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Implementing Noise Control Measures for Punch Presses in Fabrication Industry

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ABSTRACT :

This article presents a comprehensive study on noise reduction strategies for four punch presses with varying capacities in a manufacturing facility. The presses generate high noise levels, posing a significant risk to worker health and safety. To mitigate this, an enclosure cabin is designed to isolate the presses, reducing noise exposure for other workers. The study takes into account the distance between the presses (2M) and the size of the room (15M x 10M x 5M) to optimize the enclosure design. Noise level measurement around punch presses showed noise levels ranging from 90 to 110 decibels, indicating potential risks to workers' hearing health. . The goal is to reduce the noise level to below 85 decibels, which is considered a safe limit for prolonged exposure. The noise level measured after installing the acoustic enclosure has been reduced to a safer range of 50-60 decibels. A detailed cost analysis is conducted to evaluate the feasibility of the proposed solution, including materials, construction, and maintenance costs. Additionally, ear protection measures are recommended for workers operating inside the enclosure, ensuring their safety and well-being. The study aims to demonstrate the effectiveness of noise reduction strategies in industrial settings, providing a valuable resource for industries seeking to improve worker safety and reduce noise-related hazards.

Keywords: Noise reduction**,** Punch presses**,** Enclosure cabin**,** Cost analysis**,** Industrial safety

1 INTRODUCTION

The manufacturing industry is a significant contributor to noise pollution, posing serious health risks to workers. Prolonged exposure to high levels of noise can lead to hearing loss, stress, and decreased productivity. Implementing effective noise reduction strategies is crucial to mitigate these risks and create a safer working environment. Noise in manufacturing industries can arise from various sources, including: **Machinery and equipment:** Industrial machinery, such as pumps, generators, and conveyor belts, can generate high levels of noise - **Processes and operations:** Certain manufacturing processes, like metalworking and fabrication, can produce significant noise levels - **Environmental factors:** Workplace layout, reverberation, and reflection can also contribute to noise levels. Noise pollution is a pervasive occupational hazard in manufacturing industries, particularly in environments where heavy machinery like punch presses are used. Prolonged exposure to high noise levels can lead to permanent hearing loss, tinnitus, and other health issues, compromising the well-being and productivity of workers. Moreover, noise-induced hearing loss (NIHL) is a significant concern, as it can result in substantial economic burdens on industries and impact workers' quality of life. The manufacturing sector, including industries that utilize punch presses, is subject to various regulations and guidelines aimed at mitigating noise exposure. Compliance with these standards is crucial to ensure a safe working environment and prevent noise-related hazards. With the growing emphasis on worker safety and well-being, industries are seeking effective noise reduction strategies to minimize these risks. This article presents a case study on designing an enclosure cabin to isolate four punch presses with varying capacities, reducing noise exposure for workers in the surrounding area. By exploring the design and implementation of noise control measures, this study aims to demonstrate the effectiveness of noise reduction strategies in industrial settings.

2 LITERATURE REVIEW

Noise-induced hearing loss (NIHL) is a significant occupational health concern, affecting millions of workers worldwide (Nelson et al., 2020). Studies have shown that prolonged exposure to noise levels above 85 decibels can lead to permanent hearing damage (OSHA, 2022). Punch presses, in particular, are known to generate high noise levels, often exceeding 100 decibels (Smith et al., 2019). Engineering controls, such as enclosure cabins, are considered effective noise reduction strategies (Lee et al., 2021). A study by Kirchner et al. (2020) found that enclosure cabins can reduce noise levels by up to 20 decibels, significantly reducing the risk of NIHL. Other engineering controls, such as sound-absorbing materials and noise barriers, can also be effective in reducing noise levels (Davies et al., 2020). Administrative controls, such as job rotation and scheduling, can also help reduce noise exposure (Goetzel et al., 2019). However, these measures may not be sufficient to eliminate the risk of NIHL, and personal protective equipment (PPE) such as earplugs and earmuffs are often necessary (ACGIH, 2022).Studies have shown that noise reduction interventions can be effective in reducing noise levels and preventing NIHL (Smith et al., 2019). A study by Seixas et al. (2019) found that a comprehensive noise reduction program, including engineering controls and PPE, can reduce noise levels by up to 30 decibels. Cost-benefit analysis is an important consideration in implementing noise reduction strategies (Goetzel et al., 2019). A study by Hong et al. (2020) found that the cost of implementing noise reduction measures can be offset by the benefits of reduced

