APPLIED SCIENCES

Fracture Criterion for Cast Iron

COMPRESSION tests and tension tests on cast iron have been carried out in an environment of hydrostatic pressure[1]. The results for the fracture stresses are shown in Fig. 1.

Let c be the fracture stress in compression in a test carried out under a hydrostatic pressure p. Then the stress tensor σ_{ij}, taking compressive stresses as positive, is

$$\sigma_{ij} = \begin{matrix} (c+p) & 0 & 0 \\ 0 & p & 0 \\ 0 & 0 & p \end{matrix}$$

The hydrostatic or volumetric component of this stress system equals $(p+c/3)$ while the maximum deviatoric stress or the maximum difference between the principal stresses and the volumetric stress is equal to $(c+p)-(p+c/3)=2c/3$. The maximum "tensile" stress is p.

The evaluations of the volumetric stress and the maximum deviatoric stress for tension tests carried out under a hydrostatic pressure q are identical with those given for compression with the appropriate sign change—that is, the maximum deviatoric stress at fracture is equal to $-2t/3$, where t is the fracture stress in tension. The maximum tensile stress is $(q-t)$.

The experimental results for the compression tests can be obtained from the compression line in Fig. 1 (Chandler and Mair[1] denote tensile stresses as positive) and are given in Table 1.

Table 1

Hydrostatic pressure (p) (tons/in.^{2})	Fracture stress in compression (c) (tons/in.^{2})	Volumetric stress $\left(p+\frac{c}{3}\right)$ (tons/in.^{2})	Maximum deviatoric stress $\frac{(2c)}{3}$ (tons/in.^{2})
0	45·8	15·3	30·5
10	48·3	26·1	32·2
20	50·6	36·9	33·7
25	53·0	47·7	35·3
40	55·4	58·5	36·9
50	58·0	69·3	38·7

The corresponding results for tension are obtained from the "tension" curve in Fig. 1 at the values of volumetric stress shown in Table 2.

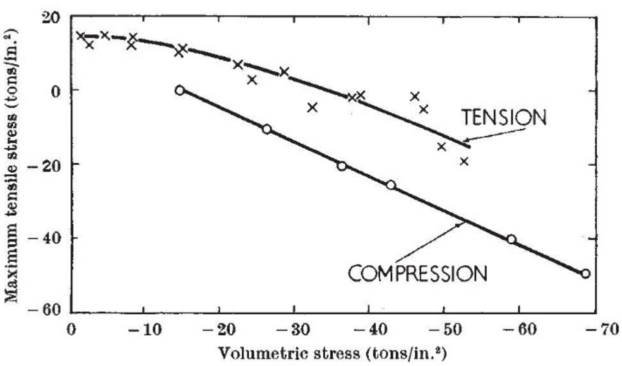

Fig. 1. Maximum tensile stress/volumetric stress curves for cast iron.

Chandler and Mair[1] examined various criteria to obtain a representation of the fracture stresses in the tension and compression tests under pressure but found none to be satisfactory. I have plotted in Fig. 2 the numerical values of the maximum deviatoric stress as a function of the volumetric stress for the fracture of cast iron in compression and in tension under various hydrostatic pressures. It can be seen that a fracture criterion of the maximum deviatoric stress gives an excellent representation of these results.

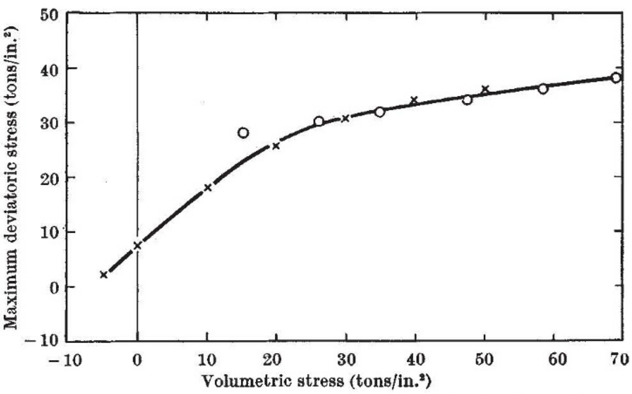

Fig. 2. Maximum deviatoric stress against volumetric stress for cast iron in tension (×) and compression (○) under hydrostatic pressure.

It has been shown that the fracture stress of cast iron under hydrostatic pressure in tension tests[2] and in torsion tests[3] could be represented by either a maximum tensile stress or a maximum deviatoric stress criterion; the criteria are equivalent for these particular stress systems. Unfolrtunately, it is not possible to compare these resuts quantitatively with the previous article, because different cast irons were used. None the less, the maximum deviatoric stress seems to represent well the results for the fracture of cast iron under hydrostatic pressure in a variety of stress systems including tension, torsion and compression tests.

Table 2

Volumetric stress $\left(q-\frac{t}{3}\right)$ (tons/in.^{2})	Maximum tensile stress at fracture $(q-t)$ (tons/in.^{2})	Maximum deviatorie stress $\frac{-2t}{3}$ (tons/in.^{2})
0	−14·1	14·1
10	−12·6	22·6
20	−8·5	28·5
30	−2·6	32·6
40	+4·6	35·4
50	+13·1	36·9

Because the maximum deviatoric stress is directly proportional to the tensile, compressive or shear stress at fracture in the corresponding tests under pressure, the latter stresses can be regarded as the determining factor. They vary because the volumetric stress at the same ambient pressure is different for each type of test.

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[2] Pugh, H. Ll. D., and Green, D., *Proc. Inst. Mech. Eng.*, **179**, Part 1 (12), 415 (1964–65).
[3] Crossland, B., and Dearden, W. H., *Proc. Inst. Mech. Eng.*, **172**, 805 (1958).

GENERAL

Pair Distribution Function for Particles in a Box

ONE method of studying the thermodynamic properties of simple liquids is to consider the packing statistics of finite model assemblages of rigid spheres[1]. This finite model approach yields not the well known pair distribution function, which describes the average distribution of atoms about a typical atom in an infinite liquid, but rather a pair distribution histogram $R(\rho)$. For an assemblage containing N spheres, $NR(\rho)\delta\rho$ gives the number of pairs of spheres the centres of which are separ-