Erecting and Dismantling Frame Shoring Towers

Fall Protection Guidelines
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Fall Protection Guidelines
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This manual was developed, reviewed, and endorsed by the IHSA.

The Infrastructure Health & Safety Association would like to thank the following organizations for contributing their knowledge, experience, and time to develop and produce this manual:

Aluma Systems
Carpentry Trade Labour-Management Health and Safety Committee
High-Rise Labour-Management Health and Safety Committee
Labourers’ International Union of North America
Ontario Formwork Association
Ontario Ministry of Labour
Scaffold Industry Association of Canada

Special thanks to:
Dennis Cancian, Trio Forming Ltd.
Dennis Kowalchuk, Labourers’ (LIUNA) Local 183
John Rosenthal, P. Eng., Dunn-Wright Engineering Inc.

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Mr. Walter Tracogna and Dennis Cancian, chair and cochair
Chairman Hi-Rise Forming Committee
C/o Infrastructure Health and Safety Association (IHSA)
5110 Creekbank Road, Suite 400
Mississauga, ON L4W 0A1

Dear Mr. Tracogna and Dennis Cancian

Re: Fall Protection during Erection of Shoring Tower Frames

Thank you for providing ministry of labor with a copy of the revised Alum Shoring Tower frame procedure.

This work procedure has been reviewed by staff of the Construction Health and Safety Program and by professional engineers employed with our professional and Specialized Services Group and has received consensus by the Construction Program Advisory Committee of the Ministry of Labour (CPPAC)

The Ministry of Labour recognizes that any work activity that places workers in a hazard of falling becomes a first priority for employers and supervisors in developing plans and procedures to protect worker safety.

The information in this document is consistent with the requirements of the Occupational Health & Safety act and appears to meet the intent of the regulation for construction projects. The ministry of labor understands that workers using the procedures outlined in the document are protected from the hazard of falling when working from towers during the process of either erecting or dismantling shoring Tower frames. It is also the understanding of the Ministry Labour that the specific implementation of this procedure and the required training of workers remains the responsibility of their employer.

Where there is a conflict between the content of this document and the Occupational Health & Safety act or regulation the requirements of the act and the regulation will prevail.

Ministry of Labour inspectors carry out workplace inspections to assess compliance with relevant provisions of the Occupational Health & Safety act and its regulations and will pay
significant attention to hazards such as falls that represent a serious threat to worker health and safety.

On behalf of the Ministry of Labour I would like to commend the high-rise forming sector labor-management health and safety committee and their working group for the reference in the production of the guideline for fall protection during erection and dismantling of shoring Tower frames. I am confident that the implementation of the principles outlined in the guideline will minimize fall hazards in advance safety procedures during erection and dismantling of shoring Tower frames.

I am to see the industry taking a leadership role in developing installation procedures to minimize the risk to workers and I wish you every success in their implementation.

Yours truly

[Signature]

Michael Chappell
Provincial Coordinator
Construction Health and Safety Program
Ontario Ministry of Labor
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>ERECTION PROCEDURE</td>
<td>2</td>
</tr>
<tr>
<td>INSTALLING THE DECK</td>
<td>6</td>
</tr>
<tr>
<td>DISMANTLING</td>
<td>6</td>
</tr>
<tr>
<td>FALL PROTECTION TEST</td>
<td>7</td>
</tr>
</tbody>
</table>
Typical shoring tower frames are approximately 6 feet high. A shoring tower consists of two end frames and two crossbraces. The crossbrace length for these towers is usually 10 feet. Once constructed, a single tier of the shoring tower would be 4 feet wide by 10 feet long by 6 feet high. Frames 4 feet high and 8 feet high are also used for shoring applications.

Screwjacks at the base can be used for leveling the frames and may be extended up to 2 feet. The screwjack is 32 inches long and telescopes inside the frame leg.

Shoring tower frames are placed one on top of another, usually in a single tower configuration. Depending on the height of the floor to be formed, the shoring tower may be as high as 5 lifts. Bridgework requires larger, heavier-duty frames and may require towers exceeding 50 feet in height.

