NOISE REDUCTION FOR SHEET METAL INDUSTRY ACHIEVED WITH AUTOMATIC STACKER

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ABSTRACT: The aim of this study was to demonstrate the noise reduction which could be achieved in a roll formed sheet metal production line when manual handling was replaced with automatic stacking. The handling noise was generated when finished sheets of profiled thin metal were moved from a runout table, and placed or dropped onto a stack. Sources of noise included impact or sliding contact between the product and parts of the machinery, and impact or sliding contact between product pieces. Considerable noise is normally generated when sheet product is dropped from a height onto a stack or the floor. While the primary incentive for the automatic stacker was to reduce the risk of back injury by eliminating much manual material handling, the noise exposure for the operator was also reduced with little additional cost by careful consideration at the design and implementation stages for the project.

1. INTRODUCTION

This study was part of a collaborative research project sponsored by Worksafe Australia, undertaken by the Acoustics and Vibration Unit (AVU) and BHP Building Products (BHP-BP). The aim of the project was to demonstrate techniques for the reduction of impact noise in industry using simple, cost effective retrofit noise reduction measures. Roll formed sheet metal products, which come in a variety of profiles, thicknesses and surface coatings, are used extensively for roofing, walling and fencing of industrial and domestic buildings. The flat sheet metal is uncoiled and passed through a series of rollers to form the finished product profile. Once formed, the profiled product is cut to length using a shear which typically impacts the sheet at high velocity, see Figure 1. It was found that once significant reduction had been achieved for the impact noise from the shearing process [1], the next main source of noise for the operator of the production line was the stacking process where sheets of profiled thin metal are moved from the runout table, in some cases turned over, and dropped onto a stack. Replacement of manual stacking with an automatic stacker has the potential for reducing two major occupational health and safety concerns. One is back injuries from materials handling and the other is high noise exposure, particularly that which occurs when the metal sheets are dropped onto a stack.

A roll formed sheet metal production line for the manufacture of a product called Bondek was selected for this case study. Bondek is made from high strength zinc-coated steel which is used as both a permanent formwork and positive tensile reinforcement in suspended concrete slab construction. It is formed from sheet steel of thickness varying from 0.75 to 1.0 mm into a profiled product normally 600 mm wide. A Bondek line was selected for study because it was known that high noise levels were associated with manual handling and stacking of this product. The design and development of an automatic stacker for this production line was carried out by engineering staff at BHP-BP in consultation with members of the AVU. Detailed noise assessment and evaluation of the manual and automatic stacking processes were carried out by the AVU and are the subject of this case study report.

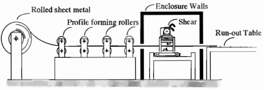

Figure 1 Schematic diagram of roll forming operations

2. THE MANUAL STACKING PROCESS

The finished sheet metal products, after being roll formed and cut to length, continue onto a run out table for stacking. In the manual handling procedure, either one or two operators, depending on the product and the length, drag the sheet from the runout table, turn over every second sheet and drop it onto the nearby stack, see Figure 2. This operation has to be done quickly to ensure that the sheet is removed from the table in time for the next sheet coming through the roll former. When the required number of sheets have accumulated in the stack for an order, the stack is strapped ready for dispatch.

Figure 2 Manual stacking of roll formed product

One of the operators normally stands very close to the shear, which in itself can be a source of high impact noise. The noise during the dragging of the sheet from the run out table is generally not too high. The noise as the sheet drops onto the stack can be quite high depending on the length, mass and profile of the sheet, the height of the drop and the orientation of the sheet as it hits the stack. All those in the vicinity can be exposed to high impact noise levels requiring personal hearing protection.

3. MEASUREMENT PROCEDURES

Sound pressure level measurements were conducted using a Brüel & Kjær (B&K) type 2231 sound level meter fitted with a BZ7110 Integrating Module. For more detailed analysis, the sound level meter was connected to a Toshiba T3200SXC personal computer and noise measurements were recorded via a Boston Technology PC30DX analog to digital data acquisition card.

The data acquisition system provided a continuous record of noise levels so that a detailed analysis of noise levels during the various stages of the stacking process could be carried out. The microphone was placed at a height of 1.5 m and close to the operator's normal position for all tests. The product size was kept to a standard size, 6 m length and 1 mm product thickness so that comparisons could be made between the noise from manual stacking and from automatic stacking as well as assessment of the effects of modifications during the development of the automatic stacker.

