Worker safety in formwork operations

Proper jobsite practices reduce injuries and accidents

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Small openings covered with a single sheet of plywood can be more dangerous than large openings which must be covered with 4x4s and plywood. The reason: a natural tendency when picking up a sheet of plywood is to step forward and into the hole.

Personal injury due to construction accidents inflicts pain and suffering on the hapless victim and costs the construction industry billions of dollars each year. Recognizing the dangers to workers in erecting and stripping formwork is a primary way of reducing this human and financial waste in concrete structures.

Major categories of accidents in forming and shoring activities are:

- Falling from one level to another
- Being hit by falling objects
- Improper lifting practices

These general hazards as well as hazards associated with particular forming systems are discussed. Recommendations are given to minimize the risks associated with the numerous hazards.

Why are falls so frequent?

Concrete formworkers often work at the upper reaches of a building where no structural members are available as anchorage for safety lines. They start with nothing in the air and work to make a solid membrane that will hold concrete. Until the last form is put into place or the last sheet of plywood is laid, there are openings in the deck. Perimeter protection or guardrails cannot be installed until something exists on which to attach the guardrails. The stripping of deck forms can leave openings in the floor through which an unsuspecting formworker may fall. And last, but not least, are inexperience and the eagerness of some formworkers to get a job done with the materials closest at hand.

Preventing falls during deck form erection

In a traditional deck forming operation, the first members raised are 4x6 stringers. Shores are attached at the ends and a tie board provides temporary support. Many formworkers feel that the easiest job in the work of raising stringers is to be on the stringers nailing the shores and the tie boards while the people below do the hard work. This requires that they walk a 4-inch beam located 10, 12, or 20 feet in the air. It may be easy, but it's an accident waiting to happen. The proper technique is to work from ladders or rolling scaffolds that rest on the finished floor.

The second step in conventional deck forming is placing the runners or ledgers—typically 4x4s or alu-

An accident waiting to happen. Walking a 4-inch beam located 10, 12, or 20 feet in the air may seem easy to some workers, but it's definitely not safe. The preferred procedure is shown in the picture on the right.

The safer way to erect stringers is to work from stable ladders. Note also that diagonal bracing is being installed as the work proceeds, contributing further to stability of the deck forming.

minum purlins. Walking 4x4 runners may be a little less dangerous than walking stringers, but stepping on a twisted 4x4 can cause a worker to lose balance and roll the 4x4. To eliminate this type of fall, keep plywood or a plank runway as close as practical to the point where 4x4s are being placed. Or in some cases the 4x4s can be distributed from below with powered lifting vehicles.

Changing the forming system is sometimes a practical way to reduce hazards. Form table panels built at ground level can be flown into place, supported on scaffold-type shoring towers or trusses. The panels also may be rolled into place on support brackets mounted on columns or bearing walls. When these panels are set in place they provide a reasonably secure platform from which to start working.

Protection at the building perimeter

The perimeter of the building is a danger area when conventional post shoring is used. Here the fall may be off the side of the building to the ground many floors below. Perimeter panels sometimes solve this problem. These panels, designed to provide continuous walkways and guardrails, make the building perimeter secure as soon as they are flown into place. On jobs that use flying deck forms, similar perimeter protection can be readily installed on the flying form unit.

Holes and openings

Elevator shafts and core walls present another problem. Guardrails are not too practical at the working levels of the deck because the wallform workers must go beyond the guardrails to do their work. Also, guardrails can be easily knocked down or damaged during stripping operations, especially if traditional stick-built forming is being used. It is more practical to cover the openings. At the wall form level, a platform can be hung by cables just below the wall forms. This platform can be built to fit tightly into the opening without dragging on the walls as it is being lifted. Being suspended by cable, it does not interfere with the contraction or expansion of the wall forms. At the stripping level, a wedged platform can be constructed. Easily lifted from one level to another, it is wedged back into place at the new location.

Other openings in the floor present different problems. It is probably safer to frame through openings at the formwork erection level and to cover openings at the stripping level, because guardrails at these levels also are susceptible to damage. Our experience indicates that small openings which can be covered with a single sheet of plywood are more dangerous than large openings that must be covered with 4x4s and plywood. The reason is that the natural tendency when picking up a sheet of plywood is to step forward and into the hole. Securing plywood to the concrete doesn't always work because the follow-up trades may remove the plywood to permit hoisting of materials or for other reasons and then fail to secure it again.

Special marked hole covers can be used, but this requires that they be available when needed and not be used for any other purpose. Covering the hole, but leaving part of it visible, will at least warn a worker that the hole is underneath. Probably the safest way to cover any opening through which a person might fall is by using cleated 4x4s in

the opening and then covering it with plywood securely nailed.

Ladders

Ladders are thoroughly covered by the Occupational Safety and Health Administration (OSHA) regulations. One special problem with extension ladders, however, is worth mentioning.

When an extension ladder is secured at the top and someone unwittingly moves the bottom of the ladder or pulls up on the top of the ladder to secure it, the latch mechanism can become undone. When the next worker goes to move the ladder and loosens the top, the ladder may collapse and cause injury. The latch mechanism should always be secured so that it cannot be unintentionally opened.

Safety belts

Safety belts should be supplied and used when erecting high scaffolding or working on wall forms. Lanyards should be used whenever working outside guardrails or when attaching rigging to flying forms.

