## Design Procedure Example 1

### See Figure 1

<table>
<thead>
<tr>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1 - Determine required rod diameter</strong></td>
</tr>
<tr>
<td>Determine the required diameter of the threaded rod by setting the factored tension load equal to the design steel strength.</td>
</tr>
<tr>
<td>( N_u = N_s )</td>
</tr>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>
| \( N_s = \phi_s A_e f_y \)  
Where:  
\( \phi_s = 0.9 \); \( A_e = 0.75(\pi d^2 / 4) \); and \( f_y = 100 \text{ ksi} \) |
| Substituting and solving for \( d \): |
| \( 18 = (0.9)\left[(\pi d^2 / 4)\right](100) \)  
\( d = 0.583 \text{ in.} \) 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 edge or spacing concerns, \( \psi_e \) and \( \psi_{gn} \) may be taken as unity. |
| \( N_c = \phi_c \psi_e \psi_{gn} N_o \) (for embedment)  
Where:  
\( \phi_c = 0.85 \);  
\( \psi_e, \psi_{gn} = 1.0 \) (no edge-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 \( N_c(\text{req'd}) = 28.75 \text{kips} \) |
| Substituting and solving for \( h_e \): |
| \( 28.75 = 0.85 (1.0) (1.0) (1.08) \pi (0.625) h_e \)  
\( h_e = 16 \text{ in} \) |
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:
- $N_{d1} = 18.0$ kips
- $f_y = 100.0$ ksi
- $f_{d1} = 125.0$ ksi
- $T' = 1.08$ ksi
## 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, $\Psi_{gn}$ may be taken as unity, and, since the edge distance (4 in) is less than $8d$ (5 in), the edge effect, $\Psi_e$, will need to be evaluated.

$N_c = \phi_c \Psi_e \Psi_{gn} N_o$ (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.

$N_c(req'd) = 1.25 A_e f_y \leq A_e f_u$

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, $N_c(req'd)$, to ensure ductile behavior.

$N_c(req'd) = 28.75 \text{ kips} = 28.75 \text{ kips}$

therefore, use $N_c(req'd) = 28.75 \text{ kips}$
### Design Procedure Example 2

**See Figure 2**

<table>
<thead>
<tr>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\psi_e = 0.70 + 0.30(c/8d)$</td>
</tr>
<tr>
<td>$\psi_e = 0.70 + 0.30[4/(8)(0.625)]$</td>
</tr>
<tr>
<td>$\psi_e = 0.94$</td>
</tr>
</tbody>
</table>

**Determine edge effect factor, $\psi_e$.**

Note: $C_{cr} = 8d$

**Substituting and solving for $h_e$:**

$$28.75 = 0.85 \times 0.94 \times 1.08 \times 0.625 \times h_e$$

$$h_e = 16.98 \text{ in}$$

### Figure 2   Adhesive Anchors Design Example 2

**Design Example 2 - Single Anchor Away from Other Anchors but Near Edge**

Design an adhesive anchor using threaded rod (ASTM A193, Grade B7) for a factored tension load of 18 kips. The anchor is located 4 inches from an edge but is isolated from other anchors. The anchor embedment length is to be sufficient to ensure steel failure.

![Diagram of Design Example 2](image)

**Given:**

- $N_u = 18.0 \text{ kips}$
- $f_y = 100.0 \text{ ksi}$
- $f_u = 125.0 \text{ ksi}$
- $T = 1.08 \text{ ksi}$
- $c = 4 \text{ inches}$

**Section View**
### Design Procedure Example 3
**See Figure 3**

#### 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.

<table>
<thead>
<tr>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>( N_u = N_s )</td>
</tr>
</tbody>
</table>

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:
\[
\phi_s = 0.9; \quad A_e = (2)0.75(\pi d^2/4);
\]

and \( f_y = 100 \text{ ksi} \)

Substituting and solving for \( d \):

\[
18 = (0.9)(2)[0.75(\pi d^2/4)](100)
\]

\( d = 0.412 \text{ in.} \) Although a 1/2" threaded rod is OK, use 5/8" threaded rod to minimize embedment length.

Design steel strength

\[
N_s = (0.9)(2)[0.75(\pi d^2/4)](100)
\]

\( N_s = 41.4 \text{ kips} > 18 \text{ kips} \)

therefore: OK

#### Step 2 - Determine required embedment length

Basic equation for embedment length calculation. Since there are edge or spacing concerns, \( \psi_e \) and \( \chi_{gn} \) will need to be determined.

<table>
<thead>
<tr>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>( N_c = \phi_c \psi_e \chi_{gn} N_o ) (for embedment)</td>
</tr>
</tbody>
</table>

Where:
\[
\phi_c = 0.85;
\]

\( \psi_e \) and \( \chi_{gn} \) are calculated below; and \( N_o = T \pi d h_e \)

Determine edge effect factor, \( \psi_e \).

\[
\psi_e = 0.70 + 0.30(c/8d)
\]

\( \psi_e = 0.70 + 0.30[4/(8)(0.625)] \)

\( \psi_e = 0.94 \)

Determine group effect factor, \( \chi_{gn} \).

\[
\psi_{gn} = A_n / A_{no}
\]

\[
\psi_{gn} = (4+8d)[8+2(8d)]/(16d)^2
\]

\[
\psi_{gn} = (4+8(0.625))[8+2(8)(0.625)]/(16(0.625)^2)
\]

\( \psi_{gn} = 1.62 \)
### Design Procedure Example 3

**See Figure 3**

| Calculation | Substituting and solving for $h_e$: $18 = 0.85 \times (1.62) \times (0.94) \times (1.08) \times \pi \times (0.625) \times h_e$  
$h_e = 6.55\text{ in.} \ (\text{say} \ 7\text{”})$  
therefore: OK |
| --- | --- |
| Design adhesive bond strength. | $N_c = (0.85) \times (1.62) \times (0.94) \times (1.08) \times \pi \times (0.625) \times (7)$  
$N_c = 19.21 \times 18 \times \text{therefore: OK}$ |

### Step 3 - Final Design Strength

| Strength as controlled by steel. | $N_s = 41.4\text{ kips} > 18\text{ kips} \ \text{therefore: OK}$ |
| Strength as controlled by adhesive bond. | $N_c = 19.21\text{ kips} > 18\text{ kips} \ \text{therefore: OK}$ |
| Final Design. | Two 5/8" anchors embedded 7 in. |
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:
- $N_u = 18.0$ kips
- $f_y = 100.0$ ksi
- $f_u = 125.0$ ksi
- $T' = 1.08$ ksi
- $c = 4$ inches
- $s = 8$ inches