Hydro-Excavation

Makes Trench Rescue Faster and Safer

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Cave-ins have always represented one of the most challenging scenarios to rescue personnel. A collapsed trench wall, like a collapsed building, is a structure in failure. It is also a structure that will continue to fail, if left to its own devices.

Many a co-worker or rescue team member has been injured or killed by secondary collapses while attempting to retrieve the initial victim. As a consequence, most rescue programs now mandate securing the excavation before allowing entry on the part of any rescue personnel.

Over the past two decades, trench rescue training has evolved from programs that focused on improvised shoring techniques to those based upon engineered solutions provided by the OSHA excavation standard. Plywood, 2-inch by 6-inch pine framing lumber and fence posts have begun to give way to pneumatic and hydraulic shoring systems and, most recently, shield systems. These systems have made it possible for rescue personnel to adequately and confidently address the first major problem confronting them: preventing a secondary collapse of the trench.

The second problem, removing the soil covering the victim, has likewise proven to be a significant challenge. The collapse of one side of a trench eight-feet deep and six-feet long can result in anywhere from 50 to 200 cubic feet (5,000 to 20,000 pounds) of soil covering the victim. Even if the rescuers have unlimited room to shovel the soil off the victim, the amount of time (to say nothing of the effort) required to do so is great.

The process is both tedious and time consuming, particularly if the soil proves difficult to excavate. Muck and sugar sands tend to flow back as quickly as they are excavated. Clays, caliche and hardpan cause the rescuers to "chip" away at them. As a consequence, most trench rescue training programs tell rescue personnel to estimate one hour of excavation effort for each vertical foot of soil covering the victim. In other words, it would take four hours of excavation to remove a victim covered by four feet of soil or if trapped chest deep in a vertical position.

Race against time

For a victim who survives the initial crushing impact of the soil, time is of the essence.

The weight of the soil pressing against the victim can impair breathing or, in the worst cases, cause sufficient fatigue and constriction of the chest and abdomen to result in suffocation. Likewise, it can restrict the flow of blood to the extremities and cause the onset of a condition known as crush syndrome, where the blood of the victim becomes poisonous in the constricted

Top left: *A typical hydro-excavator is a truck-mounted unit that consists of pumps and a vacuum system.* ***Top right:*** *In a typical scenario, the rescuers have very limited room to work and use hand tools such as spades, cut-off shovels, and trenching tools to shovel the soil into buckets which are pulled from the trench by ropes where they are dumped then lowered back in to the trench to be refilled.* ***Above:*** *Students practice hydro-excavation techniques using a pressure hose and vacuum system.*

areas and causes death when the soil is removed to the point circulation is restored. In situations where trauma, in the form of broken bones or crushed tissue is present, the situation is exacerbated.

Rescuers, particularly co-workers, who were driven by the immediacy of the need to extricate the victim, but frustrated by the time required to hand dig them free, have resorted to extreme measures such as using excavators or backhoes to attempt to remove the soil covering them. This has resulted in victims being killed by the bucket (or the compressive force it generated), or drowned by a water main accidentally burst by the effort. Similar consequences have even occurred when digging with hand tools.

Unfortunately, there has been no viable alternative to hand digging available to rescue personnel until recently. Hydro-excavation, a solution borrowed from the utility construction industry, has begun to make inroads and find favor with rescue personnel.

Hydro-excavation, as the name implies, involves the use of a pressurized stream of water to wash the soil away from the buried victim, where it is then removed from the excavation by a vacuum hose or tube.

Hydro-excavation is not the same as hydro-blasting which uses a very high pressure stream of water (up to 10,000 psi) for a range of applications from removing paint, scale and hard calcium deposits, to cutting steel. Pressures in that range can cause severe damage to human flesh, even death. By contrast, hydro-excavation uses a low pressure stream, which a properly trained technician can use to wash the soil away with no threat to a buried victim. A typical hydro-excavator is a truck-mounted unit that consists of a variable flow water pressure pump, a vacuum system and holding tanks for both the water pressure system and debris. The lengths of the vacuum and pressure hoses, capacities of the holding tanks, pressures generated by the pumps and the gross and net weights of the units vary with design.

Hydro-excavation can move a significant amount of soil in short order. It is far quicker than hand digging and poses a much less threat than either hand digging or mechanical excavation.

