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HIGH SPEED BLANKING : AN ECONOMICAL WAY OF PRODUCING PARTS

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ABSTRACT

This paper examines the effect of high speed blanking on dimensional errors, surface finish as well as load requirements on various materials. The high blanking speed was obtained using an experimental accelerator, which was designed and developed to suit a mechanical press to increase the operational speed up to about 14 m/s.

There was generally a reduction in dimensional errors and an improvement in surface finish on blanks and a higher peak load is required, as a result of the use of high blanking speeds.

INTRODUCTION

Components that are produced by blanking operations are accepted for downstream assembly operations if the surface finish of the sheared surfaces is considered to be of reasonable quality and the amount of distortion or dimensional errors is minimised. In order to achieve the desired quality in thick gauge blanks, there are two commonly methods practised. Firstly, relatively poor quality blanks, produced by the conventional press, are subjected to a secondary operation such as shaving to improve the finish and the dimensional accuracy. Secondly, blanks of good quality can be produced by the use of fine blanking press, involving accurately guided die set with very small punch-die clearance.

Although both methods can produce blanks to the desired quality, their main disadvantage lies in the high cost of production. In the first case, the machining or post blanking operation is likely to be costlier than the blanking operation itself, while in the second case, the high capital cost of the machine and tooling usually renders the method uneconomical, unless very large quantities are produced to offset the initial capital cost.

High speed blanking for thick gauge metals has been reported[1-6] and the blanks produced are of better quality at the shear-fracture surface and less distortion is encountered as compared to blanks produced by slow speed. The improvement is particularly marked for mild steel blanks produced at about 10 m/s[6]. For punch speeds beyond 15 m/s, marginal or no improvement in the surface quality and dimensional accuracy of the blanks are encountered.

It follows that if blanking operations can be performed at speeds of about 10 m/s, the advantages of high speed blanking can be achieved. A number of high speed machines such as Petro Forge, Dynapak and special air hammers are able to achieve the required speed for high speed forming [7] but because these machines are costly and bulky in structure, very few of these machines are used for production.

As conventional mechanical presses are not expensive and are easy to maintain and operate, they are commonly used for metal forming operations. An experimental pneumatic accelerator has been designed and developed to suit the conventional press to increase the operational speed up to about 14 m/s[8]. The operational speed of the accelerator is adjustable depending on the input pressure of the compressed air. This accelerator is cheap, simple in application and enables high speed forming to be carried out readily on available mechanical presses.

EXPERIMENTAL PROCEDURE

Equipment

The main equipment used in the blanking operations consists of the mechanical press, blanking die set and pneumatic accelerator. A photograph of the equipment set-up is shown in Figure 1.

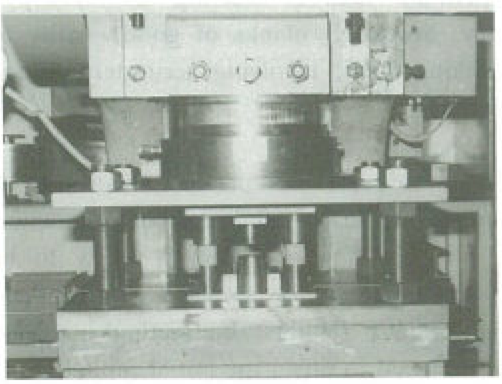


Fig. 1 A photograph of the accelerator and the die set on a mechanical press

(a) Mechanical press : The press used for this experiment was an open back inclinable press of 40 tonne capacity. Some important technical details of the press are shown in Table 1.

