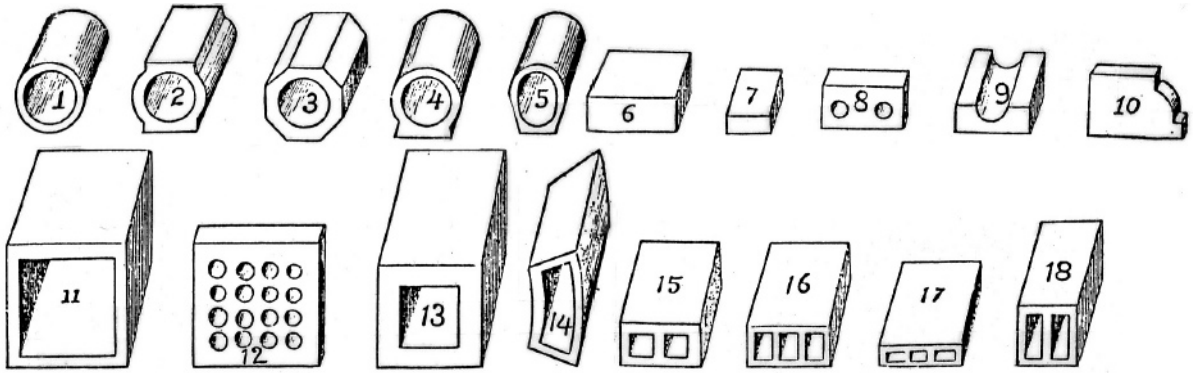


Adapted from: H.C. Plummer, *Brick and Tile Engineering Handbook of Design*, Structural Clay Products Institute, Washington, DC, 1950.

Clay Drainage Tile Manufacturing

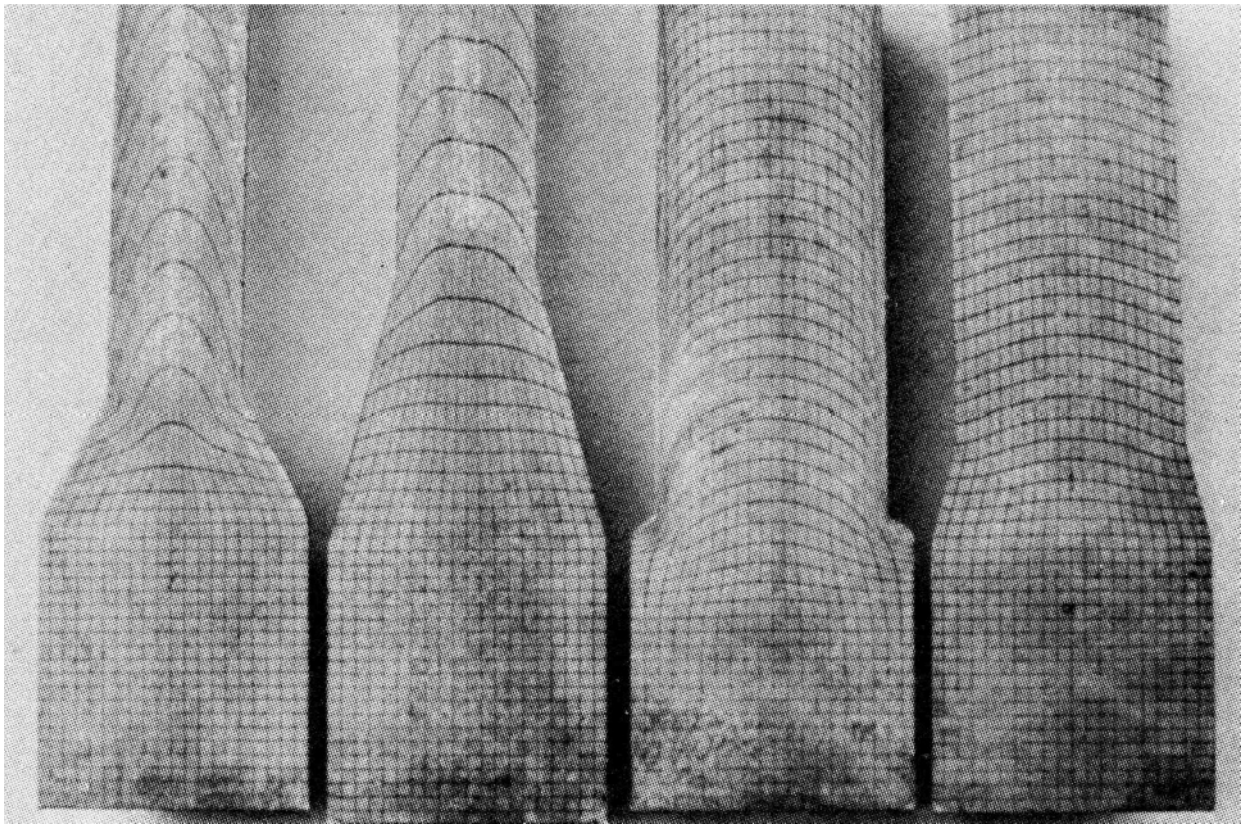
- Shapes formed by "stiff-mud" extrusion.





