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THE EFFECT OF SURFACE CONDITION ON SHOCK HARDENING

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The structural and substructural changes associated with the passage of shock waves through metals are a well known and widely documented phenomenon (1-3). The peak pressure was initially recognized as the sole parameter governing the amount of strain induced in the lattice and, consequently, the extent of residual work hardening. However, later studies showed that shock-pulse duration was also a strengthening parameter (4-7). And Orava (8) recently suggested that the rarefaction rate, the rate of decay of the pulse width and the attenuation rate of the peak pressure might also be important.

This note presents the preliminary results on the effects of the surface condition of the cover plate on the residual strength. Sheet samples of 304 stainless steel were shocked to a peak pressure of 315 Kbar and pulse duration of 1 μsec. A "mouse-trap" plane wave generator was used and the experiment was conducted according to the standard procedures (1). In order to verify the influence of the cover plate smoothness on the terminal strength of the shocked metal, serrations were inserted in one half of the cover plate. The experimental assembly is shown in Figure 1. The grooves were made with a planer mill, using an especially sharpened tool. After shocking, the serrated pattern of the cover plate was imprinted on the copper driver plate; no localized welding or abnormality was observed.

The hardnesses of the plates on the serrated and plane side were taken before and after shocking. The results are shown in Table I and are the mean of 15 measurements; the upper and lower surface of plates 2 and lower surface of plate 1 were tested. It can be seen that the hardness of the serrated side was about 2.5 Rc higher than that of the smooth side. This effect persisted through the two plates.

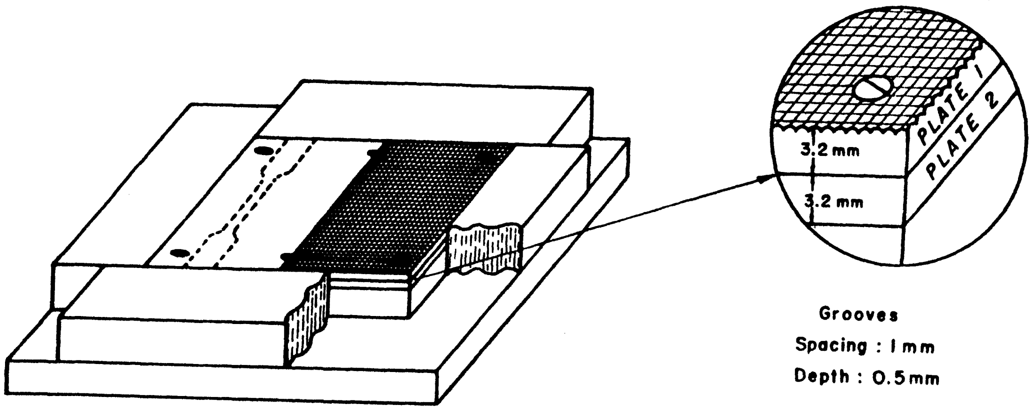

FIG. 1
Experimental Setup with Smooth and Serrated Sides

TABLE I
Hardnesses of Plates 1 and 2, Prior to and After Shocking.

Plate	Side	Hardnesses (Rockwell)	
		Mean	Std. Deviation
	(a) Prior	to Shock	
2	smooth	B 79.6	0.4
	serrated	B 80.0	0.3
	(b) After	Shock	
1	smooth	C 24.8	1.2
(lower surface)	serrated	C 27.7	1.1
2	smooth	C 26.2	1.3
(upper surface)	serrated	C 28.8	1.1
2	smooth	C 27.0	1.0
(lower surface)	serrated	C 29.6	1.0

Table II shows the results of room temperature tensile tests conducted with four samples made from plate 2. The strain rate applied was $3x10^{-3}sec^{-1}$. The longitudinal axis of the samples was taken parallel to the original rolling direction and along the direction shown in Figure 1. The yield strengths are not shown in Table II because they could not be precisely determined. The ultimate tensile strengths of the samples of the serrated side are slightly higher; the total elongations are correspondingly decreased.

TABLE II

UTS and Elongation of Plate 2 After Shocking

Side	UTS (Kg/mm^2)	Elong. (%)
smooth	77.536	36
	78.420	41
serrated	80.365	34
	79.067	34

The combined evidence of Tables I and II shows that the surface has an effect on the shape of the shock wave and, consequently, on the residual strengthening. A more detailed investigation is being conducted in order to optimize this new parameter and obtain more significant strength increases.

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