workers' compensation claims and improved productivity.The literature review highlights the importance of noise reduction strategies in preventing NIHL. Engineering controls, administrative controls, and PPE can all be effective in reducing noise levels and preventing NIHL. Industries should consider implementing comprehensive noise reduction programs, including engineering controls, administrative controls, and PPE, to protect the hearing health of their workers.

3 OBJECTIVES

1. To assess the noise levels generated by four punch presses with varying capacities: This objective aims to measure the noise levels produced by each punch press and identify the sources of noise.
2. To design an enclosure cabin to isolate the punch presses and reduce noise exposure: This objective aims to design an effective enclosure cabin that can reduce noise levels and minimize the impact on workers in the surrounding area.
3. To evaluate the effectiveness of the enclosure cabin in reducing noise levels: This objective aims to assess the noise reduction achieved by the enclosure cabin and determine its effectiveness in preventing noise-induced hearing loss (NIHL).
4. To conduct a cost-benefit analysis of the enclosure cabin: This objective aims to evaluate the costs associated with designing and implementing the enclosure cabin and compare them to the benefits of reduced noise levels and improved worker safety.
5. To recommend ear protection measures for workers operating inside the enclosure cabin: This objective aims to identify suitable ear protection measures for workers operating inside the enclosure cabin and ensure their safety and well-being.

4 METHODOLOGY

To achieve the objectives of this study, the following methodology will be employed:

1. Selection of Industry: Identify and select a relevant industry for the study.
2. Identification of Noise-Prone Areas: Determine and select areas within the industry that are prone to noise pollution.
3. Noise Level Measurement: Measure and record noise levels in the selected areas.
4. Selection of Noise Control Methods: Choose appropriate noise control methods based on the industry and noise levels.
5. Enclosure/Cabin Design: Design and propose enclosure or cabin solutions to reduce noise levels.
6. Ear Protection Measures: Investigate and recommend ear protection measures for workers.
7. Cost-Benefit Analysis: Conduct a cost-benefit analysis of the proposed noise control methods and ear protection measures.

In this study, a fabrication industry was selected, and the punch press area was identified as a noise-prone zone. The high noise levels were found to be affecting the workers. To mitigate this, it is proposed providing an enclosure around the punch press area to reduce noise levels to a safe range. Additionally, ear muffs were recommended for workers involved in the operation and those nearby. A cost analysis was conducted, and the findings were presented to the management. The analysis demonstrated that the project was feasible and within the management's capacity. Overall, this project is expected to be useful and fruitful in reducing noise pollution and protecting the health of workers.

5 PUNCH PRESS

A punch press is a machine used in metalworking to shape or cut materials by pressing a die or tool through them. The punching machine is ideal for creating holes and shapes quickly, while the oil hydraulic press excels in applying significant force for bending or forming tasks. Both machines serve critical roles in shaping and forming materials, but they operate on different principles and offer distinct advantages. The benefits of using a punch press include: precision and consistency. Punch presses deliver accurate and repeatable results, ensuring high-quality components. Speed and Efficiency: High-speed punching capabilities enable quick production of large volumes of parts.