Adapted from: H.C. Plummer, *Brick and Tile Engineering Handbook of Design*, Structural Clay Products Institute, Washington, DC, 1950.

Extrusion



Effects of die angle (α) and contact length (L) on cold extrusion deformation.

W.F. Hosford and R.M. Caddell, *Metal Forming*, 2nd Ed., Prentice-Hall, Inc., Edgewood Cliffs, NJ, 1993.

Types of Metal Flow in Extruding With Square Dies

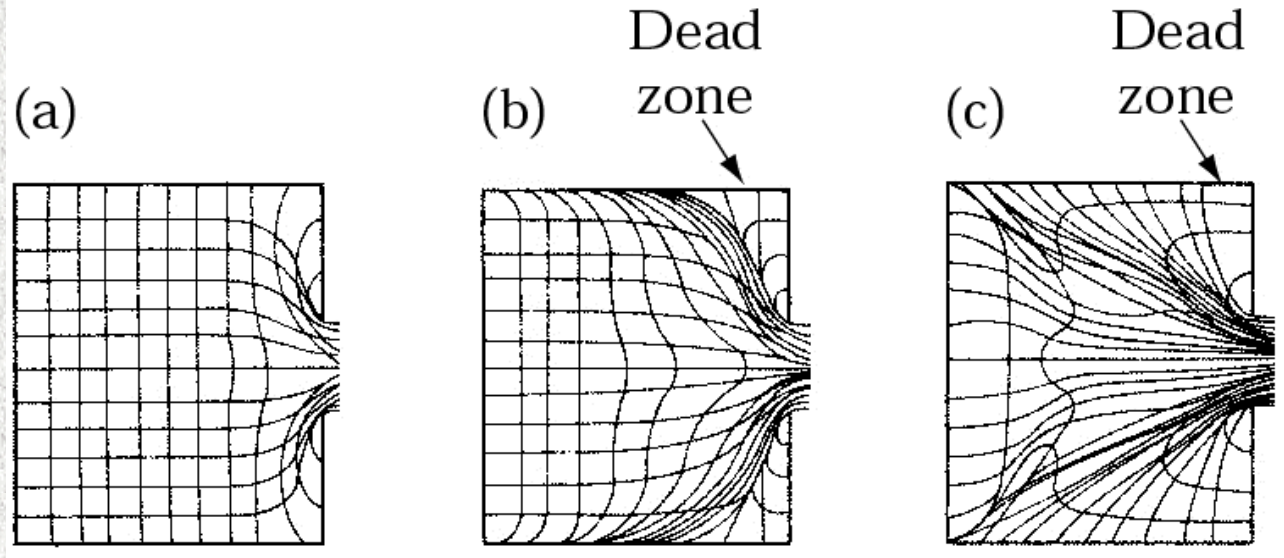


Figure 15.7 Types of metal flow in extruding with square dies. (a) Flow pattern obtained at low friction, or in indirect extrusion. (b) Pattern obtained with high friction at the billet-chamber interfaces. (c) Pattern obtained at high friction, or with cooling of the outer regions of the billet in the chamber. This type of pattern, observed in metals whose strength increases rapidly with decreasing temperature, leads to a defect known as pipe, or extrusion defect.

