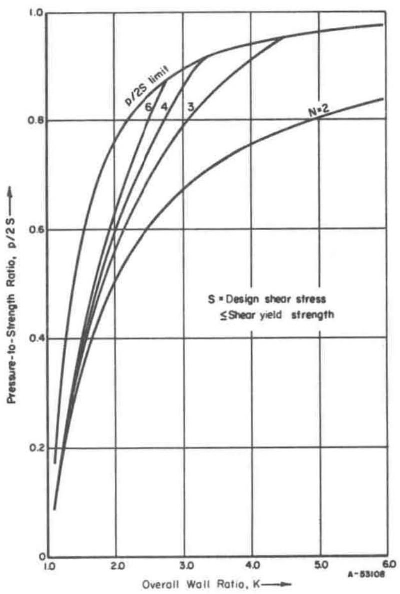

FIGURE 43. MAXIMUM PRESSURE-TO-STRENGTH RATIO, p/2S, IN MULTIRING CONTAINER DESIGNED ON BASIS OF STATIC-SHEAR STRENGTH

Each ring is assumed to be of the same ductile material.

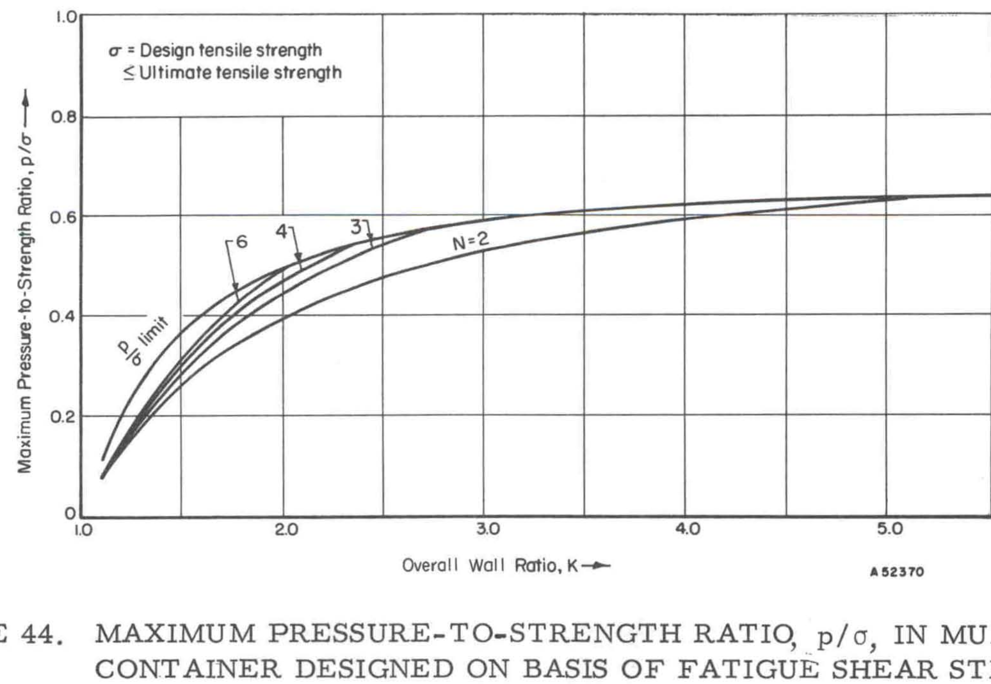

FIGURE 44. MAXIMUM PRESSURE-TO-STRENGTH RATIO, p/σ, IN MULTIRING CONTAINER DESIGNED ON BASIS OF FATIGUE SHEAR STRENGTH

Each ring is assumed to be of the same ductile material.

The stress range parameter α_r depends on the mean stress parameter α_m. The mean stress depends not only on the bore pressure p but on the interface pressures p_1 and q_1 between the liner and the second cylinder. The magnitudes of p_1 and q_1 that are possible depend upon the geometry and strength of the outer cylinders.

The outer rings are assumed to be all made of the same ductile material. Conducting a fatigue-shear-strength analysis of a multiring container having a pressure fluctuating between q_1 and p_1, we find from a method similar to that used in arriving at Equation (39) (using Equation (37) for n = 2, 3, . . . , N-1), that in this case also the optimum design has

$$k_2 = k_3 = \ldots = k_n \tag{45}$$

Calculating the mean stress σ_m at the bore of the liner, equating $\alpha_m \sigma_1$ to σ_m from Equation (10b), substituting for q_1 from Equation (32), eliminating σ_1 by use of Equation (44), and solving for p_1, one finds

$$p_1 = \frac{p}{K^2 - 1} \left[\frac{K^2 - k_1^2}{k_1^2} + \frac{(K^2 + 1)}{4} \quad \frac{(k_1^2 - 1)}{k_1^2} \quad \frac{(\alpha_r - \alpha_m)}{\alpha_r} \right] \tag{46}$$

The other interface pressures p_n, $n \geq 2$ are again given by Equation (38). Eliminating the pressures p_1 and p_n, $n \geqq 2$ from Equations (46) and (38), and solving for the pressure-to-strength ratio p/σ, one gets

$$\frac{p}{\sigma} = \frac{2(K^2 - 1)\,(k_n^2 - 1)\,(N-1)\,k_1^2\,\alpha_r}{k_n^2\,[5(K^2 - k_1^2)\alpha_r + (\alpha_r - \alpha_m)\,(K^2 + 1)\,(k_1^2 - 1)]} \tag{47}$$

The k_n, $n \geqq 2$ in Equation (47) are equal as shown by Equation (45). Whereas, p/σ_1 depended only upon α_r and K (Equation (44)), p/σ depends on N, k_n, and α_m in addition.

The ratio p/σ can also be limited by the requirement on Relations (7) and (9) that the mean shear stress S_m in Cylinder 2 at r_1 obeys the relation $S_m \geqq 0$. $S_m \geqq 0$ gives

$$\left(\frac{p}{\sigma}\right)_{limit} = \frac{2}{3} \frac{(K^2 - 1)}{K^2} \quad k_1^2 \tag{48}$$

As is evident from the limit curves plotted in Figure 46, the pressure limit for the outer rings can be increased by increasing k_1. This means that the liner has a great effect on p. The strength of the liner, σ_1, influences p in Equation (44). The size of the liner, k_1, limits p in Equation (48).

Whether or not p/σ can be allowed as high as the limit, however, depends on the other factors N, α_r, K, etc., as shown by Equation (47). This dependence is rather complicated. Example curves of p/σ are plotted in Figures 47 and 48 for $\alpha_r = 0.5$ and $\alpha_m = -0.5$. As shown by these curves p/σ increases with N and also increases with k_1 for N = 5, $K \geqq 6.5$.