24-5 HUB MOMENTS

The moments used in determining hub stresses are the products of loads and moment arms illustrated in Figure 24-1 and defined in 24-3.

In addition, reaction moments due to hub eccentricities and bearing pressure are considered.

For the operating condition, the design moment $M_o$ is the sum of six individual moments: $M_D$, $M_C$, $M_T$, $M_F$, $M_P$, and $M_R$. The bolt load $W$ used is that from eq. 24-4(d)(4).

For assembly, the design moment $M_o$ is based on the design bolt load of eq. 24-4(d)(5):

$$M_o = \frac{0.785W(C-G)}{\tan(\phi + \mu)}$$

(7)

24-6 CALCULATION OF HUB STRESSES

The stresses in the hub shall be determined for both the operating and the assembly condition.

(a) The reaction moment $M_H$ and the reaction shear $Q$ are defined in 24-3 and shall be calculated at the hub neck for rotational moment $M_o$.

(b) Hub stresses shall be calculated from the following equations:

Hub longitudinal stress

$$S_1 = f\left[\frac{PB^2}{4g_1(B+g_1)} + \frac{1.91M_H}{g_1^2(B+g_1)}\right]$$

(8)

Hub hoop stress

$$S_2 = P\left(\frac{N^2 + B^2}{N^2 - B^2}\right)$$

(9)

Hub axial shear stress

$$S_3 = \frac{0.775W}{T(B+2g_1)\tan Z}$$

(10)

Hub radial shear stress

$$S_4 = \frac{0.477Q}{g_1(B+g_1)}$$

(11)

24-7 CALCULATION OF CLAMP STRESSES

The stresses in the clamp shall be determined for both the operating and the assembly conditions. Clamp stresses shall be calculated from the following equations:

Clamp longitudinal stress

$$S_5 = \frac{W}{2C\tan Z}\left[\frac{1}{C_t} + \frac{3(C_t + 2m)}{C_t^2}\right]$$

(12)

Clamp tangential stress

$$S_6 = \frac{W}{2}\left[\frac{1}{A_c} + \frac{1}{l_c}\left(C_t - X\right)\right]$$

(13)

Clamp lip shear stress

$$S_7 = \frac{1.5W}{(C_w - C_o)C\tan Z}$$

(14)

Clamp lug bending stress

$$S_8 = \frac{3W - L_q}{L_{w,h}^2}$$

(15)

In addition, a bearing stress calculation shall be made at the clamp-to-hub contact by eq. (16):

$$S_9 = \frac{W}{(A - C_t)C\tan Z}$$

(16)

24-8 ALLOWABLE DESIGN STRESSES FOR CLAMP CONNECTIONS

Table 24-8 gives the allowable stresses that are to be used with the equations of 24-6 and 24-7.

<table>
<thead>
<tr>
<th>Stress Category</th>
<th>Allowable Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_1$</td>
<td>1.5 $S_{OH}$ or 1.5 $S_{AH}$</td>
</tr>
<tr>
<td>$S_2$</td>
<td>$S_{OH}$</td>
</tr>
<tr>
<td>$S_3$</td>
<td>0.8 $S_{OH}$ or 0.8 $S_{AH}$</td>
</tr>
<tr>
<td>$S_4$</td>
<td>0.8 $S_{OH}$ or 0.8 $S_{AH}$</td>
</tr>
<tr>
<td>$S_5$</td>
<td>1.5 $S_{OC}$ or 1.5 $S_{AC}$</td>
</tr>
<tr>
<td>$S_6$</td>
<td>1.5 $S_{OC}$ or 1.5 $S_{AC}$</td>
</tr>
<tr>
<td>$S_7$</td>
<td>0.8 $S_{OC}$ or 0.8 $S_{AC}$</td>
</tr>
<tr>
<td>$S_8$</td>
<td>$S_{OC}$ or $S_{AC}$</td>
</tr>
<tr>
<td>$S_9$</td>
<td>[Note (1)]</td>
</tr>
</tbody>
</table>

NOTE:

(1) 1.6 times the lower of the allowable stresses for hub material ($S_{OH}$, $S_{AH}$) and clamp material ($S_{OC}$, $S_{AC}$).
24-5 HUB MOMENTS

The moments used in determining hub stresses are the products of loads and moment arms illustrated in Fig. 24-1 and defined in 24-3.

In addition, reaction moments due to hub eccentricities and bearing pressure are considered.

For the operating condition, the design moment \( M_n \) is the sum of six individual moments: \( M_D, M_G, M_T, M_F, M_P, \) and \( M_R \). The bolt load \( W \) used is that from eq. (4).

For assembly, the design moment \( M_n \) is based on the design bolt load of eq. (5):

\[
M_n = \frac{0.785 \ W(C - G)}{\tan (\phi + \mu)}
\]  

24-6 CALCULATION OF HUB STRESSES

The stresses in the hub shall be determined for both the operating and the assembly condition.

(a) The reaction moment \( M_H \) and the reaction shear \( Q \) are defined in 24-3 and shall be calculated at the hub neck for rotational moment \( M_n \).

(b) Hub stresses shall be calculated from the following equations:

Hub longitudinal stress

\[
S_1 = \frac{P B^2}{8 g_1 (B + g_1)} + \frac{1.91 M_H}{g_1 (B + g_1)}
\]

(8)

Hub hoop stress

\[
S_2 = P \left( \frac{N^2 + B^2}{N^2 - B^2} \right)
\]

(9)

Hub axial shear stress

\[
S_3 = \frac{0.75 \ W}{g_1 (B + g_1) \ tan Z}
\]

(10)

Hub radial shear stress

\[
S_4 = \frac{0.477 \ Q}{g_1 (B + g_1)}
\]

(11)

24-7 CALCULATION OF CLAMP STRESSES

The stresses in the clamp shall be determined for both the operating and the assembly conditions. Clamp stresses shall be calculated from the following equations:

Clamp longitudinal stress

\[
S_3 = \frac{W}{2 \ tan Z} \left[ \frac{1}{C_1} + \frac{3(C_1 + 2 l_m)}{C_1^2} \right]
\]

(12)

Clamp tangential stress

\[
S_6 = \frac{W}{2} \left[ \frac{1}{A_c} + \frac{\epsilon_d (C_1 - X)}{l_c} \right]
\]

(13)

Clamp lip shear stress

\[
S_7 = \frac{1.5 \ W}{(C_2 - C_3) \ C \ tan Z}
\]

(14)

Clamp lug bending stress

\[
S_8 = 3 \frac{W \ l_m}{l_m l_n^2}
\]

(15)

In addition, a bearing stress calculation shall be made at the clamp-to-hub contact by eq. (15):

\[
S_9 = \frac{W}{(A - C) \ C \ tan Z}
\]

(16)

24-8 ALLOWABLE DESIGN STRESSES FOR CLAMP CONNECTIONS

Table 24-8 gives the allowable stresses that are to be used with the equations of 24-6 and 24-7.