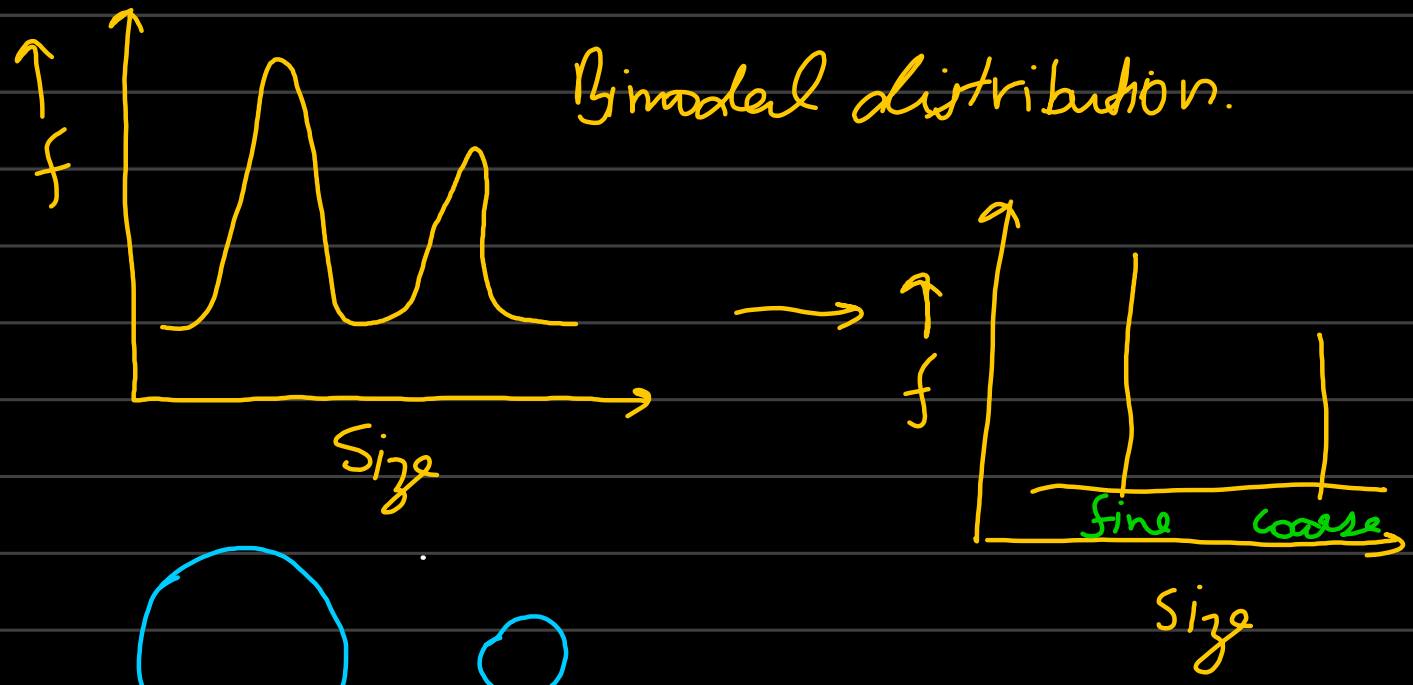
Lecture 14

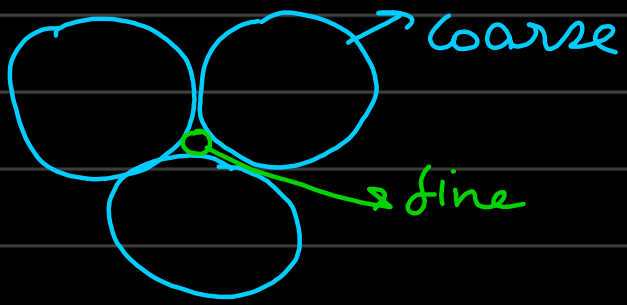
Powder Processing

→ Unisize Spheres. → regular arrangement
→ random packing.



$D_{coarse} > 10\, D_{fine}$

Q) What is the PF for such a distribution:



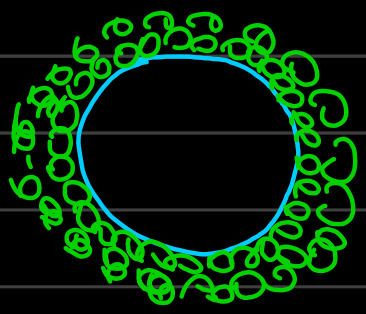
PF will be beyond 0.74.