Depending upon the capacity of the unit and the type of soil being excavated, a skilled operator can remove two to seven cubic yards of material per hour.

Hydro-excavation offers the significant advantage of allowing the operator to work atop the excavation – it does not require entry.

Shafts up to 65 feet in depth have been excavated completely from the top of the excavation by increasing the length of the excavator wand and vacuum hose as the work proceeded. Much as hydraulic shoring revolutionized the shoring process by allowing its installation and removal from the top of the excavation without any requirement for personnel entry, hydro-excavation has done the same for the excavation process. In this regard, it offers an advantage over a similar vacuum excavation process that uses pneumatic hammers to pulverize the soil then vacuum it out. With hydro-excavation, the rescuers can work in complete safety from atop the excavation.

Adapting to rescue ops

Incorporating hydro-excavation into a trench rescue program is not difficult. Hydro-excavation contractors such as Specialized Maintenance Services Inc., are usually available in industrialized areas. Municipalities have also begun to add vacuum excavators to their public works fleets to maintain sewer systems which, with minor modifications, can be used in trench rescue scenarios.

In a trench rescue or recovery emergency, the first officer arriving on the site would assume the Incident Commander position and activate the trench rescue plan.

A determination to use a hydro-excavator or vacuum truck would be made at this point if the conditions on the site indicated their use would be the best method to ensure the safety of the on-site rescuers and the victim or victims involved.

Using their resource list, the responding department would then contact the contractor or appropriate public works department to dispatch the unit to the site. In the interim, the rescue team would set about securing site in much the same manner used in haz-mat incidents. Three zones, hot, warm and cold would be established. In a perfect model, each zone would be 100 feet in diameter. The real world seldom offers perfect models, however. If job-site conditions do not permit establishing zones that size, the incident commander should claim all the area possible at the outset and make the zones as large as possible, as it is difficult to claim more area once a rescue operation has begun.

While waiting for the arrival of the hydro-excavator, the rescue team should continue their site preparation efforts. Removing and/or limiting the surcharge loads (spoil, equipment, materials) and other destabilizing influences around the trench should be a priority goal. The target distance to remove the surcharge loads from the edge or lip of the trench should be at least one and a half times to twice its depth. In other words, if a trench is six feet in depth, the surcharge loads should be moved at least nine feet back.

More prep

Any heavy equipment operating in the area should be stopped, secured and turned off. As a general rule, moving any equipment positioned by the trench away from it is not advised, as its movement and vibration may further destabilize the trench walls. If site conditions require its removal or relocation, the incident commander should make that judgment carefully. It is advisable to do so only after the trench has been properly shored or shielded.

Plywood ground pads (4 by 8-feet) should then be placed alongside the excavation to provide safe footing and a better distribution of the load imposed by the weight of personnel and equipment along the edge of the excavation. The rescue personnel would then begin installing the shoring or shielding equipment to prevent a secondary collapse of the trench and make it safe for entry.

The atmosphere of the trench should then be checked for oxygen concentration, flammability and toxicity. The team should utilize their established operating procedures for controlling hazardous atmospheres.

The OSHA standard requires an oxygen level between 19.5 and 23.5 percent, a lower explosive limit of 10 percent for any flammables, and a reduction of any toxics to a safe level.

It is advisable to reduce the flammability and toxicity levels to zero. Ventilation should be provided by blowers, not only to help ensure a safe atmosphere, but to carry away any gases that might be released by the disturbance of the soil during the rescue procedure. It also provides cooling on hot days for rescue personnel involved in the excavation.

Teams

The labor intensive nature of hand excavating the victims has, historically, required Incident Commanders to establish at least three (preferably four) teams of two rescuers each to be rotated on fifteen minute intervals to reduce fatigue and minimize injuries. While hydro-excavation dramatically reduces the amount of physical effort and time involved on the part of the rescuers, it is still recommended that the teams be established and staged to function and support each other in a manner consistent with standard rescue training.

When the hydro-excavator arrives, it should be directed to the staging area after charging the water tank from a convenient hydrant. When the Incident Commander is ready for it to be used, it should be driven slowly and positioned forward or rearward of the collapsed zone at a distance at least twice the depth of the trench away from its

edge (see Figure 2). While the unit will generate vibration, it is both high frequency and low amplitude in nature and does not affect the trench in the same manner as low frequency/high amplitude vibrations generated by traffic, trains, etc. Since the excavation will be properly shored or shielded or shielded at this point, the vibratory effect is typically negligible.

