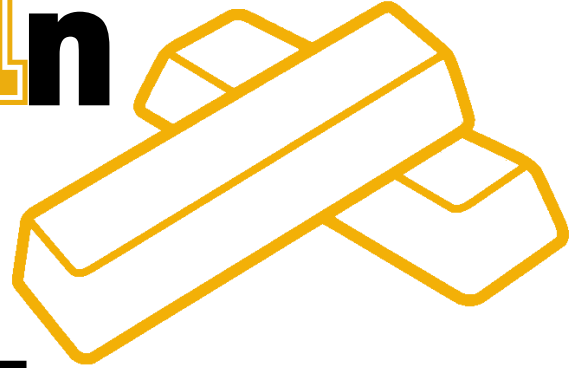


Mechanics n Design and Manufacturing

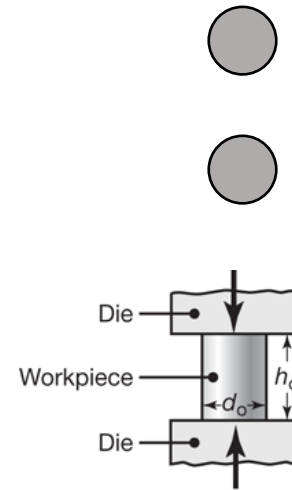
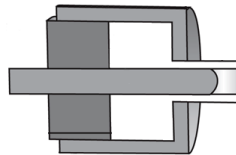
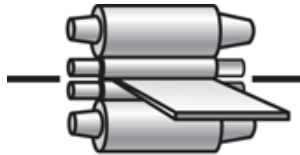
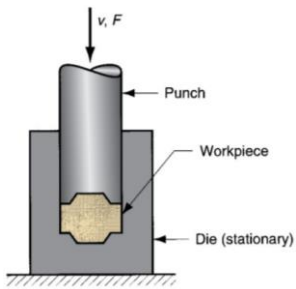


+ Bulk Deformation Processing

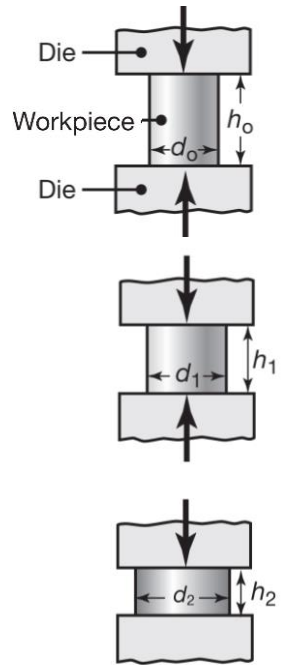
Bulk Deformation Processes

Primary
working:

Secondary
working:



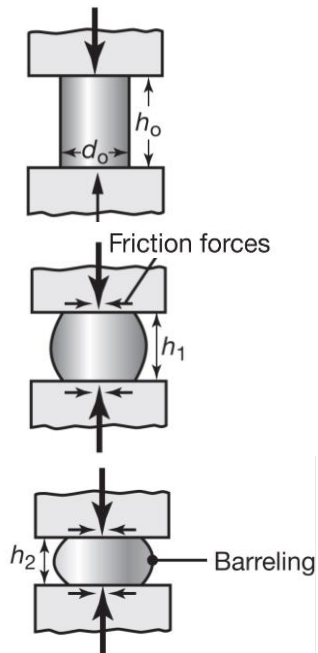
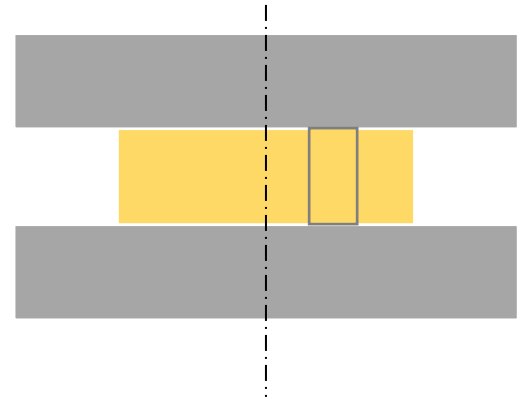
Frictionless Open Die Forging



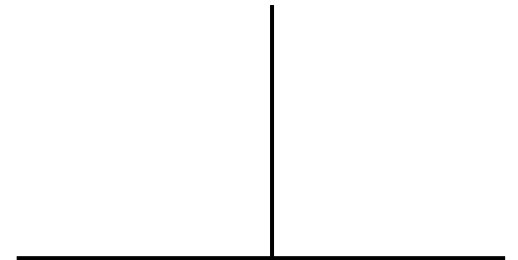
Strains and strain rate

Work of deformation

Slab Analysis - Open Die Forging w/ Friction

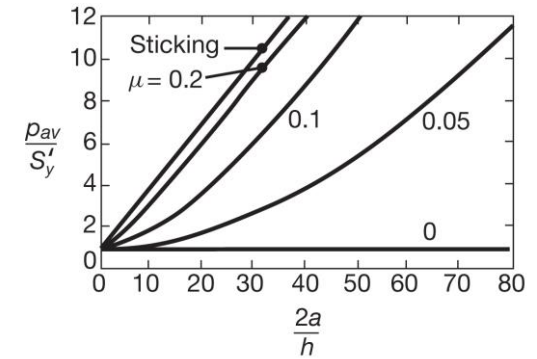
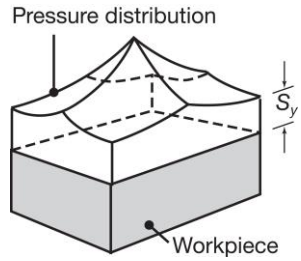


