MIFACE INVESTIGATION REPORT: #09MI009

Subject: Construction Laborer Pinned Under Tire of Articulated Machine

Summary

In the winter of 2009, a 30-year-old male construction laborer was pinned under the tire of an articulating DitchMaster M450 with a front end loader and tree spade attachment that overturned to the side. The decedent's employer had parked the machine, placing the front end loader attachment across a construction trailer tongue and its 2-foot crank hitch with the driver's side front tire against the trailer tongue. The decedent and two coworkers arrived at the worksite and wanted to haul the construction trailer from the worksite. The decedent, against company policy, climbed onto the seat, pulled the Kill switch, and started the machine. The machine stalled, and he started it again. The machine was in first gear. When he applied power, the machine started forward. The front driver's side front tire drove up and over the trailer tongue hitch, puncturing the tire. The machine articulated (bent in on itself), and then overturned. Either the decedent was trying to jump from the machine as it articulated or he was thrown from the machine as it overturned. He was pinned under the machine's rear passenger side tire (Figure 1). His two coworkers attempted to get the machine off of him by placing a car jack at the location of the tire that pinned the decedent and attaching a chain to the loader arm and the pickup truck they arrived in. When they were unable to lift the machine from him, the coworkers called for emergency response. Upon emergency response arrival at the site, his vital signs were absent. Emergency response personnel began the recovery operation.

Figure 1. Position of decedent under passenger side rear tire of tree spade attachment

RECOMMENDATIONS

- Construction employers should identify all equipment that can articulate and determine if a steering frame articulation lock is present and functional. If a lock is not present, the employer should determine the feasibility of installing such lock; if the lock is not functional, the equipment should not be used until the lock is repaired.

- Employers should develop and communicate a written safety and health plan that includes the actions an employee should take in an emergency situation. Independent contractors who work for employers need to be given the same information. The employer should require employees to call for emergency assistance immediately upon discovery of the emergency.

Recommendations to Emergency Responders

- Fire Departments/Emergency responders should request companies to report the type of heavy equipment they have and should include an inventory of such equipment when they perform training program evaluations. In the interim, employers utilizing unusual heavy machinery and/or construction equipment should identify such equipment and send this information to their local emergency responders to assist them in responding to an emergency.
- Emergency responders should periodically review procedures for implementing a lifting and stabilization plan.
- Emergency responders should consider utilizing community resources, such as wreckers, to assist with extrications.

INTRODUCTION

In the winter of 2009, a 30-year-old male construction laborer was pinned under the tire of an articulated DitchMaster M450 with a front end loader and tree spade attachment that overturned to the side. MIFACE investigators were informed of this work-related fatality by the Michigan Occupational Safety and Health Administration (MIOSHA) personnel, who had received a report on their 24-hour-a-day hotline. The MIFACE researcher interviewed the contracting employer and one of the decedent's coworkers at the contracting employer's home in May, 2009. The contracting employer also owned the DitchMaster. The responding fire department personnel were interviewed in August 2009; incident scene pictures taken by the responding police department were reviewed. To gather additional understanding concerning extrication techniques, MIFACE interviewed a fire service instructor familiar with machine extrication techniques in January 2010. During the course of writing this report, the police report, pictures supplied by the fire and police departments, death certificate, medical examiner report, and the MIOSHA file and citations were reviewed. Pictures used in Figures 1, 4, 5, 6, 7, and 8 are courtesy of the responding police department and fire department. Pictures used in Figures 2 and 3 were taken by the MIFACE researcher at the time of the site visit.

The decedent was self-employed. The contracting employer was a construction business owner and he was usually the sole worker at a jobsite. When he needed assistance for a job contract, he paid the decedent and the decedent's coworkers as independent contractors to work part-time. At the time of the incident, the decedent worked from 8:30 a.m. – 4:00 p.m. The employer indicated that the decedent had operated a backhoe for previous employers.

