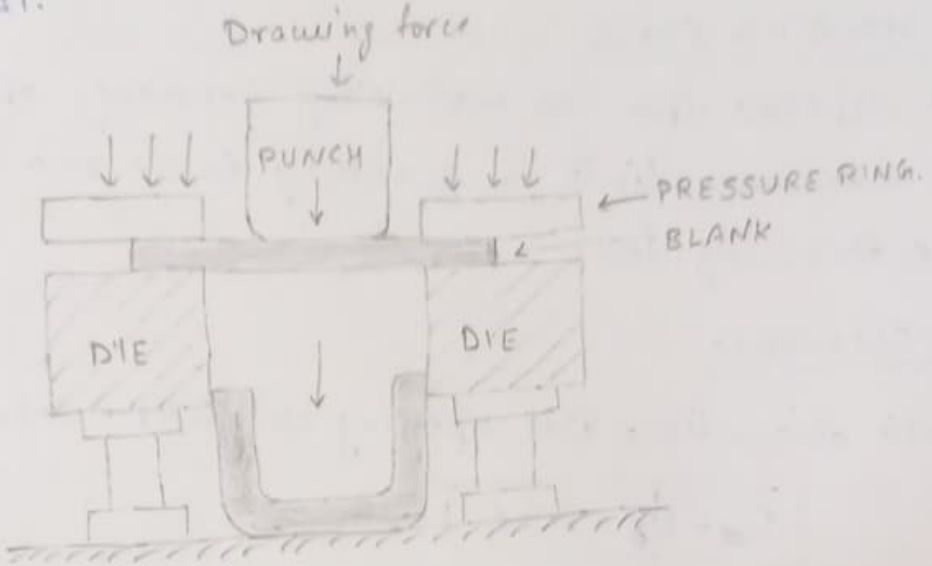
DRAWING / DEEP DRAWING

Drawing is a plastic deformation process in which a flat sheet or plate is formed into a three-dimensional part with a depth more than several times the thickness of the metal.



As the punch moves downwards into a mating die, the metal Blank attains the desired Configuration.

- Hot drawing is used for thick-walled parts ~~of~~, after drawing the material shab get thinner.
- Cold drawing uses thin metal sheet, changes its thickness very little or not at all, and produces parts in a wide variety of shapes.

BLANK SIZE

When $d < 10r$

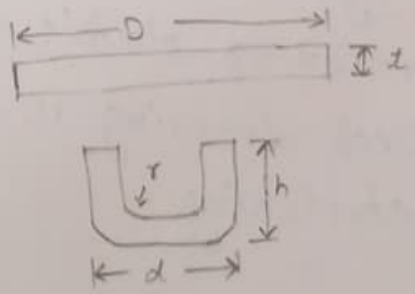
$$D = \sqrt{(d-2r)^2 + 4d(h-r) + 2\pi r(d-0.7r)}$$

When $15r \le d \le 20r$

$$D = \sqrt{d^2 + 4dh} - 0.5r$$

When $d > 20r$

$$D = \sqrt{d^2 + 4dh}$$ [negligible radius]



r = corner radius of cup.

Drawing Force:

$$P = \pi dt \sigma \left[\frac{D}{d} - c\right]$$

BLANK HOLDING FORCE

- It depends upon the wrinkling tendency of the cup.
- The maximum limit is generally to be one-third of the drawing force.

Draw Clearance

Punch diameter = Die opening diameter − 2·5 t.

$$D_d - d_p = 2.5t$$

DEEP DRAWING

- Drawing when cup height is more than half the diameter is termed as deep drawing.

$$h \geq 0.5d$$

- Easy with ductile material.
- Due to radial flow of material, the side wall increases in thickness as the height is increased.
- A cylindrical vessel with flat bottom can be deep drawn by double action deep drawing.
- Deep drawing is a combination of drawing and stretching.

Stresses in Deep Drawing.

(a) In flange of blank : Biaxial tension and compression.

(b) In the wall of cup : Simple uni-axial tension.

Limiting Drawing Ratio (LDR)

The average reduction in deep drawing.

$$\frac{d}{D} = 0.5$$

Successive reduction.

First draw = 50%.
Second draw = 30%.
Third draw = 25%.
Fourth draw = 16%.
Fifth draw = 13%.

