Seal Course

A seal course is a layer of concrete placed in an excavation for the purpose of preventing groundwater infiltration. Use of a seal course allows the footing reinforcement and concrete to be placed under dry conditions. Seal courses can be used for both shallow and deep foundation (e.g., pile cap, CIDH, CISS) construction. This module provides guidance on how to calculate a seal course thickness for a shallow foundation and pile cap. Seal courses for CISS foundations are addressed in the *Driven Pile Foundations* module.

The thickness of a seal course is a function of the hydrostatic pressure at the bottom of seal course (i.e., bottom of excavation). The hydrostatic pressure is dependent on the hydrostatic head (feet), which is the distance from the bottom of excavation elevation to the highest anticipated groundwater elevation surrounding the footing excavation.

The minimum seal course thickness is 2 feet.

Spread Footing

Use the following equation to calculate the seal course thickness.

Seal course thickness (feet), $$t \geq \frac{(\text{hydrostatic head})(62.4\ \text{pcf})}{145\ \text{pcf}}$$

Where: $\gamma_{concrete} = 145\ pcf$

$$t \geq (0.43)(\text{hydrostatic head})$$

Pile Cap Foundation

The uplift buoyancy force acting on the seal course must be less than the capacity of the piles in tension and the frictional resistance between the piles and seal course concrete. An additional one foot of seal is provided to allow for irregularity between the top and bottom surfaces.

Uplift buoyancy force ≤ Total uplift resistance

$$(\text{hydrostatic head})\,(\gamma_w)(A_f - a_p) \leq \left[\gamma_c(A_f - a_p) + \tau(p)\right](t-1)$$

$$t \geq \frac{(\text{hydrostatic head})(\gamma_w)(A_f - a_p)}{\gamma_c(A_f - a_p) + \tau(p)} + 1$$

Where:

t = seal course thickness (feet)

γ_w =unit weight of water = 62.4 pcf

A_f = Tributary area (ft^2) of footing for a single pile = S_1^2 (for square spacing) or S_1 * S_2 (for rectangular spacing), or S_1 * Footing Width (for a single pile row)

S_1, S_2 = center-to-center pile spacing in each direction (feet)

a_p = Pile cross sectional area = π r^2 (circular pile) or d^2 (square pile)

r = pile radius (feet)

d = pile side length (feet)

For other pile types (e.g., H-Pile), refer to the manufacturer’s specifications for a_p

γ_c =unit weight of concrete = 145 pcf

τ = bond strength between the pile (steel or concrete) and seal course concrete (use 10 psi = 1440 psf)

p = perimeter of pile = 2πr (circular pile) = 4d (square pile)

Example 1: Seal Course Thickness Calculation with Given Hydrostatic Head

Assume:

- 14-inch square reinforced concrete piles
- Pile spacing: S_1 = 3.5 feet by S_2 = 4.0 feet
- Hydrostatic head = 15.0 feet
- Bond strength between pile and seal course concrete = 1440 psf

Tributary Area (A_f) = S_1*S_2 = 3.5*4.0 = 14 ft^2

Pile Area (a_p) = d^2 = $\left(\frac{14}{12}\right)^2 = 1.36$ ft^2

Pile Perimeter (p) = 4d = $4\left(\frac{14}{12}\right) = 4.67$ feet

Seal course thickness is calculated as follows:

$$t \geq \frac{(\text{hydrostatic head})(\gamma_w)(A_f - a_p)}{\gamma_c(A_f - a_p) + \tau(p)} + 1$$

$$t \geq \frac{(15)(62.4)(14 - 1.36)}{(145)(14 - 1.36) + (1440)(4.67)} + 1$$

t ≥ 2.38 feet say 2.5 feet (exceeds 2-foot minimum) OK

Calculate the tension load demand (bond strength) per pile:

$$\left(1440\frac{lb}{ft^2}\right)(4.67\ ft)(2.5\ ft) = 16800 \text{ pounds} = 16.8 \text{ kip}$$

Calculate the nominal tension resistance per pile and verify that it is greater than 16.8 kips.