At each corner of the top of the tower are U-heads with screwjacks, aluminum stringers, and aluminum joists. Plywood is nailed onto the aluminum joists.

To comply with fall protection requirements in the construction regulation (O. Reg. 213/91), the following guidelines have been developed by the industry and approved by the Ministry of Labour. The guidelines should be viewed as only one solution to fall protection for scaffold erectors.

By following the guidelines, a worker is protected if a fall should occur. The shoring tower is not subjected to additional external loads. The three components of the fall arrest system—two adjustable horizontal lifelines, two 3½–4 foot non-shock-absorbing lanyards, and the worker’s approved safety harness (capable of attaching two lanyards)—are readily adapted to use on the tower. The industry believes this to be the safest method of erecting this type of scaffolding.

Shoring towers are designed for supporting concrete and are not intended for use as access. The only time a worker is required to work off these towers is during erection and dismantling.
Erection Procedure

Two workers erect the base lift, one at each frame. Each worker is equipped with two lanyards attached to an approved safety harness. The screwjacks, frames, and crossbraces are installed from the support surface (ground).

Wherever feasible, ladders shall be employed for access and egress as the construction of the shoring tower progresses. If it is not feasible to use a ladder, Worker A climbs one of the frames onto the planks placed at level 2.

Worker B, at the support surface, passes the frames and crossbraces for the second lift to Worker A, at level 2.

The planks required for installation of the second lift are placed on level 2. Planks must be cleated or otherwise secured against slipping.

Worker A sets the frames in place at each end of the tower. Note that one end frame has one end of the horizontal lifeline already attached to the top rung, as close to the middle of the rung as possible.

Before setting the second frame in position, the horizontal lifeline is attached to its top rung. Once the second frame is in place, Worker A installs the crossbraces.

The horizontal lifeline system must meet the minimum requirements of the construction regulations (O. Reg. 213/91) and must be designed in accordance with good engineering practice.
Once all the connections are made to the second lift, Worker A tightens the adjustment on the horizontal lifeline and attaches the lanyard.

From this point, the worker is tied off at all times.

Worker B passes additional plank(s) to Worker A, who places plank(s) at level 5.

Worker A, standing on a single plank, moves the remaining plank from level 2 to level 5. The one plank is left at level 2, and moved to lie directly beneath the two planks at level 5.

Regardless of the height of the individual frames used in the tower, the planks are always moved to one level below the top of the highest frame until the required height of frames has been reached.

Worker A climbs from level 2 to level 5.
At level 5, Worker B again passes frames and crossbraces from the support surface to Worker A.

Worker A moves along the planks at level 5 while tied to the horizontal lifeline at level 6.

Note that one end of a second horizontal lifeline is already attached to the top rung of the next frame to be placed.

Worker A attaches the other end of the second horizontal lifeline to the top rung of the second end frame prior to setting it on the coupling pins.
While Worker A is still connected to the lower horizontal lifeline, the crossbraces are installed on the third tier.

Once both crossbraces are installed, the third tier is completed. The worker tightens the adjustment on the upper horizontal lifeline and connects the second lanyard to the upper line.

When one lanyard is connected to the upper horizontal lifeline, the other lanyard is disconnected from the lower horizontal lifeline. The lower line is removed to be used again later, on the next lift.

Worker A now sets planks at level 7 because this is the required height of the tower. If the tower were to be higher, the planks would be set at level 8. The worker climbs onto the planks to prepare for installing the deck.

For higher towers, the same procedure is followed until the required frame height has been reached.
Installing the Deck

As soon as the top tier is braced, and the horizontal lifeline is tightened between the topmost rungs, Worker A connects one lanyard to the upper line. The other lanyard is disconnected from the lower horizontal lifeline. The lower horizontal lifeline may be left in place for descent.

Worker B passes a plank to Worker A, who places it on the third rung from the top. Worker A, standing on a single plank, moves the remaining plank from his level to the working level.

Worker A climbs the frames while attached to the horizontal lifeline. Now it is possible to move along the top of the tower to install the deck components.

The process is repeated until all the towers for the formwork have been erected.

