DISCUSSION

J. H. Brunton[1] (*written discussion*)—Some early work by Hancox[2] showed that in a wheel and jet test the length of the incubation period increased approximately linearly with decreasing diameter of the jet over the range 2 mm down to 0.4 mm. The explanation given was that the duration of the maximum impact pressure decreased in a linear manner with jet diameter, and this had a direct influence on the amount of damage produced. Related to this result is the effect of surface roughness on damage. For a constant drop size, decreasing the size of projections on a roughened surface or, in some way, thinning down the specimen so that the initial area of impact is small compared with the section of the drop sharply reduces the amount of damage produced per unit area.[3] This arrangement for reducing the size of the solid rather than the size of the drop similarly will reduce the duration of the water–hammer pressure and hence the damage.

The cushioning effect of a protective water film on the surface will depend on the thickness of the film relative to the size of the drop. Several mechanisms favoring a reduction in damage will be present. The pressure delivered to the solid will be reduced by half due to the equality in accoustic impedance at the drop-film interface. If, however, the time of transit of the pulse through the film is short compared with the time elapsed before the drop begins to flow, then reflection of the pulse at the solid will bring this value up to that for a "dry" impact. Divergence of the wave through the film can be expected to reduce the energy density and pressure at the solid surface according to $1/t^2$ and $1/t$, respectively, where t is the film thickness. Finally, the surface film, by reducing contact between the liquid flowing out from the drop and the solid surface, thereby will cause a reduction in surface shear damage. The jetting effect in the outward flow, which is important in producing shear damage, now takes place away from the solid surface. Some of these individual effects have been discussed previously,[3] but the combined effects have been found difficult to interpret.

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[2] Hancock, N. L. and Brunton, J. H., *Philosophical Transactions*, Royal Society of London, Series A, Vol. 260, No. 1110, pp. 121–139.
[3] Brunton, J. H., *Proceedings of the Second Meersburg Conference on Rain Erosion and Allied Phenomena*, Royal Aircraft Establishment (Great Britain), 1968, p. 535.

F. G. Hammitt[4] (*written discussion*)—An impact experiment which we have done recently with water jets on 6061–T6 wrought aluminum alloy, using two different jet diameters and velocities (1 mm diameter with 520 m/s velocity versus 3 mm diameter with 220 m/s velocity), produced about the same maximum rate of damage in each case though the incubation time was longer for the high velocity jet. This indicates that the damage rate is approximately proportional to the product of velocity and diameter for this particular case. I wonder if this result is at all consistent with any of the observations of the present authors.

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