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Chevron Cracking

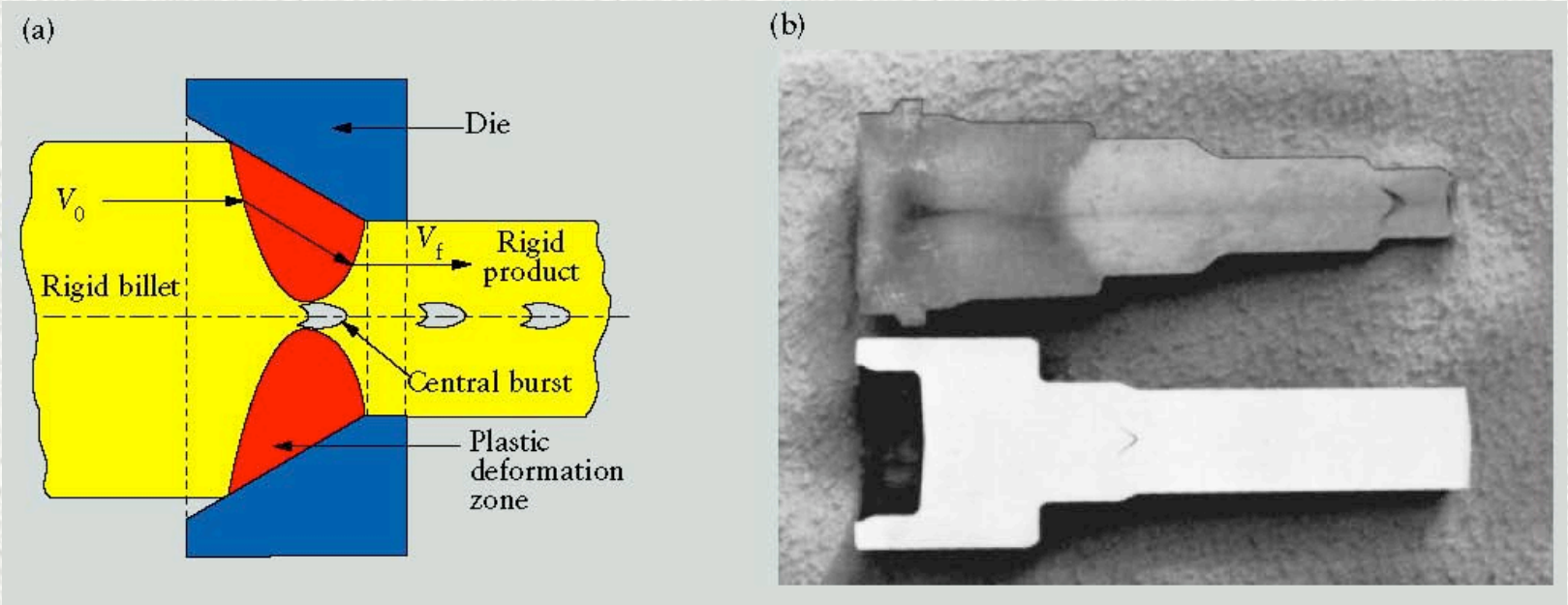


FIGURE 6.59 (a) Deformation zone in extrusion, showing rigid and plastic zones. Note that the plastic zones do not meet, leading to chevron cracking. The same observations are also made in drawing round bars through conical dies and drawing flat sheet plate through wedge-shaped dies. Source: After B. Avizur. (b) Chevron cracking in round steel bars during extrusion. Unless the part is inspected properly, such internal detects may remain undetected and possibly cause failure of the part in service.

