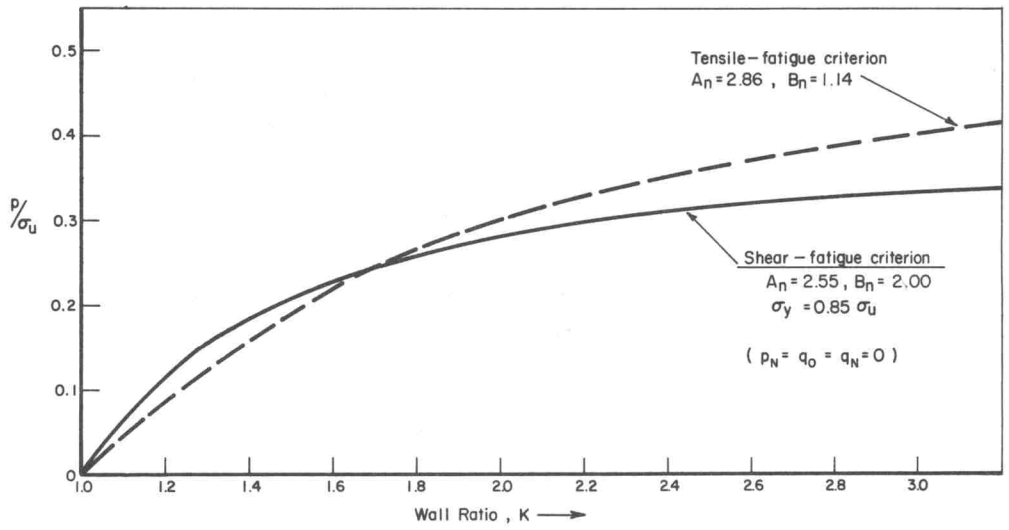

FIGURE 64. PRESSURE-TO-STRENGTH RATIOS FOR SINGLE-RING CONTAINER FOR 10^6-10^7 CYCLES LIFE

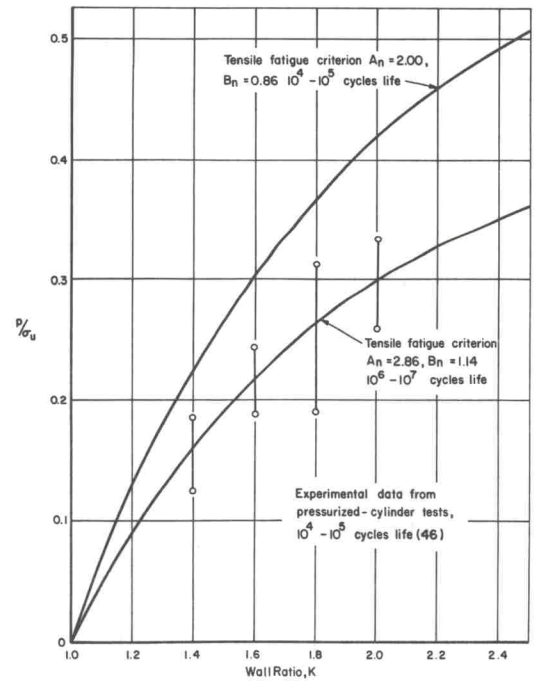

FIGURE 65. COMPARISON OF THEORY AND EXPERIMENT FOR SINGLE-RING CONTAINERS

containers for bore pressures $250,000 \leq p_o \leq 450,000$ psi depends upon the validity of the postulated tensile-fatigue criterion.

In Figure 65 a comparison of the theory based on the tensile criterion is made with experimental data of Reference (46). The data from Reference (46) are for 4340 steel with ultimate tensile strength $\sigma_u = 160,000$ psi. Unfortunately, the experiments were run only for lifetimes up to 10^5 cycles. The comparison, Figure 65 shows that the theory predicts a too high pressure capability in this case. If the theory derived for high-strength steels is valid for the lower strength 4340 steel, then Figure 65 indicates that a cylinder designed for 10^6-10^7 cycles life would actually fail earlier at 10^4-10^5 cycles. This may result from the detrimental effect of fluid entering voids in the materials under pressure. It is expected that large compressive prestresses from shrink-fit in multiring units will prevent this detrimental effect. This expectation needs to be investigated experimentally.

When design pressures are low enough, the more conservative shear criterion should be used. In some cases the tensile criterion can be used for an inner ring and the shear criterion for outer rings as described earlier and in Example Design 2 discussed below.

Example Designs of Containers

The design of the multiring components of the ring-fluid-ring container require not only calculation of required diameters and interferences but also due consideration of the feasibility of manufacture and assembly. Excessive size and interference requirements will render a design impracticable. Calculations are described here, using computer code MULTIR, for two example designs. The diameter and interference requirements are listed so that they may be used as a basis for judging the feasibility of manufacture. Calculations are performed for 6-inch-diameter-bore designs. A larger design, with a 15-inch-bore diameter, is then considered by scaling up the diameter and interference requirements for the smaller design.

Example Design 1

A two-unit, multiring container is analyzed based entirely on the tensile-fatigue-strength criterion. The inner unit consists of only one ring. The data for the inner unit are as follows:

$$\begin{aligned} &\text{wall ratio, } K = 1.5 \\ &\text{inner radius, } r_o = 3.0 \text{ in.} \\ &\text{outer radius, } r_1 = 4.5 \text{ in.} \\ &\text{design tensile strength, } \sigma_1 = 300,000 \text{ psi} \\ &\text{maximum internal bore pressure, } p_o = 450,000 \text{ psi} \\ &\text{minimum internal bore pressure, } q_o = 0 \ . \end{aligned} \tag{86}$$

It is assumed that

$$(\sigma_\theta)_r \cong 1/3\, \sigma_1 \tag{87}$$