TABLE 1
SPECIFICATIONS OF THE PRESS

Description	Value
No. of rev.per min	45
Ram stroke	80 mm
Distance between ram and table	330 mm
Table dimensions	700 × 460 mm
Ram speed	0.13 m/s

(b) Blanking die set : The die set is designed for the blanking of 25 mm nominal diameter blank measuring up to 9.5 mm thick. The punch-die clearance is 0.47 mm. A block diagram of the instrumentation set-up for the experiment is shown in Figure 2. The main objective is to measure the blanking load on the punch as the punch shears through the thickness of the material. Four strain gauges are mounted on the punch and are connected to the dynamic strainmeter via a bridge box. The amplified signal from the strainmeter, which is a function of the punch load, is fed to a storage oscilloscope. The punch displacement during blanking is measured by means of a linear variable differential transducer (LVDT). A change in inductance resulting from the movement of the upper die shoe relative to the lower die shoe will generate a voltage signal proportional to the displacement, this signal being fed also to the storage oscilloscope.

(c) Accelerator : A schematic diagram of the pneumatic accelerator is shown in Figure 3. Basically, the function of the accelerator is to convert the mechanical energy of the press during its downward stroke by compressing air in the piston chamber, this energy being released near to the end of the stroke to accelerate the ram. The ram of the accelerator is capable of achieving a speed of up to 14 m/s. This speed is enough for high speed blanking as it was reported earlier that there is no advantage in blanking materials beyond a speed of 15 m/s.