Form stripping hazards

An innocent act that can lead to a serious fall may occur during the stripping process. Sometimes when shoring is removed, the plywood still sticks to the concrete and can overhang the edge of the building or into an opening. An unsuspecting worker on the concrete floor above may step on this unsecured plywood and fall. The stripping crew must be told of this danger and instructed to remove such plywood as soon as possible.

In some areas it is still common for the crane to snatch material off the side of a building. This requires a worker to lean out over an unguarded edge of the building to pull in the cables. If this technique is used, the worker doing the rigging should be secured with a lanyard. It is better to use an outrigger platform. Then the load can be wheeled outside the building line and the rigging can be done in a safer way.

Steel pan forms or domes are commonly removed from the ceiling by workers on an elevated platform. Usually the platform is elevated less than 6 feet above the ground, therefore requiring no guardrails to meet OSHA standards. However, it is necessary to equip at least one edge of the stripping platform with a guardrail to prevent dangerous falls at the edge of the building.

Injuries caused by falling objects

Being hit by falling objects is the second largest category of construction accidents. It's easy to see why falling objects can be a problem in formwork erection and stripping.

Material handling is 50% to 80% of formwork labor. Material is being put up, taken down, and moved horizontally. The areas to which material is moved are not completely decked over, nor is all the material immediately fastened to what is already in place. Tools, material, and debris can be knocked off easily or dropped from an uncompleted formwork deck. During stripping even the most experienced formworker can sometimes be hit by a falling object. Other tradespeople not aware of the dangers of form stripping should be kept out by a warning rope strung around the stripping area.

Precautions during formwork erection

All formwork members should be secured as they are put into place. Butted stringers should be nailed in a special head designed for this purpose. Shores should be secured at the stringers with a wire head or other means of fastening. An unsecured shore can fall as loads are placed on the deck or moved along the deck. A falling shore can injure an unsuspecting worker. Wooden crossbracing or other means of lateral support should be installed as soon as the first stringers are raised. Stringers being raised from a stabilized deck should be secured with a tie-off board. Lateral stability must be established before any loads are placed on the shoring.

Using fewer loose pieces reduces the likelihood of falling objects. Using perimeter panels, interior panels, column mounted shore panels, or truss panels wherever practical reduces significantly the number of loose pieces. When flying any panels from one level to another, remove all loose objects or see that they are secured to the panel. Debris and concrete chips should be removed from the panels before flying.

Objects falling during stripping and reshoring

In stripping operations, controlled lowering with scissors-lift platforms reduces the danger from falling objects. A scissors-lift platform is especially useful at the perimeter of the building or near large openings that for some reason are not covered.

Reshores should be held in place with spring boards or spring clips. These devices allow the reshores to be snugged to the ceiling without putting undue load on the reshores, and they can accommodate movement in the building. Extra care is needed when placing reshores at the perimeter of the building. Perimeter reshores that are outside the guardrails or are exceptionally tall should be laced together with horizontal wood strips. If any perimeter reshore becomes loose, the lacing keeps it from falling off the building.

When pushing out large panels that completely frame under an opening, be sure to clean out the rebar, chairs, excess concrete, and other debris that may have accumulated in the opening. If the panel is not lowered so that this debris can clear the ceiling, the material will slide on top of the panel and shower an unsuspecting worker who is pushing out the panel.

Formwork material should never be left stuck to a ceiling. It may seem tight but a few temperature cycles and drying of adjacent areas can loosen stuck pieces and cause them to fall. Used dome pans and used steel forms, which usually require a

considerable effort to break free, are generally considered safe to be left in the ceiling. However, new glass-fiber-reinforced forms, new wide-module steel forms, and joist forms with cover plates to create skip joist framing can and should be expected to fall by themselves. Special care should be used when working with this type of form.

Stacking of long slender materials, such as wooden shores, that could easily fall from the stack should be done carefully, especially at the perimeter of the building or near large openings. A stack placed parallel to the building edge or an opening edge greatly increases the possibility of a falling object accident. Stacking materials perpendicular to these edges will reduce the possibility of a piece falling off the stack and off the building. Banding a completed stack before moving the stack also is a good practice.

Improper lifting

The third most significant cause of accidents is improper lifting. Improper lifting is an accident factor once again because of the large amounts of material that must be moved on formwork jobs. Another concern is that sometimes material moving may be done under less than ideal footing conditions. Unused rebar, loose concrete, and formwork debris are common in construction areas. Slipping or tripping while carrying even a light load can cause a strain.

The best way to avoid improper lifting accidents is to:

- Teach employees to lift properly
- Teach them when to get help in lifting or moving material

Good housekeeping is a must in reducing lifting accidents. In addition to preventing tripping or stumbling, it makes it easier for an employee to position himself properly to lift the load.

Formwork systems also can be designed so that fewer pieces need to be moved manually. Many of the panelized systems previously mentioned fit into this category.

Wheels can be a big help in reducing lifting strains. Putting material on carts and pushing it is more efficient and is less likely to cause accidents. It also requires that the areas in which the carts are used be kept clean.

The controlled stripping techniques using scissors lifts also can reduce improper lifting. Removing material at a convenient working height is much less likely to cause strains than picking up everything from the floor.

Supervision and experience needed

Erecting and removing formwork exposes workers to many hazards. Good engineering and a good safety program are important. But competent jobsite supervision and experienced formworkers are the real keys to accident-free jobs.

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