comparison, the theoretical elastic breakdown pressure factor, based on the von Mises and Tresca yield criteria for the open end condition, are also shown. Based on the von Mises yield criterion and assuming $\sigma_z = 0$, elastic breakdown occurs when:

$$PF = \frac{W^2 - 1}{\sqrt{(3W^4 + 1)}} \tag{1}$$

From the Tresca yield criterion elastic breakdown is:

$$PF = \frac{W^2 - 1}{2W^2} \tag{2}$$

As can be seen from the figure, there is close correlation between the experimentally determined and the theoretical von Mises elastic breakdown condition.

100 Percent Overstrain

When the internal pressure exceeds the elastic breakdown pressure, the elastic-plastic interface moves from the bore towards the outside diameter. This movement is a function of the internal pressure, yield strength, diameter

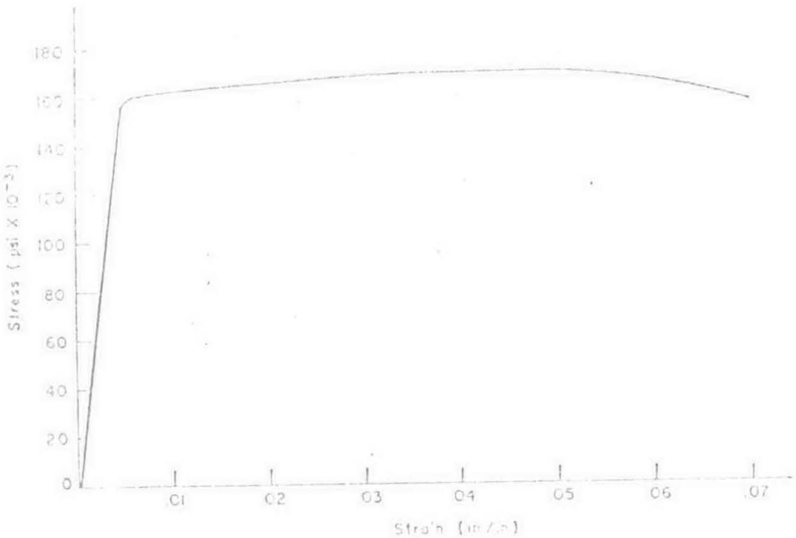

FIG. 8. Stress–strain diagram.

ratio and the strain hardening capabilities of the material. The strain hardening of this material at the yield-strength level considered is small, as shown in Fig. 8 which is a tensile stress-strain diagram for the material used in this program. As can be seen from the figure, for purposes of calculation and

interpretation of the experimental results, the assumption of a elastic-perfectly plastic material is valid.

The exterior surface of an open end cylinder subjected to internal pressure is in a condition of uniaxial stress since σ_r and σ_z are zero. Therefore, the condition of 100 percent overstrain may be defined as that at which the outside surface strain equals the strain associated with the yield stress of the material in uniaxial tension or

$$\epsilon_0 = \frac{\sigma_y}{E} \tag{3}$$

The pressure required to produce this condition (P_0) was experimentally determined for the specimens tested. It should be noted that, since most of the specimens were designed for greater than 100 percent overstrain, there was usually no contact between the specimen and container at the 100 percent overstrain condition. These values of P_0 were converted to pressure factor, and all values for the same diameter ratio were averaged and plotted in Fig. 7. These data may be represented by an empirical relationship:

$$P_0 = 1.08\, \sigma_y \log W \tag{4}$$

Weigle[1] gives the following equation for the 100 percent overstrain pressure based on the von Mises yield criterion and assuming $\sigma_z = 0$:

$$2\sqrt{(3)} \tan^{-1}[(\partial_0 - 1)^{\frac{1}{2}}] + \ln \partial_0 - \ln[1 + \sqrt{(3)}(\partial_0 - 1)^{\frac{1}{2}}]^2 + \ln 3W_1^4 - \sqrt{(3)}\,\pi = 0 \tag{5}$$

where $\partial_0 = \frac{4K^2}{P_0^2}$

and K = yield stress in simple shear.

For ease of application, this equation may be approximated very accurately by the relationship

$$P_0 = 1.10\, \sigma_y \log W_1 \tag{6}$$

It should be noted, however, that W_1 in Eq. (6) refers to the diameter ratio under pressure which is slightly less than the initial diameter ratio used in Eq. (4). Both equations, then, are in very close agreement and, for calculation purposes, the initial diameter ratio and Eq. (4) will be utilized.

The close agreement of Eq. (6) with the experimental data of Fig. 7 again verifies the assumption of an open end test condition.

Partial Overstrain

In deriving relationships for stresses and strains in a partially overstrained cylinder the following basic assumptions are made.