element, was approximately 1 percent in the pressure measuring system and 4 per cent in the strain measurement circuit.

Test Procedure

As previously stated, all the data in this study was obtained from cylinders laterally supported by restraining containers during autofrettage. The predicted percent bore enlargement was controlled by the outside diameter of the specimen, thus controlling the subsequent expansion of each specimen. In order to determine when the desired percent overstrain was obtained, the container was strain gaged using SR-4 type, A-7 gages tangentially directed and diametrically opposed at intervals along the length of the container. When a small, but substantial reading (generally between 100 and 200 μin./in.), was obtained on all container gages, it was assumed that the specimen had uniformly contacted the container and uniform plastic flow achieved.

Strain readings from the 2 tangential gages on the midsection of the specimen were recorded at appropriate intervals of induced internal pressure. From these data, plots of internal pressure vs. outside surface strain from both tangential strain gages were made for increasing and decreasing pressure. On a few tests, longitudinal strain was measured by using longitudinally oriented strain gages.

Physical dimensions of the bore, external diameter, and length were measured, before and after autofrettage, utilizing screw micrometers and dial bore gages to an accuracy of $\pm$ 0.0002 in.

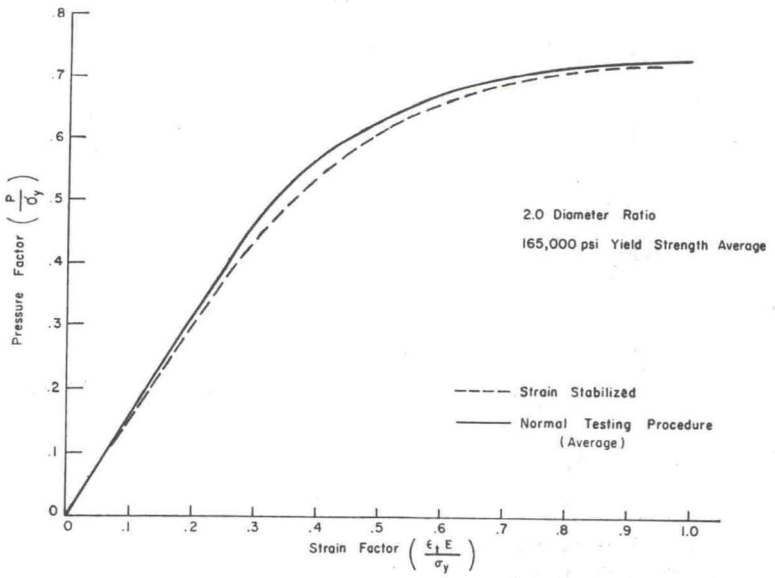

FIG. 5. Pressure factor vs. strain factor showing effect of strain stabilization.

Z

During the tests, the delay or "stabilization" period for the measurement of the increment of strain produced by a pressure change was maintained at approximately 30 sec per reading. Some specimens were tested, however, allowing complete strain "stabilization" at each pressure increment. As shown in Fig. 5, the use of the 30 sec "stabilization" period did not significantly change the results as derived from the pressure-strain data and it allowed the testing of a large number of cylinders in a limited period of time.

RESULTS AND DISCUSSION

End condition Analysis

In the pressure seal configuration utilized, the seal was not mechanically fixed to the tube or cylinder. However, since the steel ring moves up the

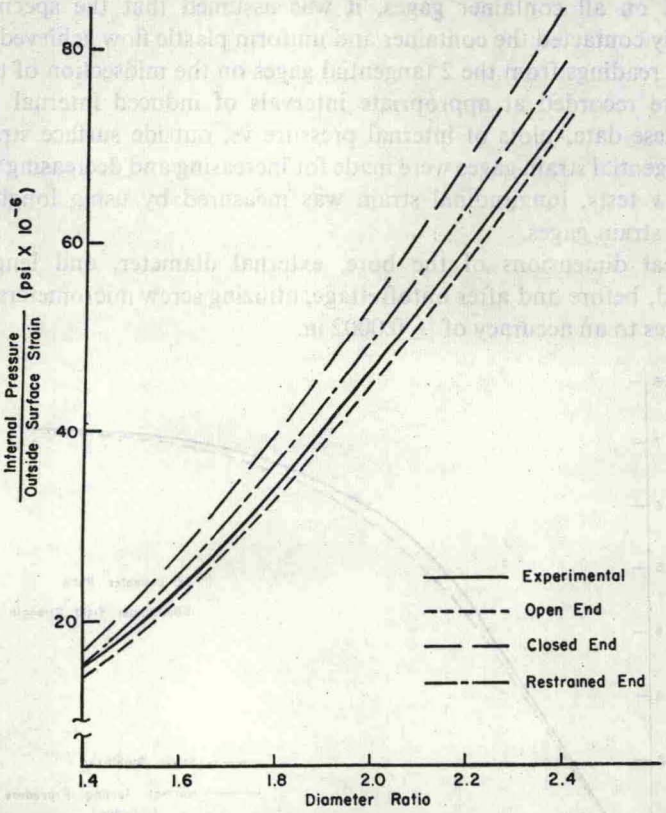

FIG. 6. Slope in the elastic range of internal pressure—outside surface strain curve vs. diameter ratio.

inclined plane of the seal head, there is a tensile longitudinal stress induced in the cylinder from the frictional forces between the ring and the inner cylinder wall. As will be shown, however, this stress is of low enough magnitude that