Leonard's and Frost Model

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$$\rho_i = C_1 \cdot \Delta p \cdot \Delta z \cdot \sum_{i=1}^{i=NEL} I_{iz} \left[\frac{R_{izoc}}{E_{izoc}} + \frac{R_{iznc}}{E_{iznc}} \right]$$

ρ_i : immediate settlement in ft

C_1 : correction to account for strain relief from embedment

- $C_1 = 1 - \frac{0.5\,\sigma_o'}{\Delta_p} \geq 0.5$
  - σ_o' : effective vertical overburden pressure at bottom of footing, in tsf

Δp : net applied footing pressure, in tsf

- $\Delta p = q - \sigma_o'$
- q : bearing pressure on footing

Δz : depth increment, in ft

I_{iz} : influence factor of soil layers i (see figure 3-4)

R_{izoc} : stress increment of overconsolidated soil in layer / total stress increment in soil layer
(ratio, overconsolidated)

$R_{izoc} = \frac{\sigma_p' - \sigma_v'}{\sigma_f' - \sigma_v'}$

- σ_p' : preconsolidation / max past pressure, in tsf
- σ_v' : initial vertical effective stress, in tsf
- σ_f' : final effective stress at center of the layer, in tsf

$\sigma_p' = (OCR)\,\sigma_v'$

→ OCR (over consolidation ratio):

$OCR = \left[\frac{K_{oc}}{1 - \sin\phi_{ax}} \right]^{\frac{1}{0.8 \cdot \sin\phi_{ax}}}$

- ϕ_{ax} : axial friction angle, in degrees

$\phi_{ax} = \phi_{px} - \left[\frac{\phi_{px} - 32}{3} \right]$

- ϕ_{px} : plane strain angle
  - → SPLINE / SOLVE / BICUBIC are used to solve this
- $K_{oc} = 0.376 + 0.095 K_D - 0.0017 \left(\frac{\gamma_c}{\sigma_v'} \right)$
  - → coefficient of earth pressure
- K_D : horizontal stress index
- $K_D = \frac{(P_o - u_w)}{\sigma_v'}$

R_{iznc} : stress increment in normally consolidated soil in layer / total stress increment in soil layer
(normally consolidated)

$R_{iznc} = \frac{\sigma_f' - \sigma_p'}{\sigma_p' - \sigma_v'}$

E_{izoc} : Young's modulus of overconsolidated soil at layer i and depth z, in tsf
(overconsolidated, depth, layer)

E_{iznc} : Young's modulus of normally consolidated soil at layer i and depth z, in tsf

If $R_{izoc} = 0$, $E_{iznc} = 0.9 E_D$

→ $E_D = 34.7 (P_1 - P_0)$

Code

```
UW=0.0
IF(DXX.GT.DGWT) UW=(DXX-DGWT)*GAW
AKD = (PO(MTYP)-UW)/PR1
AID = (P1(MTYP)-PO(MTYP))/(PO(MTYP)-UW)
ED = 34.7*(P1(MTYP)-PO(MTYP))
RQC = QC(MTYP)/PR1
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unit weight? $u_w = z_w \gamma_w$

z_w, γ_w

σ_o'

$E_D = 34.7 (P_1 - P_0)$ (F-7)