Graph axes and labels:
- Y-axis: Pressure-to-Strength Ratio, p/σ → (range 0.8 to 1.6)
- X-axis: Overall Wall Ratio, K → (range 4.0 to 9.0)
- Legend: Liner wall ratio, k_l
- Curve labels: 2.0, 1.75, 1.5

Inset text:
N = 5 rings
$\alpha_r = 0.5$
$\alpha_m = -0.5$ } Fatigue parameters
σ = Design tensile stress of outer rings
≤ Ultimate tensile strength

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FIGURE 15.   INFLUENCE OF LINER SIZE ON MAXIMUM PRESSURE-TO-STRENGTH RATIO, p/σ, IN MULTI-RING CONTAINER WITH HIGH-STRENGTH LINER

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The interferences Δ_n required between the outer cylinders is again given by Equation (36) for $n \geq 2$. The residual pressures q_n needed in calculating the Δ_n are found from Equation (35) for p_n given by Equations (49) and (41). In the calculation of the u_n from Equation (17a), the values of the moduli of elasticity, E_n at temperature should be used.

The container designed for use at temperature will have residual pressures q_n^* at room temperature different from the q_n necessary at temperature. The q_n^* are found as follows: the u_n^* are first expressed in terms of q_n^* from Equation (17a) using the values of E_n at room temperature, the Δ_n are expressed in terms of the u_n^* from Equations (52) and (36) for $\Delta T = 0$. This procedure gives the following system of equations in the q_n^*:

$$A_{11}q_1^* + A_{12}q_2^* = E_2 \frac{\Delta_1}{r_1}$$

$$A_{nn-1}q_{n-1}^* + A_{nn}q_n^* + A_{nn+1}q_{n+1}^* = E_n\frac{\Delta_n}{r_n}, \quad n = 2, 3, \ldots, N-1 \tag{53a, b, ..}$$

where

$$A_{11} = \frac{k_2^2 + 1}{k_2^2 - 1} + \nu + \frac{E_2}{E_1}\left(\frac{k_1^2 + 1}{k_1^2 - 1} - \nu\right)$$

$$A_{12} = \frac{-2k_2^2}{k_2^2 - 1}$$

$$A_{nn-1} = \frac{-2}{k_n^2 - 1}$$

$$A_{nn} = \frac{k_n^2 + 1}{k_n^2 - 1} + \frac{k_{n+1}^2 + 1}{k_{n+1}^2 - 1} = 2\frac{k_n^2 + 1}{k_n^2 - 1}$$

$$A_{nn+1} = \frac{-2k_{n+1}^2}{k_{n+1}^2 - 1} = -2\frac{k_n^2}{k_n^2 - 1}$$

and where Δ_1 and the Δ_n, $n \geq 2$ have been previously calculated for $\Delta T \neq 0$. There are N-1 linear equations (53a, b, ...) in N-1 unknowns q_n, $n = 1, 2, \ldots, N-1$ ($Q_N = 0$). These are easily solved by matrix solution on the computer.

Having calculated the residual pressures q_n^* at room temperature the residual stresses can be calculated from Equations (16a, b). These residual stresses can then be checked in order to assure that they are within tolerated bounds. Examples of such calculations are described later when specific designs are considered. Next, the ring-segment container is considered.