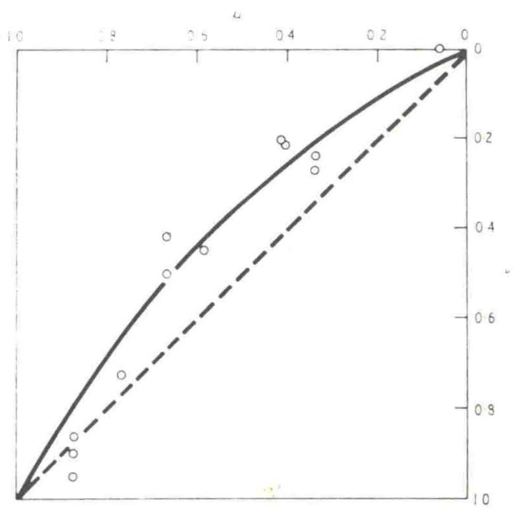

— — — Lévy–von Mises relation.
——— Law derived from equation (4).
○ Experimental data.

Fig. 4. Strain law for a mild steel at room temperature, according to reference (11)

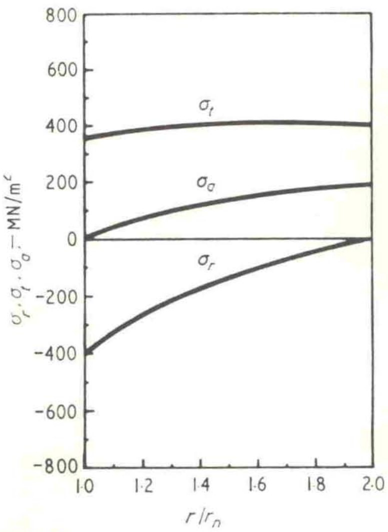

Fig. 6. Stress distribution in a cylinder with an r_o/r_n ratio of 2 made from steel D, subjected to an internal pressure of 3·970 kbar

Calculation of the stress distribution in a cylinder

A method has been worked out for calculating the stress distribution in a thick-walled cylinder subjected to an internal pressure. In this method, which is described in Appendix 1, it is assumed that (*a*) the cylinder is of the closed-end type; (*b*) its length is such that the stress distribution can be considered as independent of the geometry of the heads; and (*c*) it has not yet been subjected to an internal pressure: this restriction is imposed by the fact that equation (2) holds only for a metal which has never been stressed.

It makes use of the law of microplasticity of the material and the strain law proposed above, involving the simple superimposition of plastic shear strains in planes lying at 45° to the principal stresses.

The stress distributions calculated by this method for two cylinders with an r_o/r_n ratio of 2, made from steels C and D respectively, are given in Figs 5 and 6. These two steels were selected because their laws of microplasticity differed greatly. In each case the internal pressure was selected so as to obtain an external circumferential stress of 400 MN/m². Comparison of Figs 5 and 6 shows that:

(*a*) the stress distribution is highly dependent on the law of microplasticity of the material;

(*b*) whatever the case considered, the distinction between elastic and plastic strain loses all significance; and

(*c*) the calculation method can be used over a wide range of laws of microplasticity.

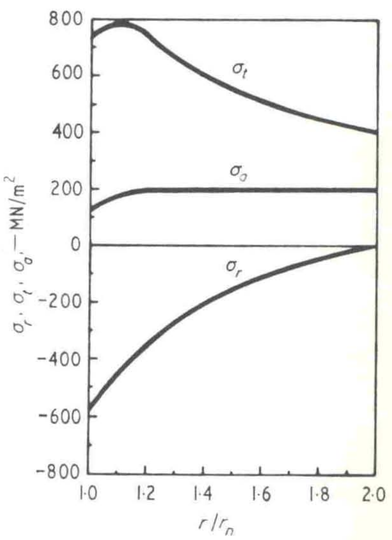

Fig. 5. Stress distribution in a cylinder with an r_o/r_n ratio of 2 made from steel C, subjected to an internal pressure of 5·760 kbar.

This calculation method allows the strains at the cylinder's outer radius to be determined. Fig. 7 shows how the following values compare with one another: the microstrains obtained by this calculation, in the case of a cylinder with an r_o/r_n ratio of 2 made from steel D; those derived from the Lévy–von Mises relation; and those measured while the pressure progressively builds up in the cylinder. It is seen that the microstrains calculated according to the proposed method agree closely with the experimental microstrains.

CONCLUSIONS

The results reported above confirm the existence of a size effect in the case of steels A, B, and C: when geometrically similar cylinders made from the same steel are compared, the pressure corresponding to the onset of plastic strain in the cylinder is observed to decrease slightly as the cylinder's size increases. This size effect can be accounted for in terms of Weibull's theory, in which the *m* exponent increases with increasing yield stress of the material.

A method has been worked out for calculating the stress distribution in a thick-walled cylinder subjected to an internal pressure. This method takes into account the laws of microplasticity of the material and is based on the assumption that plastic strain results from the simple superimposition of plastic shear strains in planes forming