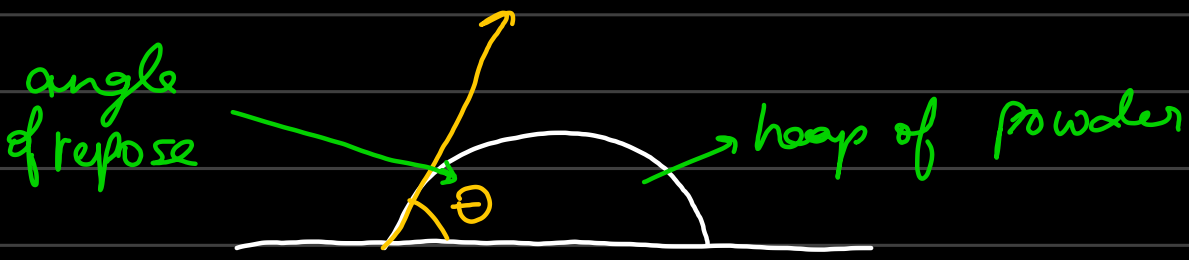
Lecture 15

Power Processing

Agglomeration:

↳ agglomerated particle would always reduce packing density because of irregular shape.

→ cohesive forces causes agglomeration.



$\theta > 45^\circ \Rightarrow$ high cohesive forces
high agglomeration tendency

θ low $\Rightarrow$ good flowability,
$\{0-20^\circ\}$ low cohesive for
low agglomeration tendency

→ De-Agglomeration can be accomplished by a combination of drying milling & surface treatments.

Functionalised surface: surface treatment

2) Calculate X_c that would yield best packing fraction, if it known that smaller particles pack in loose random packing and larger particles acquire dense random packing, when required.

$PF_{fine} = 0.6$ $\quad$ $PF_{coarse} = 0.64$

$$PF_{app} = PF_c + PF_f (1 - PF_c)$$

$$PF_{app} = 0.64 + 0.6(0.34)$$

$$= 0.844$$

$$PF_{app} = PF_f + X_c (1 - PF_f)$$

$$0.844 = 0.6 \times X_c (0.4)$$

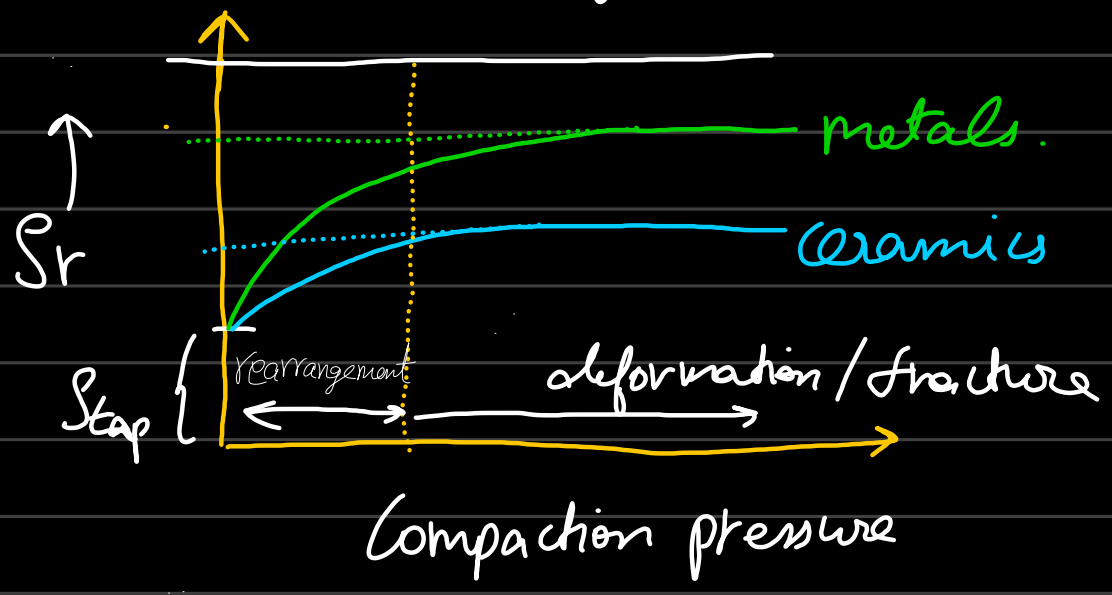
$$0.244 = X_c \times 0.4$$

$$\boxed{X_c = 0.61}$$

Powder Compaction:

Stages in Compaction: tapping, rearrangement, deformation.

