Meltshop Tackles Challenging Fall Protection Issue

Hazards are ever-present in the steel plant environment, and a heightened awareness and emphasis on safety is a necessary priority for our industry. This monthly column, coordinated by members of the AIST Safety & Health Technology Committee, focuses on procedures and practices to promote a safe working environment for everyone.

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Comments are welcome. If you have questions about this topic or other safety issues, please contact safetyfirst@aist.org. Please include your full name, company name, mailing address and email in all correspondence.

The environment within any meltshop in the steel industry is one of extremes. This high-heat environment requires any equipment used in the meltshop to be designed and engineered with this in mind. Recently, a steel mill witnessed how equipment that is not designed for these extremes can be stressed to a critical state. When this type of failure is found on a piece of fall protection equipment that is intended to save lives — and is located 120 feet above the lower level — the organization knew something needed to change.

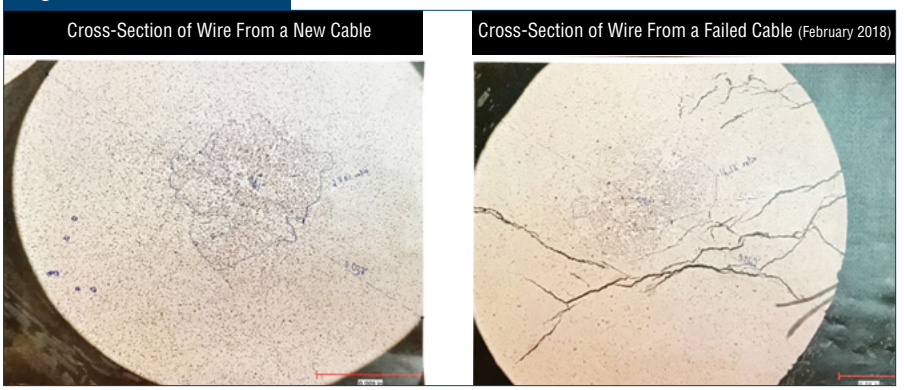
Prior to conducting work on the crane, the maintenance crew was performing a routine Competent Person inspection that included the horizontal lifelines used for fall protection on the meltshop charge cranes. During the inspection, a section of the lifeline was found to be deteriorated, as shown in Fig. 1. The damaged lifeline, which had been installed 5 years earlier, was replaced, and no other lifelines were found in the same condition. Approximately 16 months later, another horizontal lifeline in the meltshop began to show similar signs of damage. During a visual inspection, broken wires were observed on the outer layer of the wire rope, and once removed from service, the lifeline laid broken in short pieces approximately 2 inches long.

A visual inspection of one such horizontal lifeline, which had been in the meltshop for just 3 months, showed no signs of stress or failure. Even though no concerns were identified, the decision was made to remove it and test the material. After the cables were removed and coiled up, they failed — with the outer layer once again breaking into pieces approximately 2 inches long.

Furthermore, the removed cables, as well as brand-new cables, were pull tested to evaluate their strength. The 3-month-old removed cables from the meltshop failed at less than 50% of the unused cable. It was suspected that the root cause of the failure was that the outside layer had become brittle due to heat exposure during pour backs and dropping charges in the furnace.

The issues and concerns were apparent, as well as the acknowledgment that a new fall protection solution was needed — one that would

Figure 1



View of damaged horizontal lifeline cable in place at the meltshop.

Figure 2

Conceptual design of a fall protection solution for bridge crane and end trucks.

provide appropriate safety for workers within the extreme environment of the meltshop. Considering the unique conditions, it did not appear any manufactured systems or equipment would adequately protect the workers. Exploring effective, customized options would require a combined knowledge and experience in both structural engineering and fall protection safety regulations and standards.

Why Conceptual Design?

In situations like these, when the best fall protection solution is not obvious or cannot be agreed upon, organizations can undertake a conceptual design phase to determine a final solution that will provide protection for the worker. Another way to say this is that conceptual design can be used when no off-the-shelf solution can sufficiently abate the hazards. This approach generates visualization of the options, develops objective risk, ease of use, costs, and maintenance criteria to consider, and helps achieve buy-in from key stakeholders before a significant investment is made in design or equipment.

During the conceptual phase, representatives from all the stakeholders should be involved. Ideally, individuals that represent users, safety, management, maintenance and facilities all participate, along with any other groups deemed to be important in successfully implementing an abatement method. The purpose of this group is to determine the most important criteria for an abatement method, as well as provide debate, ideas and feedback on the solutions proposed.

