inter•noise 83

DAMPING OUT PUNCH PRESS NOISE

G. Stimpson

Institute of Sound and Vibration Research, The University, Southampton, England.

INTRODUCTION

Although many sources of noise may be present during the operation of a typical industrial power press, the dominant source during a metal cutting operation (blanking, piercing or cropping) is usually that related to the recoil of the structure following fracture of the workpiece material. Substantial reductions of noise can be achieved by preventing this sudden unrestrained recoil so that stored strain energy is dissipated slowly, minimising structural vibrations and noise. There are basically two methods by which this can be achieved: by tooling modifications to inhibit a sudden material fracture or by additive damping and cancellation devices to oppose the structural springback.

Tooling modifications such as the use of sheared punches or dies, reduced punch/die clearance, etc., can be very effective and give significant reductions of noise. Such methods are often rejected in practice, however, as they can lead to reduced component quality and production rates, and increased tooling costs and wear. Damping and cancellation devices would appear to offer a much more industrially acceptable approach to reducing noise levels if such systems can be made to operate effectively.

DAMPING AND CANCELLATION DEVICES

A number of devices aimed at restraining the structural springback of the presses have been used to date. The most effective of which have been hydraulic systems. Such systems are set in parallel with the tooling and range from simple dashpot type dampers or "shock absorbers" to quite complex active cancellation systems.

A simple damping system (passive system) is set to act as a cushion or shock absorber to the structural springback, the damping cylinder being contacted by the moving ram or tool at the position in the stroke that material fracture occurs. Contacting the damping cylinder too early leads to substantially increased press loads (damper load + tooling load) which could seriously overload the press. Height setting is thus very critical with this type of system - far too critical for industrial use unless press capacity is sufficient to cope with damping and tooling loads. The critical height setting problems can be overcome by the use of a semi-active damping system. Such systems have a two-stage operation and are set to be continuously in contact with the moving ram or tool throughout the working part of the stroke. The system is initially soft, offering minimal resistance to the press stroke and then switches over to hard to oppose structural springback at the instant of material fracture. The switch from soft to hard can be achieved either electronically by sensing the pressure changes in the damping cylinder or using valves which respond to the sudden surge of flow which occurs as the structure begins to close. The system response must be very rapid with this type of system, however, as structural unloading typically takes place in 0.5 to 2 ms.

Damping systems can be made to work reasonably effectively on certain types of presses. Their operation is limited by the effective stiffness of the damping cylinder in relation to the press structural stiffness. Because it is very large loads (20-200+ tonnes) and very small deflections (>> 1 mm) which need to be opposed, damping cylinders must be made large in diameter and squat, to attain the necessary stiffness. Calculations show that cylinder diameters need to be excessively large to effectively restrain springback on all but the softer 'C' frame presses or when blanking soft materials which transfer loads more gradually to the damping cylinders. Hard, brittle materials such as stainless steel exhibit a very sudden fracture, imposing a large shock loading onto the damping cylinder(s).

A method to overcome the stiffness limitation of the damping is by making the system respond more actively as a cancellation system rather than a simple damper. A cancellation device serves to apply an opposing force (i.e., pressure into the cancellation cylinder) at the insant of material fracture. Thus, there is no sudden unbalance of forces and a much smoother structural unloading can be achieved.

EXPERIMENTAL WORK

This work is being conducted in collaboration with the French research association CETIM and experimental work is being conducted on two typical industrial presses: a 20 tonne 'C' frame press at the ISVR and a 200 tonne straight-sided press at CETIM.

Three basic types of experimental hydraulic system have been fitted to the ISVR press. A simple passive shock absorber, consisting of a hydraulic cylinder exhausting through an adjustable flow control (throttle type) valve. This system worked reasonably effectively when optimally set as is shown in fig. 1.

The system was then modified to operate semi-actively by replacing the throttle valve with a flow-sensitive surge valve. This valve switched from a high-to-low flow regime in response to the sudden surge of flow accompanying material fracture. Although maximum performance with this system was only marginally better than the simple passive system (see fig. 2) optimum performance was maintained over a much wider range of settings.

The system is being modified to act as an active cancellation device and to apply an opposing force at the instant of material fracture by injecting a sudden pressure pulse into the cancellation cylinder. The pulse is triggered from a signal obtained from the moving ram of the press. Results with this system will be presented as available.

Two commercial damping systems have been tested on the 200 tonne press at CETIM. Results have shown, however, that these systems are only marginally effective because of the stiffness incompatibility with this type of press.

CONCLUSIONS

Simple press damping systems can be an effective method of smoothing structural springback and reducing noise in certain (at the moment very restricted) instances. Their performance, however, is limited by the degree to which the damper stiffness can be made to match that of the press structure. This limitation may be overcome with active cancellation systems but this represents a complex and expensive solution.

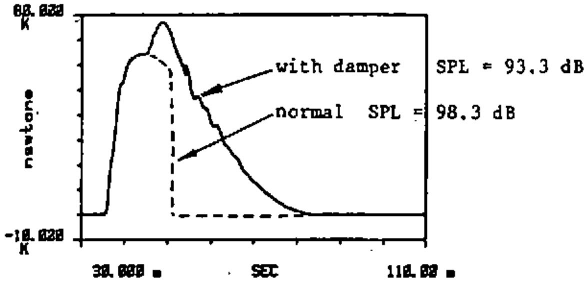

Fig. 1 Punch force with passive damper

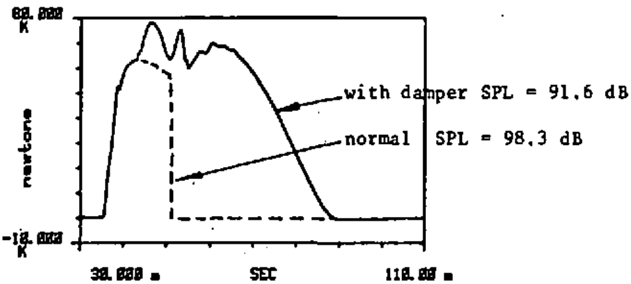

Fig. 2 Punch force with semi-active damper