Deep Drawability

- The ratio of the maximum blank diameter to the diameter of the cup drawn. i.e. D/d.
- There is a limiting drawing ratio (LDR), after which the punch will piece a hole in the blank instead of drawing.
- This ratio depends upon material, amount of friction present etc.
- Limiting drawing ratio (LDR) is 1.6 - 2.3.

LUBRICATION

In drawing operation, proper lubrication is essential for.

- To improve die life.
- To reduce drawing force.
- To reduce temperature.
- To improve surface finish.

DEFECTS IN DRAWING

1.) Wrinkle: Due to insufficient blank holder force/pressure ~~causes~~ wrinkles to develop on the flange, it may also extend to the wall of the cup.

2.) Fracture: Due to too much of a blank holder pressure and friction, a thinning of the walls and a fracture at the flange, bottom and the corner.

3.) Earing: While drawing a rolled stock, ear or lobes tends to occur because of non-uniform deformation induced by the rolling operation.

4.) Miss strike: Due to misplacement of stock, unsymmetrical flanges produce.

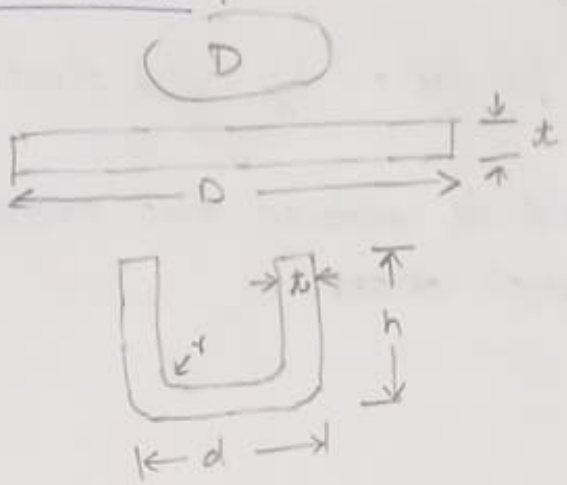
5.) Orange peel: A surface roughening (defect) encountered in forming products from metal stock that has a coarse grain size. It is due to uneven flow or to the appearance of the overly large grains usually the result of annealing at too high temperature.

6. Stretcher Strains [Like Luders Lines]
- Caused by plastic deformation due to inhomogenous yielding.
- These lines can be criss-cross the surface of the work-piece and easily visible.
- Low carbon steels and aluminium show more stretcher strains.

7. Surface Scratches:
Die or punch not having a smoth surface, insufficient lubrication.

Batch Time: _____ Roll Number: _____

BLANK SIZE :



$\frac{h}{d} < 0.5$ → Shallow Drawing.

$\frac{h}{d} \geq 0.5$ → Deep Drawing.

Blank area = Area of cup shaped Component.

$$\frac{\pi}{4} D^2 = \frac{\pi}{4} d^2 + \pi d h.$$

$$D^2 = d^2 + 4dh.$$

$$\boxed{D = \sqrt{d^2 + 4dh}} \rightarrow \text{when } \frac{d}{r} \geq 20 \quad [\text{Corner radius negligible}]$$

when $\frac{d}{r} = 15\text{-}20$, $15r \leq d \leq 20r$

$$D = \sqrt{d^2 + 4dh} - \frac{r}{2}$$

when $\frac{d}{r} = 10\text{-}15$, $10r \leq d \leq 15r$.

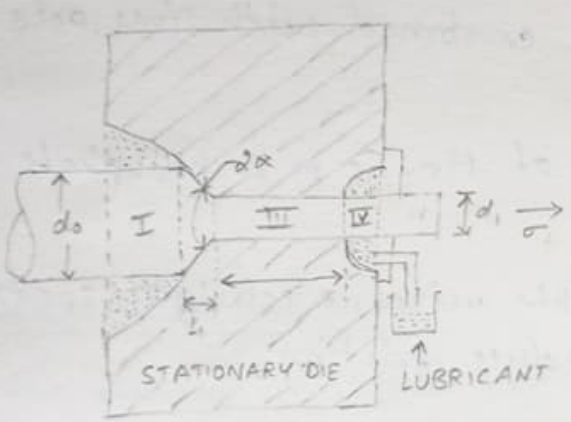
$$D = \sqrt{d^2 + 4dh} - r.$$

when $d < 10r$

$$D = \sqrt{(d-2r)^2 + 4d(h-r) + 2\pi r(d - 0.7r)}$$

WIRE DRAWING

- It is a cold working process. to obtain wires from rods of bigger diameters through a die.
- Bar drawing is similar to wire drawing except that it involves smaller-diameter material.
- At the start of wire drawing, the end of the rod or wire to be drawn is pointed to make for an easier entrance of wire into the die. This pointing is done by means of rotary swaging or by simple hammering.