The employer did not have a written health and safety program. He indicated he verbally instructed the decedent and his coworkers on job safety issues. The work crew had been instructed by the company owner that only the company owner and one of the decedent's coworkers were permitted to operate the machine. The coworker had been trained to operate the DitchMaster. The decedent had never operated the machine nor was he permitted to operate the machine. The coworker MIFACE spoke with at the employer's home reiterated the restriction of operation of the DitchMaster.

The employer had both the DitchMaster and trash trailer involved in the incident at his home. The employer agreed to show the MIFACE researcher how he had positioned the DitchMaster the night before the incident (Figure 3).

The MIOSHA Construction Safety and Health Division did not issue a citation at the conclusion of their investigation.

MIFACE could not determine if the machine could have been retrofitted to start the machine with a key, rather than using the choke.

INVESTIGATION

The Vermeer M450 DitchMaster with the loader and tree spade attachment had been built in 1976 (Figure 2). The employer bought the machine five years ago. The machine controls were clearly labeled. The employer indicated that the machine did not have any operational issues, but that it had recently been at the repair shop to repair some stress cracks. Under the operator's seat was an articulation joint that joined the front assembly to the rear assembly so that the front and rear assemblies could pivot about a vertical pivot axis relative to one another. To start the machine, the operator was required to pull out the choke and then pull the "Kill" switch.

Figure 2. DitchMaster with front end loader and tree spade

The employer also had a home rental business. An arson fire had damaged both the garage and the home's siding at one of his rental properties. He contracted with the decedent and his coworkers to raze the garage and clean up the property. A trailer had been delivered and placed on the property to hold trash. He positioned the trailer tongue onto two ramps to support the tongue seven inches above the ground. The trailer had a 2-foot crank hitch. The driveway had a slight downward slope and was dry. It was cold but there was no snow on the ground.

The decedent and his coworkers had been working at the site for two days. The night before the incident, the owner had moved the DitchMaster next to the trailer to prevent the trailer from being stolen. He placed the DitchMaster's driver's side tire next to the trailer tongue and placed the 66-inch by 26-inch front end loader bucket over the hitch and rested the bucket on the ground (Figure 3).

Figure 3. Re-enactment of position of DitchMaster, bucket and trailer hitch

On the morning of the incident, the decedent and coworkers arrived at the site at approximately 8:30 a.m. The crew was aware that the trailer was scheduled to be removed from the site so it could be emptied and returned.

The decedent climbed into the DitchMaster's operator's seat. His coworkers told him to get off of the machine and to wait for the employer to arrive to move the machine. The decedent did not get off of the machine, tried to start it but was unsuccessful. His second attempt was successful. He raised the front end loader bucket approximately three feet above the ground.

Apparently unbeknownst to the decedent, the DitchMaster was in forward gear instead of reverse gear. One of his coworkers thought that the decedent's foot may have slipped off of the clutch, causing the DitchMaster to jump forward. The driver's side front tire drove up and over the crank stand. The DitchMaster twisted at its articulation point and turned in on itself to the decedent's right side as it proceeded over the crank stand. The decedent either attempted to jump from the equipment or was thrown from it. He was pinned under the passenger side tire that was associated with the tree spade attachment.

Figure 4. Fire fighters recovery operation

The decedent was initially responsive to his coworkers. His coworkers attempted to free him by attempting to upright the DitchMaster. They placed a car jack under the tree spade support closest to the decedent. They also placed a chain/sling on the front end loader bucket arms and attached it to the pickup truck they had driven to the site. They also attached a sling to the dump trailer but it was not attached to the rear axle of the DitchMaster when the fire fighters arrived. They attempted to lift the machine by driving the truck away. When they could not lift the DitchMaster from him, they called for emergency response.

The fire department was the first to arrive approximately five minutes after the emergency call was received. Upon arriving at the site, his vital signs were absent, thus the 14 fire department personnel began the recovery operation. The police arrived, set up and secured a protective area around the incident scene to permit the fire fighters to work (Figure 4).

