Bulk Density and Void Content
Question

A 1-ft³ bucket holds 100 lb of aggregate. How much volume is occupied by the air and how much by the aggregate particles?
Bulk Density

**Bulk density** (*n.*) the mass of a unit volume of bulk aggregate including the volume of the individual particles and the volume of the voids between them.

\[
\text{bulk density} = \frac{m_{\text{agg}}}{V_{\text{bucket}}} = \frac{\text{kg}}{\text{m}^3}
\]
Unit Weight

**Unit weight** \((n.)\) the weight of a unit volume of bulk aggregate including the volume of the individual particles and the volume of the voids between them.

\[
\text{unit weight} = \frac{W_{\text{agg}}}{V_{\text{bucket}}} = \frac{\text{lb}}{\text{ft}^3}
\]
Void Content

**Void Content** (*n.*) the volume of void spaces between particles expressed as a percentage of the volume needed to contain all of the particles.

\[
\text{void content} = \frac{V_{\text{voids}}}{V_{\text{bucket}}} \times 100\%
\]
Volume of Voids

\[ V_{\text{agg}} = \frac{W_{\text{agg}}}{G_s \gamma_w} = \frac{m_{\text{agg}}}{G_s \rho_w} \]

\[ V_{\text{voids}} = V_{\text{bucket}} - V_{\text{agg}} \]
Which Void Content?

Voids + Pores

Voids Alone
Question

What determines the void content of a given aggregate sample?
Effects of Particle Size

Void content = 48%  
Void content = 48%
Effects of Particle Gradation

Void content = 48%

Void content = 41%
Effects of Particle Gradation

100% CA
Void content = 48%

CA:FA Blend
Void content = 41%

100% FA
Void content = 48%
Effects of Particle Gradation

![Graph showing the relationship between void content and the percentage of sand in a blend. The graph has a curve that decreases from left to right, reaching a minimum at around 40%. The x-axis represents the percentage of sand in the blend, ranging from 0% to 100%, while the y-axis represents void content, ranging from 0% to 40%.]
Question

A 1-ft³ bucket holds a blend of aggregates. How much volume is occupied by the air and how much by the aggregate particles?
Volume of Voids

\[ V_{agg} = \left( \frac{W_{agg}}{G_s \gamma_w} \right)_A + \left( \frac{W_{agg}}{G_s \gamma_w} \right)_B + \cdots \]

\[ V_{voids} = V_{bucket} - V_{agg} \]