Achievable

FE CIVIL DUMP SHEET

Geotechnical, hydrology, and hydraulics

Geotechnical

- Soil relations:
  - Void ratio: $e = \frac{V_v}{V_s}$
  - Porosity: $n = \frac{V_v}{V_t}$
  - Water content: $w = \frac{W_w}{W_s}$
  - Saturation: $S = \frac{V_w}{V_v}$
  - Buoyant unit weight: $\gamma' = \gamma_{sat} - \gamma_w$
- Stress in soil:
  - $\sigma = \gamma z$
  - $u = \gamma_w z$
  - $\sigma' = \sigma - u$
- **Compaction, zero air voids:** $\gamma_{zav} = \frac{G_s \gamma_w}{1 + w G_s}$
- Consolidation:
  - $S_c = \frac{C_c H}{1 + e_0} \log \frac{\sigma'_f}{\sigma'_0}$
  - $T_v = \frac{C_v t}{H_d^2}$
- **Shear strength:** $\tau = c + \sigma' \tan \phi$
- Bearing capacity:
  - $q_{ult} = cN_c + \gamma D_f N_q + 0.5 \gamma B N_\gamma$
  - $q_{allow} = \frac{q_{ult}}{FS}$
- Earth pressure:
  - $K_a = \tan^2(45^\circ - \phi/2)$
  - $K_p = \tan^2(45^\circ + \phi/2)$
  - $\sigma_h = K \sigma_v$

Hydraulics

- **Continuity:** $Q = VA$
- Fluid statics and energy:
  - Bernoulli: $\frac{p}{\gamma} + z + \frac{V^2}{2g} = \text{constant}$
  - Hydrostatic pressure: $p = \gamma h$
  - Force on a submerged surface: $F = \gamma h_c A$
- Pipe flow:
  - Reynolds number: $Re = \frac{VD}{\nu}$
  - Darcy-Weisbach: $h_f = f \frac{L}{D} \frac{V^2}{2g}$
- **Pump power:** $P = \frac{\gamma Q h_p}{\eta}$
- Open channels:
  - Manning (SI): $V = \frac{1}{n} R^{2/3} S^{1/2}$; US units use $\frac{1.49}{n}$
  - Froude number: $Fr = \frac{V}{\sqrt{gD}}$
  - Critical depth (rectangular): $y_c = \left(\frac{q^2}{g}\right)^{1/3}$

Hydrology

- **Rational method:** $Q = CiA$
- NRCS (SCS) runoff:
  - $Q = \frac{(P - 0.2S)^2}{P + 0.8S}$
  - $S = \frac{1000}{CN} - 10$
- **Time of concentration (Kirpich):** $T_c = 0.0078\, L^{0.77} S^{-0.385}$