4. DESIGN OF STACKER

The functional requirements for the automatic stacking process were the same as those for the manual stacking. The formed sheet must first be moved from the run out table. Every second sheet must be turned over so that stacking is efficient and stable. The sheets must also be moved longitudinally to ensure that the ends are lined up when they are added to the stack. The automatic stacker uses pneumatic rams plus some driven rollers on the table to perform these various movements and also caters for a range of product lengths from 1.5 m to 12 m.

The goals of efficiently performing the stacking and minimising the noise were treated as equally important considerations during the design of the stacker. The prototype was initially installed in a testing environment so that all the aspects of its performance could be checked and modified as necessary before it was put into the production environment. While it was immediately obvious that the main impact noise from the sheet drop had been significantly reduced, design modifications were made to further reduce the noise during operation. This noise analysis guided changes which were made to the design to further reduce the operating noise level. Once this modified stacker was shown to work satisfactorily it was installed in a production environment where it has continued to perform effectively for over two years.

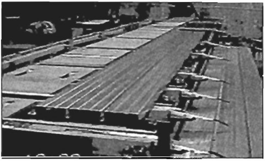

Figure 3 The sheet has been cut to length and pushed from the runout table prior to being rotated. The "rubber fingers" can be seen on the end of the horizontal arms.

5. RESULTS AND DISCUSSION

The detailed noise data from individual stacker operations were examined during the development process for the automatic stacker and changes made to the design to further reduce the operating noise level before the stacker was placed in the production environment. Typical modifications included polyurethane coatings applied to the rollers, reduction of the speed for the turn over and installation of rubber "fingers", on the ends of the horizontal stacker arms to allow the sheet to be placed more gently onto the stack. These "fingers" were of 10 mm thick rubber, as used in conveyor belts. The effects of some of these modifications can be seen from Figures 4 and 5.

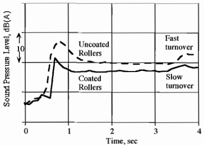

Figure 4 Sound Pressure Level during the push across from the run out table and the turn over of the sheet. The reduction in noise level from the use of the coated rollers and the reduced turn over speed can be clearly seen.

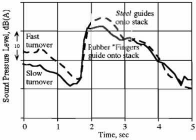

Figure 5 Sound Pressure Level for the completion of the turn over of the sheet and the drop onto the stack. The reduction in noise level from the use of the reduced turn over speed and the rubber "fingers" on the guide arms can be clearly seen.

The comparison of the noise for the operator when manual stacking in the Bondek production environment was replaced by the automatic stacker can be seen in Figure 6. The very high impact noise from the new sheet dropping onto the stack has been removed. The maximum noise level during the process has been reduced by over 20 dB(A). The L_{Aeq} for one cycle in the stacking process, over a period of 15 sec, has been reduced by 8 dB(A).

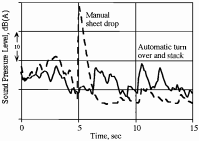

Figure 6 Noise levels for the operator for the manual and the automatic turn over and drop.

6. CONCLUSIONS

This case study has shown that the high levels of impact noise from manual stacking of profiled roll formed sheet steel can be greatly reduced by the use of a well designed automatic stacker. The major impact noise was from the dropping of the sheet onto the stack. The level of this noise depended on the length, mass and profile of the sheet, the height of the drop and the orientation of the sheet as it contacted the stack. In this study, the automatic stacker was designed to move the sheet from the run out table, to rotate every second sheet, to line up the end of the sheet and to place the sheet onto the stack ready for packing. These movements were performed with pneumatic rams and driven rollers.

The prototype stacker performed all the required tasks and a detailed noise investigation identified the parts of the stacking process where further noise reduction could be achieved. The modifications, which further reduced the noise of individual parts of the process included:

- polyurethane coatings on the rollers for the run out table and the stacking table;
- reduction in the speed of the turn over ; and
- rubber "fingers" on the ends of the horizontal stacker arms.

Noise measurements in the production environment showed that the maximum noise during stacking was reduced by over 20 dB(A) and that the L_{Aeq} during the 15 second stacking process was reduced by 8 dB(A). The additional costs for these modifications were very minor in the total cost for the stacker, of the order of 2%.

The above achievements in noise reduction apply to the specific roll forming operation used for this study. However, techniques which can be used to achieve significant noise reduction in product stacking applications in the sheet metal industry have been illustrated.

REFERENCES

1. Burgess M., Williamson H.M., Speakman C., "Some Experiences With Noise Control For Roll Former Shears", Internoise 98, 16-18 Nov, Christchurch paper 279 (1998).

6. ACKNOWLEDGMENT

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