### Soldier Pile Design – Cantilever With Uniform Surcharge:

**Design Parameters:**
- Spacing of Piles: \( S = 8 \text{ ft} \)
- Width of Piles: \( b = 14 \text{ in} \)
- Soil weight: \( \gamma = 120 \text{pcf} \)
- Frictional angle: \( \phi = 28 \text{deg} \)
- Live Load: \( q_{LL} = 30 \text{psf} \)

**Soil Properties:**
- Active Pressure Coefficient: \( K_a = 0.35 \)
- Passive Pressure Coefficient: \( K'_p = 2.77 \)
- Factor of Safety on passive pressure: \( K_{pFS} = 1.0; \quad K_p = K'_p / K_{pFS}; \quad K_p = 2.770 \)
- At-Rest Pressure Coefficient: \( K_0 = 0.531 \)

**Cantilever Design:**
- Height of Excavation: \( H = 8 \text{ ft} \)
- Embedment below bottom grade: \( D = 13.8 \text{ ft} \)
  - *Increase 20-40 percent or use FOS=1.5 / 1.75*;
  - \( D_{use} = 1.30 \cdot D; \quad D_{use} = 17.940 \text{ ft} \)
- Arching Adjustment Factor: \( f_{arch} = \min(3, 0.08 \cdot \phi) \); \( f_{arch} = 2.240 \)
- Soldier Pile Spacing Factor: \( f = \min(1, f_{arch} \cdot b/S) \); \( f = 0.327 \)
- Active soil pressure on lagging: \( P_{a1} = \gamma \cdot H \cdot K_a \); \( P_{a1} = 336,000 \text{psf} \)
- Active soil pressure on pile at bottom grade: \( P_{a1} = f \cdot \gamma \cdot H \cdot K_a \); \( P_{a1} = 109,760 \text{psf} \)
- Active soil pressure on pile at bottom of pile: \( P_{a2} = f \cdot \gamma \cdot D \cdot K_a + P_{a1} \); \( P_{a2} = 299,096 \text{psf} \)
- Net Soil pressure at bottom of pile due to passive pressure below bottom grade: \( P_e = f \cdot \gamma \cdot D \cdot (K_p - K_a) - P_{a1} \); \( P_e = 1199.363 \text{ psf} \)
- Net Soil pressure at bottom of pile due to passive pressure below top grade: \( P_j = f \cdot \gamma \cdot D \cdot (K_p - K_a) + f \cdot \gamma \cdot H \cdot K_p \); \( P_j = 2177.795 \text{ psf} \)
- Active surcharge pressure: \( P_q = K_a \cdot q_{LL} \); \( P_q = 10.500 \text{ psf} \)
- Distance from bottom of pile to point where passive pressure below bottom grade turns to active pressure (inflection point in soil pressure diagram): \( Z = ((P_e - P_{a1}) \cdot D - H^*P_{a1} - H^*P_q)/(P_e + P_j); \quad Z = 3.632 \text{ ft} \)

**Sum of Horizontal Forces:**
\[
F_H = H^*P_{a1}/2 + P_q \cdot H^*(P_{a1} + P_{a2}) \cdot D/2 + (P_e + P_j) \cdot Z/2 - (P_e + P_{a2}) \cdot (D/2); \quad F_H = 42,000 \text{plf}
\]

**Sum of Moments about bottom of pile should be equal to Zero. “Increase embedment,D, by 20-40 percent unless a FOS=1.5 or 1.75 has been used on passive pressure”:**
\[
R = (H^*P_{a1}/2) \cdot (H/3 + D) + P_q \cdot H^*(H/2 + D) + P_{a1} \cdot D/2 + (P_e + P_j) \cdot Z/2 - ((P_e + P_j) \cdot Z) + ((((P_e + P_{a2}) \cdot D) \cdot /2) \cdot (D/3); \quad R = 50,494 \text{lbs}
\]
Moment;
Locate Plane of zero shear;
Distance from bottom grade to point where net
pressure turns from active to passive pressure
(inflection point A in pressure diagram);
Surcharge pressure at A;
Shear due to surcharge at A due to surcharge
pressure above point A;
Total Shear at A;
Point of zero shear (point B) will be located a
proportional distance with the same amount of
shear from point A;
Soil pressure on pile;
Surcharge pressure on pile;
Total shear must equal c1;
Determinate;
Add determinate;
Subtract determinate;
Distance to equivalent amount of shear;
Check;
This should equal Vtotal(+-);

Moment at B
Moment due to soil pressure above A;
Moment due to soil pressure between A and B;
Moment due to surcharge above excavation;
Moment due to surcharge below excavation;
Lagging (multiply height of lagging by load);
Load per foot of height;
Moment per foot of height;