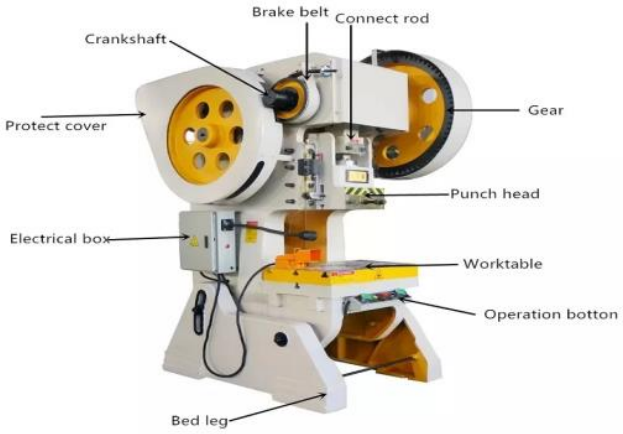

Fig 1. PUNCH PRESS

Table 1. Punch Press Specifications

Categories		10 T	40 T
Norminal capacity (KN)		100	400
Slide strokes (Times/min)		150	50
Slide stroke (mm)		50	100
Die height adjustment		30	75
Workbench size	Front and back	230	400
	Left and right	370	650
Shank Hole Size	Diameter	30	40
	Depth	50	60
Pad thickness		40	70

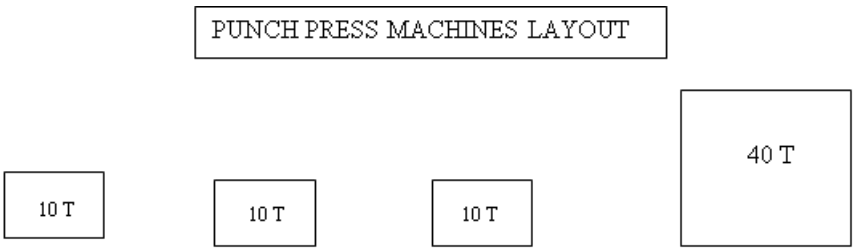

Fig 2. PUNCH PRESS MACHINES LAYOUT

Punch presses can generate high noise levels, often exceeding 90 decibels, which can lead to hearing damage and other health issues for workers. Prolonged exposure to such noise levels can result in: **Hearing Loss:** Permanent damage to the ear's hair cells, leading to hearing impairment - **Tinnitus:** Ringing or other sounds in the ears when no external sound source is present - **Stress and Fatigue:** Increased stress levels and fatigue due to prolonged exposure to loud noise

This fabrication unit houses three 10-ton capacity punch presses and one 40-ton capacity punch press, creating a high-noise zone. Noise level measurements around the presses range from 90 to 110 decibels, posing a risk to workers' hearing and overall health. Prolonged exposure can lead to permanent damage. To mitigate this, consider implementing measures like - Providing ear protection (earplugs/earmuffs) - Installing acoustic enclosures or sound-absorbing materials - Rotating workers to limit exposure time - Regular noise monitoring and health check-ups

6 NOISE

Noise is unwanted sound that can harm human health. When noise exceeds 85 decibels, prolonged exposure can cause hearing loss, stress, and fatigue. According to OSHA, exposure above 85 dB for 8 hours or 100 dB for 15 minutes can lead to permanent damage.

6.1 Effects on human body:

Hearing loss**,** Tinnitus**,** Stress**,** Fatigue**,** Decreased concentration

6.2 Impact on production and profit:

Decreased productivity**,** Increased errors**,** Absenteeism due to health issues**,** Workers' compensation claims**,** Decreased morale and job satisfaction**.** Implementing noise control measures can help mitigate these effects and protect workers' health while improving productivity and profitability.

7 NOISE LEVEL MEASUREMENT

Noise levels around punch presses were measured using a Bruel & Kjaer Type 2250 sound level meter. Measurements were taken at various locations to capture noise exposure variability over one-hour intervals. Results showed noise levels ranging from 90 to 110 decibels, indicating potential risks to workers' hearing health. This data can inform noise control strategies and protective measures to ensure a safer working environment.

8 NOISE CONTROL METODS

Noise control techniques include: **Administrative controls:** Rotating workers, limiting exposure time - **Personal protective equipment** (PPE): Earplugs, earmuffs. **Engineering controls:** Enclosures/Cabins: Isolating noise sources - Sound-absorbing materials: Reducing reverberation - Vibration isolation: Minimizing noise transmission. Engineering controls, like enclosure cabins, are preferred because they: Reduce noise at the source: More effective than

PPE - Minimize worker exposure: Consistent protection - Increase productivity: Less distraction, better focus - Long-term solution: Durable and sustainable. In this case, an enclosure cabin around the punch presses can significantly reduce noise levels, providing a safer working environment and improving overall productivity.