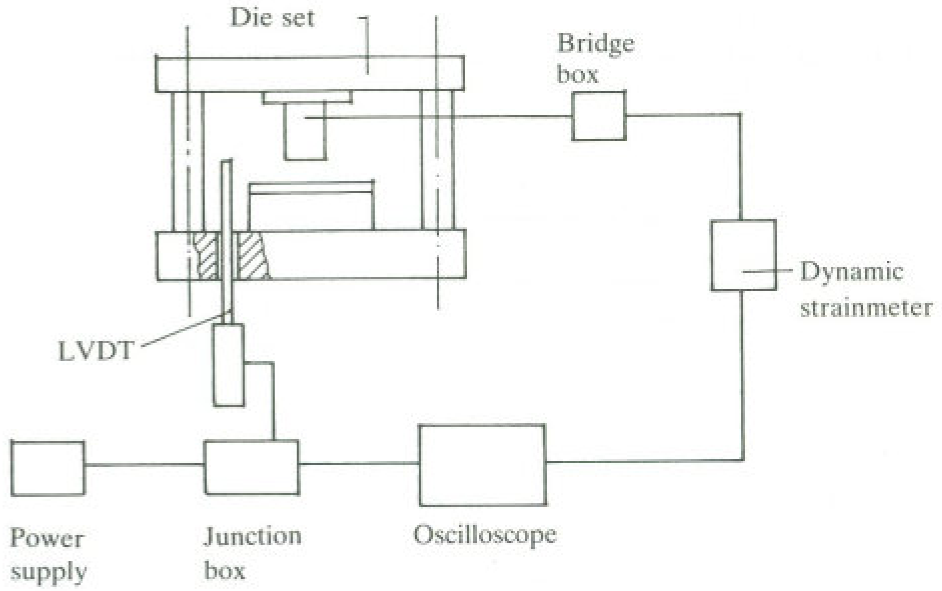


Fig. 2 A block diagram of the instrumentation set-up

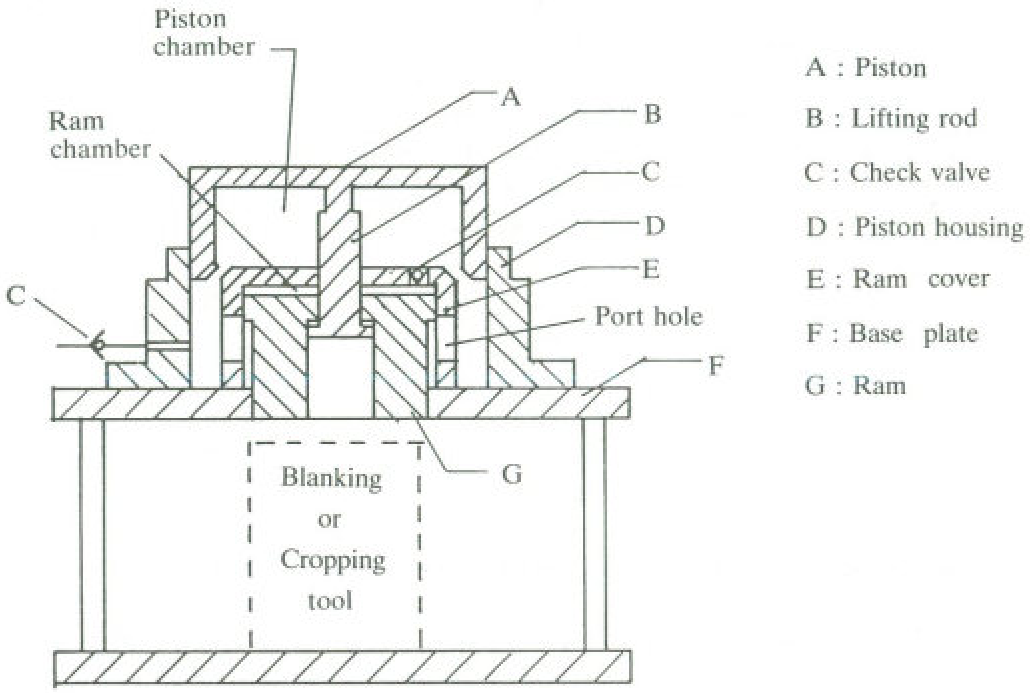


Fig. 3 A schematic drawing of the accelerator

Materials

The materials used for both conventional (0.13 m/s) and high speed blanking were mild steel (M.S.), aluminium (Al), brass and copper (Cu), all of 9.5 mm (3/8 inch) thickness.

Experimental results

The dimensional errors encountered in blanking process are doming, dishing and edge taper, as defined[1] and shown in Figure 4.

To access the surface finish at the shear-fracture region of blanks, the most commonly used method is by visual examination although it is the least satisfactory method.

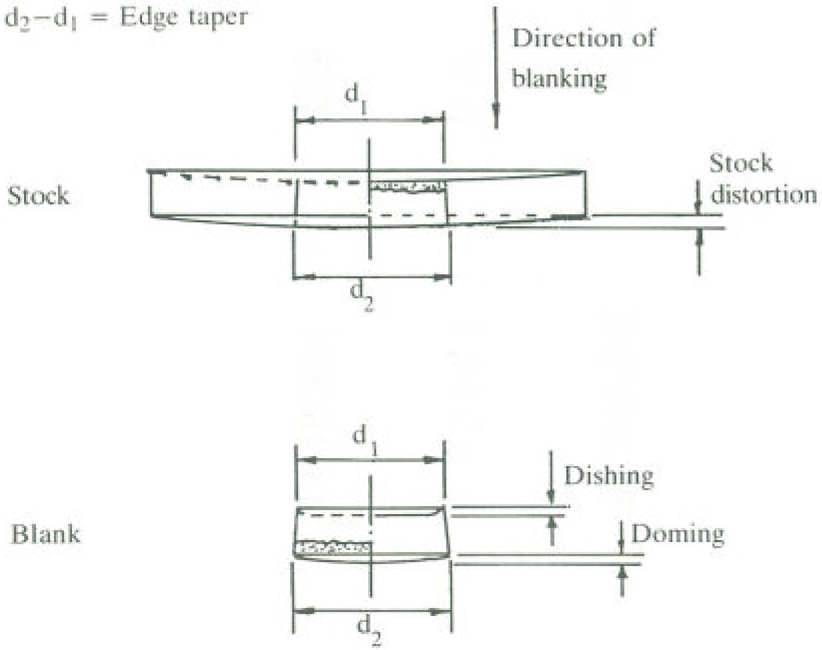


Fig. 4 Dimensional errors of the blank and stock[1]

Effects of high speed on dimensional errors

Blanks produced at high punch speeds of 11.6 and 12.3 m/s were compared with those obtained at conventional speed of 0.13 m/s (see Figure 5). In the case of mild steel blanks, there is a substantial reduction of doming and dishing, at high speed. For aluminium blanks, there is a substantial reduction of doming, at high speed. For brass and copper blanks, there is no significant reduction in the dimensional errors found.

