Safe Use of Lift Equipment in Shotcrete

By Mason Guarino

With shotcrete needed in a wide variety of locations and environments, we have often learned that aerial lift equipment is the best and fastest way to access all the places where shotcrete is placed. Lift equipment saves immense time over scaffolding and really helps you get close to the work you are doing without having parts of the scaffolding get in the way. However, working at heights can get dangerous, especially when people can easily manipulate the work platform that they are on.

There are many different types of aerial lifts but they boil down to two main types: the scissor lift and the boom lift. These tools are very basic to use when used properly. The owner's manual can be the most useful item when first using a lift that you are unfamiliar with. In addition to the potential fall hazard, these lifts can also create dangerous scenarios because they are self-propelled and some can be moved while the platform is extended. With all the dangers that these tools have on their own, we then introduce shotcrete nozzling to the aerial work platform.

The first step to using lifts safely is common sense. Common sense is probably the most important tool that a person can have when working around anything that can be dangerous. The first thing anyone should do when they first get onto a piece of lift equipment they have never used is to read the owner's manual. The manual will describe the basic safety requirements and how to operate the lift and all of its features correctly—for example, whether or not this type of lift requires a harness. All boom lifts require harnesses and typically scissor lifts do not. However, some jobsites require the use of harnesses in all lifts.

Understanding the tool is a good way to keep from hurting yourself or others. A popular thing in the construction industry is to disable safety features that are either "annoying" or "slow us down." These safety features are there for a reason and should stay operational. It is very popular to use lifts provided by rental companies and I have found that when first using rental equipment, sometimes the previous renter had disabled a safety feature and the rental company did not pick up on it when transferring to you. These are hard to spot but worth checking when going through the owner's manual on first use of the lift. Reconsider the "If it ain't broke, don't fix it" attitude because an OSHA visit would most likely not accept the "they gave it to me like this" excuse, especially if someone gets hurt. So reading the owner's manual and making sure the lift is operating correctly with all safety features operational is an important step.

Some routine misuses of common sense are when you are at the maximum height and just need to reach another foot, so you stand on a bucket or climb the railing to get that extra foot out of the lift. This is when you need to realize you do not have the correct tool for the job. There are a multitude of different types of lifts that can reach in all different ways, so if you can't reach it with the one you have, there is most likely another one out there that can. Rental company sales people are always happy to make a site visit to help you get the correct tool for the job. Typically the rental company will also provide a class and certification to all employees who will be using the lift to ensure safe operation and proficiency (refer to Fig. 1).

Before getting into shotcrete specific lift knowledge, I need to touch on driving safety. Remember that lifts are designed to have a massive amount of weight very close to the ground and you are a very light thing potentially very high off the ground or at least very far away from the lift's center of gravity, especially on a boom lift, even when retracted. There is another piece of equipment that has a very large weight on one end and a very small weight on the other end, and it looks surprisingly like a boom lift. It's called a catapult, and it is possible to use a lift as a catapult with the operator as the projectile. It is more common with boom lifts than with scissor lifts but the rules apply to both. When driving a lift,

always stay on secure, stable ground. Never drive a lift off a small ledge or step thinking that because it has off-road tires it can handle this stuff. The off-road tires are to prevent these heavy things from getting stuck on flat ground that is slightly uneven, not to go rock crawling such as one would in a Jeep. When the counterweight portion of the lift steps off the ledge or step, it will sway and try very hard to launch the operator out of the basket. Additionally, when driving up or down a hill, always keep the counterweight on the upside of the hill. If the counterweight is on the downside of the hill and the hill is steep enough, the lift can overturn and the operator could get seriously injured. Remember that with scissor lifts raised and with boom lifts you are at the end of a very long stick and when the base moves slightly, the movement of the basket is magnified immensely.

Adding shotcrete to a scissor lift adds its own issues to be careful about—primarily weight and movement. When renting a lift for shotcrete work, I like to get the largest one that will fit for the job while not causing any of its own risks and not pricing you out of the job. A larger lift is more stable because it is heavier and can typically support more weight on the work platform. The heavier lift will reduce motion of the lift caused by the nozzlemen's movements while shooting, especially with the wet-mix process, where the hose is heavier. Less movement of the lift allows for better nozzle control. Nothing in shotcrete is light; even the small parts are heavier than they look. So let's think about what a basket is really holding up. A nozzlemen weighs, on average, between 230 and 300 lb (100 to 140 kg) with their PPE, basic tools, clothes, and boots. So even before you add a concrete hose, nozzle, and concrete in the hose to the lift, you have already most likely exceeded 500 lb (230 kg), which is a common weight limit for small and medium lift equipment. Add the empty concrete hose and you get 3 lb/ft (4.5 kg/m)—say the job is 50 ft (15 m)

Fig. 1: Nozzlemen shooting a research tank from a lift. The site had terrible soil, which required an all-terrain lift with tracks instead of wheels to give safe access for nozzling and finishing

high at maximum, that is another 150 lb (68 kg) straight line from the ground to the basket, add 10 ft (3 m) of hose in the basket and another 5 ft (1.5 m) of hose because it's not perfectly straight down and you get 180 lb (82 kg) of empty hose on the basket before you add concrete. The concrete in the hose will add another 2 to 3 lb (3 to 4.5 kg/m) per foot, getting your hose weight upwards of 360 lb (160 kg) that the basket is supporting as well. You should also be sure to tie the hose off well to the basket to support it. Also, it is a good idea to tie a rope from the basket to the halfway point on the hose to give the hose more support and reduce the swinging motion of the hose while shooting. Based on these weights, you would want a minimum 1000 lb (450 kg) weight limit basket in a lift (refer to Fig. 2 and 3).

Fig. 2: Nozzlemen using scissor lift instead of scaffolding to gain access to the 270 ft (82.3 m) perimeter research tank project

Fig. 3: Using the lift on the research tank allowed us to easily reach the 20 ft (6 m) heights and move along quickly and safely

It is also a tempting idea to tie the nozzle to the handrail on the boom lift to allow for shooting with less fatigue of the nozzlemen. This may work, but if the shotcrete needs to encapsulate reinforcing bar well, the nozzlemen should really be holding the nozzle to provide the precise nozzle motion needed for good encasement. Additionally, if the nozzle is tied off, the higher pressures of wet-mix shotcreting can add higher risk if the nozzle plugs. If seriously high volumes are needed, I would recommend a shotcrete robotic arm over a boom lift. Finally, make sure the hose is safe. If the hose gets kinked or crushed under any moving parts or the tires, this can cause a dangerous situation for the nozzlemen when flow restarts suddenly after the constriction is removed. It can also weaken the hose and make it more prone to breaking in the near future.

In summary:

- Use common sense;
- Read the manual; and
- Use the lift per the manufacturer's directions.

Following the lift guidelines and being fully aware of the loads on the lifts and maximum safe reach, along with and the basic safety rules, will keep everyone in and around the equipment safe.

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