NOISE REDUCTION IN A FACTORY WORKPLACE USING RAY TRACING METHOD

Jean-Luc Wojtowicki & Jean Nicolas
Acoustic and Vibration Group
Mechanical engineering dept.
University of Sherbrooke
Sherbrooke (Quebec)
J1K 2R1
CANADA

I- INTRODUCTION

This paper presents the results of a noise control study using the RAYSCAD+ software based on the ray tracing method developed by INRS [1].

The aim of this study is to test the efficiency and the accuracy of the ray tracing method applied to factory noise predictions. The originality of the work lies in the complete validation of the method on a real factory workplace instead of a well controlled laboratory case.

II- DESCRIPTION OF THE FACTORY HALL

The factory is 60 meters long, 29 meters wide and 6 meters high. It is separated in three areas: the fabrication area, the delivery area and the assembly lines (figure 1).

The noise sources (punch presses, cutting presses, ...) are located in the fabrication area. The broadband noise generated by impacts propagates through the factory hall from the fabrication area to the assembly lines as well as across the separating wall to the delivery area.

The problem in this study was to protect the workers on the assembly lines and in the delivery area from the fabrication area noise.

III- MODELING THE FACTORY HALL AND PRELIMINARY MEASUREMENTS

Because punch presses generate noise with a strong variability, the sound field in the factory has been characterized using a well controlled sound source.

Sound propagation decay and sound pressure level distribution have been measured and calculated using the RAYSCAD+ software. As a example, figure 2 presents calculated and measured sound propagation decay for the 1 kHz octave band. The comparison of the two curves demonstrate a very good agreement between calculated and experimental results. The difference is less than 2 dB at any distance from the source.

IV- DESCRIPTION OF THE STUDIED ACOUSTICAL TREATMENTS

The advantage of the RAYSCAD+ software lies in the possibility to make assessments of various scenarios of acoustical treatments.

It has been used to find the most promising ideas of treatments. It appears that the noise in the delivery area could be easily reduced raising a wall between the delivery area and the fabrication area (figure 3). The noise of the noisiest punching machines could be reduced with a partial enclosure (acoustical screens) around the machines (figure 4). And the best solution to decrease the sound propagation from fabrication area to the assembly lines was to use acoustical baffles hanging from ceiling.

V- MODELING THE ACOUSTICAL TREATMENT AND VALIDATION MEASUREMENTS

The modeling of the acoustical treatments has been made modifying the initial model. Absorbing planes were added to simulate the partial enclosure, the separating wall and the baffles.

The RAYSCAD+ software has been used to study several configurations of screens and baffles to obtain the highest reduction with the minimum absorbing material quantity. Parametric studies have been performed to optimize baffles (number, spacing, size, ...) and screen positioning.

The predicted reductions are given in table 1. These calculated results were presented to the company executives and engineers. The decision of settling up the acoustical treatment could have been taken knowing both the involved reduction and the cost.

The actual baffles were made of a sandwich of two 2.5 cm acoustic tiles separated by an air gap and supported by a light steel frame. The screens are made with 1.2 cm plywood boards, absorbing material in the inner face of the partial enclosure and protected by a perforated steel sheet. The separating wall is made of two corrugated steel sheets separated by an air gap and thermo-acoustic material (figure 6).

Figure 5 shows the sound propagation decay at 1 kHz. One can see that the agreement is good from 0 to 15 meters from the source and the calculated sound pressure levels are a bit overestimated from 15 to 25 meters. The measured reductions are given in table 1. The comparison of the calculated and measured reductions proves the efficiency of the method to predict reliable noise abatements. The main objectives of noise reduction in the factory were reached in the delivery area and in the assembly lines.

VI- CONCLUSION

The RAYSCAD+ software has proven its ability to guide decisions when an acoustical treatment is needed in a factory workplace. The main advantage is the possibility to associate predicted reduction and costs to various scenarios of acoustical treatments.

Actually there are several local discrepancies between calculations and measurements. Those errors are due to the calculation hypothesis of the ray tracing method which neglects phenomena like wave diffraction on the edge of screens. But for industrial applications where no detailed precision is needed, the method gives a good estimate on the sound field in a room.

VI- ACKNOWLEDGMENTS

The authors would like to thank the Venmar Company for its technical and financial support during this study.

VII- REFERENCES

[1]: A-M. Ondet and J-L. Barbry, "Modelling of sound propagation in fitted workshops using ray tracing", *J. Acoust. Soc. Am.I* **82**(2), 787-796 (1989).

[2]: M. Hodgson, "Case history: Factory prediction using ray tracing - Experimental validation and the effectiveness of noise control measures", *Noise Control Engineering Journal*, **33**(3), 97-104 (1989).

