

<p align="center">Design Procedure Example 1 See Figure 1</p>	<p align="center">Calculation</p>
<p>Step 1 - Determine required rod diameter</p>	
<p>Determine the required diameter of the threaded rod by setting the factored tension load equal to the design steel strength.</p>	$N_u = N_s$
<p>The effective area for the threaded rod may be taken as 75% of the gross area. As with reinforcing bars, the minimum specified yield strength of the rod is used to determine the required diameter.</p>	$N_s = \phi_s A_e f_y$ <p>Where: $\phi_s = 0.9$; $A_e = 0.75(\pi d^2 / 4)$; and $f_y = 100$ ksi</p>
<p>Substituting and solving for d:</p>	$18 = (0.9)[(\pi d^2 / 4)](100)$ $d = 0.583 \text{ in. therefore, use } 5/8''$ <p>threaded rod.</p>
<p>Step 2 - Determine required embedment length to ensure steel failure</p>	
<p>Basic equation for embedment length calculation. Since there are no edge or spacing concerns, ψ_e and ψ_{gn} may be taken as unity.</p>	$N_c = \phi_c \psi_e \psi_{gn} N_o \text{ (for embedment)}$ <p>Where: $\phi_c = 0.85$; $\psi_e, \psi_{gn} = 1.0$ (no edge/spacing concern); and $N_o = T' \pi d h_e$</p>
<p>For ductile behavior it is necessary to embed the anchor sufficiently to develop 125% of the yield strength or 100% of the ultimate strength, whichever is less.</p>	$N_c(\text{req'd}) = 1.25 A_e f_y \leq A_e f_u$
<p>Determine the effective area for a 5/8" threaded rod:</p>	$A_e = 0.75 (\pi 0.625^2 / 4)$ $A_e = 0.23 \text{ in}^2$
<p>Determine the required tension force, $N_c(\text{req'd})$, to ensure ductile behavior.</p>	$N_c(\text{req'd}) = 1.25 A_e f_y \leq A_e f_u$ $N_c(\text{req'd}) = 1.25(0.23)(100) \leq (0.23)(125)$ $N_c(\text{req'd}) = 28.75 \text{ kips} = 28.75 \text{ kips}$ <p>therefore, use $N_c(\text{req'd}) = 28.75 \text{ kips}$</p>
<p>Substituting and solving for h_e :</p>	$28.75 = 0.85 (1.0) (1.0) (1.08) \pi (.625) h_e$ $h_e = 16 \text{ in}$

Figure 1 Adhesive Anchors Design Example 1

Design Example 1 - Single Anchor Away from Edges and Other Anchors

Design an adhesive anchor using threaded rod (ASTM A193, Grade B7) for a factored tension load of 18 kips. The anchor is located more than 8 anchor diameters from edges and is isolated from other anchors. The anchor embedment length is to be sufficient to ensure steel failure.

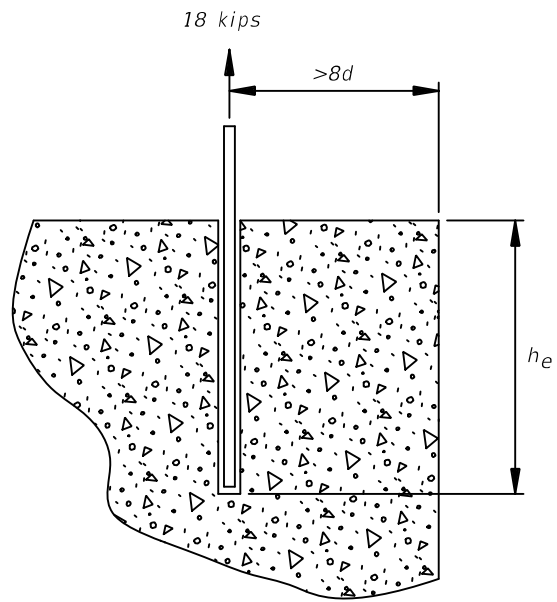
Given:

$$N_u = 18.0 \text{ kips}$$

$$f_y = 100.0 \text{ ksi}$$

$$f_u = 125.0 \text{ ksi}$$

$$T' = 1.08 \text{ ksi}$$

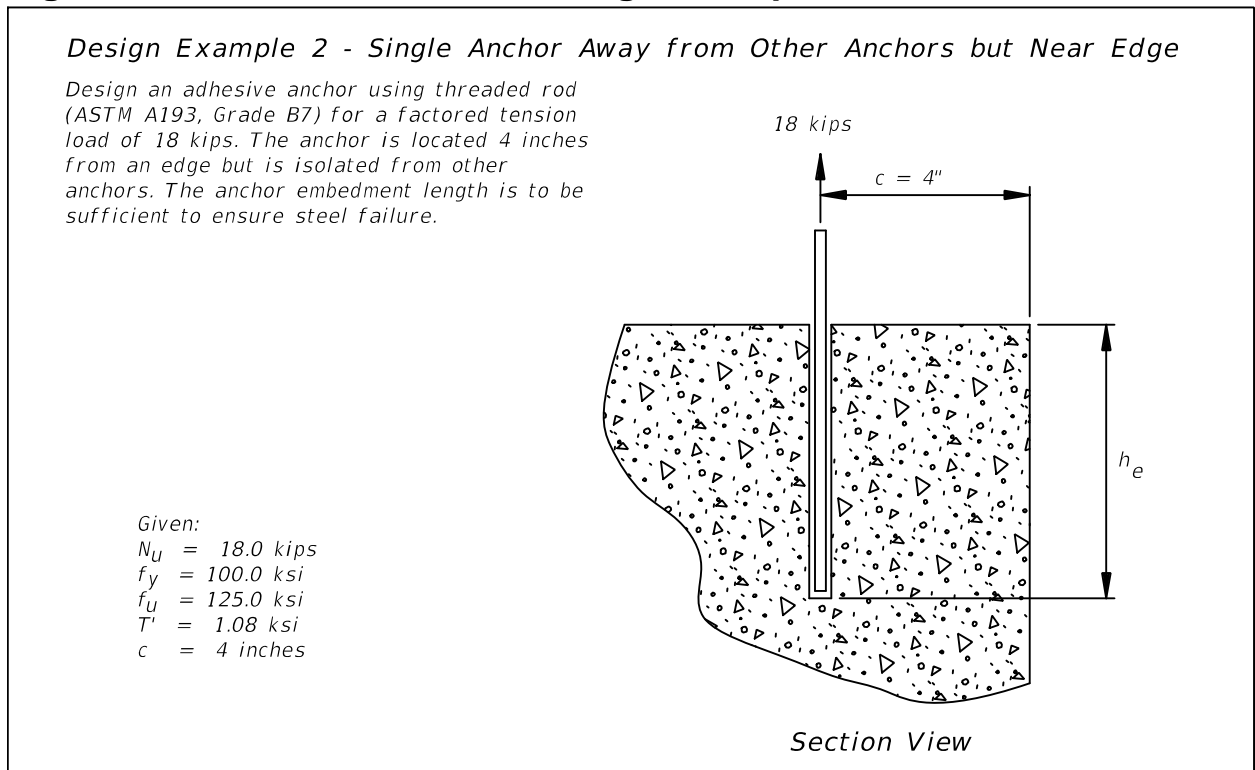


Section View

Design Procedure Example 2 See Figure 2	Calculation
Step 1 - Determine required rod diameter	
Determine the required diameter of the threaded rod by setting the factored tension load equal to the design steel strength.	$N_u = N_s$
The effective area for the threaded rod may be taken as 75% of the gross area. As with reinforcing bars, the minimum specified yield strength of the rod is used to determine the required diameter.	$N_s = \phi_s A_e f_y$ Where: $\phi_s = 0.9$; $A_e = 0.75(\pi d^2 / 4)$; and $f_y = 100$ ksi
Substituting and solving for d :	$18 = (0.9)[0.75(\pi d^2 / 4)](100)$ $d = 0.583 \text{ in. therefore, use } 5/8''$ threaded rod.
Step 2 - Determine required embedment length to ensure steel failure	
Basic equation for embedment length calculation. Since there are no spacing concerns, Ψ_{gn} may be taken as unity, and, since the edge distance (4 in) is less than $8d$ (5 in), the edge effect, Ψ_e , will need to be evaluated.	$N_c = \phi_c \Psi_e \Psi_{gn} N_o \text{ (for embedment)}$ Where: $\phi_c = 0.85$; $\Psi_{gn} = 1.0$ (no spacing concern); and $N_o = T' \pi d h_e$
For ductile behavior it is necessary to embed the anchor sufficiently to develop 125% of the yield strength or 100% of the ultimate strength, whichever is less.	$N_c(\text{req'd}) = 1.25 A_e f_y \leq A_e f_u$
Determine the effective area for a 5/8" threaded rod:	$A_e = 0.75 (\pi 0.625^2 / 4)$ $A_e = 0.23 \text{ in}^2$
Determine the required tension force, $N_c(\text{req'd})$, to ensure ductile behavior.	$N_c(\text{req'd}) = 1.25 A_e f_y \leq A_e f_u$ $N_c(\text{req'd}) = 1.25(0.23)(100) \leq (0.23)(125)$ $N_c(\text{req'd}) = 28.75 \text{ kips} = 28.75 \text{ kips}$ therefore, use $N_c(\text{req'd}) = 28.75 \text{ kips}$

