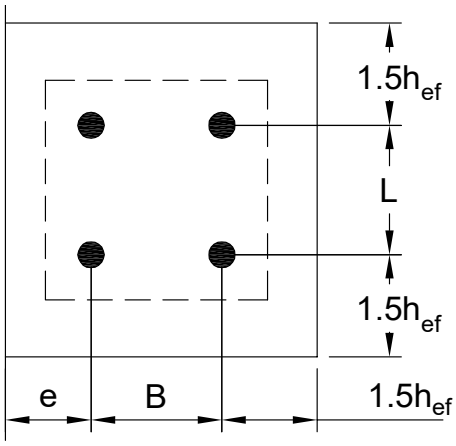
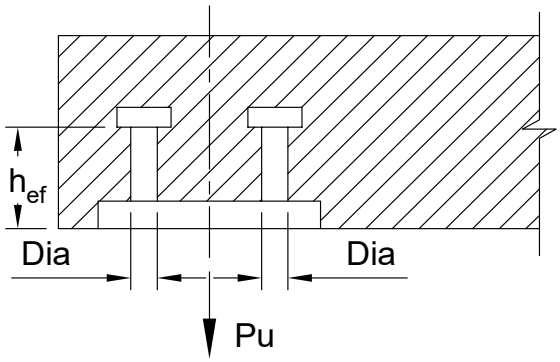
## Group of Headed Studs in Tension Near an Edge as per ACI 318-11 Appendix D




### System

| | |
|---|---|
| Spacing between Bolts along x-x, B= | 6.00 in |
| Spacing between Bolts along y-y, L= | 6.00 in |
| Distance to Edge from Nearst bolt, e= | 3.00 in |

### Load

| | |
|---|---|
| Ultimate Load, $P_u$= | 14000 lb |
| Number of Anchors, n= | 4 |

### Material Properties

| | |
|---|---|
| Concrete Strength, $f'_c$= | 4000 psi |
| Tensile Strenth of Anchor Bolt Grade, $f_{uta}$= | 60000 psi |
| Strength Reduction Factor (According to Cl.D.4.4.a of ACI318), $\Phi_1$= | 0.75 |
| Strength Reduction Factor (According to Cl.D.4.4.c of ACI318), $\Phi_2$= | 0.70 |
| Modification Factor for Lightweight Concrete, $\lambda$= | 1.00 |

### Determine Anchor Diameter

Required Effective Area of Anchor Bolt (According to Eq.D.2 of ACI318),

$$A_{se\_Req} = \frac{P_u}{\Phi_1 * n * f_{uta}} = 0.078 \text{ in}^2$$

| | | | |
|---|---|---|---|
| Provided Anchor Bolt, Dia= | SEL("ACI/Anchor"; Dia; ) | = | 0.500 in |
| Provided Area of Anchor Bolt, $A_{se\_Prov}$= | TAB("ACI/Anchor"; Ase; Dia=Dia) | = | 0.142 in$^2$ |
| Check Validity= | IF($A_{se\_Prov} \geq A_{se\_Req}$; "Valid"; "Increase Dia") | = | Valid |

### Determine Embedment Length

Assume that, $h_{ef\_Prov}$= 4.50 in

Projected Area of Failure Surface for Anchors (According to Cl.D.5.2.1 of ACI318),

$A_{nc}$= $(1.5*h_{ef\_Prov} + L + e)*(1.5*2*h_{ef\_Prov} + B)$ = 307 in$^2$

Projected Area of Failure Surface for Single Anchor (According to Cl.D.5.2.1 of ACI318),

$A_{nco}$= $9*h_{ef\_Prov}^{2}$ = 182 $in^2$

Check Validity= IF($A_{nc}$<n*$A_{nco}$; "Valid"; "Increase hef") = Valid

Factor (According to Cl.D.5.2.4 of ACI318), $\psi_{ec,N}$= 1.00

Factor (According to Cl.D.5.2.5 of ACI318), $\psi_{ed,N}$= $0.7+\frac{0.3*e}{1.5*h_{ef\_Prov}}$ = 0.83

Factor (According to Cl.D.5.2.6 of ACI318), $\psi_{c,N}$= 1.00

Factor (According to Cl.D.5.2.6 of ACI318), $\psi_{cp,N}$= 1.00

Basic Strength of Concrete Breakout (According to Eq.D-6 of ACI318),

$N_b$= $24*\lambda*\sqrt{f'c}*h_{ef\_Prov}^{1.5}$ = 14490 lb

Nominal Strength of Concrete Breakout (According to Eq.D-5 of ACI318),

$N_{cbg}$= $\frac{A_{nc}}{A_{nco}}*\psi_{ec,N}*\psi_{ed,N}*\psi_{c,N}*\psi_{cp,N}*N_b$ = 20287 lb

Check Validition= IF($P_u$< $\Phi_2$*$N_{cbg}$; "Valid"; "Increase $h_{ef}$") = Valid

**Calculation of Reqired Head Size**

Factor (According to Cl.D.5.3.6 of ACI318), $\psi_{c,P}$= 1.00

Required Head Size for Anchor Bolt (According to Eq.D-15 of ACI318),

$A_{brg}$= $\frac{Pu/n}{\Phi_2*\psi_{c,P}*8*f'c}$ = 0.156 $in^2$

**Design Summary**

Diameter of Anchor Bolt, Dia= Dia = 0.500 in

Embedment Length of Anchor Bolt, $h_{ef}$= $h_{ef\_Prov}$ = 4.50 in

Head Size of Anchor Bolt, $A_{brg}$= $A_{brg}$ = 0.156 $in^2$