Slab Analysis Continued

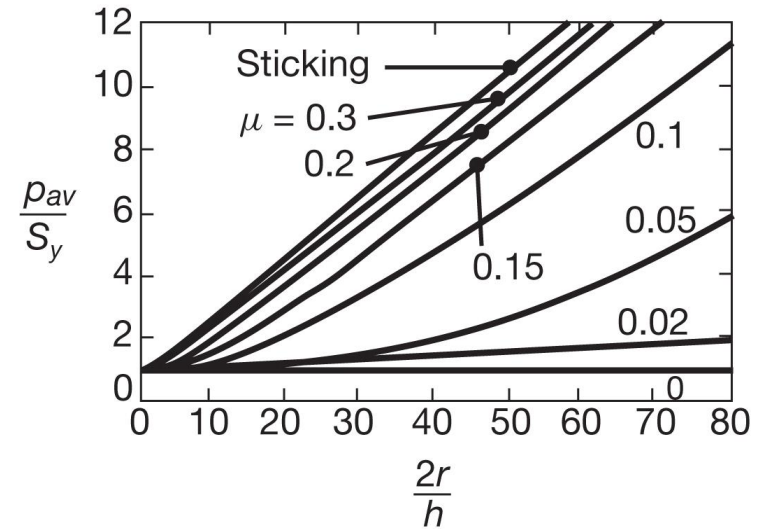
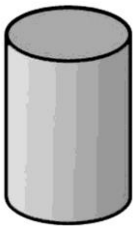


Average Pressure

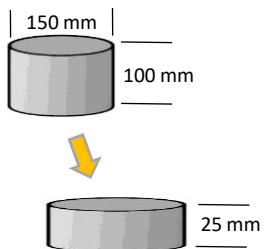
Rectangular forgings



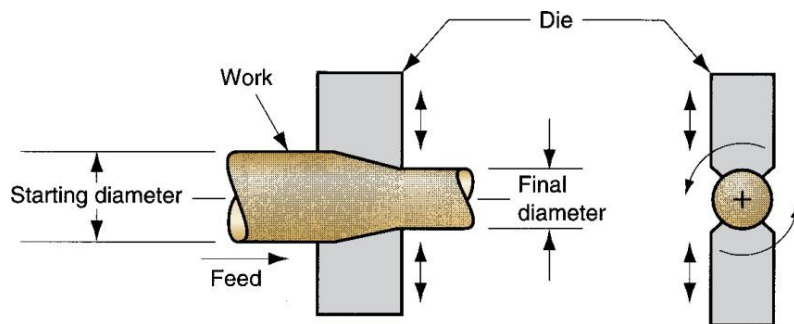
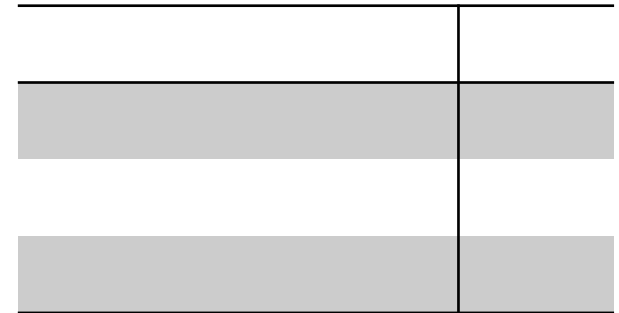
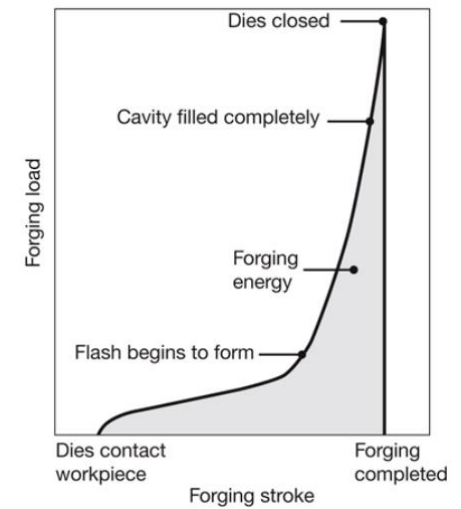
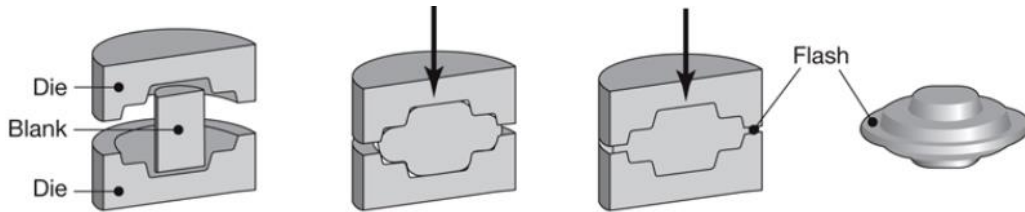
Cylindrical forgings



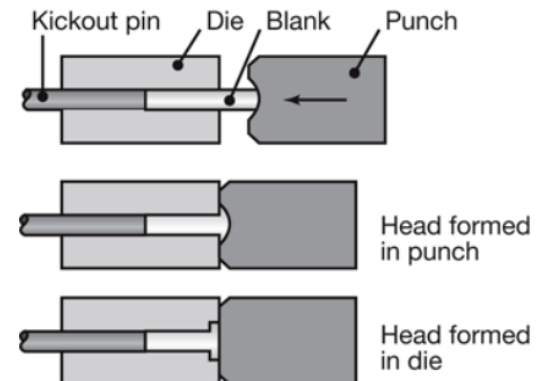
Example: Cylindrical forging is upset as shown. $\mu=0.2, S_y=361$ MPa
Find: the upsetting force at end of stroke



Forging Processes



Groover 6th ed.