The vacuum and pressure hoses would be extended to the trench, and the pump and vacuum units started. The technicians, or rescue personnel, would then begin to hydro-excavate the soil from atop the excavation. The decision to allow the civilian contractor or public works personnel to assist in the process by operating the equipment rests solely with the Incident Commander. Using non-department personnel to assist in a rescue is an acceptable practice; there is considerable precedent for doing so. Their expertise and experience can be relied upon like any other tool or resource. It is advisable to establish a working relationship with contractors or public works personnel in advance and undertake joint training exercises to determine how to best integrate and utilize them in a rescue scenario. It is far preferable to undertaking training during the course of a rescue, particularly one fraught with as many potential problems as a trench rescue.

The rescue team would determine the position of the victim and the best place to excavate a "sump." As water and soil is washed away by the process, it would flow into the sump and be vacuumed away by the vacuum hose. The water is removed within a few seconds of being sprayed. As a consequence, pooling or seepage into the soil is eliminated. Should the hydro-excavator need to be emptied when the debris tank is filled, it should be moved outside the "cold" zone to dump the material, then returned to the original position or to a new one, determined by the rescue team, to continue the operation.

When sufficient soil has been removed to allow for the extrication of the victim, the technician would vacuum up the residual water and wet soil. The rescue personnel would then enter the trench, at the direction of the Incident Commander, and remove the victim using the most appropriate means and methods.

Impressed

The Pearland Volunteer Fire Department recently hosted a demonstration of hydro-excavation in trench rescue application for Houston-area fire departments. Captain Tommy Holliday of the Pearland Department and Chief Richard Cole of the Houston Rescue Team (both veterans of trench rescue/recoveries themselves) had an opportunity to evaluate the procedure and reflect upon its usefulness in scenarios they had encountered.

"After being involved with a trench collapse and having to deal with the stress of putting our own into what was, potentially, a very bad situation, I wish that hydro-excavation was more prevalent in the fire service," said Holliday. "This technique affords rescue personnel a vastly increased level of safety while giving the victim a much better chance of a favorable outcome.

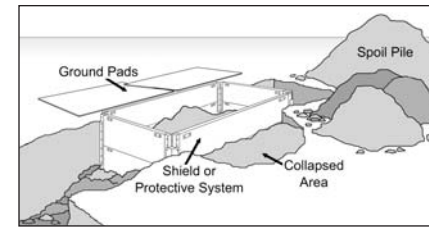
"A trench rescue is not a scenario that comes along all that often, which is all the more reason to take the time to learn all you can about hydro-excavation in advance," he said. "It could very well mean the difference between life and death for both rescue personnel and the trapped victim."

Cole added, " I think hydro-excavation is the greatest thing to come to the fire service since the thermal image camera. It allows us to perform safely from outside the trench, which limits our team members exposure."

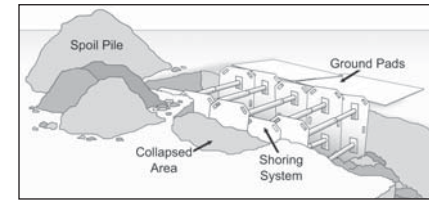
As they rightly observed, hydro-excavation represents a quantum leap forward in trench rescue technology. Rescue teams should avail themselves of this valuable tool and add it to their resources.

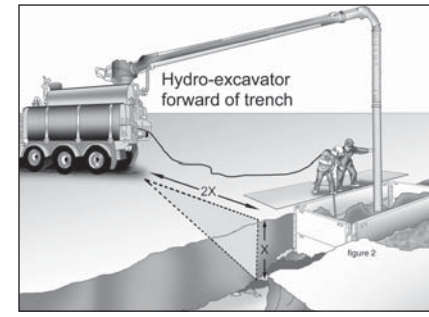
FOR MORE INFORMATION:

Trench safety:
Speed Shore, (800) 231-6662, speedshore.com
Hydro excavation:
Specialized Maintenance Services,
(281) 476-1010, specializedmaintenance.com



Either a shielding system (above) or a shoring system (below) should be used in preparing the site.





Above: Figure 2, The hydro-excavator should be positioned forward or rearward of the collapsed zone at a distance at least twice the depth of the trench from its edge. Below: Hazardous atmosphere chart.