1) Case I: Adding fine powder particles to coarse

PF ↑ se

Case II: Adding coarse to fine powder

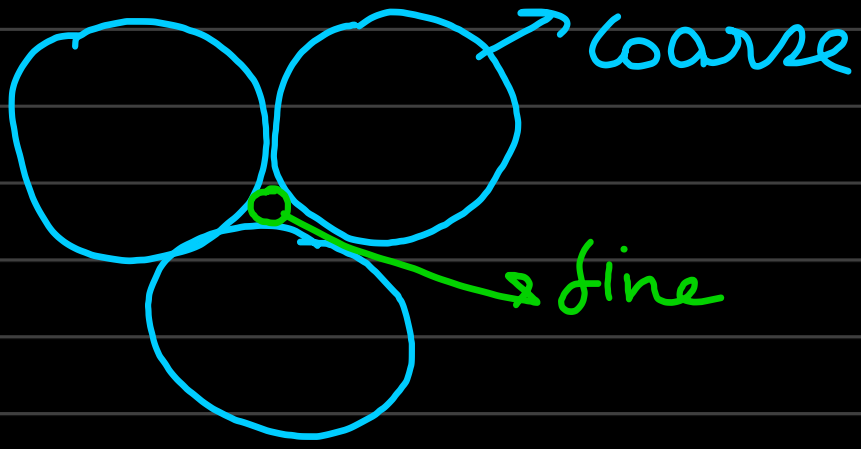
↳ displacement of fine particles.



PF ↑ se

{ edge effect }

Case I:



$$V_T = V_{fine} + V_{coarse} + V_{pores}$$

mass of Coarse = $m_c \leftrightarrow V_c$

mass of fine = $m_f \leftrightarrow V_f$

True density / Bulk density: ρ_t

Apparent density: ρ_a

$$\rho_{app} = \frac{m_f + m_c}{V_T} \qquad \rho_t = \frac{m_f}{m_c} \quad \{Case\ 1\}$$

$$\rho_{app} = \frac{m_f}{V_T} + \frac{m_c}{V_T} = \frac{m_f}{V_T} \times \frac{V_f}{V_f} + \frac{m_c}{V_T} \times \frac{V_c}{V_c}$$

$$= \rho_t \times \frac{V_f}{V_T} + \rho_t \times \frac{V_c}{V_T}$$

$$\rho_{app} = \rho_t \left(\frac{V_f}{V_T} + \frac{V_c}{V_T} \right)$$

$$\frac{\rho_{app}}{\rho_t} = \frac{V_c}{V_T} + \frac{V_f}{V_T} \times \frac{(V_T - V_c)}{(V_T - V_c)}$$

$$\frac{\rho_{app}}{\rho_t} = (PF)_c + (PF)_f \left[1 - (PF)_c \right]$$

$$\frac{\frac{m_c + m_f}{V_T}}{\frac{m_c}{V_c} + \frac{m_f}{V_f}} = (PF)_c + (PF)_f \left[1 - (PF)_c \right]$$

$$\frac{V_c + V_f}{V_T} = (PF)_c + (PF)_f (1 - (PF)_c)$$

for Case I { fine to coarse

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

Eg: Coarse = fcc, fine = fcc

$$PF_{app} = 0.74 + 0.74(1 - 0.74)$$

$$= \underline{0.9324}$$

Case II: $X_c = \frac{V_c}{V_T} \neq PF_c$

X_c ↓ fraction of coarse particles added.