[Radial Forging](#)

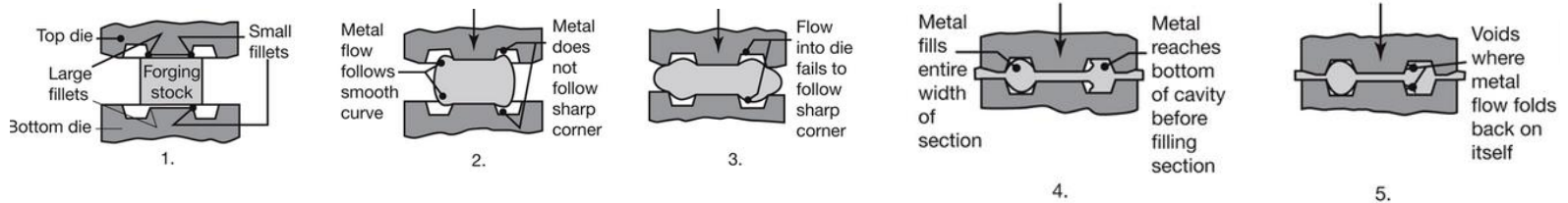
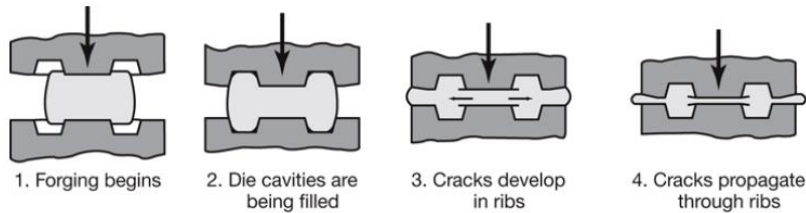
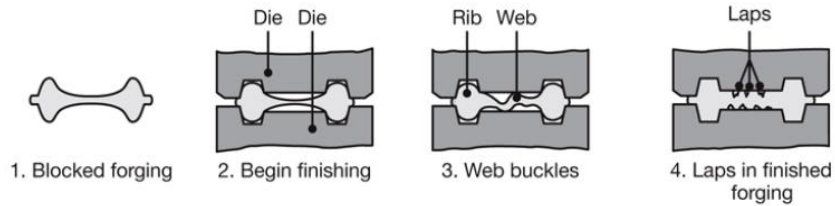
Forging Defects/Design

