EQUATIONS FOR CALCULATING UPLIFT FORCES AT BASE OF FIRST-STORY WALL

(Based on limiting concrete bearing on a 3½" wide base plate at the edge of the concrete)

These equations may be used to calculate uplift forces at the base of the 1st-story wall to aid Designers in developing anchorage solutions other than those shown on pages 50–54.

NEW Equations have been revised and are based on a rectangular compression stress block.

2.5 ksi concrete

12 in. wall $T = \left[28.1 - \sqrt{788 - 5.95\,(3.4P + Vh)}\right] - P$

15 in. wall $T = \left[36.1 - \sqrt{1301 - 5.95\,(4.6P + Vh)}\right] - P$

18 in. wall $T = \left[45.0 - \sqrt{2025 - 5.95\,(6.1P + Vh)}\right] - P$

21 in. wall $T = \left[53.9 - \sqrt{2908 - 5.95\,(7.6P + Vh)}\right] - P$

24 in. wall $T = \left[62.8 - \sqrt{3950 - 5.95\,(9.1P + Vh)}\right] - P$

3.0 ksi concrete

12 in. wall $T = \left[33.7 - \sqrt{1135 - 7.14\,(3.4P + Vh)}\right] - P$

15 in. wall $T = \left[43.3 - \sqrt{1874 - 7.14\,(4.6P + Vh)}\right] - P$

18 in. wall $T = \left[54.0 - \sqrt{2916 - 7.14\,(6.1P + Vh)}\right] - P$

21 in. wall $T = \left[64.7 - \sqrt{4187 - 7.14\,(7.6P + Vh)}\right] - P$

24 in. wall $T = \left[75.4 - \sqrt{5688 - 7.14\,(9.1P + Vh)}\right] - P$

4.5 ksi concrete

12 in. wall $T = \left[50.5 - \sqrt{2554 - 10.71\,(3.4P + Vh)}\right] - P$

15 in. wall $T = \left[64.9 - \sqrt{4216 - 10.71\,(4.6P + Vh)}\right] - P$

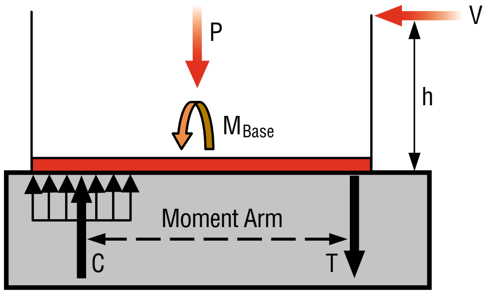
18 in. wall $T = \left[81.0 - \sqrt{6560 - 10.71\,(6.1P + Vh)}\right] - P$

21 in. wall $T = \left[97.1 - \sqrt{9421 - 10.71\,(7.6P + Vh)}\right] - P$

24 in. wall $T = \left[113.1 - \sqrt{12{,}797 - 10.71\,(9.1P + Vh)}\right] - P$

Notes:

1. Equations may be used to calculate uplift forces at the base of first-story walls on concrete foundations.
2. Equations are based on the design methodology contained in AISC Steel Design Guide 1 – Base Plate and Anchor Rod Design, second edition using a rectangular compression stress block.



Forces at Base of Wall

T = Resulting anchorage tension (uplift) force (kips)
V = Design shear (kips)
P = Total vertical load (kips)
h = Wall height (inches)

For two-story stacked applications, substitute M_{base} for Vh:

$$Vh = M_{base}\left(\frac{12}{1000}\right)\text{ kip-in}$$

Where M_{base} = Design moment at base of wall (ft-lbs)

EXAMPLE 1 – Single-Story S/SSW:

Given:

- S/SSW18x9X wall on 2.5 ksi concrete
- 2006 International Building Code®, Seismic
- Design Shear (V) = 1.5 kips < 1.835 kips ($V_{allowable}$)
- P (Vertical Load) = 1.0 kip
- h = Wall height = 109"

$$T = \left[45.0 - \sqrt{2025 - 5.95\,(6.1P + Vh)}\right] - P$$

$$T = \left[45.0 - \sqrt{2025 - 5.95\,(6.1 \times 1 + 1.5 \times 109)}\right] - 1.0 = \underline{\underline{12.1\text{ kips}}}$$

EXAMPLE 2 – Two-Story Stacked S/SSW Condition:

Given:

- See Two-Story Design Example on page 49
- S/SSW18x9X-STK wall on 2.5 ksi concrete
- 2006 International Building Code®, Wind
- M_{base} = 17,550 ft-lbs. (Moment at base of two-story stacked wall)
- $Vh = 17{,}550 \times \left(\frac{12}{1000}\right)$ kip-in = 210.6 kip-in
- P (Vertical Load) = 2.0 kips

$$T = \left[45.0 - \sqrt{2025 - 5.95\,(6.1P + Vh)}\right] - P$$

$$T = \left[45.0 - \sqrt{2025 - 5.95\,(6.1 \times 2 + 210.6)}\right] - 2 = \underline{\underline{16.6\text{ kips}}}$$