↳ 3rd stage = fracture in case of ceramics.

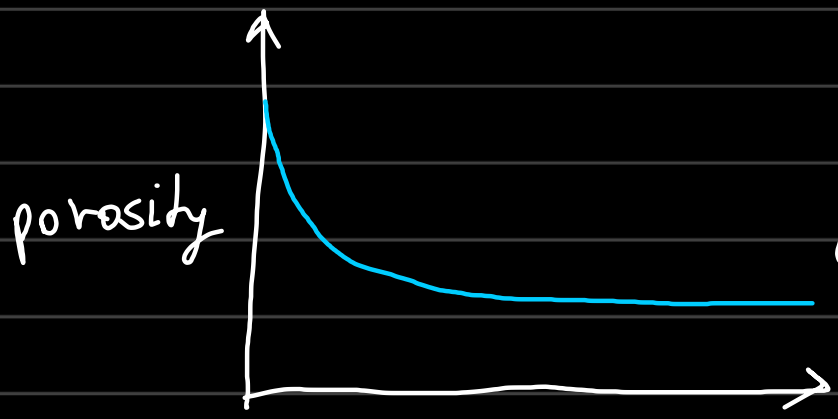


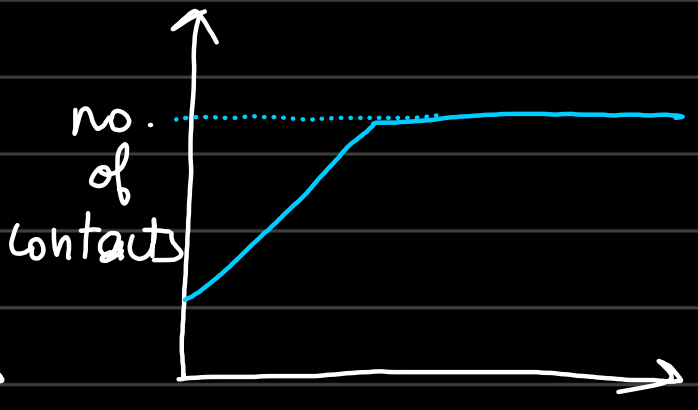
→ Saturation (decrease in slope) due to Work Hardening

→ Hot/Warm Compaction:

↳ dynamic recovery & dynamic recrystallization can happen which soften and allow increase in strain.

→ not popular as high surface area allows for rapid oxidation.





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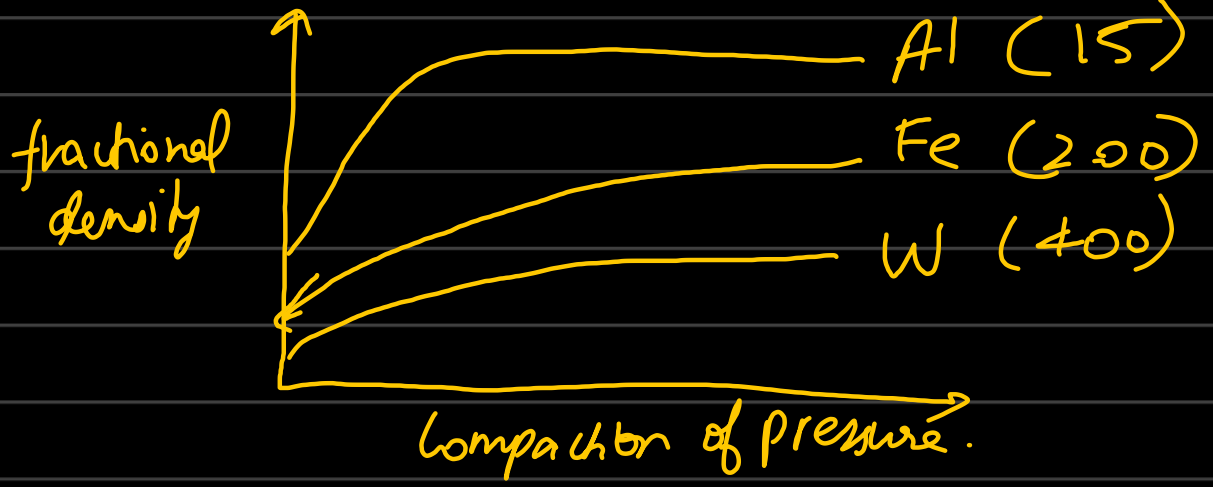
↳ Typical green density :
Metals > 80%
Ceramics < 60%