With one lanyard attached to the upper horizontal lifeline, Worker A climbs down the frames to the next lower plank. Standing on that plank, the worker connects the second horizontal lifeline to the rung of the frame one level higher than the plank level. The worker climbs up once more, disconnects the second lanyard, and loosens and removes the top horizontal lifeline for further use while descending the tower. This procedure continues until the worker reaches the support level.

Dismantling

The dismantling of shoring towers is no different from most other types of scaffolds. Generally, the dismantling procedure is the exact reverse of the erection procedure; the last component installed is the first to be removed.
Test Outline

Tests were carried out to simulate a worker falling

(1) inside the frame shoring tower, and

(2) with the centre of mass approximately 2 feet outside the tower.

The 4’ x 6’ frames were erected two tiers high, with the bottom screwjacks extended 18”. An adjustable horizontal lifeline was connected between the top horizontal members of the second tier frames (approximately 13 feet above the floor) to function as a horizontal anchor line. The line was positioned between the two diagonal support members of the top rungs. The midpoint of the line was measured to be 12’ 10” above the floor, representing a 2” sag in the line.

A 220-pound weight was connected to the horizontal lifeline by a 4-foot non-shock-absorbing lanyard. In both cases, the weight was raised to slightly higher than 4½ feet above the planks to represent the location of the centre of mass of the worker, and released to fall as required.

For the fall within the tower, the planks were pushed to one side of the tower, and the weight was located approximately in the middle of the space between the edge of the plank and the inside faces of the crossbraces.

During the falls, the forces on the horizontal lifeline caused the top frames to be drawn inwards. Consequently, the crossbraces bowed (but did not break) to accommodate the inward motion. The tower shook considerably and shifted slightly out of its initial position on the floor, but remained upright during and after the falls.

In each case, there appeared to be no distress to the top frame horizontals, to the nylon line, or to the lanyard. Both nylon members were the same length before and after the tests.

Test Results

Within tower fall:

After settling, the end of the lanyard was approximately 7 feet above ground level. The tests were videotaped. Close review of the tape indicates that the hook of the lanyard reached 13½ inches below the top rung of the lower frame. This indicates that the fall-arrest system experienced a total “stretch” of 11¼ inches. It also indicates that a worker’s feet, located 5 feet below the end of the lanyard (allowing for slippage of the D-ring and slack in the harness), would be slightly less than 1 foot above the floor at the maximum fall distance.

Comment:

The planks were purposely moved out of the way of the falling weight. If a normal fall occurred within a tower, it is likely that the worker would contact planks and/or braces on the way down, thus reducing the amount of free fall and the amount of force applied to the body. The reduction in free fall distance would also reduce the amount of “stretch” in the fall-arrest system, ensuring that the worker’s feet would not contact the floor.

Although a non-shock-absorbing lanyard was used, and the fall distance was approximately 9 feet, the force exerted on the worker’s body would have been reduced considerably because the scaffold system absorbed much of the shock load by partially collapsing. The force exerted on the body was identified with a dynamometer.
Outside tower fall:

After settling, the end of the lanyard was approximately 7 feet above ground level. The tests were videotaped. Close review of the tape indicates that the hook of the lanyard reached approximately the same location as within the tower, that is, 13½ inches below the top rung of the lower frame.

This indicates that the fall-arrest system experienced a total “stretch” of 11¼ inches. It also indicates that a worker’s feet, located 5 feet below the end of the lanyard (allowing for slippage of the D-ring and slack in the harness), would be only slightly less than 1 foot above the floor at the maximum fall distance.

Additional Testing

A further test was carried out to determine the amount of force on a body during the fall. A dynamometer was connected to the 220-pound dead weight and set to record the maximum force applied. After the drop of approximately 9 feet, which would result in a force on a body of 3,600 pounds, the reading was 1345 pounds or 5.98 kN, about ¾ the maximum allowable force. [Maximum allowable force is 8 kN or 1800 pounds.] Therefore, the shoring tower, horizontal lifeline, lanyard, and harness absorbed over 2,000 pounds of force through deformation.
About IHSA

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