- Gutter

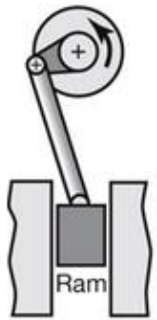
- Flash clearance

- Draft angles

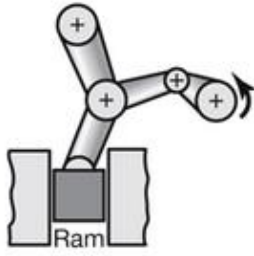
- Radii



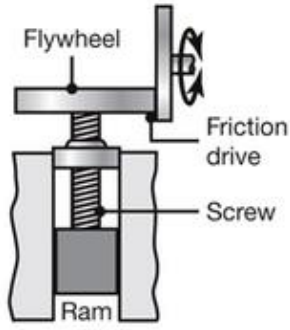
Forging Equipment



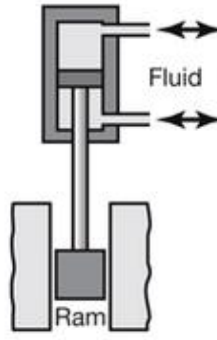
Crank



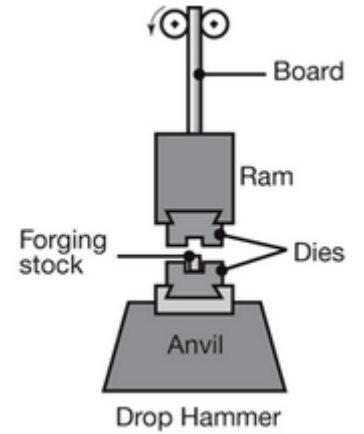
Knucklejoint



Screw



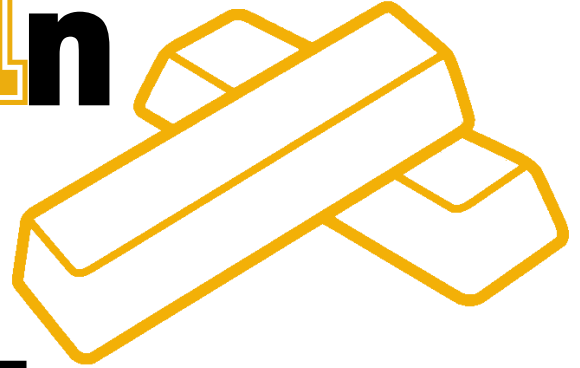
Hydraulic



Drop Hammer

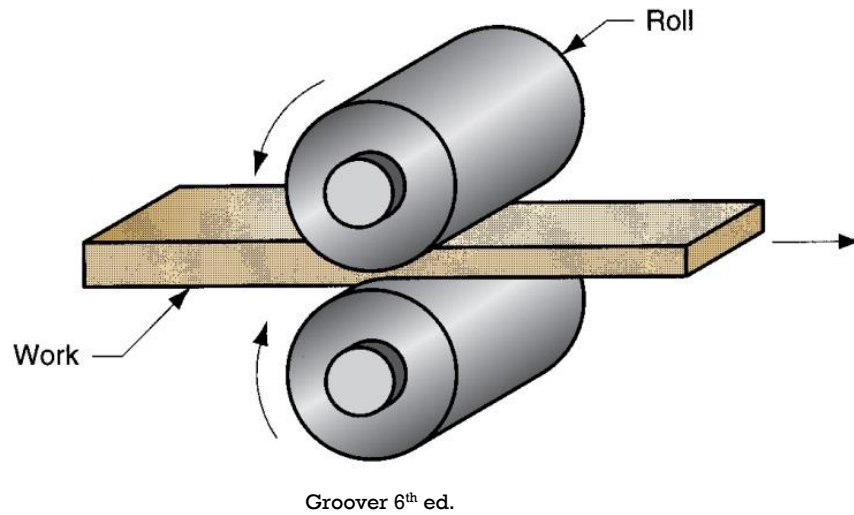


Mechanics**I****n** **Design and** **Manufacturing**

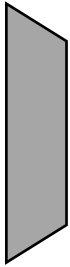


+ Rolling

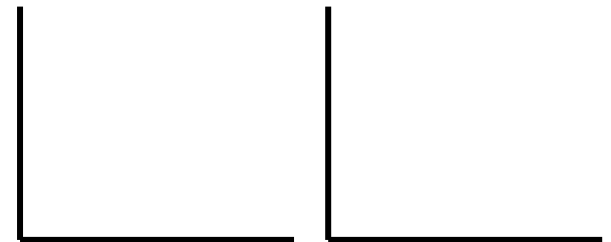
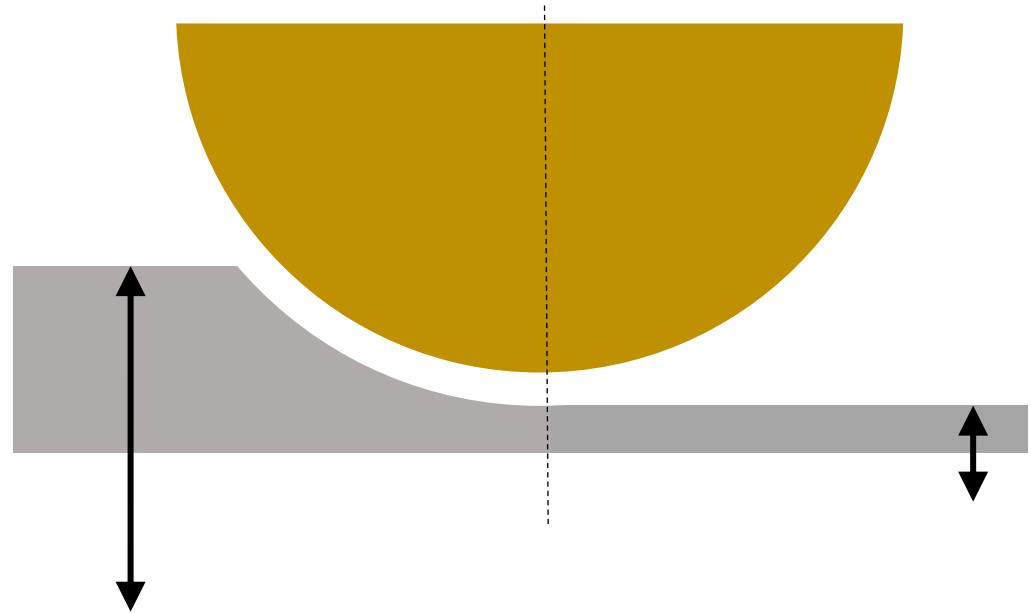
Rolling



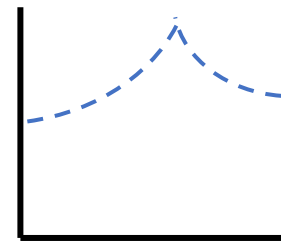
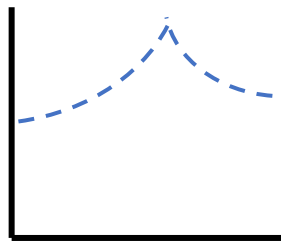
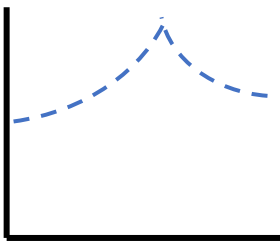
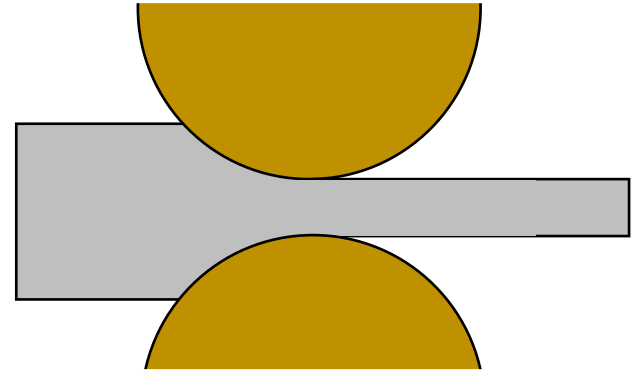
Analysis



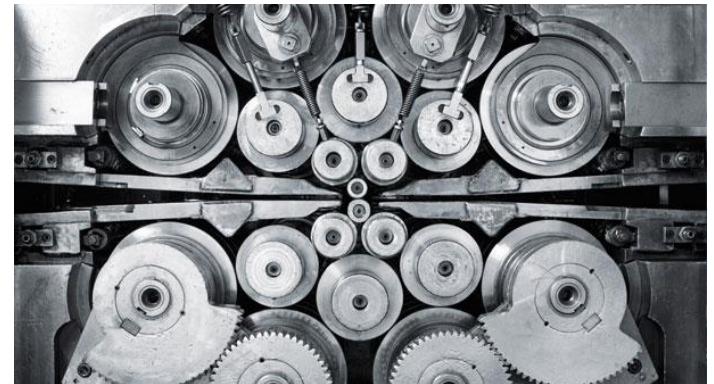
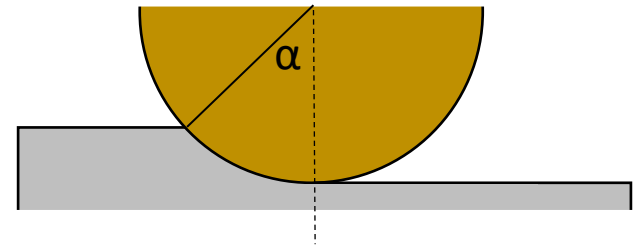
Constant Volume