The fire department developed and implemented a lifting plan which entailed building cribbing and using two high- and one medium- pressure bags. The department also developed and implemented a stabilization plan which entailed building cribbing, as well as using a Paratech® strut, and 2-inch rachet straps rated for 13,000 pounds to minimize vehicle movement. The placement of the car jack by the decedent's coworkers under the tree spade complicated their efforts as the rescue tools had to be located around the jack. The height capacity of the high pressure bags was maximized during the lift.

The fire department indicated as they raised the DitchMaster, it began to move/roll down the slight grade of the driveway and continued to articulate. Eventually, the fire department was able to raise the DitchMaster high enough and remove the decedent from under it.

CAUSE OF DEATH

The cause of death as stated on the death certificate was traumatic asphyxiation due to compression of torso. Toxicology was negative for illegal drugs and alcohol.

RECOMMENDATIONS/DISCUSSION

- Construction employers should identify all equipment that can articulate and determine if a steering frame articulation lock is present and functional. If a lock is not present, the employer should determine the feasibility of installing such lock; if the lock is not functional, the equipment should not be used until the lock is repaired.

The machine involved in the incident did not have a steering frame lock (articulation lock) that prevented the machine from articulating (Figure 5). The intended use of the lock is to prevent unintended articulation of the machine either during lifting, shipping, or maintenance/repair operations. The machine involved in the incident was repaired at a contracted maintenance facility. Although the machine was not being lifted, shipped or repaired at the time of the incident, MIFACE recommends that the employer determine if the machine can be retrofitted with a lock that prevents unintended articulation, and

Figure 5. DitchMaster articulation point under machine

use the lock when the machine is in storage or parked overnight to ensure that unintended articulation does not occur at startup of the machine.

- Employers should develop and communicate a written safety and health plan that includes the actions an employee should take in an emergency situation. Independent contractors who work for employers need to be given the same information. The employer should require employees to call for emergency assistance immediately upon discovery of the emergency.

Although the employer was the sole owner and usually the sole worker at a site, he had hired the decedent and his coworkers using an IRS 1099 contractual form. Per IRS, "under common-law rules, anyone who performs services for you is your employee ***if you can control what will be done and how it will be done.*** This is so even when you give the employee freedom of action. What matters is that you have the right to control the details of how the services are performed." MIOSHA requires a construction employer to develop, implement and communicate a construction safety plan to employees.

The decedent's coworkers initial response was to attempt to lift the machine from the decedent using the car jack and tow straps. The amount of time spent on attempting to lift the machine to free the decedent was unknown. Only when they were unsuccessful did they call for emergency response. Their initial attempts at rescue, although understandable and well-intentioned, created a longer period of time in which the decedent was under the DitchMaster, and by placing the car jack under tree spade support, made it more difficult for emergency responders to extricate the decedent. The fire fighters indicated that the jack's placement exacerbated the degree of articulation while the fire fighters implemented the lifting plan.

The purpose of an emergency plan in a safety and health program is to facilitate and organize employer and employee actions during a workplace emergency, such as equipment overturns. As the first individuals at the emergency situation, the decedent's coworkers' knowledge about proper rescue and emergency medical procedures was limited. Improper rescue actions can aggravate an injury as well as place the rescuer at risk.

The first action an individual coworker should take when an emergency is discovered is to call for emergency assistance. Depending upon the situation and the knowledge of the individual, equipment stabilization, victim extrication, and resuscitation efforts should be initiated after the emergency response call is placed.

Recommendations for Emergency Responders

- Fire Departments/Emergency responders should request companies to report the type of heavy equipment they have and should include an inventory of such equipment when they perform training program evaluations. In the interim, employers utilizing unusual heavy machinery and/or construction equipment

should identify such equipment and send this information to their local emergency responders to assist them in responding to an emergency.