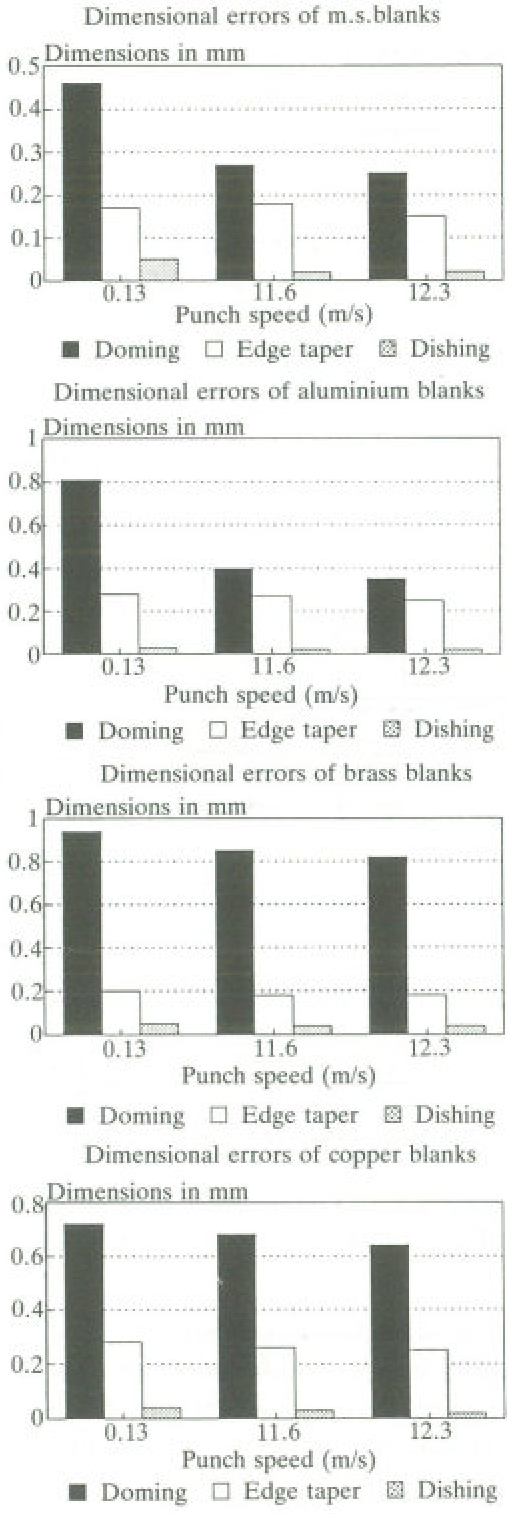
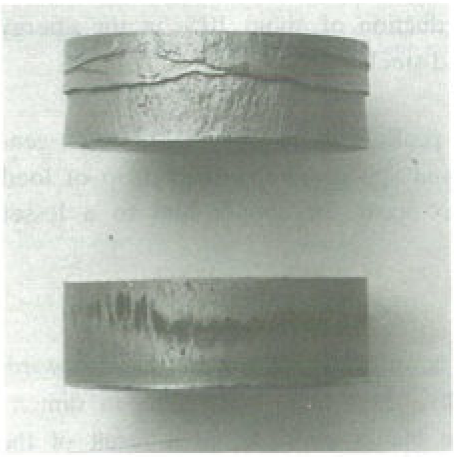