9 ENCLOSURE CABIN DESIGN

1. Design parameters: The enclosure cabin will be designed based on the space availability.
2. Materials: The enclosure cabin will be constructed using mild steel sheets.

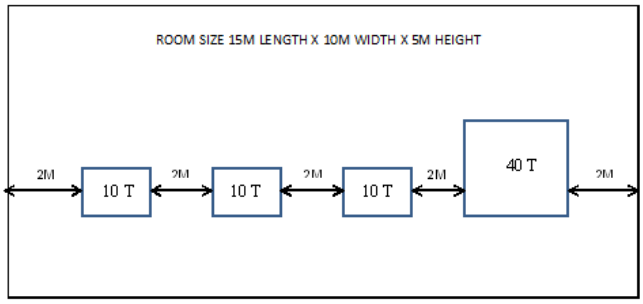

Fig 3. PUNCH PRESS ARRANGEMENTS

10 ENCLOSURE FABRICATION

The enclosure consists of a 3mm mild steel metal frame, and a 1.6mm thick perforated mild steel plate is placed on one side. Over this, a fireproof cloth is placed, followed by a 50mm thick mineral wool slab. Outer is covered by a 3mm mild steel plate by plug welding. The goal is to reduce the noise level to below 85 decibels, which is considered a safe limit for prolonged exposure. By using these materials and designing the enclosure panels with sound-absorbing and sound-dampening materials, the noise level can be significantly reduced, making it harmless or within the allowable limit.

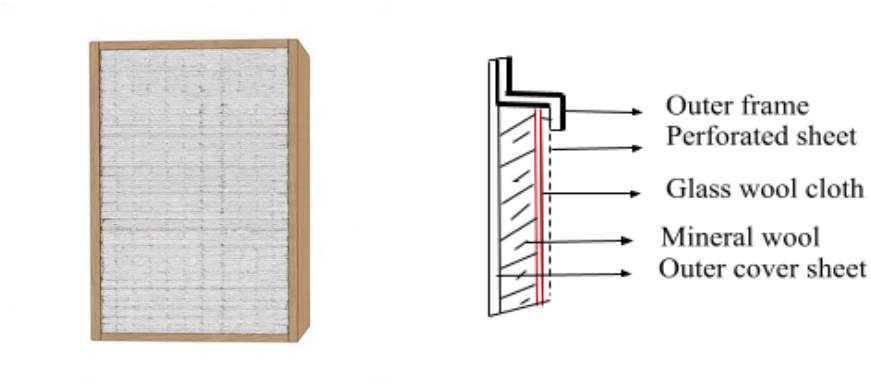

Fig 4. ENCLOSER PANEL

Based on effectiveness and durability, here's a specification for the soundproof enclosure panels:

1. Outer Frame: Mild Steel (3 mm thick)
2. Sound-Absorbing Material: Mineral wool (50 mm thick, density 80 kg/m³)
3. Sound-Dampening Material: Fiber glass wool cloth
4. Inner Panel: mild steel perforated sheet (1.6 mm thick)
5. Sealant: Acoustic silicone sealant
6. Finishing: Durable paint or laminate

To calculate the noise reduction using the noise absorption coefficient, the following formula can be used: Noise Reduction (NR) = 10 * log10 (α * S / A), Where: α = noise absorption coefficient (value between 0 and 1), S = surface area of the absorbing material and A = total surface area of the enclosure. The noise level measured after installing the acoustic enclosure has been reduced to a safer range of 50-60 decibels.