The employer relied on the local public resources, such as fire and police to handle an emergency situation. The fire department personnel who were on site were not familiar with this type of articulating equipment. MIFACE recommends that employers contact the local fire department to show them the equipment, how the equipment functions, and the hazards the equipment poses. This action allows employers to share their expertise about the equipment, so if an emergency situation arises the responders have the knowledge necessary to ensure their own safety as well as to quickly take the actions necessary to rescue the injured person.

An introduction to the equipment will also enable the local fire department to comply with Section 4.1.10.4 of NFPA 1670, Standard on Operations and Training for Technical Search and Rescue Incidents. Section 4.1.10 – Training - requires an authority having jurisdiction (AHJ) to evaluate the department's training program to determine whether the current training has prepared department personnel to function at the established operations level under abnormal weather conditions, extremely hazardous operational conditions, and *other difficult situations. (italics added).* Additionally, this knowledge would aid the fire department personnel who are trained to the technician level to perform a technical rescue the opportunity to apply this knowledge to meet the requirements specified by the situational (e.g., vehicle, machine, confined space, etc.) rescue operation.

This piece of construction equipment had technician level elements applying to both vehicle search and rescue and large machine search and rescue (as defined by NFPA 1670). For vehicle search and rescue, the technician level mandated, among other requirements, the development and implementation of procedures for:

(a) Performing extrication and disentanglement operations involving packaging, treating, and removing victims injured or trapped in large, heavy vehicles
(b) Stabilizing in advance of unusual vehicle search and rescue situations

The technician level for machine emergencies requires the development and implementation of procedures for, among other requirements:

(a) Performing extrication and disentanglement operations from large machines (defined by NFPA as "complex machines (or machinery systems) constructed of heavy materials, not capable of simple disassembly, and presenting multiple concurrent hazards (e.g. control of energy sources, HAZMAT, change in elevation, multiple rescue disciplines, etc.), complex victim entrapment, or partial or complete amputation, and requiring the direct technical assistance of special experts in the design, maintenance, or construction of the device or machine".

The development of the procedures prior to use can only happen if the fire department is informed as to the types and operation of equipment they may encounter and perform their rescue operations. Additionally, the equipment review with the owner can identify rescue tools that may be required. If the fire department does not have such tools, there would be time to obtain such tools if the budget allows or to identify and contact outside resources who could supply these tools in an emergency.

- Emergency responders should periodically review procedures for implementing a lifting and stabilization plan.

Figure 6. Lifting bags "maxed out"

Many pieces of construction equipment are heavier than an automobile. Thus, it is important that the lifting and stabilization plan take into account that the routine extrication tools utilized by the fire department personnel not be "maxed out" during a rescue, or exceed the load rating of the tool (Figures 6 and 7). Because of the weight of the construction equipment, the amount of extrication force that must be applied is increased. These higher forces increase the likelihood of rescue tool failure and slippage or equipment damage. The failure or slippage of the rescue tool or the damage to the equipment can be disastrous to an injured individual, rescuer or bystander.

The fire fighter MIFACE consulted to gain insight into extrication procedures noted that fire fighters developed a lifting and stabilization plan but identified two areas where failure and/or slippage of the extrication tool, in this case the lifting bags, could have occurred. These areas are identified by the arrows in Figures 6 and 7.

