Explosive welding : Crossland and Williams



For Trimonite No. 1 and No. 3, the value of VD varies with thickness of explosive charge and in these cases it was found that the scatter of data was a minimum when V_P was plotted against R, as in Fig. 5, 10, and II. These values were obtained on small plates and there is some indication for very large plates with a uniform layer of explosive that the value of V_P increases significantly with the distance from the point of initiation of the detonation. Williams et al.32 found it necessary to use a non-uniform thickness of charge to ensure a constant impact velocity, but no experimental data or theoretical analysis of this aspect appear to have been published.

It is also apparent from the analysis that the sonic velocities of the materials being welded are very important. The values given in the International Critical Tables³³ are shown in Table IV.

For satisfactory welds there appear to be three essential requirements. First, it is necessary that a re-entrant jet should be formed and for this to occur the main jet velocity, V_P tan β , must be less than or only slightly greater than the sonic velocity in the flyer plate, so that either there are no shock waves or only detached shock waves. Secondly, a hump is needed in front of the collision point, either to disrupt the oxide film or to assist in the scouring action of the re-entrant jet. This requires that V_P /sin β should be less than the sonic velocity in the parent plate. Thirdly, the impact pressure must be sufficiently great to produce a fluid-like behaviour necessary

for the formation of a re-entrant jet, and it is also essential that the re-entrant jet velocity should be sufficiently high to give the desired scouring action. Fourthly, the flyer plate is subject to a bending action and according to Carpenter et al.34 it must be able to withstand a 5% strain. There is also the possibility that a reflected tension wave in either the flyer plate or the parent plate can cause a 'spalling' failure, though this has only rarely been noted. Such a failure is more likely to occur with a high-detonation-velocity explosive, which gives a higher pressure pulse and hence a greater reflected tension pulse, and with materials that contain planes of weakness parallel to the surface. If spalling of the flyer plate occurs in flight, welding of the two pieces of the flyer plate

Table III. Variation of ratio of flyer plate to detonation velocity/ratio of mass of explosive to mass of flyer plate (R) for Metabel

R	V _P /V _D	
	Experiment	Equation [8]
0.2	0.062	0.056
0-4	0.104	0.102
0.6	0.143	0.141
0.8	0.180	0.175
1.0		0.204
1.2		0.23

Table IV. Sonic velocity of metals³³

Metal	Velocity, m/s
Aluminium	5105
Gold	2645
Silver	2080
Tin	5000 2490
Zinc	3680

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