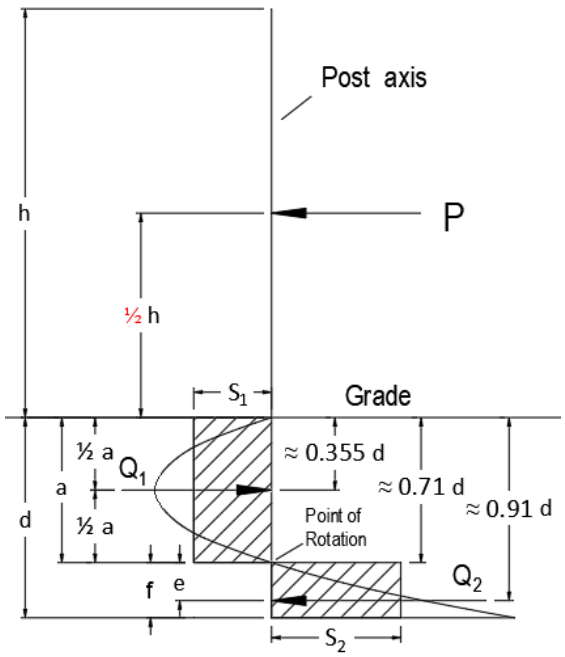
Derivation of the IBC Minimum Depth Formula for Non-constrained Posts

Variable	**Units**
P is the horizontal wind force	lbs
h is the overall fence height	ft
½ h is the force application height for fencing	ft
b is the diameter of the footing	ft
a is the depth of the point of rotation	ft
S_1 is the average soil pressure above the point of rotation	psf
Q_1 is the resultant of the soil pressure above the point of rotation	lbs
S_2 is the average soil pressure below the point of rotation	psf
Q_2 is the resultant of the soil pressure below the point of rotation	lbs
d is the minimum embedment depth	ft
D is the depth being checked D ≥ d is OK	ft

M is the modifier for isolated posts – 2.0 if applicable – 1.0 if not

S is the soil Lateral Bearing Pressure $S_1 = \frac{1}{3}\ D\ S\ M$ $Q_1 = S_1\ a\ b$



Taking the moment about Q_1: $P\ (½\ h + ½\ a) = Q_2\ (½\ a + e)$

Rearrange for Q_2 formula $$Q_2 = \frac{P\ (½\ h + ½\ a)}{(½\ a + e)}$$

Set Q_1 to sum of opposing forces $Q_1 = P + Q_2$

Replace Q_1 & Q_2 with their formulas $$S_1\ a\ b = P + \frac{P(½\ h + ½\ a)}{(½\ a + e)} = P\frac{(½\ a + e)}{(½\ a + e)} + \frac{P(½\ h + ½\ a)}{(½\ a + e)}$$

Condense the formula $$S_1\ a\ b = \frac{P(½\ h + a + e)}{(½\ a + e)}$$

Rearrange the formula $$\frac{P}{S_1} = \frac{a\ b(½\ a + e)}{(a + ½\ h + e)}$$

Values to match derived formula to IBC a = 0.6775 d ½a = 0.33875 d e = 0.2399 d

$$\frac{P}{S_1} = \frac{0.6775\ d\ b\ (0.33875\ d + 0.2399\ d)}{(0.6775\ d + ½\ h + 0.2399\ d)} = \frac{0.392\ d^2\ b}{(0.9174\ d + ½\ h)} = \frac{d^2\ b}{(2.34\ d + 2.55½\ h)}$$

Set up as a quadratic equation ($ax^2 + bx + c = 0$) $(S_1\ b)\ d^2 + (-2.34\ P)\ d + (-2.55\ P\ ½\ h) = 0$

Calculating the positive solution with the quadratic formula $$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$d = \frac{-(-2.34\ P) + \sqrt{(-2.34\ P)^2 - 4(S_1\ b)(-2.55\ P\ ½\ h)}}{2\ S_1\ b} = \frac{2.34\ P + \sqrt{(2.34\ P)^2 + S_1\ b(10.2)\ P\ ½\ h}}{2\ S_1\ b}$$

$$d = \frac{2.34\ P}{2\ S_1\ b} + \sqrt{\frac{(2.34\ P)^2}{(2\ S_1\ b)^2} + \frac{S_1\ b\ (10.2)\ P\ ½\ h}{(2\ S_1\ b)^2}} = \frac{2.34\ P}{2\ S_1\ b} + \sqrt{\frac{(2.34\ P)^2}{(2\ S_1\ b)^2} + \frac{S_1\ b\ (4.36)(2.34\ P)½\ h}{(2\ S_1\ b)^2}}$$

$$d = \frac{2.34\ P}{2\ S_1\ b} + \sqrt{\frac{(2.34\ P)^2}{(2\ S_1\ b)^2} + \frac{S_1\ b\ (4.36)(2.34\ P)\ ½\ h}{(2\ S_1\ b)^2}\ \frac{(2.34\ P)}{(2.34\ P)}} = \frac{2.34\ P}{2\ S_1\ b} + \sqrt{\frac{(2.34\ P)^2}{(2\ S_1\ b)^2} + \frac{(2.34\ P)^2}{(2\ S_1\ b)^2}\ \frac{S_1\ b}{2.34\ P}\ \frac{(4.36)\ ½\ h}{1}}$$

Common Factor, $A = \frac{2.34\ P}{S_1\ b}$

$$d = \frac{A}{2} + \sqrt{\frac{A^2}{2^2} + \frac{A^2}{2^2}\ \frac{1}{A}\ \frac{4.36\ ½\ h}{1}}$$

$$d = \frac{A}{2}\left(1 + \sqrt{1 + \frac{4.36\ ½\ h}{A}}\right)$$

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