## Design of wall footings

### Critical sections of wall footings:

Shear:

1. Footing supporting a masonry wall: at ¼ thickness from the face of wall.
2. Footing supporting a concrete wall: at one effective section from the face of wall.

Moment: at face of wall;

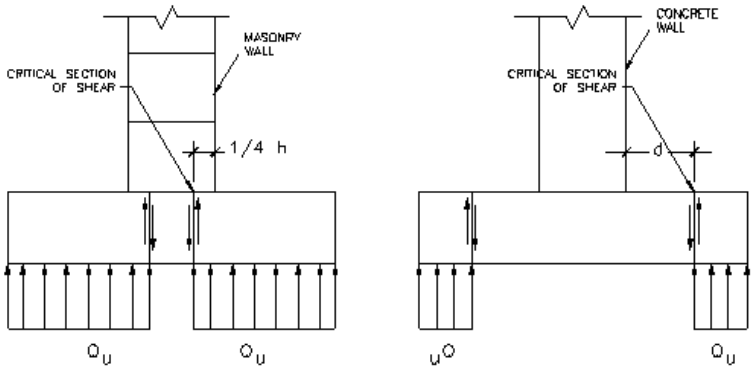


Figure 2.4 critical shear section of masonry wall footing and concrete wall footing.

### Design procedure:

Service load design:

1. Design footing width based on service load. If wall footing is an exterior wall, check required frost depth.

Reinforced concrete design:

2. Determine footing depth and check direct shear stress at critical section.
3. Design transverse reinforcements based on factored moment.

4. Design longitudinal reinforcements for temperature and shrinkage.

### Example 10: Design of a wall footing

**Given:**

- Wall loads:
- Live load: 2.5 kips/ft
- Dead load:3 kips/ft
- Wall type: 8” concrete masonry wall
- Soil information:
- Allowable soil bearing capacity: 2500 psf
- Required frost depth: 18”
- Unit weight of soil: 100 pcf
- Materials used:
- Concrete strength at 28 day = 3000 psi
- Yield strength of rebars = 60 ksi

Design code: ACI 318-05

**Requirement:** Determine width, depth, and reinforcement.

**Solution:**

**Service load design:**

1. Determine width of footing:

Assume that the footing depth is 10 inch with 8” overburden soil. The bottom of footing is at 18” below ground surface that meet frost depth requirement.
The net soil bearing capacity is
$p$ = 2500 – 15*10/120 – 100*8/12 = 2308 psf
The required footing width is
B = (2500 + 3000) / 2308 = 2.4 ft=29” Use 2’6” =30” width

**Reinforced concrete design**

2. Check direction shear

The ultimate footing pressure,
$p_u$ = (1.2 x 3 + 1.6 x 2.5 ) / 2.5 = 3.04 kips/ft

The effective depth of footing,
d = 10" - 3" (cover) - 0.25" (half of bar size) = 6.75"
The distance from critical section to the edge of the wall is
$l$ = 30/2 - 4 (half of wall)+2” = 13"
The direct shear stress at critical section is
$v_u$ = (3.04)(1000)(13/12)/(6.75*12) = 40.5 psi

The shear strength of concrete is
$v_c$ = (0.75)(2 $\sqrt{}$2500) = 75 psi > 40.5 psi O.K.

3. Design transverse reinforcement:
The distance from critical section of moment to the edge of the wall is
$l$ = 15-4 = 11"
The ultimate moment at critical section is
$M_u$ = (3.04)(11/12)2 / 2 = 1.27 k-ft/ft

Use trail method for reinforcement design
Factor $R_n$ = (1.27)(1000)(12)/[(0.9)(12)(6.75$^2$)]= 31 psi

Factor m = 60000/[(0.85)(3000)] = 23.5
The reinforcement ratio is $\rho$ = (1/23.5){1-$\sqrt{}$[1-(2)(23.5)(31)/60000]} = 0.00103
Minimum reinforcement ratio, $\rho$ = 0.0033 or $\rho$ = (4/3)*0.00103 =0.0014
Use $\rho_{min}$ =0.0014

$A_s$ = (0.0014)(8.75)(12) = 0.14 in$^2$

Use #4 at 18" spacing, $A_s$ = 0.15 in$^2$

4. Design longitudinal reinforcement

The temperature reinforcements at longitudinal direction is

$A_s$ = (0.002)(12)(2.5)(8.75) = 0.525 in2

Use 3 - #4, spacing, *As* = 0.66 in2

The footing reinforcements is as shown below.