Design Procedure Example 2 See Figure 2	Calculation
Determine edge effect factor, Ψ_e . Note: $C_{cr} = 8d$	$\Psi_e = 0.70 + 0.30(c/8d)$ $\Psi_e = 0.70 + 0.30[4/(8)(0.625)]$ $\Psi_e = 0.94$
Substituting and solving for h_e :	$28.75 = 0.85 (1.0) (0.94) (1.08) \pi (.625)h_e$ $h_e = 16.98 \text{ in}$

Figure 2 Adhesive Anchors Design Example 2



<p align="center">Design Procedure Example 3 See Figure 3</p>	<p align="center">Calculation</p>
<p>Step 1 - Determine required rod diameter</p>	
<p>Determine the required diameter of the threaded rod by setting the factored tension load equal to the design steel strength.</p>	$N_u = N_s$
<p>The effective area for the threaded rod may be taken as 75% of the gross area. As with reinforcing bars, the minimum specified yield strength of the rod is used to determine the required diameter.</p>	$N_s = \phi_s A_e f_y$ <p>Where:</p> $\phi_s = 0.9 ; A_e = (2)0.75(\pi d^2 / 4);$ <p>and $f_y = 100$ ksi</p>
<p>Substituting and solving for d:</p>	$18 = (0.9)(2)[0.75(\pi d^2 / 4)](100)$ $d = 0.412 \text{ in.}$ <p>Although a 1/2" threaded rod is OK, use 5/8" threaded rod to minimize embedment length.</p>
<p>Design steel strength</p>	$N_s = (0.9)(2)[0.75(\pi d^2 / 4)](100)$ $N_s = 41.4 \text{ kips} > 18 \text{ kips}$ <p>therefore: OK</p>
<p>Step 2 - Determine required embedment length</p>	
<p>Basic equation for embedment length calculation. Since there are edge or spacing concerns, ψ_e and ψ_{gn} will need to be determined.</p>	$N_c = \phi_c \psi_e \psi_{gn} N_o \text{ (for embedment)}$ <p>Where: $\phi_c = 0.85$;</p> <p>ψ_e and ψ_{gn} are calculated below; and</p> $N_o = T' \pi d h_e$
<p>Determine edge effect factor, ψ_e.</p>	$\psi_e = 0.70 + 0.30(c / 8d)$ $\psi_e = 0.70 + 0.30[4 / (8)(0.625)]$ $\psi_e = 0.94$
<p>Determine group effect factor, ψ_{gn}.</p>	$\psi_{gn} = A_n / A_{no}$ $\psi_{gn} = (4 + 8d)[8 + 2(8d)] / (16d)^2$ $\psi_{gn} = (4 + 8(0.625))[8 + 2(8)(0.625)] / 16(0.625)^2$ $\psi_{gn} = 1.62$

Design Procedure Example 3 See Figure 3	Calculation
Substituting and solving for h_e :	$18 = 0.85 (1.62) (0.94) (1.08) \pi (.625) h_e$ $h_e = 6.55 \text{ in (say 7")}$ therefore: OK
Design adhesive bond strength.	$N_c = (0.85)(1.62)(0.94)(1.08)\pi(0.625)(7)$ $N_c = 19.21 > 18$ therefore: OK
Step 3 - Final Design Strength	
Strength as controlled by steel.	$N_s = 41.4 \text{ kips} > 18 \text{ kips}$ therefore: OK
Strength as controlled by adhesive bond.	$N_c = 19.21 \text{ kips} > 18 \text{ kips}$ therefore: OK
Final Design.	Two 5/8" anchors embedded 7 in.

Figure 3 Adhesive Anchors Design Example 3

Design Example 3 - Two Anchors Spaced at 8 inches, 4 inches from Edge

Design a group of two adhesive anchors using threaded rod (ASTM A193, Grade B7) for a factored tension load of 18 kips. The anchors are located 4 inches from an edge and are spaced 8 inches apart. Steel failure is not required.

Given:

$$N_U = 18.0 \text{ kips}$$

$$f_y = 100.0 \text{ ksi}$$

$$f_U = 125.0 \text{ ksi}$$

$$T' = 1.08 \text{ ksi}$$

$$c = 4 \text{ inches}$$

$$s = 8 \text{ inches}$$