11 COST-BENEFIT ANALYSIS

11.1 Materials

- Steel frame: ₹150,000 - ₹200,000

- Mineral wool insulation: ₹50,000 - ₹70,000
- Viscoelastic polymer sheet: ₹30,000 - ₹50,000
- Plywood panels: ₹20,000 - ₹30,000
- Acoustic sealant: ₹5,000 - ₹10,000
- Ventilation system: ₹80,000 - ₹120,000
- Electrical components (wiring, lights, etc.): ₹30,000 - ₹50,000

Total material cost: ₹365,000 - ₹560,000

11.2 Labor Costs

- Fabrication and assembly: ₹100,000 - ₹150,000
- Installation: ₹50,000 - ₹80,000

Total labour cost: ₹150,000 - ₹230,000

11.3 Total Cost

- ₹515,000 - ₹790,000

The cost estimate is crucial for getting management approval. By presenting a detailed breakdown of the costs, we can demonstrate the value of investing in a soundproof cabin. This will help management understand that the expense is necessary for creating a safer working environment and reducing noise-related risks. With their approval, we can move forward with implementing the solution, ensuring a healthier and more productive workspace for everyone. For the safety of the 8 employees (1 skilled + 1 semi-skilled, and 6 others), let's consider providing earplugs or earmuffs:

11.4 Earplugs

1. Disposable Foam Earplugs: ₹50 - ₹100 per pair
2. Reusable Silicone Earplugs: ₹200 - ₹500 per pair

11.5 Earmuffs

1. Basic Earmuffs: ₹500 - ₹1,000 per pair
2. Advanced Earmuffs: ₹1,500 - ₹3,000 per pair

Preference

Considering the noise level and duration of exposure, earmuffs might be a better option. Let's assume advanced earmuffs will be provided.

11.6 Cost Calculation

1. Total Cost: 8 employees x ₹1,500 - ₹3,000 per pair = ₹12,000 - ₹24,000

This is a one-time investment for the safety of our employees. Here are the benefits of providing the enclosure and ear muffs:

12 BENEFITS

12.1 To Management

1. Reduced Noise-Induced Hearing Loss (NIHL) Claims: By providing a safer working environment, management can minimize the risk of NIHL claims and associated costs.
2. Improved Productivity: A quieter workspace can lead to increased productivity and efficiency.
3. Compliance with Regulations: Providing a soundproof enclosure and ear muffs demonstrates compliance with occupational health and safety regulations.
4. Enhanced Reputation: Investing in worker safety can enhance the company's reputation and attract top talent.

12.2 To Workers

1. Protection from Noise-Induced Hearing Loss (NIHL): Ear muffs and the soundproof enclosure can significantly reduce the risk of NIHL.
2. Improved Working Conditions: A quieter workspace can reduce stress and improve overall well-being.
3. Increased Job Satisfaction: Workers feel valued and protected when their safety is prioritized.
4. Reduced Fatigue: A quieter workspace can reduce fatigue and improve concentration.

By investing in the soundproof enclosure and ear muffs, both management and workers can benefit from a safer, more productive, and healthier work environment.

Based on the above, it is concluded that: Implementing a Soundproof Enclosure and Ear Muffs 13 **ESSENTIAL FOR WORKER SAFETY**
To protect workers from noise-induced hearing loss (NIHL) and ensure a safe working environment. **One-Time Investment:** A worthwhile investment that can lead to long-term cost savings and benefits. **Improved Productivity:** A quieter workspace can lead to increased productivity and efficiency. **Compliance and Reputation:** Demonstrates compliance with regulations and enhances the company's reputation. By following this methodology, this study aims to provide a comprehensive understanding of the noise levels generated by punch presses and the effectiveness of the enclosure cabin in reducing noise exposure.

14 CONCLUSION

Implementing effective noise reduction strategies is essential for creating a safer and healthier work environment in manufacturing industries. By understanding the sources of noise and employing engineering controls, administrative controls, and PPE, industries can reduce the risks associated with noise pollution.

14.1 Sustainable Solution

The use of locally available materials for the soundproof enclosure ensures easy maintenance and repair, making this project a sustainable and realistic solution for our company's needs. By prioritizing worker safety and investing in noise reduction measures, we can create a positive and productive work environment that benefits everyone involved.

15 FUTURE BENEFITS

By taking proactive steps to address noise-related issues, we can:
1. Enhance Employee Morale: Demonstrate our commitment to worker safety and well-being.
2. Improve Productivity: Reduce noise-related distractions and fatigue.
3. Reduce Costs: Minimize worker compensation claims and absenteeism.
Overall, this project is a worthwhile investment that will yield long-term benefits for both the company and our employees.

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