Safety Innovation for Steel Mill Ladle Access

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.

Steel industry operations pose several potential hazards for lost-time injuries associated with trips, slips and falls. According to the National Institute for Occupational Safety & Health (NIOSH), the leading factor across all industries at 27% of the total 888,220 non-fatal work injuries that resulted in days away from work were related to slips, trips and falls in 2019.[1]

In addition to the 2019 NIOSH statistics, the World Health Organization (WHO) reports that the U.S. currently leads the world in ladder-related deaths. Each year, there are more than 164,000 emergency room–treated injuries and 300 deaths in the U.S. that are caused by falls from ladders, most of which are from 10 feet or less.[2]

Within the steel industry, one of the most prominent areas where potential fall hazards exist is ladle maintenance. These maintenance areas accommodate several routine jobs that can require personnel to climb in and out of the ladle frequently throughout the workday utilizing a ladder or similar variant.

While ladle sizes vary throughout the industry, a typical ladle depth ranging from 13 to 17 feet presents a major safety concern when compared to the injury/fatality statistics reported.

In addition, work deck platforms inside the ladle are typically congested with pallets, refractory brick, tools, equipment and other common refractory items. The need to move the ladder around the work deck while in a constricted work environment results in compounding potential occupational hazards.

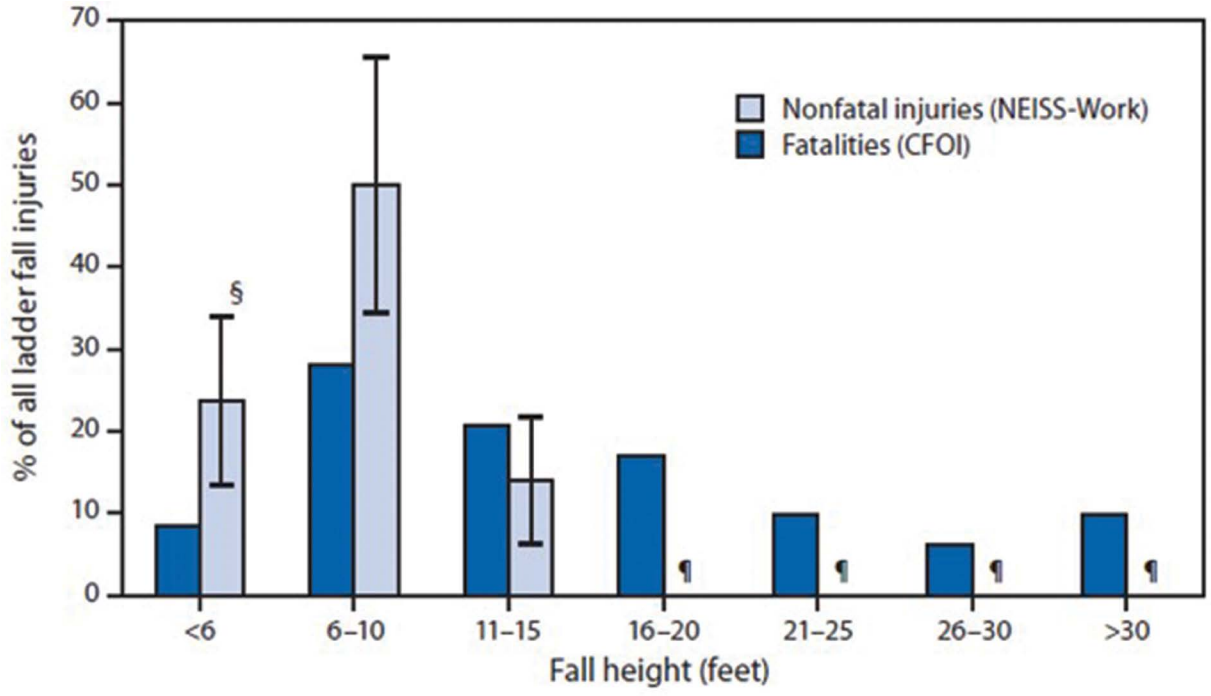
In 2018, J.H. Fletcher & Co. in association with a southern U.S. meltshop began a project to help improve safety measures for safer ladle access. The objective was to design and manufacture a hydraulically operated, radio-remote-controlled man-lift that allowed safe access in and out of the deep ladle during the re-lining process which did not take up excessive space or slow down the work process while reducing potential hazards.

