NOISE REDUCTION FOR A SHEET METAL SHEAR – A PROGRESSIVE APPROACH

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Introduction

The control of industrial noise, and the reduction of noise induced hearing loss among workers, remains a serious challenge to industry and to the engineering and acoustics communities. This is particularly the case in smaller manufacturing facilities where practical and effective noise control measures need to be retrofitted to existing machinery. This paper reviews a case study[1-4] where noise control measures were progressively developed for a manufacturing facility which produced roll-formed sheet metal for the building industry. The study demonstrates how noise control goals can be achieved through a step by step development process with the effectiveness of each measure being assessed at each stage of development.

BHP Building Products obtains coils of pre-coated sheet steel from a central production facility, however roll-forming operations are decentralised at smaller plants at many locations throughout Australia. The roll forming production line discussed in this case study was one of approximately 100 similar roll-forming lines operated by the company. The sheets, metal thickness approximately 0.45 mm, were roll-formed to a sinusoidal or corrugated profile typically used as a roofing material. Sheets were approximately 900 mm wide and cut to various lengths to suit customer requirements using a flying shear, Figure 1. The high level of impact noise produced by the shear was the most significant source of noise on the production line.

Noise Source Assessment and Measurement

Prior to the development of control measures, it was necessary to identify which components of the operation were the major radiators of noise. This was done by recording the sound pressure signal using a PC based data acquisition system so that sound emissions could be correlated with mechanical operations during the shearing process, Figure 2. Additionally, an accelerometer was used to measure the vibration of various machine components, simultaneously with noise measurements, to further assist in identifying the noise sources. These preliminary measurements

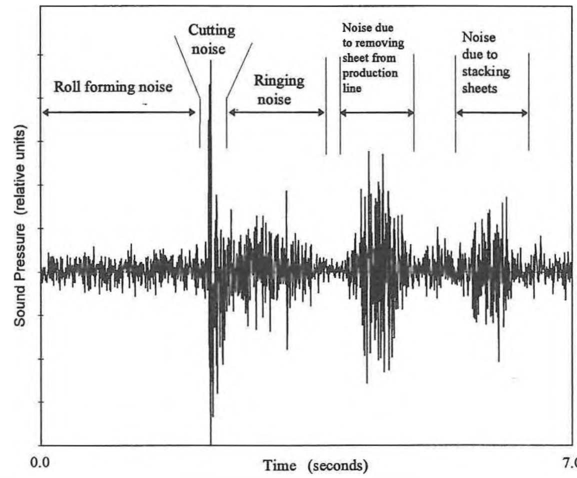

Figure 2 Typical sound pressure during roll-forming

showed that the shearing process resulted in high levels of transient vibration in the sheet product which were the major source of impact noise for the process. It was clear that the control of these transient vibrations travelling upstream and downstream from the shear would be the key to effective noise control.

The noise measurement procedure allowed the impact noise due to shearing to be separated from noise due from other sources such as material handling. The analysis was primarily based on the A-weighted L_{max} and L_{eq} for just the shearing part of the operation. It was found that the noise produced during a shear cut varied by several dB depending on the length of sheet being cut. Hence a standard product length of 5 m was used so that the effectiveness of noise control measures could be evaluated.

Noise Control Measures

Having established a suitable measurement procedure, a series of noise control measures were applied to the shear. The results in terms of A-weighted L_{max} and L_{eq} are shown in Figure 3.

