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STRUCTURE - BORNE SOUND AND NOISE LEVEL AT A DROP HAMMER'S MODEL

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INTRODUCTION

Nowadays the drop hammers still belong to the loudest ones among the forming machines [1]. As a reason, the advantage of the machine-implied change from high forming energy to high forming load within a series of blows is accompanied by the production of high noise level at the last blow or percussion. As long as deafness is one of the wide-spread industrial diseases in Europe, efforts have to be done to reduce the hammer noise.

For measurements of structure-borne sound and noise level of a drop hammer the responsible parameters have to be changed.

They are for instance:
- geometry of the body
- stiffness of the exciting system
- material of the body parts
- provided energy
- acoustic coupling of the body parts

This wide variety of parameters cannot be changed at a normal production hammer. Therefore the IFUM built a scaled model of a typical four part drop hammer (Fig. 1).

Fig.1. Scaled model

TEST SITE

The basic construction conditions for the model were:

- 3rd scale size compared to a representative normal-sized machine
- geometrical similarity
- four part type, which in combination with the small size of the body (height: 2m) makes it easy to move parts. As well, it creates more chances to measure the influence of joints.
- functionality
- same material as in normal-sized machines

The ram is just dropped by its own weight in order to get reproducable measurement results. By this means friction at the guides has little influence on the variance of the provided forming energy.

OFF CENTER LOAD AND DIE-TO-DIE BLOW AS SPECIFIC OPERATIONS

Small hammers often contain different stages in one die. This means that the operator has to manipulate the workpiece during operation. At big hammers, off center load can appear if big workpieces do not have a symmetric shape. Consequently we see that off center load can appear with different sizes of hammers. Such a positioning of the load causes a horizontal motion of the ram dependent on the clearance between ram and guide. A typical die displacement diagram is shown in Fig.2.

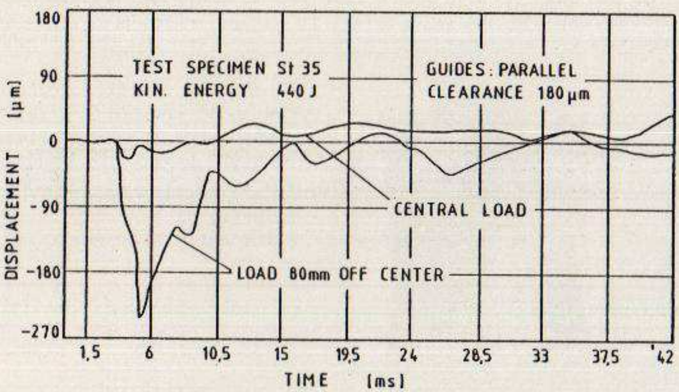

Fig.2. Horizontal displacement of upper die

The displacement signals were taken by a non-contacting system based on the eddy current effect. It is linear enough to work at a distance of 3mm ± 2mm and allows to follow up to 12kHz. Dispositioning of the test specimen was 80mm out of the center.

In many cases it is sufficient to measure and to check the influence of the loudest part of the machine. In this paper it will be done with the dies. Fig. 2 shows that with off center load the displacement of the die becomes up to 10 times bigger than with central load. This phenomenon is not only bad for the product quality but turns out to bring an amount of acoustic energy into the central region of the body as well.

Fig. 3 shows the influence of off center load on the excitation of structure-borne sound at the dies as the loudest parts and on the sound pressure level (Lp) in front of the operating region.

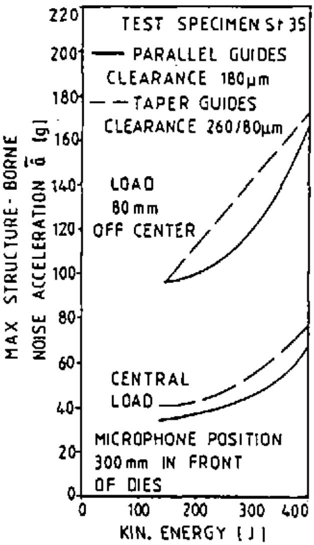

Fig.3. Influence of central/ off center load on the acceleration

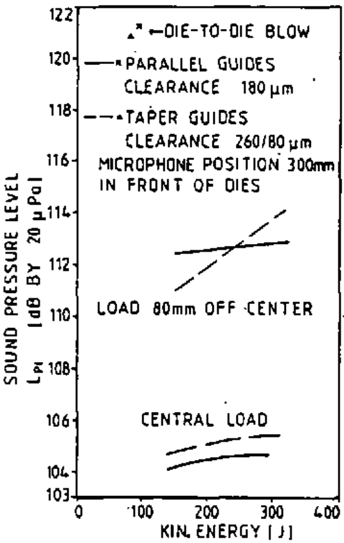

Fig.4. Influence of central/ off center load and die-to-die blow on Lp

Measurements of the die surface acceleration show that the excitation follows the kinetic energy of the ram. The off center load test opens the eyes for the 2.5 times stronger excitation compared to central load. The Lp is measured unweighted between 22Hz and 22kHz. We see that the Lp increases with the provided operation energy. Off center load gives a level of 8dB(I) more than central load. This effect appears similarly with different clearances.

In Figs. 3 and 4 die-to-die blows were used to simulate the percussion of the dies. In the case of the die-to-die blow the acceleration at the die becomes up to 18 times stronger than compared to off center load. The Lp in this case is raised up to 121dB(I), which is another 8dB(I) more than with off center blow (see Fig. 4).

MEASURES TO REDUCE THE NOISE

The off center load has to be avoided if possible. The influence of guide clearance is a minor one, but has to be at an optimum in case that off center load cannot be avoided.

The die-to-die impact deserves special attention because it represents the strongest excitation at all. In fact the last blow of a forging series is almost a die-to-die impact. Apart from doing its duty of final work-hardening, the operators like to obtain the impuls response of the structure to check the keys etc. This means that they in fact use the disadvantage of the machine to get profit out of it. So what can be done? Only primary-active measures can limit the excitation in the hammer's operating region. This claim demands to smooth the force-time diagram of the process [2]. A small counter-force of about 5% which is working against the ram and applied at the very beginning of the force pulse, eases the force-time diagram at its origin, makes the higher-frequency components of the force signal decrease, and drops the Lp by up to 6dB(I). Negative consequence is a lack of peak force which can amount up to 20% in the described case. The measure is applicable in cases where the peak force has not necessarily to be obtained.

CONCLUSION

Off center load and die-to-die blow represent two extreme situations in forging which cannot be neglected because they are strongly responsable for structure excitation and noise emission. Under certain conditions strong primary-active measures like application of an auxiliary counter-force can help to reduce noise to a noticable extent.

REFERENCES

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[2] E.J. Richards et al., "On the prediction of impact noise, I: Acceleration noise", Journal of Sound and Vibration 62, 419-451, (1979).