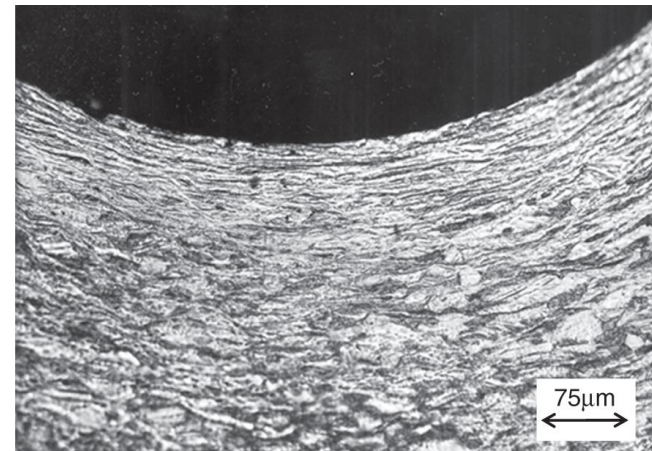
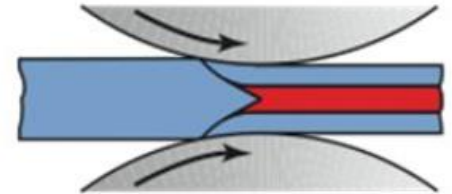
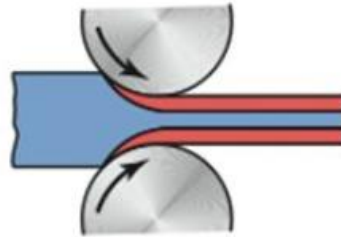
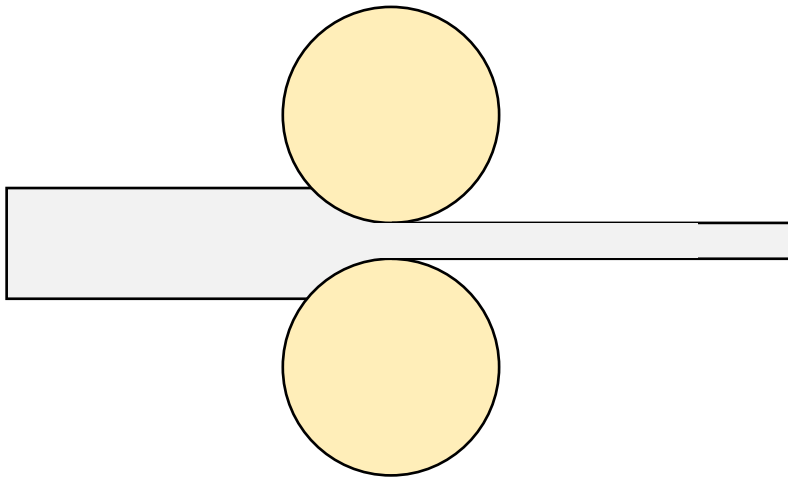
Effect of Tension



