Method of Calculation

From the impact time measured by the probes and the time of shock arrival at the transducers, the shock velocity can be calculated. In each round the peak stress and measured shock and impact velocities had values which were consistent with published data for magnesium. From the impact time and the shock velocity, the distance-time point is calculated where the shock in the flying plate is reflected from its back surface as a release wave. This point, together with the stress-time profile, enables the velocity of the release wave to be found as a continuous function of stress. From this, density and particle velocity are calculated using the following equations [7] based on conservation of mass and momentum:

$$\rho_1 - \rho_0 = \int_{p_0}^{p_1} \frac{dp}{c^2}$$

$$\int_{u_0}^{u_1} du = \int_{p_0}^{p_1} \frac{dp}{\rho c} .$$

Here ρ represents the density, p the stress in the direction of wave propagation, c the wave velocity relative to the local material (for a continuous wave), and u the particle velocity. This calculation is done at small stress decrements down the release wave. The wave velocity is corrected for movement of the transducer and expressed relative to the local material, using the calculated particle velocity. Density and particle velocity at the top of the release wave are taken from published Hugoniot data for magnesium corresponding to the measured stress.

Stress-strain Curve

Figure 5 shows the resulting release velocities and Fig. 6 the corresponding stress-strain relation taken from experiments at one flying plate thickness. These are again markedly different from the hydrodynamic predictions. The stress-strain curve first falls steeply below the Hugoniot and then becomes shallower. This is attributed to elasto-plastic behaviour of the metal [9]. The results at five flying plate thicknesses have not been used in this type of calculation because of the possible difficulty in interpreting the initial fall in stress. However, an elasto-plastic release path would predict a discontinuity of release wave velocity at the reverse yield point, and hence a stress plateau. The period of almost constant stress shown at five flying plate thicknesses is identified with this plateau, and the regions above and below it with the elastic and plastic parts of the release process. The size of the elastic stress release is, therefore, 16 Kb, determined by the stress difference between the plateau and the beginning of the release process as recorded by one flying plate thickness experiments. Single experiments at six and eight flying plate thicknesses support this interpretation.

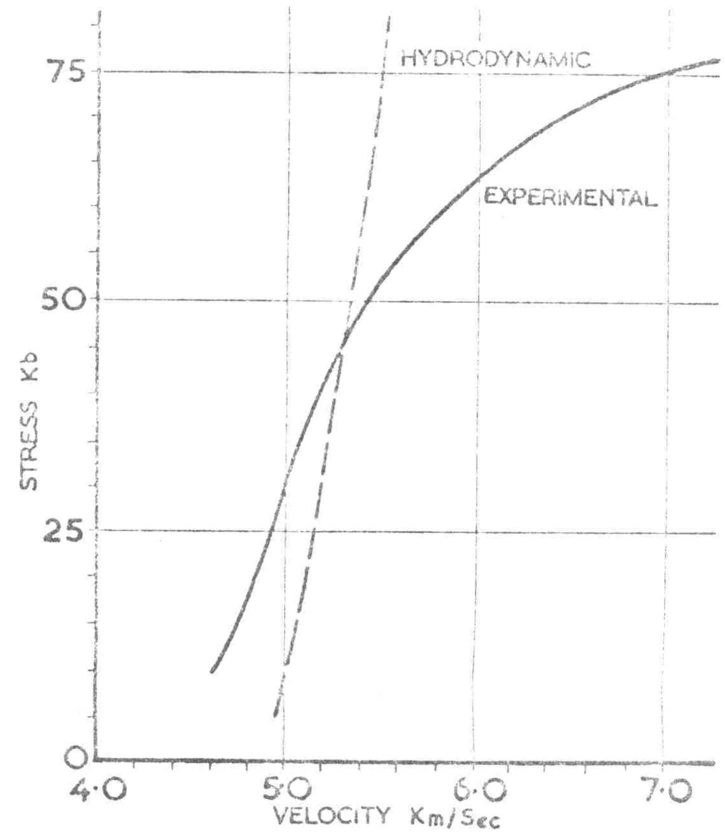

Fig. 5 - Mean velocities measured from 28 stress profiles at one flying plate thickness

Elastic Properties

Some elastic properties can now be calculated from the elastic and plastic wave velocities c_e and c_p. Bulk modulus is found in the plastic region using

$$c_p^2 = K/\rho$$

(Fig. 7); a considerable increase with stress is obtained. The curve is consistent with the small stress bulk modulus for magnesium [10].

While the initial fall in stress of the profiles at five flying plate thicknesses may be difficult to interpret, the ratio of the elastic and plastic wave velocities at the yield point nevertheless allows an estimate to be made of Poisson's ratio r. Using