★ Al - Softest (fcc)
Steel → Hard (bcc)
Mg → Brittle (hcp)

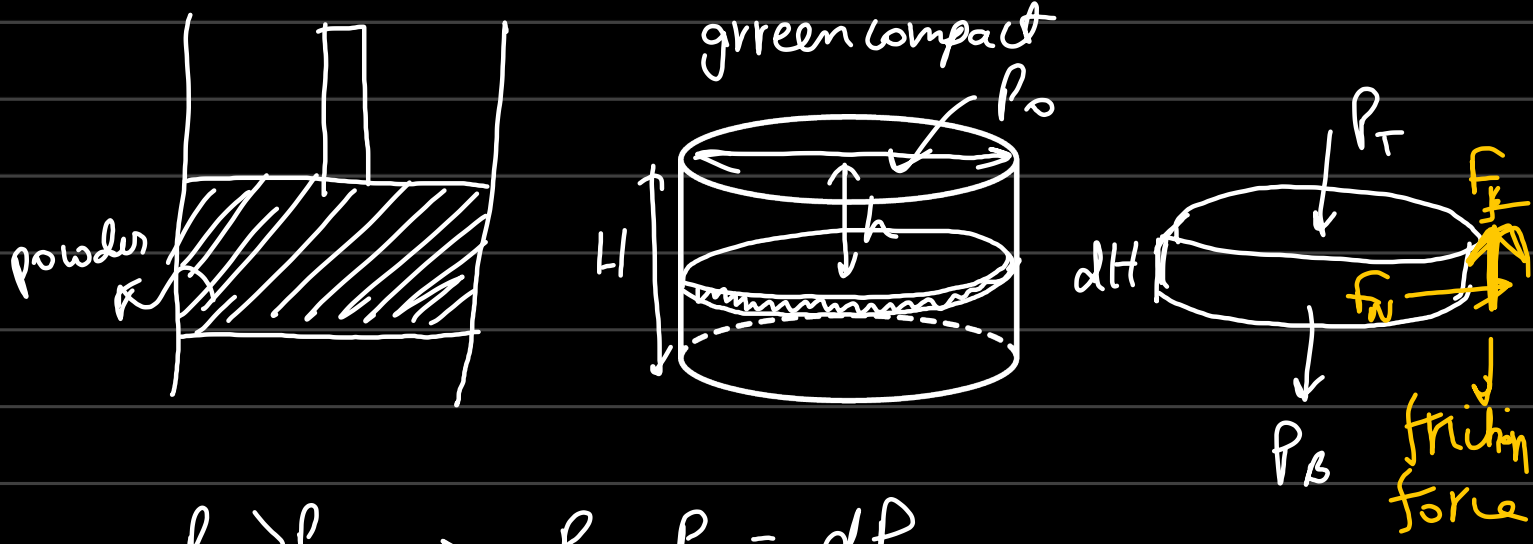


Hardness ∝ Melting Temperature.

Friction Analysis

→ friction can cause varying pressure across the pattern along the depth & radius.

→ friction decides spatial distribution of pressure.



$P_T > P_B \Rightarrow P_T - P_B = dP$

$F_f = \mu F_N$

μ = coefficient of restitution.

$F_N = 2(P_T)(\pi D)(dH)$

$F_f = \mu 2 P_T \pi D \, dh$

Apply force balance:

$A(P_T - P_B) + \mu f_N = 0$

$$A\,dP = -\mu F_N$$

$$\frac{\pi D^2}{4} dP = -\mu Z P_T \pi D\, dh$$

$$\int_{P_T}^{P} dP = -\int_{0}^{H} \frac{4\mu Z P_T\, dh}{D}$$

$$\ln\left(\frac{P}{P_0}\right) = -\frac{4\mu Z h}{D}$$

$$P = P_0 \exp\left(-\frac{4\mu Z h}{D}\right)$$

decaying of pressure.

→ not acceptable as for low pressure more shrinkage takes place.

→ tapered compact formed after sintering.