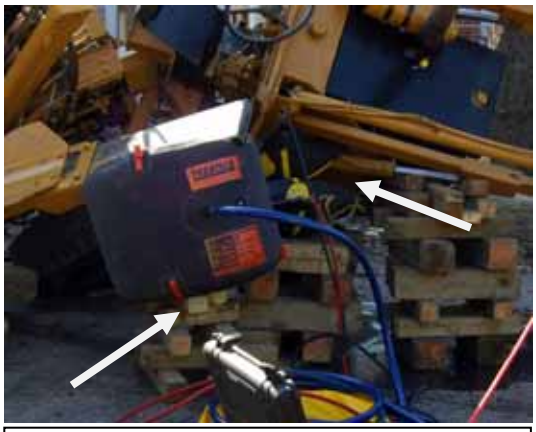

Figure 7. Cribbing and unstable base for bags

The cribbing used to support the high pressure lifting bags was not initially built high enough, and thus the lifting bags rounded out, neared their ratings, and lost lift capacity during the initial lift. Similarly, the cribbing used to support the medium pressure lifting bag was not initially built high enough, and thus reached its maximum rating during the initial lift. A lifting plan should endeavor to not waste the travel of the tool to get to the problem. Adequate cribbing should be built so the travel of the tool (in this case, bags) can be used to displace the load. During a post-incident critique with the MIFACE researcher, the responding fire department indicated that they barely had enough cribbing.

Additionally, a solid base to stabilize the lifting bags during use is recommended. The solid base, or platform crib, will prevent the bag from settling into the opening between cribbing members and thus losing lifting capacity.

During the post-incident review, the responding fire department also identified other stabilization options that were not utilized: place a strap and/or chains and binder or

chains and a "come-a-long" to secure and prohibit the equipment from spreading as it was being lifted (Figure 5). The fire fighters also discussed placing a strap around the tires to minimize equipment spreading and the use of chocks at the wheels. It is unknown to whom the bottle jack belonged and why it was not used.

- Emergency responders should consider utilizing community resources, such as wreckers and truck cranes, to assist with extrications.

NFPA 1670 Section 4.2 Hazard Identification and Risk Assessment, subsection 4.2.4 states that the "authority having jurisdiction identify the type and availability of external resources needed to augment existing capabilities for technical search and rescue incidents and shall maintain a list of these resources, which shall be updated at least once per year." Especially when extricating an individual from under construction equipment, utilizing heavy duty wreckers or truck cranes, which have experience in conducting vertical lifts and moving equipment, and which can respond quickly, can assist the responding fire department to safely extricate the individual, and perhaps save time in doing so (Figure 8). The responding fire department noted that they barely had enough cribbing. An outside resource, especially in rescue situations where the fire department resources are limited, may be helpful to the rescue operation. MIFACE encourages fire departments to identify and contact the external resources in their community, such as wreckers or truck cranes, and develop a mutual aid agreement with them to assist in rescue operations.

Figure 8. Use of heavy duty tow truck to upright DitchMaster

ACKNOWLEDGEMENT

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REFERENCES

The MIOSHA standard cited in this report may be found at and downloaded from the MIOSHA, Michigan Department of Energy, Labor & Economic Growth (DELEG) website at: www.michigan.gov/mioshastandards. MIOSHA standards are available for a fee by writing to: Michigan Department of Energy, Labor & Economic Growth, MIOSHA Standards Section, P.O. Box 30643, Lansing, Michigan 48909-8143 or calling (517) 322-1845.

- MIOSHA Construction Safety Standard, Part 1. General Rules. http://www.michigan.gov/documents/CIS_WSH_part_1_38098_7.pdf
- Evacuation Plans and Procedures e-tool. OSHA. http://www.osha.gov/SLTC/etools/evacuation/eap.html
- NFPA 1670. Standard on Operations and Training for Technical Search and Rescue Incidents, 2009 Edition. NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471.
- Independent Contractor (Self Employed) or Employee? IRS.gov http://www.irs.gov/businesses/small/article/0,,id=99921,00.html
- Shannon, Mike. *The Use of Cranes and Heavy Equipment in Rescue and Hazmat.* Fire Engineering. March 1, 1999. http://www.fireengineering.com/index/articles/display/60890/articles/fire-engineering/volume-152/issue-3/features/the-use-of-cranes-and-heavy-equipment-in-rescue-and-haz-mat.html

Key Words: Articulated construction equipment, lifting plan, stabilization plan, DitchMaster, front-end loader, tree spade, machine