ZONE-I: Lubricating zone.
Liquid Lubricant → SAE oils, Mineral oils, kerosene.

Zone-II: Deformation Zone.
Die angle → $2\alpha = 12° - 48°$ [for Soft & Hard Material]

Zone-III :- Sizing Zone (2-5 m)
Convert elastic deformation to plastic deformation.

Zone-IV: Exit zone / Safety Zone
High pressure and temp. is reduced.

- In drawing the wire is pulled, rather than pushed, through the die.
- To reduce the frictional force b/w the die and the metal, the die is kept well lubricated.
- Die usually made up of Carbides.
- Wire getting continuously wound on Drum.
- For fine wire, the material may be passed through a number of dies, receiving successive reductions in diameter, before being coiled and known as Tandem Drawing.
- The wire is subjected to tension only, But when it is in contact with dies then a combination of tensile, compressive and shear stresses will be there in that portion only.
- Material should be ductile and may be annealed before drawing

CLEANING AND LUBRICATION in Wire Drawing.

Cleaning is done in two steps.

(a) Acid pickling: Acid (H_2SO_4) is used to remove scale and rust.

(b) Alkaline flushing: It is used to remove soft impurities and excess acid.

LUBRICATION: Lubrication boxes precede the individual die to help reduce friction drag and prevent wear of the dies.

[i] SULLING: The wire is coated with a thin coat of ferrous hydroxide which when combined with lime acts as filler for the lubricant.

[ii] PHOSPHATING: The ~~thick~~ thin film of Mn, Fe or Zn phosphate is applied on the wire.

[iii] ELECTROLYTIC COATING: For very thin wires, electrolytic coating of copper is used to reduce friction.

BUNDLE DRAWING:

In this process, many wires are drawn simultaneously as a bundle. To prevent sticking, the wires are separated from each other by a suitable material. The cross-section of the wire is somewhat polygonal.

ROD DRAWING:

Rod drawing is similar to wire drawing except for the fact that the dies are bigger because of the rod size being larger than wire.

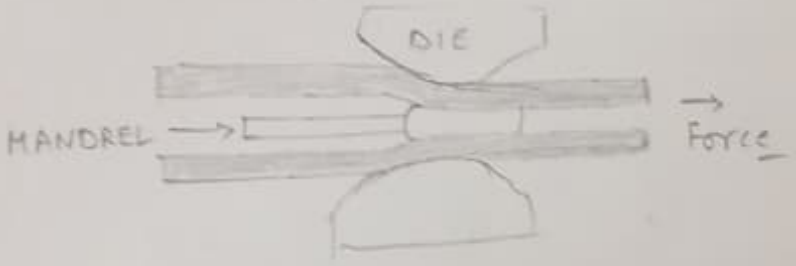
TUBE SINKING: The practice of drawing tubes without the help of an internal mandrel is called tube sinking.

TUBE DRAWING:

for the tubes, material [Rod, Wire, tube] are also first pointed and then entered through the die where the point is gripped in a similar way as the bar drawing and pulled through in the form desired along a straight line.

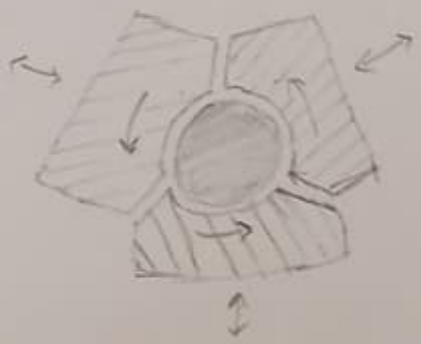
When the final size is obtained, the tube may be annealed and straightened.

TUBE DRAWING
- Tube Sinking
- Fixed Mandrel
- Moving Mandrel



SWAGING OR KNEADING:

- The hammering of a rod or tube to reduce its diameter where the die itself acts as the hammer.
- Repeated blows are delivered from various angles, causing the metal to flow inward and assume the shape of the die.



SEAMLESS TUBE

- Upto 4m are made by Rolling and Extrusion.
- Tubes between 4 and 10m are made by tube drawing.