Solution

A baseline set of requirements was established by working closely with mill management and operating personnel to collect relevant data regarding typical trips into and out of the ladle and common obstacles that may be encountered with the maintenance area, as well as mill-specific preferences. This included a small footprint on the working platform and inside the ladle, ease of use through operator-friendly controls/programming, mitigation of human error during operation, reliability and additional safety measures for hazards that may be introduced with a new piece of equipment in the work area.

Taking the baseline requirements into account, the ladle access device (LAD), as seen in Fig. 2, was designed, and installed in the ladle maintenance area in one shift. The system is comprised of a 12-square-foot base that houses the hydraulic powerpack and controls, a swinging boom capable of reaching two separate ladle stations, a multi-stage hydraulic mast to lower into the ladle, an ergonomic operator's basket with self-closing doors, and two handheld remotes. The unit is complete with programmed positions, including a home position, parked at platform, and up to four alternate positions including exit positions

Figure 1



Documented percentage of ladder fall fatalities and non-fatal ladder fall injuries treated in emergency departments in the U.S., by fall height.[3]

inside the ladle. All positions are accessible using the handheld pocket-sized remote.

In assessing possible human error during operation for any new hazards that may be introduced with a new piece of powered equipment in the work area, collisions with material beneath the operator's basket, and within the swinging radius of the boom between the lowered and parked positions, were identified. These were mitigated through an ultrasonic stop sensor mounted at the bottom of the operator's basket to aid in preventing lowering of the mast when obstructions are within the travel path of the basket as well as gated safety guarding on the work platform to help prevent personnel from inadvertently entering the swing path of the boom.

With the implementation of the ladle access device, personnel are now able to safely enter and exit the ladle with reduced physical effort. The system helps reduce slip, trip and fall potential and aids in reducing personnel strain from climbing, bending, twisting, and lifting. If personnel are unable to exit the ladle under their own power, the unit can also be operated from a touchscreen display mounted at the base

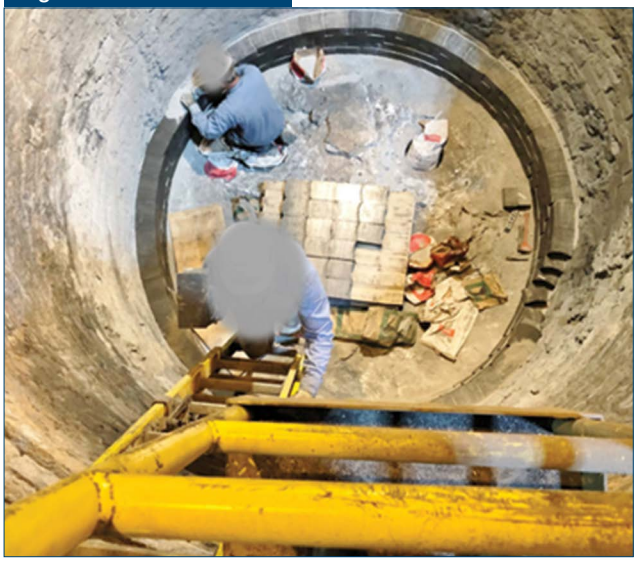
Figure 2

Dual ladle access device (LAD) installation.

Figure 3

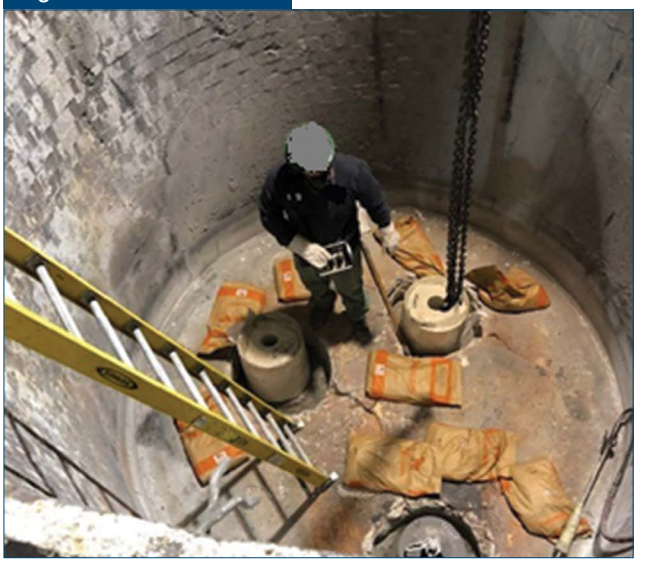
Typical work deck platform area.