Drawing

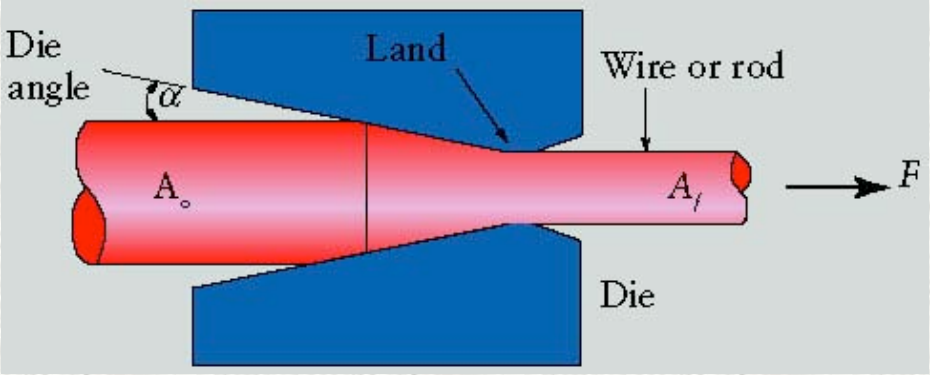
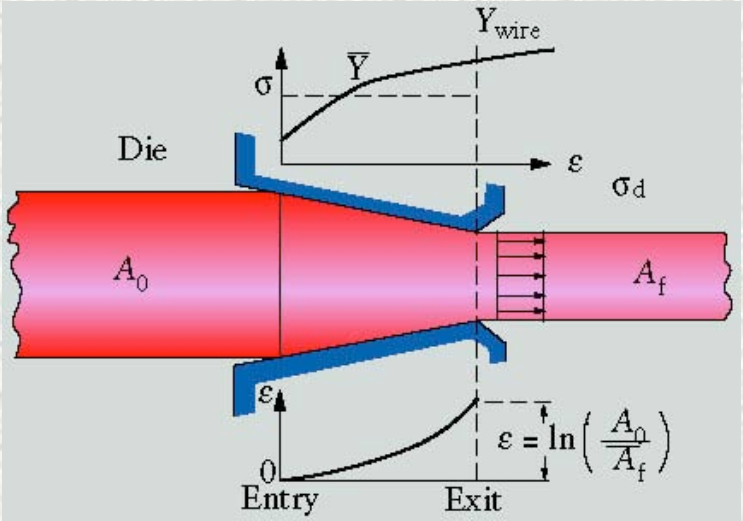


FIGURE 6.62 Variables in drawing round rod or wire.

FIGURE 6.63 Variation in strain and flow stress in the deformation zone in drawing. Note that the strain increases rapidly toward the exit. The reason is that when the exit diameter is zero, the true strain reaches infinity. The point Y_{wire} represents the yield stress of the wire.