Roll Forces



Microstructure and Defects



Rolling Materials/Equipment

Bloom

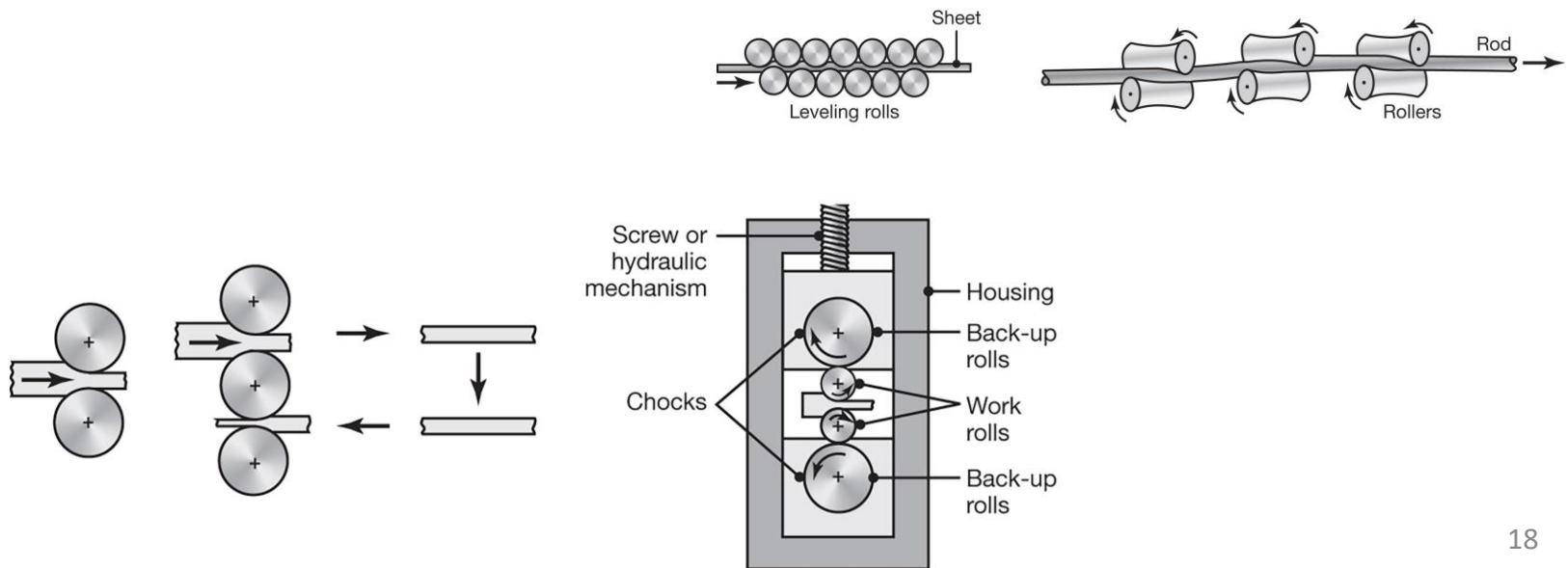
Billet

Slab

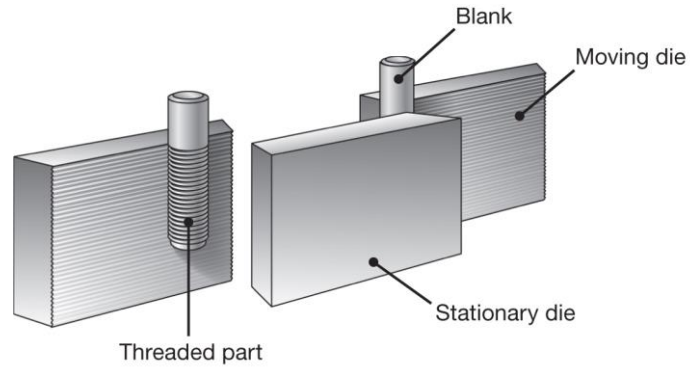
Plate

Sheet

Strip

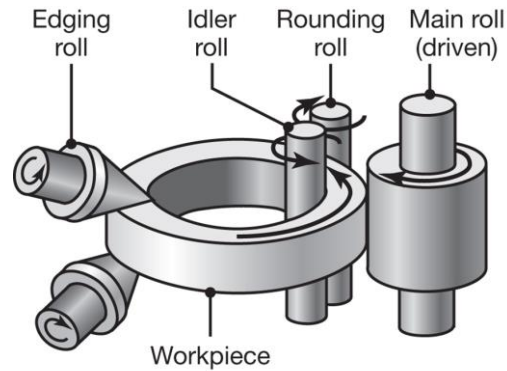


Misc Rolling Operations

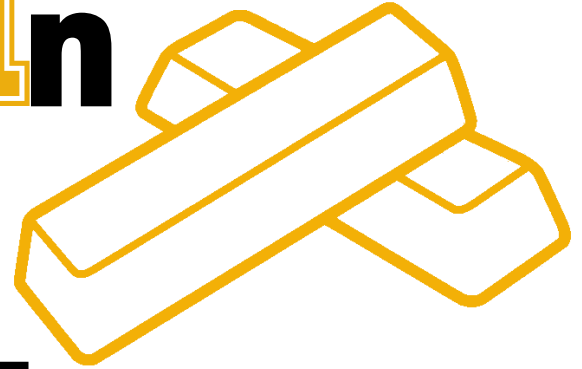


Thread Rolling

Automatic screw making machine

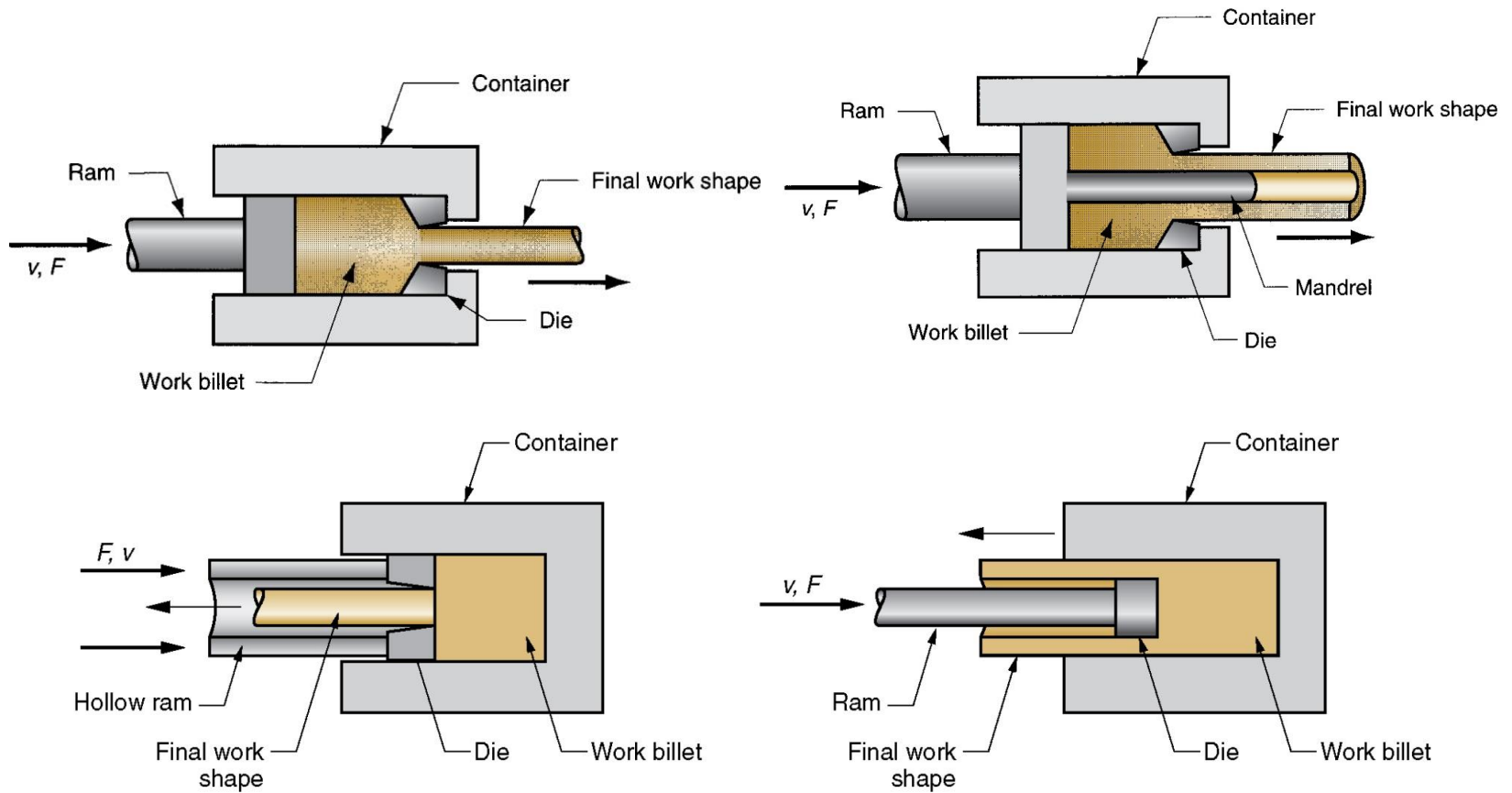


Mechanics**I****n** **Design and** **Manufacturing**



