Injury on a Construction Site

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.

A construction worker was assigned to guide seven 250 MCM cables into a 6-inch-diameter conduit (Figure 1). In the course of the pull, the overhead pulley assembly became dislodged and injured the worker, hitting him on the head. He was not wearing any personal protective equipment (PPE).

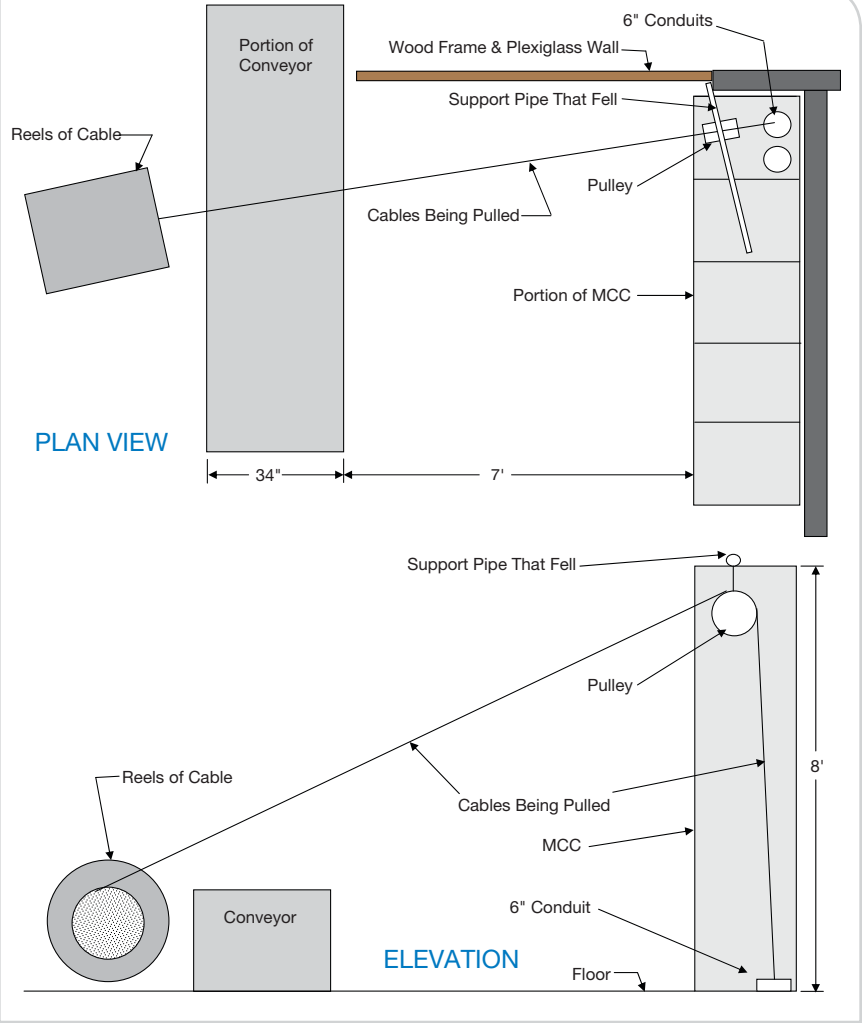
Chain of Events

1. The cables each came from a spool set off to the front of a motor control center, were led up to a pulley assembly that was positioned vertically over the motor control center (MCC) and were fed down through the cableway in the MCC (Figures 2–4). From here they entered the conduit at the floor and proceeded about 100 feet down and out horizontally. A tractor was stationed at the ground level and pulled the cables down and into a connection box for splicing.
2. The worker at the MCC had radio communication with the tractor driver.
3. When the "Chinese finger" cable grip entered the conduit, one of the cables caught on the inside diameter of the conduit and stopped moving.
4. The worker at the MCC hit the cables so as to free them and allow the pull to continue.
5. When the cables started to move again, the entire support for the overhead pulley broke loose. The falling parts of the pulley assembly hit the worker and caused the injury.

Figure 1

View of cables and conduit.

Figure 2



Sketch of cable pulling setup.

Analysis

The approximately 100 feet of 1/4-inch wire rope that was used to pull the electrical cables was stretched when they became lodged at the entrance to the conduit.

The breaking strength of this wire rope was found to be about 5,000 lbs. Since the wire rope did not break, it can be assumed that a force of 5,000 lbs. could be exerted on the stuck electrical cables.

When the electrical cables became free and capable of moving, after they were shaken, they "instantaneously" began to move. Since an instantaneous time is impossible to use in calculations, the assumption was made that the entire group of cables would have accelerated to move 2 inches in 0.10 second.

The required accelerating forces were calculated. These are the forces that would have been needed to move the masses of:

a. The assumed 20 feet of each cable already pulled off the reels.
b. The remaining cable on each reel.
c. The reels themselves.

Figure 3

View of motor control center.

Figure 4

View of pulley and "Chinese finger" in truck bed.

The total linear force (linear for the cables and the linear result of the rotating force for the reels) needed to accelerate each of the seven cables, and their associated fully loaded reels, was found to be 1,750 lbs. Thus, for seven cables the total load would have been about 12,000 lbs., which would have broken the wire rope pulling the electrical cables.

The maximum wire rope breaking limit of 5,000 lbs. would have been exceeded if the pulley assembly had not been torn loose.

The resultant force on the pulley system was calculated to be about 9,000 lbs., at a maximum of the 5,000-lb. breaking strength, given that the electrical cables entering and leaving the pulley formed an angle of about 45°.

The worker who was guiding the cables on the pull was not an experienced worker, and therefore had no knowledge of the stored energy in a stretched wire rope that was about 100 feet long. He also did not have the experience to know that if he shook the cables to get them moving, the stored energy would cause such a tremendous instantaneous load to be applied to the pulley system.

This pulley system was not strong enough to withstand the added load. In fact, it is difficult to imagine a contractor installing any pulley system in this type of situation that would withstand such an added load.

Opinion

When the cable became stuck, nothing should have been done until the tractor released the tension on the wire rope that was pulling the electrical cables.

The worker at the MCC should have called the tractor driver and told him to back up to release the tension.

The worker at the MCC was not trained properly to perform the task that he was assigned, nor was he directed by his supervisor to be wearing a hard hat. ✦