Embragues, frenos, coples y volantes de inercia

Embragues y frenos de tambor de expansión interna

$$M_f = \frac{f p_a b r}{\sin(\theta_a)} \int_{\theta_1}^{\theta_2} \sin(\theta)(r - a\cos(\theta))\, d\theta$$
$$M_n = \frac{p_a b r a}{\sin(\theta_a)} \int_{\theta_1}^{\theta_2} \sin^2(\theta)\, d\theta$$

$$A = \int_{\theta_1}^{\theta_2} \sin(\theta)\cos(\theta)\, d\theta = \left(\frac{1}{2}\sin^2(\theta)\right)\Big|_{\theta_1}^{\theta_2}$$
$$B = \int_{\theta_1}^{\theta_2} \sin^2(\theta)\, d\theta = \left(\frac{\theta}{2} - \frac{1}{4}\sin(2\theta)\right)\Big|_{\theta_1}^{\theta_2}$$

$$T = \frac{f p_a b r^2(\cos(\theta_1) - \cos(\theta_2))}{\sin(\theta_a)}$$

Caso I (fuerza $\rightarrow$ pasador)

$$F = \frac{M_n - M_f}{c}$$

$$R_x = \frac{p_a b r}{\sin(\theta_a)}(A - fB) - F_x$$
$$R_y = \frac{p_a b r}{\sin(\theta_a)}(B + fA) - F_y$$

Caso II (pasador $\rightarrow$ fuerza)

$$F = \frac{M_n + M_f}{c}$$

$$R_x = \frac{p_a b r}{\sin(\theta_a)}(A + fB) - F_x$$
$$R_y = \frac{p_a b r}{\sin(\theta_a)}(B - fA) - F_y$$

Embragues y frenos de contracción externa

$$M_f = \frac{f p_a b r}{\sin(\theta_a)} \int_{\theta_1}^{\theta_2} \sin(\theta)(r - a\cos(\theta))\, d\theta$$
$$M_n = \frac{p_a b r a}{\sin(\theta_a)} \int_{\theta_1}^{\theta_2} \sin^2(\theta)\, d\theta$$

$$A = \int_{\theta_1}^{\theta_2} \sin(\theta)\cos(\theta)\, d\theta = \left(\frac{1}{2}\sin^2(\theta)\right)\Big|_{\theta_1}^{\theta_2}$$
$$B = \int_{\theta_1}^{\theta_2} \sin^2(\theta)\, d\theta = \left(\frac{\theta}{2} - \frac{1}{4}\sin(2\theta)\right)\Big|_{\theta_1}^{\theta_2}$$

$$T = \frac{f p_a b r^2(\cos(\theta_1) - \cos(\theta_2))}{\sin(\theta_a)}$$

Caso I (fuerza $\rightarrow$ pasador)

$$F = \frac{M_n + M_f}{c}$$

$$R_x = \frac{p_a b r}{\sin(\theta_a)}(A + fB) - F_x$$
$$R_y = \frac{p_a b r}{\sin(\theta_a)}(fA - B) + F_y$$

Caso II (pasador $\rightarrow$ fuerza)

$$F = \frac{M_n - M_f}{c}$$

$$R_x = \frac{p_a b r}{\sin(\theta_a)}(A - fB) - F_x$$
$$R_y = \frac{p_a b r}{\sin(\theta_a)}(-fA - B) + F_y$$

Embragues y frenos de banda

$$\frac{P_1}{P_2} = e^{f\phi}$$

$$T = (P_1 - P_2)\frac{D}{2}$$

$$p = \frac{P}{br} = \frac{2P_1}{bD}$$

Embragues axiales de fricción de contacto

Desgaste uniforme

$$F = \frac{\pi p_a d}{2}(D - d)$$

$$T = \frac{\pi f p_a d}{8}(D^2 - d^2)$$

$$T = \frac{Ff}{4}(D + d)$$

Presión uniforme

$$F = \frac{\pi p_a}{4}(D^2 - d^2)$$

$$T = \frac{\pi f p}{12}(D^3 - d^3)$$

$$T = \frac{Ff}{3}\frac{D^3 - d^3}{D^2 - d^2}$$

Frenos de disco

Desgaste uniforme

$$F = (\theta_2 - \theta_1) p_a r_i (r_o - r_i)$$

$$T = \frac{1}{2}(\theta_2 - \theta_1) f p_a r_i ({r_o}^2 - {r_i}^2)$$

$$r_e = \frac{r_o + r_i}{2}$$

$$\bar{r} = \frac{\cos(\theta_1) - \cos(\theta_2)}{\theta_2 - \theta_1} \frac{r_o + r_i}{2}$$

Presión uniforme

$$F = \frac{1}{2}(\theta_2 - \theta_1) p_a ({r_o}^2 - {r_i}^2)$$

$$T = \frac{1}{3}(\theta_2 - \theta_1) f p_a ({r_o}^3 - {r_i}^3)$$

$$r_e = \frac{2}{3} \frac{{r_o}^3 - {r_i}^3}{{r_o}^2 - {r_i}^2}$$

$$\bar{r} = \frac{2}{3} \frac{{r_o}^3 - {r_i}^3}{{r_o}^2 - {r_i}^2} \frac{\cos(\theta_1) - \cos(\theta_2)}{\theta_2 - \theta_1}$$

Freno de yugo de zapata circular (de botón o de disco)

$$r_e = \delta e$$

$$F = \pi R^2 p_{prom}$$

$$T = fFr_e$$

Embragues y frenos cónicos

Desgaste uniforme

$$F = \frac{\pi p_a d}{2}(D - d)$$

$$T = \frac{\pi f p_a d}{8\sin(\alpha)}(D^2 - d^2)$$

$$T = \frac{Ff}{4\sin(\alpha)}(D + d)$$

Presión uniforme

$$F = \frac{\pi p_a}{4}(D^2 - d^2)$$

$$T = \frac{\pi f p_a}{12\sin(\alpha)}(D^3 - d^3)$$

$$T = \frac{Ff}{3\sin(\alpha)}\frac{D^3 - d^3}{D^2 - d^2}$$