Fig. 5 Doming, edge taper and dishing of the blanks produced

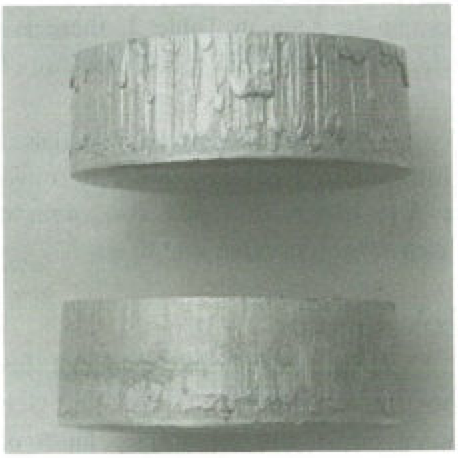
Generally, the dimensional errors of the blanks reduced as a result of the use of high blanking speed and this reduction is significant for mild steel blanks.

Effects of high speed on surface finish

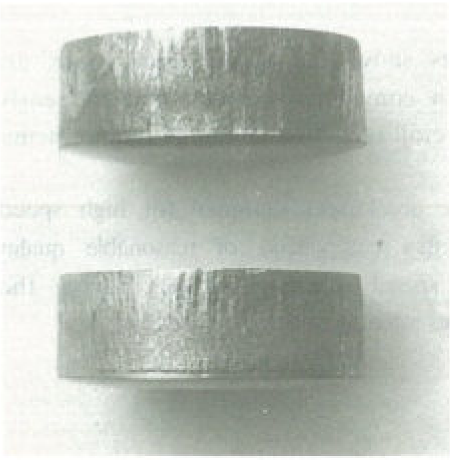
Generally the blanks produced by high speed show an improvement in surface finish over those produced by conventional speed and this is particularly marked for mild steel blanks (see Figure 6). Secondary shears on the mild steel blanks are eliminated when high blanking speed was used. Aluminium blanks show a moderate improvement whilst for brass and copper blanks, there were no significant difference in the surface finish produced.



(a)



(b)



(c)

(d)

Fig.6 Specimens blanked at conventional speed (upper) and high speed (lower). (a) Mild steel (b) Aluminium (c) Brass (d)Copper

Effects of high speed on load requirements

The blanking load and punch displacement curves were captured and stored in the oscilloscope during the blanking process. Table 2 shows the peak load required for the blanking of the different materials at both conventional and high speeds. The energy required is derived from the load obtained. The graphs of blanking load versus punch displacement are shown in Figure 7. Generally, the peak loads required in high speed blanking were greater but fell rapidly to a low value after part-penetration. It was reported[6] that the sudden drop of load at part-penetration seems to coincide with the establishment of a narrow band of severe deformation between the punch and die corners, where cracks can propagate. The early drop in load for high speed blanking has contributed to an overall reduction in the energy requirement. As can be seen in Table 2, there is a reduction of about 10% in the energy required for the high speed blanking of mild steel.

As for non-ferrous materials, the peak loads at high speed were generally about 1.5 times those at conventional speed. The sudden drop of load at part-penetration was also observed to occur for copper and to a lesser extent for aluminium and brass.

CONCLUSION

The experiments conducted have shown some favourable results towards the use of high speed blanking. Generally, there were reductions in dimensional errors and the surface finish of the blanks improved as a result of the use of high blanking speeds. These improvements are particularly marked for mild steel blanks as secondary shears were eliminated when high speed was used.

The blanking force measurements show that higher peak loads are required for high speed blanking than in conventional speed and the early drop in load has the effect of causing an overall reduction in energy requirements.

The successful use of a pneumatic accelerator designed for high speed blanking on a mechanical press indicates that components of reasonable quality can be economically produced by high speed blanking without having the blanks undergo further secondary operations such as shaving or machining.