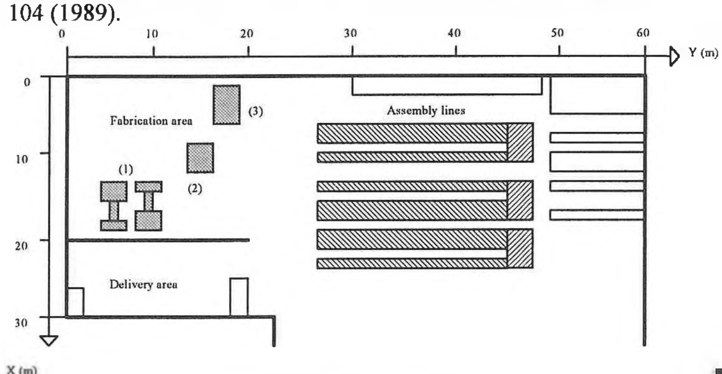

Figure 1. General overview of the factory hall

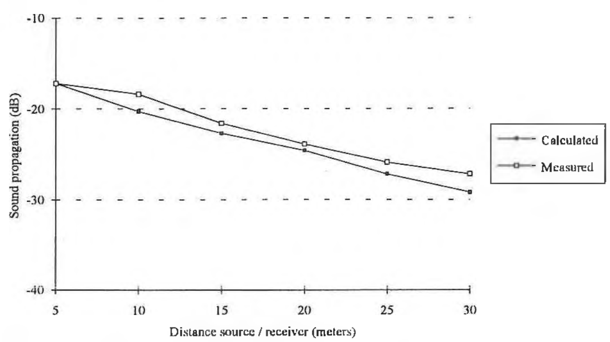

Figure 2. Sound propagation decay at 1 kHz before treatment

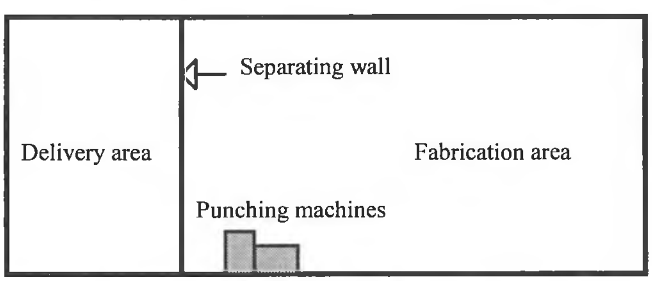

Figure 3. Separation wall between fabrication and delivery areas

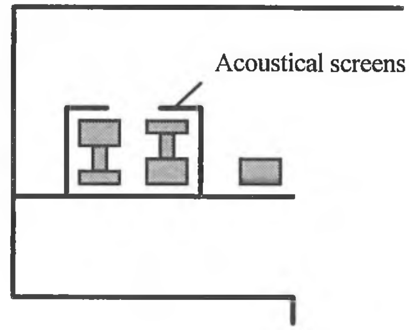

Figure 4. Acoustical screens around the pair of punching machines

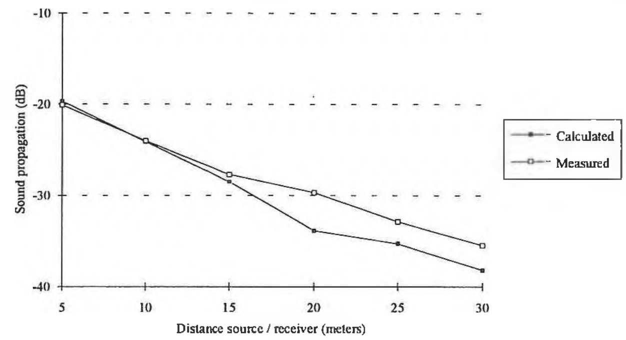

Figure 5. Sound propagation decay at 1 kHz after treatment

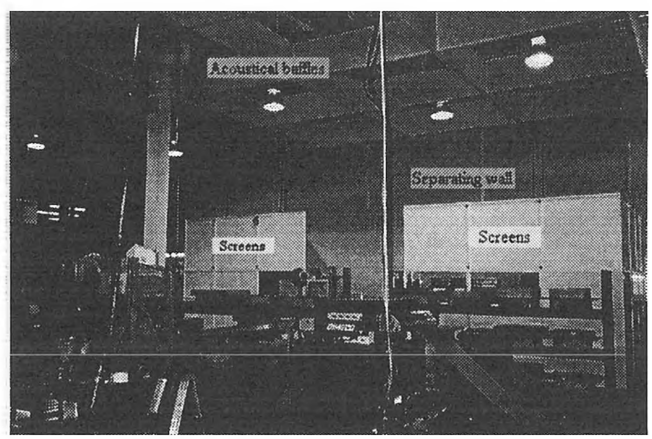

Figure 6. Actual acoustical treatment

	Calculated reduction	Measured reduction
Fabrication area	6 dB	5.5 dB
Assembly lines	8 - 12 dB	7 - 10 dB
Delivery area	12 dB	13.5 dB

Table 1. Predicted and measured reduction at 1 kHz