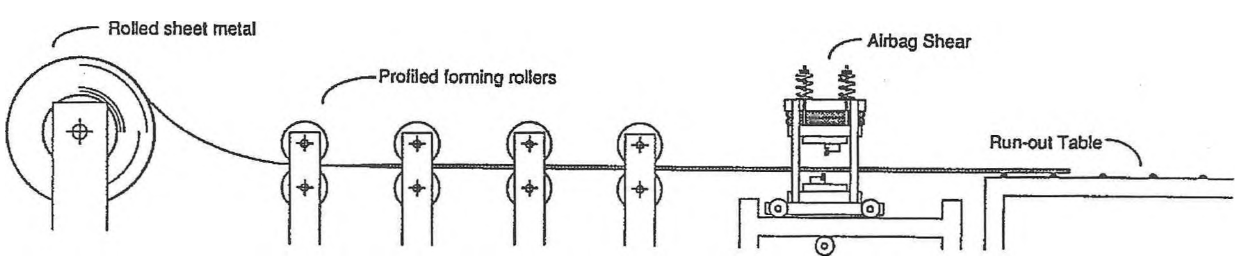

Figure 1 Roll-forming production line

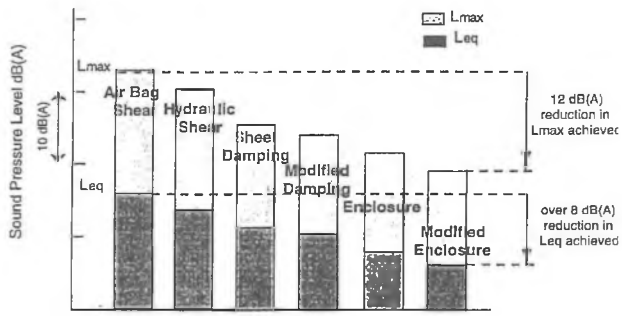

Figure 3 Results of noise control measures

Hydraulic Shear At other production facilities the pneumatic (air bag) shear operating mechanism had been replaced by hydraulic operation resulting in an improved control of the shear stroke. When this modification was applied to the shear under study approximately 2 to 3 dBA reductions in noise levels were achieved. These reductions were attributed to a better controlled and slower shear blade movement.

Sheet Damping To reduce the sheet vibrations induced by shearing, sheet dampers were developed. It was found that these dampers needed to be located as close as possible to the shear blades, say within 10 to 15 mm, in order to be effective. Polyurethane dampers were developed which were profiled to the shape of the sheets and operated in conjunction with the motion of the shear blades. As can be seen in Figure 3, these dampers, particularly after some modifications, resulted in reductions of 5 to 6 dBA.

Enclosure Following the above measures, an enclosure was built over the shear with entry and exit apertures for the product. Double glazed windows and a door gave the operator good visual and physical access to the shear. Heavy vinyl sheeting was used to block air-borne sound transmission at the entry and exit apertures. The further sound reduction achieved, 2 to 3 dBA, was beneficial but was far less than the 10 to 15 dBA, say, which might be expected from a full enclosure. This lack of effectiveness is due to two factors. Firstly it is not practical to completely seal the entry and exit apertures to air-borne noise. Secondly the transient vibrations readily travel along the sheet and out of the enclosure resulting in structure-borne impact noise being radiated by the sheet.

Modified Enclosure Powered rollers were installed at the exit aperture of the enclosure. As well as assisting in transporting the cut sheet out of the enclosure, the rollers reduced vibrations in the downstream portion of the sheet. This modification led to a further 2 to 3 dBA reduction in noise. In essence, structure-borne noise, due to vibrations travelling downstream along the sheet, was reduced by the rollers. (Similar measures were not applied at the entry side of the enclosure because the sheet was already well constrained there by the roll-former. Accelerometer measurements had shown that the vibrations were considerably larger in the sheet downstream of the shear. Once the cut has occurred, the cut sheet was virtually unconstrained.)

Following all these modifications, measurements of the noise exposures of plant operators were carried out under a variety of production circumstances. The exposures included noise from the shear plus other sources such as material handling noise. These measurements showed that the factory could be operated ear-muff-free under most production conditions.

Further research and development work[5] has studied improved blade profiles as a means to reduce shear noise. New blade designs have been developed which give a much smoother shearing action and have the potential for further noise reductions of the order of 6 dBA.

Conclusions

This case study shows how relatively low-cost retrofit noise reduction measures can be successfully applied to existing machinery through a progressive or evolutionary development process. In many instances this will be more practical and cost effective than replacing existing machinery with less noisy new equipment. In many specialised processes, there may be no obvious suppliers of less noisy equipment and a developmental approach may be preferred in order to control costs and avoid risks.

Essential steps in this approach are as follows.

- Establish the noise source and noise generating mechanisms
- Establish noise measurement techniques which can evaluate the effectiveness of retrofit measures
- Develop retrofit measures in collaboration with plant management, operators and maintenance personnel in order to ensure that measures are practical and cost-effective. At each stage of development, retrofit measures are evaluated for effectiveness.

Acknowledgements

This study was jointly carried out by the Acoustics and Vibration Unit at the Australian Defence Force Academy and by engineering staff at BHP Building Products. The authors express their appreciation for the support and encouragement of Worksafe Australia, BHP Building Products and the University of New South Wales.

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