EXAMPLE 7.10 *Concrete Wall to Footing (Shear) Connection*

Given

Maximum transverse shear load on bottom of wall = 1,050 plf (due to soil)
Dead load on wall = 1,704 plf
Yield strength of reinforcement = 60,000 psi
Wall thickness = 8 inches
Assume μ = 0.6 for concrete placed against hardened concrete not intentionally roughened.
f'_c = 3,000 psi

Find

- Whether a dowel or key is required to provide increased shear transfer capacity
- If a dowel or key is required, size accordingly

Solution

1. Determine factored shear load on wall due to soil load (i.e., 1.6H per Chapter 3, Table 3.1)

$V = 1,050$ plf
$V_u = 1.6\ (1,050\ \text{plf}) = 1,680$ plf

2. Check friction resistance between the concrete footing and wall

$V_{friction} = \mu N = \mu$(dead load per foot of wall)

$= (0.6)(1,704\ \text{plf}) = 1,022\ \text{plf} < V_u = 1,680$ plf

Therefore, a dowel or key is needed to secure the foundation wall to the footing.

3. Determine a required dowel size and spacing (Section 7..2 and ACI-318•5.14)

$A_{vf} = V_u / (\phi f_y \mu)$

$= (1,680\ \text{plf})/[(0.85)(60,000)(0.6)] = 0.05\ \text{in}^2$ per foot of wall

Try a No. 4 bar ($A_v = 0.20\ \text{in}^2$) and determine the required dowel spacing as follows:

$A_{vf} = A_v/S$
$0.05\ \text{in}^2/\text{lf} = (0.2\ \text{in}^2)/S$
$S = 48$ inches

Conclusion

This example problem demonstrates that for the given conditions a minimum of one No. 4 rebar at 48 inches on center is required to adequately restrict the wall from slipping. Alternatively, a key may be used or the base of the foundation wall may be laterally supported by the basement slab.

It should be noted that the factored shear load due to the soil lateral pressure is compared to the estimated friction resistance in Step 1 without factoring the friction resistance. There is no clear guideline in this matter of designer judgment.

EXAMPLE 7.11 *Concrete Anchor*

Given

- 1/2-inch diameter anchor bolt at 4 feet on center with a 6 inch embedment depth in an 8-inch thick concrete wall
- The bolt is an ASTM A36 bolt with f_y = 36 ksi and the following design properties for ASD; refer to AISC Manual of Steel Construction (AISC,1989):

  F_t = 19,100 psi (allowable tensile stress)
  F_u = 58,000 psi (ultimate tensile stress)
  F_v = 10,000 psi (allowable shear stress)
- The specified concrete has f'_c = 3,000 psi
- The nominal design (unfactored) loading conditions are as follows:

  Shear load = 116 plf
  Uplift load = 285 plf
  Dead load = 180 plf

Find Determine if the bolt and concrete are adequate for the given conditions.

Solution

1. Check shear in bolt using appropriate ASD steel design specifications (AISC, 1989) and the ASD load combinations in Chapter 3.

$$f_v = \frac{\text{shear load}}{\text{bolt area}} = \frac{116 \text{ plf } (4 \text{ ft})}{(0.196 \text{ in}^2)} = 2{,}367 \text{ psi}$$

F_v = 10,000 psi

$f_v \le F_v$ OK

2. Check tension in bolt due to uplift using appropriate ASD steel design specifications (AISC, 1989) and the appropriate ASD load combination in Chapter 3.

$$T = [(285 \text{ plf}) - 0.6\,(180 \text{ plf})]\,(4 \text{ ft}) = 708 \text{ lb}$$

$$f_t = T/A_{bolt} = \frac{708 \text{ lb}}{0.196 \text{ in}^2} = 3{,}612 \text{ psi}$$

$f_t \le F_t$

3,612 psi < 19,100 psf OK

3. Check tension in concrete (anchorage capacity of concrete) using ACI-318•11.3 and the appropriate LRFD load combination in Chapter 3. Note that the assumed cone shear failure surface area, A_v, is approximated as the minimum of π (bolt embedment length)^2 or π (wall thickness)^2.

$$V_u = T = [1.5\,(285 \text{ plf}) - 0.9\,(180 \text{ plf})]\,(4 \text{ ft}) = 1{,}062 \text{ lb}$$

$$A_v = \text{minimum of} \begin{cases} \pi\,(6 \text{ in})^2 = 113 \text{ in}^2 \\ \pi\,(8 \text{ in})^2 = 201 \text{ in}^2 \end{cases}$$

$$\phi V_c = \phi 4 A_v \sqrt{f'_c} = (0.85)(4)(113 \text{ in}^2)\sqrt{3{,}000 \text{ psi}} = 21{,}044 \text{ lb}$$

$V_u \le \phi V_c$

1,062 lb ≤ 21,044 lb OK