Figure 4



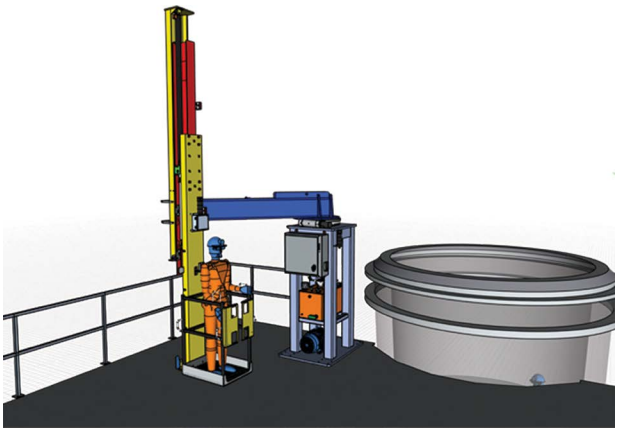
Typical refractory re-lining area within ladle.

Figure 5

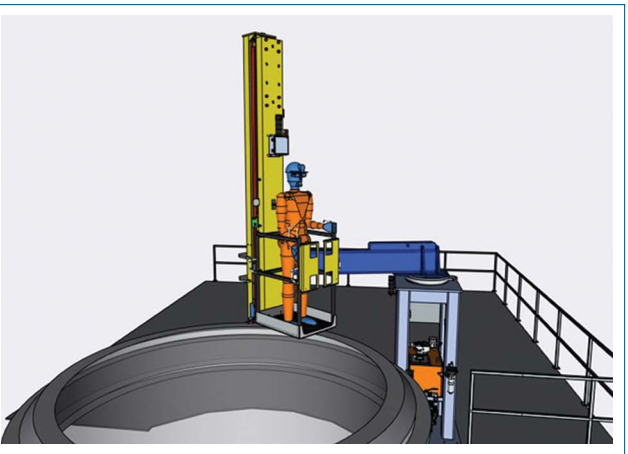


Typical refractory re-lining area within ladle.

Figure 6



(a)



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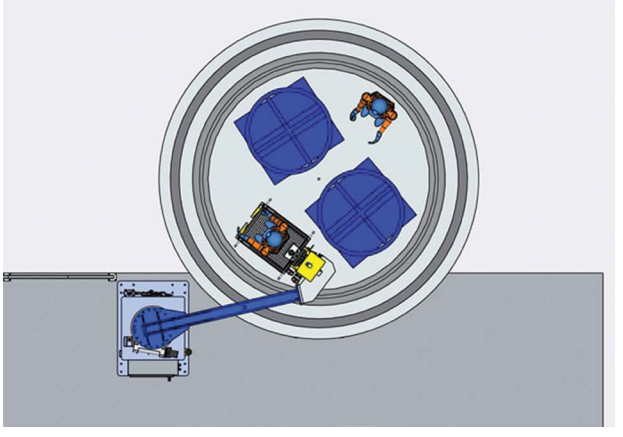

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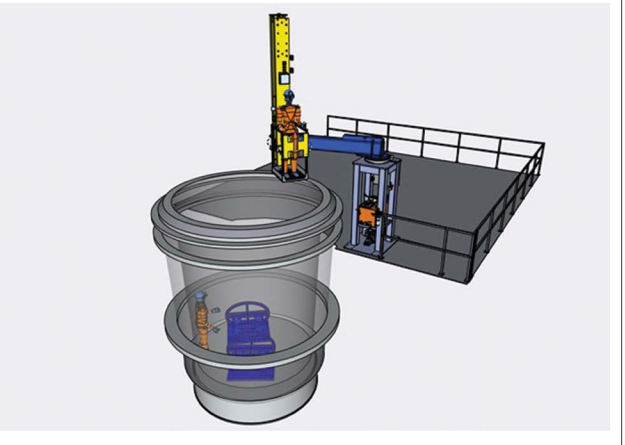

(d)

3D concept drawing of a worker in basket (a); 3D rendering of a worker descending into ladle (b); 3D concept drawing of a worker in a basket and pallets for refractory brick in the ladle (c); and 3D rendering of a worker descending into ladle from a different angle (d).

housing, therefore providing a means for recovery of incapacitated personnel.

Following the successful installation of the first unit, an additional eight units have been built with slight design modifications to fit the unique work area of each mill. The ability to adapt the base design to meet each mill's specific needs, as well as flexibility in the installation process, are key to ensuring a safer product design by meeting the needs and requirements as defined by the operation.

References

1. https://www.cdc.gov/niosh/injury/fastfacts.html.
2. https://www.nachi.org/ladder-safety.htm.
3. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6316a2.htm. ✦