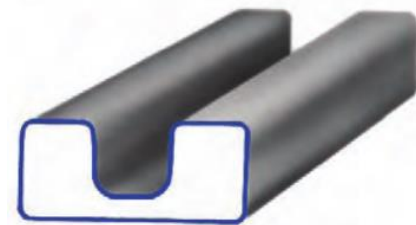
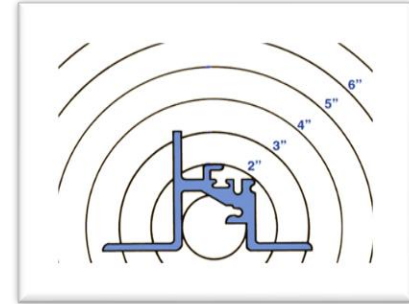
+ Extrusion

Extrusion

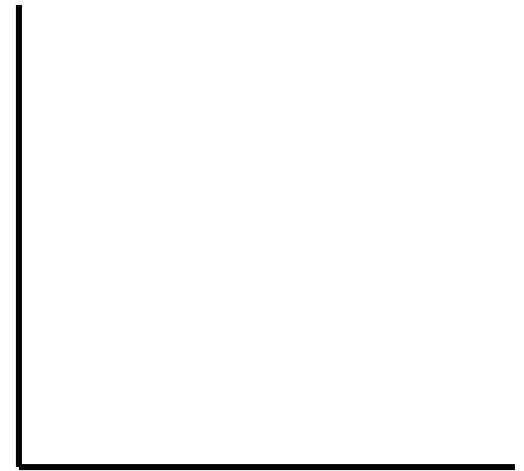
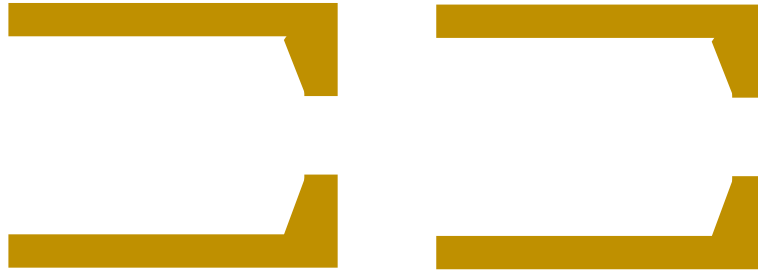
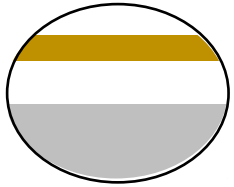


Extrusion Parameters

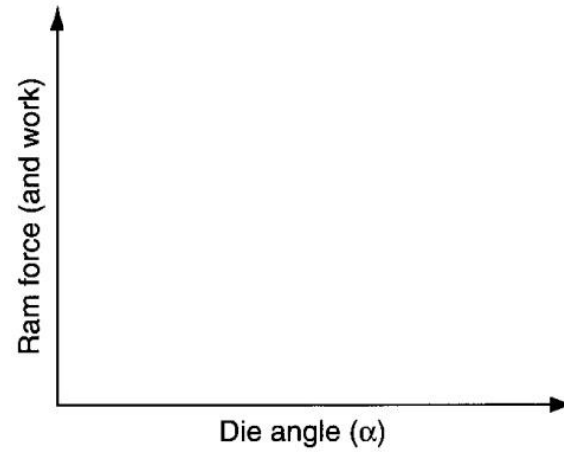
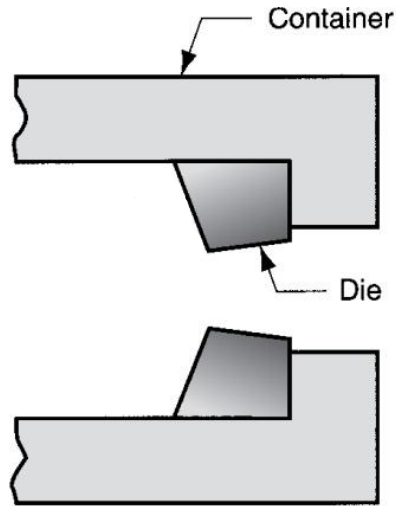
- Extrusion Ratio
- Circumscribed Circle Diameter:
- Shape Factor