Conceptual Design Process

The access to the crane trolley and associated work areas for this location includes several complex fall protection elements: it is heavily congested, access is complex and multiple fall hazards need to be addressed by a coordinated solution. To complete the conceptual phase for this project, LJB researched possible abatement options and prepared conceptual solutions. Based on evaluation and feedback from the stakeholder group, conceptual solutions were developed to abate fall hazards associated with performing maintenance on the bridge, end trucks and trolley of the meltshop crane. Along with descriptions and visualizations of the options, the conceptual design report included a summary of advantages and disadvantages and an objective evaluation of the proposed solutions.

The abatement options were evaluated and measured by referencing the hierarchy of controls, which includes options of elimination, engineering controls and active fall protection systems. In this case — as in many cases — elimination is not practical since access is required and the nature of the work process requires workers to be elevated. From a safety standpoint, passive controls, or engineering controls, are generally preferred over equipment-based solutions, since they are a more effective and less "defeatable" solution. The preference is to provide mechanisms or guards that the user would have to actively and consciously overcome to be at risk of a fall.

Overall, the conceptual design process followed the steps outlined below:

1. Site Visit — LJB visited the site to perform on-site observation and evaluation of existing conditions, and to discuss work activities with stakeholders to better understand the feasibility of potential abatement solutions.
2. Concept Design — Using the knowledge gained while on-site and by reviewing drawings of the facility, LJB developed potential abatement solutions and delivered a report, detailing advantages and disadvantages of the options presented from a risk and ease-of-use perspective.
3. Interactive Stakeholder Meeting — LJB met with representatives from the client, including the safety coordinator, maintenance coordinator, shift supervisor, crane crew members, millwrights and department managers, to discuss and debate the conceptual solutions, and ultimately select the abatement option to take to final design.
4. Final Design of Certified System — Using the feedback from the stakeholder meeting, LJB completed final design and construction documents for the selected abatement solution.

Final Design of Certified System

Well-planned and properly designed fall protection systems can only function if they are installed and used properly. To achieve a certified fall protection system — which increases the likelihood that a system is installed and used according to original design intent — it is important for an organization to take the steps below during system implementation:

- Final Design — Design the final solution, using a certified qualified person in fall protection — a professional who understands both the structural engineering and behavioral safety aspects of a fall protection system.
- Field Verification — Confirm that the design is constructed and/or installed per the design drawings.
- Use and Rescue Procedure — Create procedures that inform all employees and contractors on proper equipment, use, limitations and rescue plans related to the system.
- System-Specific Training — Train all authorized workers on the specifics of the fall protection system, including pre-use inspection requirements, necessary equipment, and system use and rescue procedures.
- System Certification — Perform and document system certification in accordance with the ANSI Z3359.6 standard to increase the reliability of the installed fall protection system.

The Solution

For this meltshop fall hazard situation, the final solution included both engineering controls and active fall protection systems. For the trolley, the abatement solution is a raised guardrail with integral horizontal rail designed for fall arrest. LJB selected and designed the fall arrest rail with solid bar stock, replacing the horizontal lifeline systems that had been weakened by heat stress. On the outbound side, a lockable gate is provided in the raised guardrail for equipment removal. In this area, a fall arrest system is used for ladder climbing to gain access to the work location and protect against falls to the lower level (approximately 120 feet).

Specifically for the bridge girders and end trucks, the existing guardrail was replaced with a specially designed fall protection system that serves as guardrail. This custom-designed guardrail includes a top rail that is designed for fall arrest, to take the place of the weakened horizontal lifeline system.

Some key items to note about this fall protection solution:

Figure 3

Conceptual fall protection solution for trolley maintenance.

- Due to the specific parameters of the solution — including the use of horizontal rail for fall protection — this solution required that a qualified person design the active fall protection systems.
- Different steel shapes were used to differentiate between horizontal rail that is designed for fall arrest and standard guardrail, which is not rated for fall arrest and should never be used for anchorage.

Value of Conceptual Design

The extreme environment of the meltshop changed the previous fall protection system from solution to hazard for workers. Completion of regular Competent Person inspections of fall protection systems provided a valuable opportunity to address concerns that could directly prevent a serious injury or fatality. By working together as a team — and leveraging fall protection experts — a solution was developed that would not only protect workers, but also withstand the extreme meltshop environment. The conceptual design process was the vehicle that combined the knowledge of the client's team with LJB's engineering and fall protection expertise to develop a comprehensive solution to a critical safety concern. ✦