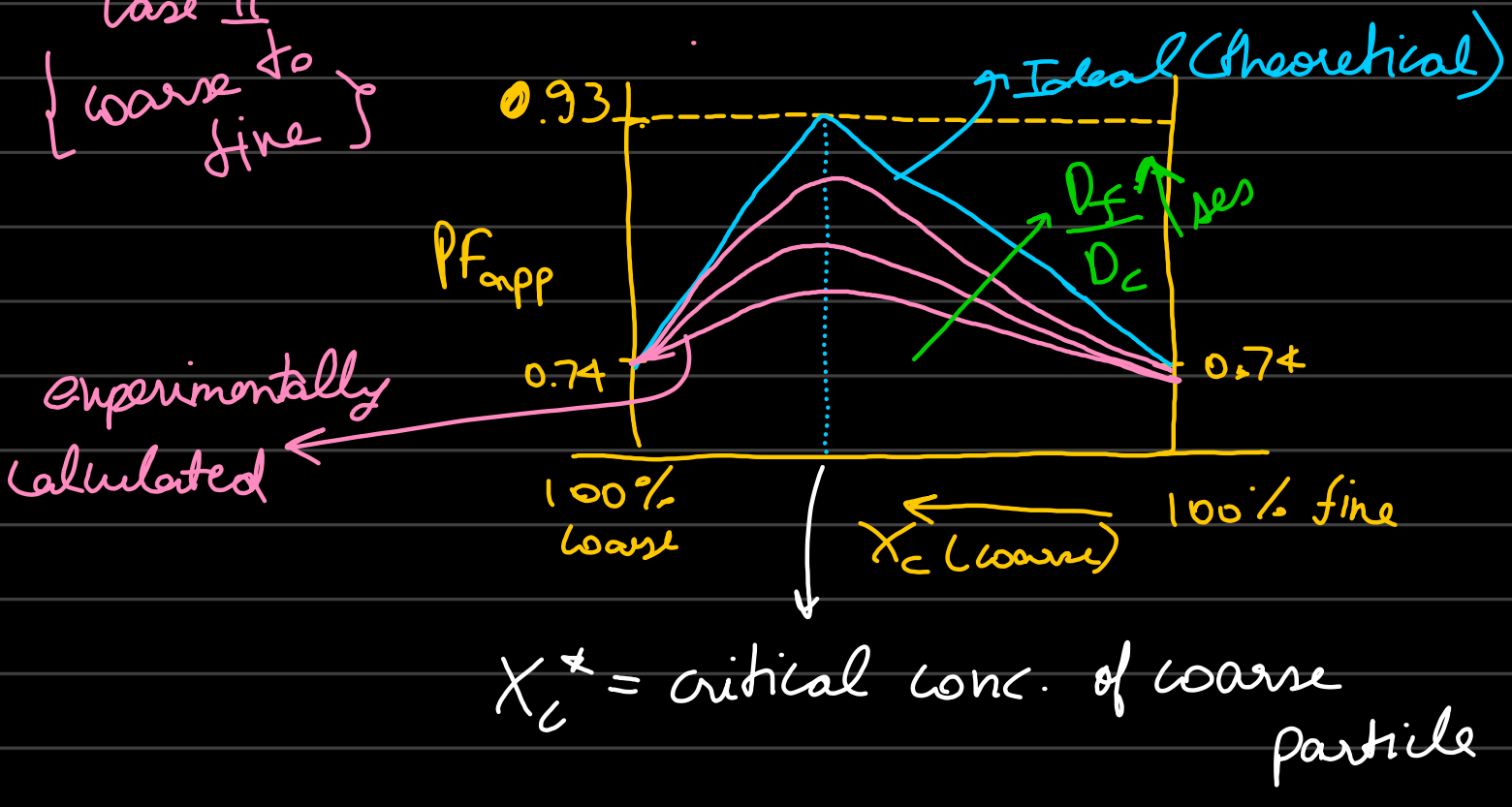
Initially $X_c = 0$

$$\frac{\rho_{app}}{\rho_t} = PF_f$$

$$\rho_{app} = \rho_t \times PF_f + X_c(1 - PF_f)\rho_t$$

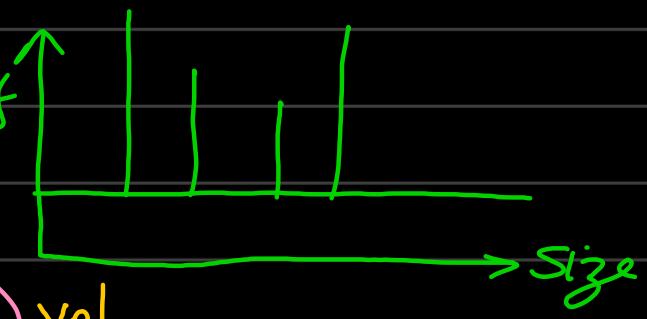
$$PF_{app} = PF_f + X_c(1 - PF_f)$$

Case II { coarse to fine }



X_c^* = critical conc. of coarse particle

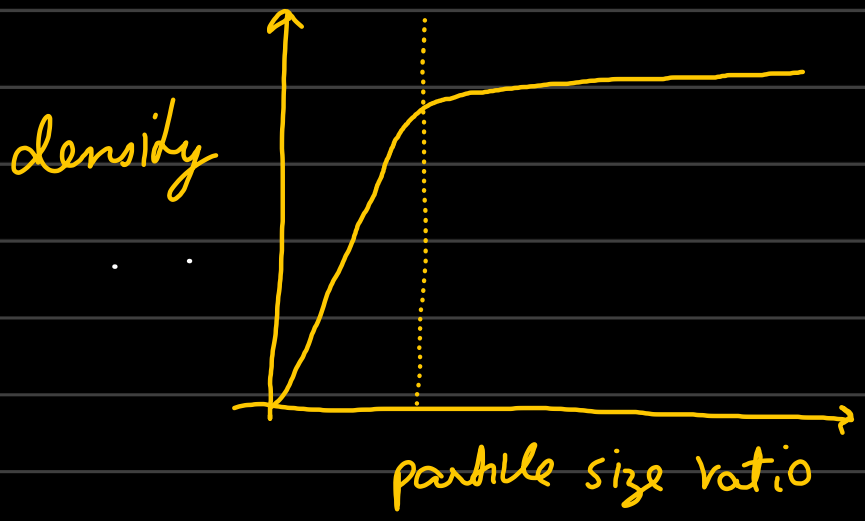
Quaternary Dist.



$(1 : 7 : 38 : 316)_{\text{Size ratio}}$

$(6.1 : 10.2 : 23 : 60.7)_{\text{Vol ratio}}$

$PF_{app} \approx 0,951$



Effect of powder shape and roughness:

→ strongly influences the fractional density / PF

→ lower Packing density indicate particle particles do not easily slide past each other.