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SCALE MODEL STUDIES OF STEAM HAMMER NOISE

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Introduction

Although the usefulness of physically scaled models is accepted in auditorium acoustics, and is becoming recognised in studies of sound propagation outdoors, their value in reproducing the noise of complex machinery within enclosed industrial environments remains undetermined. The work to be described here gives some preliminary assessment of the usefulness of a small scale model in the prediction of noise from steam hammers.

The Model

The model used in this work was a 1/12th scale model of a 10 cwt Rigby pattern, Ross type steam hammer. Although drop forging is much more common nowadays, small capacity steam hammers are still used, and the use of a scale model steam hammer with an accelerated tup has the advantage of producing a greater range of impact forces than would be possible using a fixed, and fairly restricted, drop height of a model drop hammer.

The model was operated from a supply of compressed air and the range of impact forces was gained by varying the pre-release air pressure. The small mechanical actuating lever (Figure 1) requires a degree of skill in operation in common with full size equipment, for repeatable blows. This mechanical system was eventually replaced by a solenoid operated valve to achieve greater consistency of impact force. Silencers fitted on the solenoid valve and on the hammer exhaust reduced the level of noise reaching the anvil from these sources to about 50 dB below the noise of the actual hammer blow.

The billets used were cold and flat faced, as commonly used in full scale experiments, to emphasise the impact noise produced by the tup striking the billet. The billets were 6.3 ± 0.5 mm. square sectioned bars having a length of 22 ± 0.5 mm. Two types of billet were used in these experiments; one of brass and the other of EN24 steel.

Results

Initial experiments indicated the possibility of highly fluctuating maximum peak values for model tests with constant conditions. It was postulated that a large number of repeated loads might be ~~producing an extraneous effect on the billet.~~ Further tests with substantially more loads cycled between extreme levels did not reveal any such behaviour.

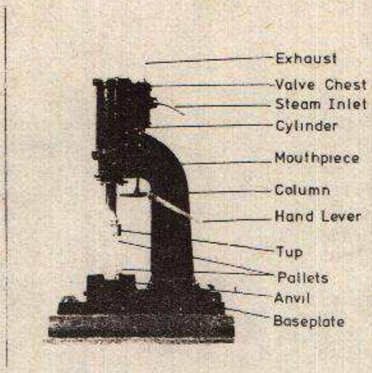

Figure 1

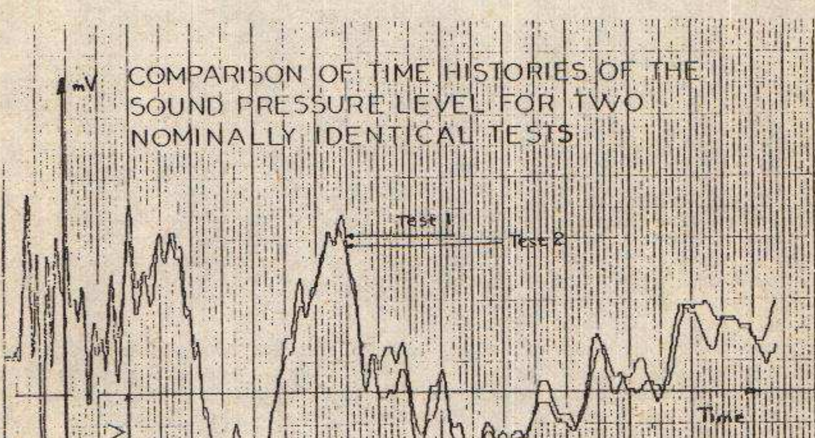

Figure 2

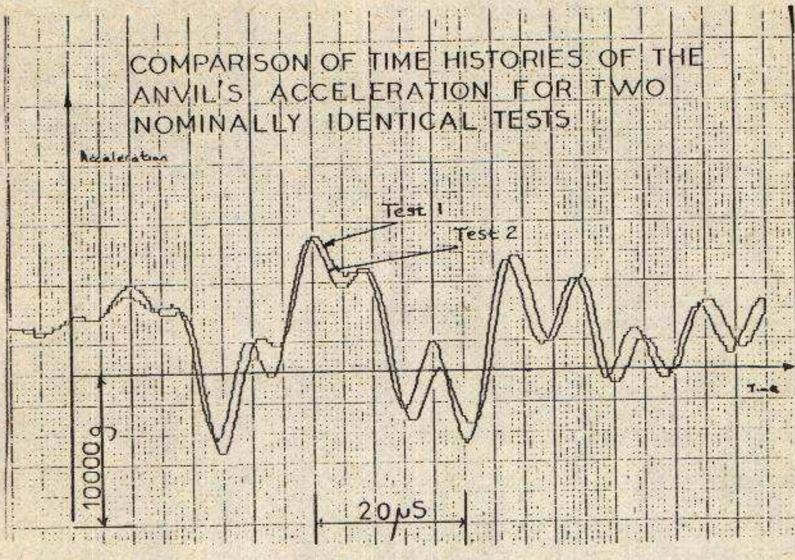

Figure 3

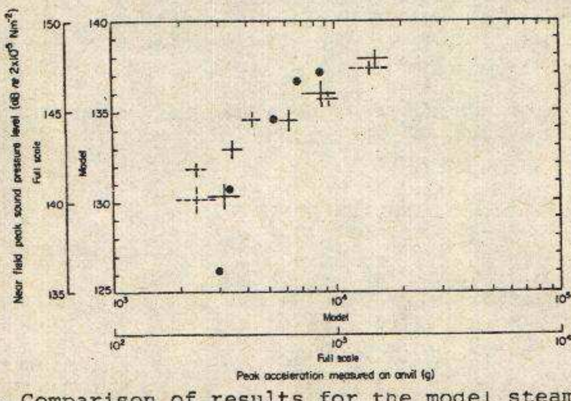

Figure 4. Comparison of results for the model steam hammer and a full scale CECO 60FD drop hammer [2] —, Steel model billet (E.N.24); ---, brass model billet (vertical and horizontal extensions show ± one standard deviation); ,● full scale drop hammer

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It became clear that the alignment between the tup and the billet was critical. A 1 mm deep locating slot was milled into the anvil pallet's surface to ensure reasonably constant positioning of the billet. Spacers were inserted between the cylinder and the tup's collar, and the friction restrained pallets were re-aligned if necessary, after each test. The modifications improved the consistency of results quite dramatically such that the form of the time histories of both the Sound Pressure Level and the anvil acceleration, remained virtually the same for repeated tests. Figures 2 and 3 show the close repeatability of the results, but peak levels still changed quite appreciably. Therefore the value of the maximum peak is meaningless if obtained from a single record. Conversely the mean of such values observed in ten nominally identical tests was found to be fairly stationary and hence repeatable. Hence, ten tests were performed consecutively at any one condition to enable the mean and standard deviation of the maximum peak values to be calculated.

Figure 4 (from reference 1) shows L_{peak} plotted as a function of peak anvil acceleration. The trend of these results also compares favourably with full scale work although there is an order of magnitude difference in levels.

Conclusion

This initial comparison suggests that trends observed for isolated full scale drop hammers might be duplicated by geometrically scaled and carefully operated models. A more detailed comparison is at present underway with a full size Rigby steam hammer in order to test if the ringing noise is simulated correctly. If this is so, then it may be that correspondence for L_{peak} between scale model and full size can be extended to the mean energy level, L_{eq} which might be more appropriate in an assessment of the noise nuisance of a steam hammer in a typical semi reverberant factory.

References

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Acknowledgment

The authors thank Academic Press Ltd. for their permission to reproduce Figures 1 and 4 which originally appeared in Reference 1.