TABLE 2
LOAD AND ENERGY REQUIREMENTS

Material	Peak load (kN)		Energy (J)	
	0.13 m/s	11.6 m/s	0.13 m/s	11.6 m/s
Mild steel	350	456	1507	1350
Brass	200	310	498	1120
Aluminium	134	185	603	925
Copper	152	280	960	840

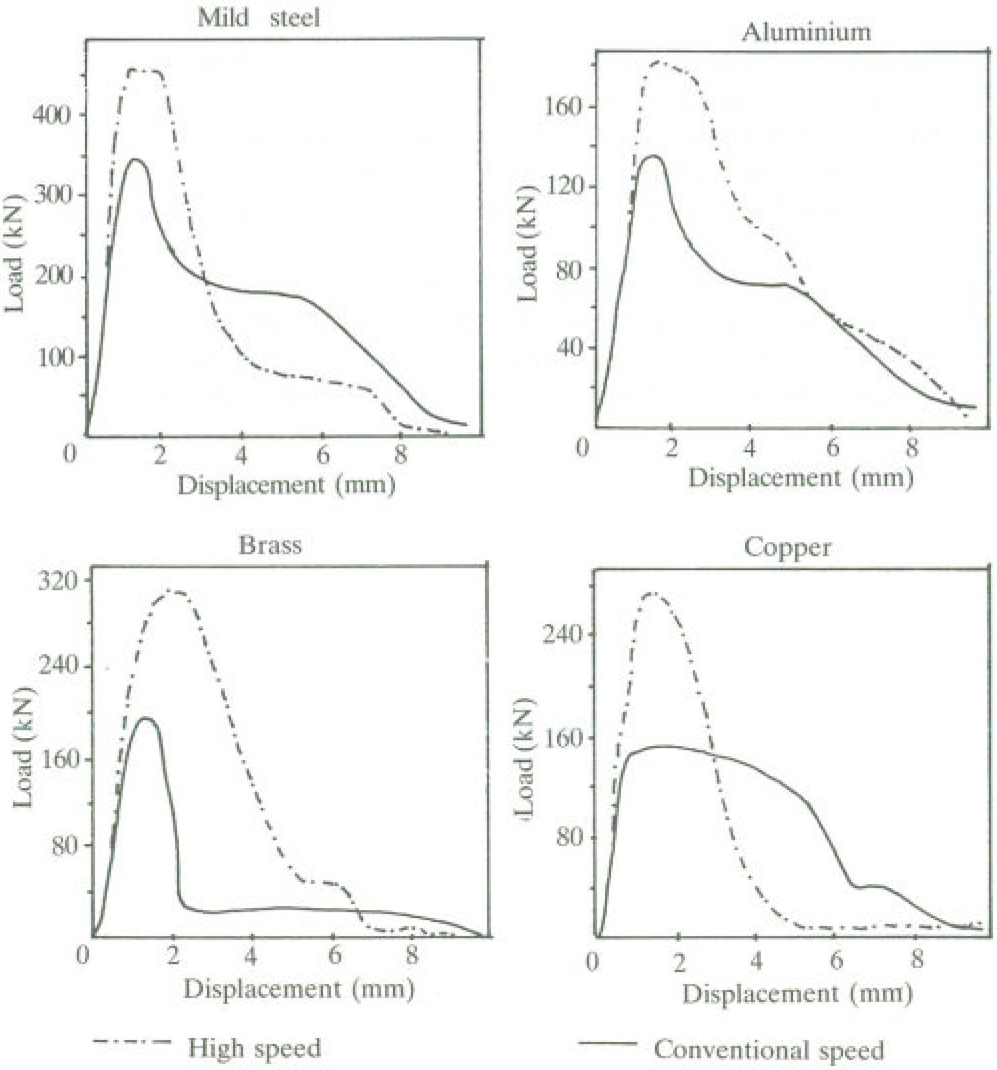


Fig. 7 Blanking load versus punch displacement for the materials tested

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