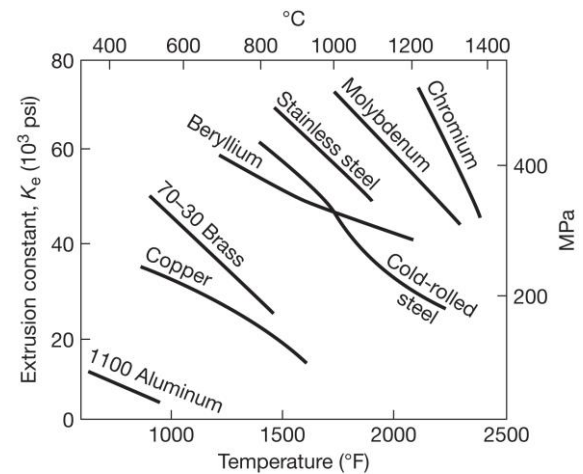
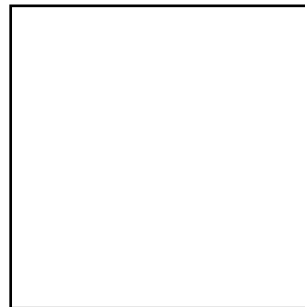
Metal Flow and Extrusion Mechanics



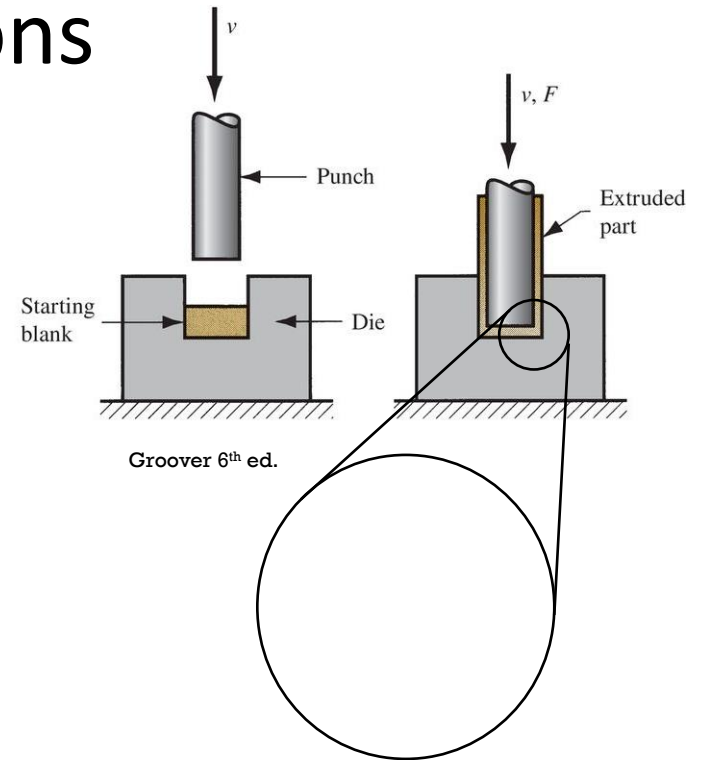
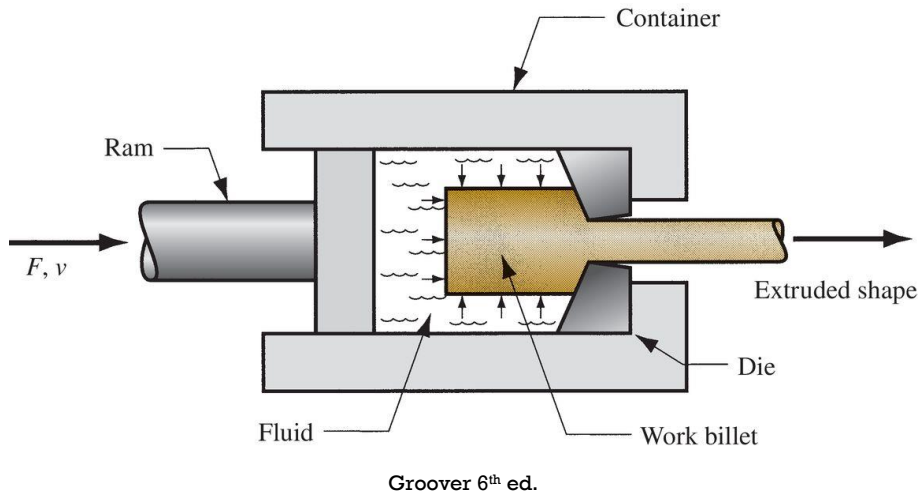
Optimum Die Angle



Hot Extrusion

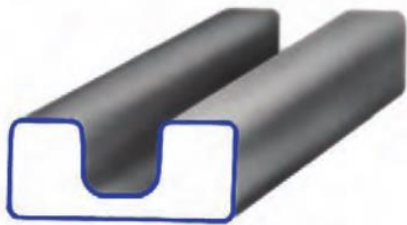


Misc. Extrusion Operations



[Impact Extrusion](#)

Design Considerations/Defects



Diameter of Circumscribed Circle (Inch)	6061 (Min. Wall Thickness)	2014 (Min Wall Thickness)	2024 7050 7075 (Min Wall Thickness)
0.5 - 2.0	0.040	0.040	0.040
2 - 3	0.045	0.050	0.050
3 - 4	0.050	0.050	0.062
4 - 5	0.062	0.062	0.078
5 - 6	0.062	0.078	0.094
6 - 7	0.078	0.094	0.109
7 - 8	0.094	0.109	0.125
8 - 9	0.109	0.125	0.156
9 - 10	0.109	0.125	0.156
10 - 11	0.125	0.125	0.156
11 - 12	0.156	0.156	0.156
12 - 14	0.188	0.188	0.188
14 - 17	0.188	0.188	0.188
17 - 20	0.188	0.188	0.250
20 - 24	0.188	0.250	0.500

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