Tube Drawing

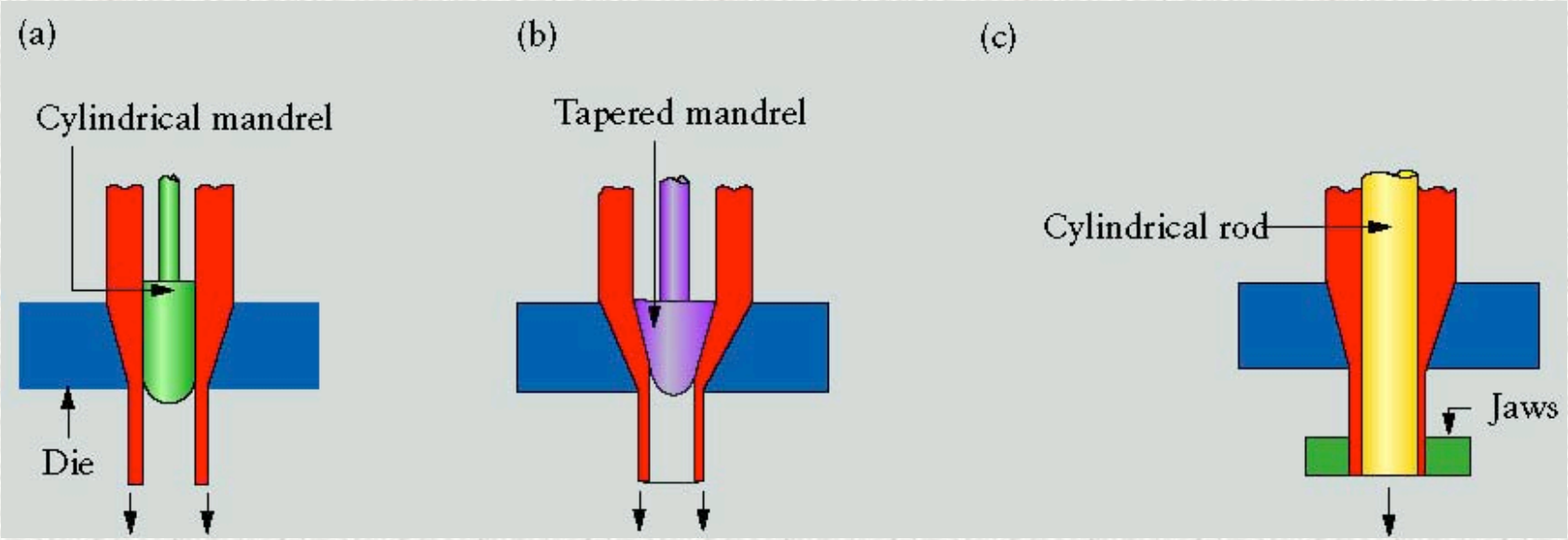


FIGURE 6.67 Various methods of tube drawing.

Drawing Dies

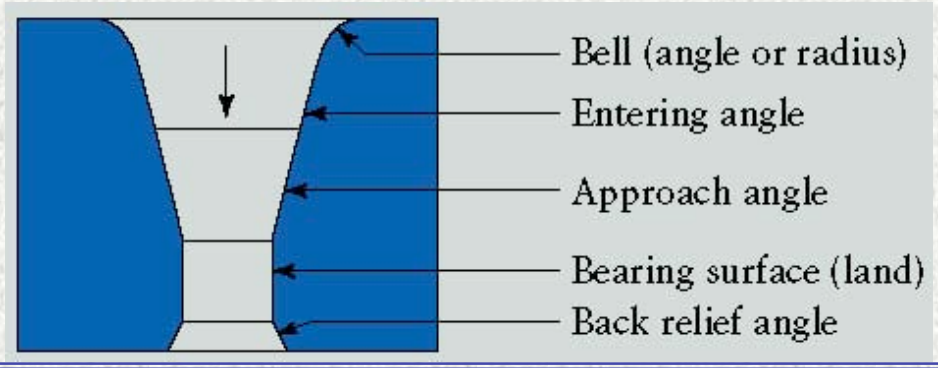


FIGURE 6.69 Terminology for a typical die for drawing round rod or wire.

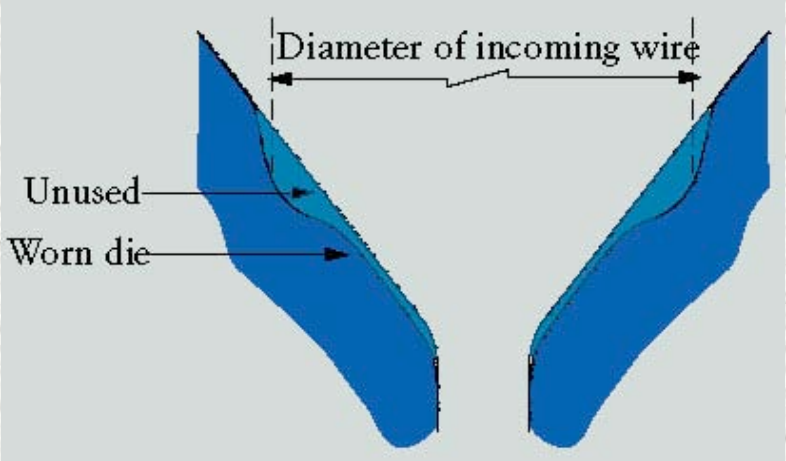



FIGURE 6.70 Schematic illustration of a typical wear pattern in a wire-drawing die.