While the general solution of the elastic stress field around a cavity in an isotropic matrix subjected to high hydrostatic pressure has been known since the classical work of Lamé in 1852, the extension of these calculations to the case of an elastic inclusion taking into specific consideration of the differences in compressibilities between matrix and inclusion has not been reported. The calculations made here† follow the continuum mechanics principles outlined by Sokolnikoff (1956) and assume that the elastic properties of the matrix and the inclusion are isotropic, the inclusion is spherical with a smooth surface and the stress fields of different particles do not interact. Under these conditions, the maximum shear stress, τ_{max}, which develops at the inclusion–matrix interface is given by the following relationships for the cases of a cavity, cavity with internal pressure, a rigid inclusion and an elastic inclusion:

Cavity: $$\tau_{max}=\tfrac{3}{4}P \qquad (1)$$

Cavity with internal pressure P_i and external pressure zero: $$\tau_{max}=\tfrac{3}{4}P_i \qquad (2\,a)$$

Cavity with internal pressure P_i and external pressure P: $$\tau_{max}=\tfrac{3}{4}(P-P_i) \qquad (2\,b)$$

Rigid inclusion: $$\tau_{max}=\frac{G}{K}.P \qquad (3)$$

Elastic inclusion: $$\tau_{max}=\frac{3G}{K}\left[\frac{K-K_i}{3K_i+4G}\right].P \qquad (4)$$

where G is the shear modulus of the matrix, P is the applied hydrostatic pressure, P_i the internal pressure in the cavity and K and K_i are the bulk moduli of the matrix and the inclusion respectively. On substituting values of K_i appropriate to the limiting cases of the cavity and the rigid inclusion (i.e. zero and infinity), eqn. (4) reduces to eqns. (1) and (3) respectively.

The complete set of equations for the radial, circumferential and maximum shear stresses are given in table 1 for the cases of a cavity, rigid inclusion and elastic inclusion (the corresponding strains and other details of the calculations can be obtained from the authors). The table also contains the value of τ_{max} for inclusions as calculated by Hahn and Rosenfield‡ (1966). Table 2 gives the values of the maximum shear stress computed from the equation in table 1 as a function of the externally

† An alternative approach to that used here for the elastic particle is the generalized misfit-strain type of analysis developed by Eshelby (1957) subsequent to the work of Nabarro (1940). As is discussed later, Lally and Partridge (1966) have used an extension of Eshelby's approach in an attempt to compute matrix shear stresses adjacent to a cavity containing gas at high pressure.

‡ While their approximation is useful for the case of the inclusion, it is inapplicable to the limiting case of an internal cavity. See table 1.