Example 2 – Seal Course Thickness Calculation as a Function of Hydrostatic Head

Assume:

- 12-inch diameter steel pipe piles
- Pile spacing: S_1 = 3.0 feet center-to-center both directions
- Bond strength between steel pile and seal course concrete = 1440 psf

Tributary Area (A_f) = S_1^2 = 9 ft^2

Pile Area (a_p) = $\pi r^2 = \pi(0.5)^2 = 0.785 \text{ ft}^2$

Pile Perimeter (p) = $2\pi r = 2\pi(0.5) = \pi$

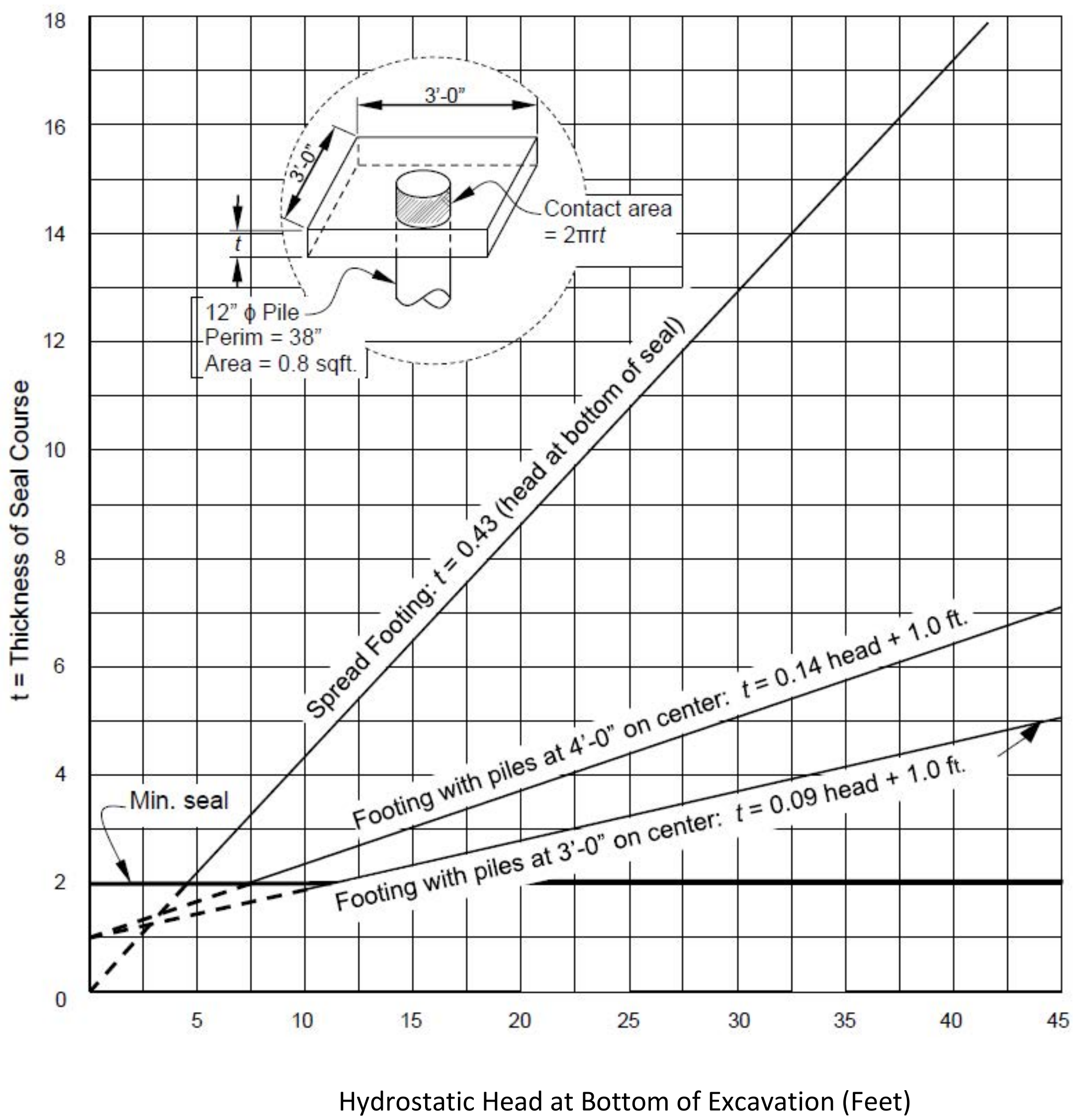
Seal course thickness is calculated as follows:

$$t \geq \frac{(\text{hydrostatic head})(\gamma_w)(A_f - a_p)}{\gamma_c(A_f - a_p) + \tau(p)} + 1$$

$$t \geq \frac{(\text{hydrostatic head})(62.4)(3^2 - 0.785)}{(145)(3^2 - 0.785) + 1440(\pi)} + 1$$

$$t \geq (0.09)(\text{hydrostatic head}) + 1$$

The following graph presents the seal course thickness as a function of hydrostatic head for a spread footing, and a pile cap with center-to-center pile spacings of 3 feet and 4 feet. The graph shows the requirement for a minimum thickness of 2 feet by using dotted lines for calculated thicknesses of less than 2 feet.



Seal Course Thickness for Spread Footing and Pile Cap Foundations