Title: Safe Work Procedures	Section: 23	Issue Date: February 2022
Approved by: Walter Spivak, President	Signature:	Revision Date: NA

23.1 Policy Statement

A safe work procedure includes activities that have been shown in the industry to have potentially serious consequences when performed improperly. CF recognizes that these activities require stringent safe work procedures, and that these activities may be determined through job safety analysis. CF requires all employees be trained in and use safe work procedures to assure safe completion of tasks. In addition, some jurisdictions may require a site-specific safety plan.

23.2 Confined Space Entry

Standard

This Procedure has been developed to aid CF employees in identifying and protecting themselves in the event of working in a confined space.

A **confined space** means a fully or partially enclosed space that is not both designed and constructed for continuous human occupancy and in which atmospheric hazards may occur because of its construction, location, contents, or because of the work that is done in it atmospheric hazards may occur.

Examples of Confined Spaces	Common Hazards
Welding the interior of large pipe.	Accumulation of welding fumes
Vessels	Welding process may displace 02 and create CO
Pits	Possible spills of chemical leaking into pits
Excavations	Leaking bottles 02, acetylene, nitrogen product heavier than air leaking in nearby pits
Confined Areas	Co-emitting internal combustion engines operating nearby.
Utility Maintenance Holes	Accumulation of toxic and/or combustible fumes from ducts entering the chamber and water

The Permit System must be obtained separately for each job, location, person, and time. Permits are only good for the shift they were issued for. Confined Space Entry forms must be returned to the supervisor at the end of each shift.

Note: The specific gravity of carbon monoxide (CO) is slightly lighter than air, and as such could be found at any level within a restricted/confined space. Be sure to sample every 3-feet of elevation, in the corners for CO and other contaminants are required.

Prior to entry into a confined space, a Confined Space Hazard Assessment, Confined Space Plan and Confined Space Entry is required. All these documents are known collectively as the Confined Space Entry Permit System see H&S_FORM_041. This permit system is available through the supervisor.

The "Permit System" must be accurately completed before entering into the confined space. If you require any assistance please contact the H&S Department.

Procedure

- No worker shall enter into a confined space or perform related work until they have been trained on the permitting system.
- The permitting system will include hazards associated with work inside the confined space and safe work practices for working in confined spaces and performing related work.
- All training records shall be kept on the project and indicate who provided the training and date provided
- Access and egress from all accessible parts of the confined space is required prior to entry (e.g. a secured ladder).
- If a possibility exists for any unauthorized entry into a confined space, signs or barricades or both will be used to warn against unauthorized entry.
- All electrical and mechanical equipment attached to the process in the confined space must be isolated or disconnected from its power source and locked and tagged out.
- Any moving parts and other equipment that may store energy and have the capability of movement must be de-energized and blocked to prevent movement.
- No testing is permitted on any pipe when men are working inside (e.g. x-ray, die penetrant, etc.).
- All pipes and other supply lines to the confined space must be bled off of any residual energy and blanked off (with blinds sufficiently strong to withstand the line pressure and not susceptible to corrosion by materials in line).
- Prior to entry into a confined space, a competent person will perform adequate tests as often as necessary before and while a worker is in the confined space to ensure acceptable atmospheric levels are maintained.
- All permits are to be returned to the issuer (Supervisor) at the end of each shift.
- A confined space shall be entered when:
    - The Permitting System is complete and all workers have been instructed as to the permitting system requirements

  - All workers entering in to the confined space are trained as to the hazards inside the confined space.
  - The space is purged, continuously ventilated and continuously monitored as the case may be.
  - All measures necessary to maintain a safe atmosphere have been taken.
  - A trained worker is stationed outside the confined space.
  - Suitable arrangements have been made to remove the worker from the confined space should he/she require assistance and a person adequately trained in artificial respiration is conveniently available.
- All work must cease and workers must evacuate when there is or is likely to be:
- Hazardous – gas, vapour, dust, mist or fume; or
- An oxygen content of less than 19.5% or more than 22% at atmospheric pressure
- Whenever the alarm is sounded indicating a warning

Note: When a confined space cannot be purged of all atmospheric hazards due to the process or nature of work/equipment or confined space and CF employees may be required to enter the space, the H&S Department shall be notified prior to any entry.

Responsibilities

Program Development and Administration

The confined space program, hazard assessments and entry procedures shall be developed by a qualified person. Qualified person indicates the individual has experience in the recognition, evaluation and control of confined space hazards and can satisfy one of the following requirements:

- Certified Industrial Hygienist (CIH)
- Registered Occupational Hygienist (ROH)
- Certified Safety Professional (CSP)
- Canadian Registered Safety Professional (CRSP)
- Professional Engineer (P.Eng.)
- Experience working with confined space and has a combination of education and training as deemed acceptable by the local jurisdiction

Stand By Attendant

1. Is stationed outside and near the confined space entrance
2. Maintains communication with the confined space worker at all times.
3. Is trained in the confined space entry permit system and first aid and cardiopulmonary resuscitation.

4. Is trained in the use of non-entry rescue equipment as per the "Confined Space Permit System" and work activity (consult with the safety department for further clarification).
5. Is provided with an alarm or similar device to summon adequate rescue
6. Ensure a means of emergency signal is available; fire extinguisher, mechanical ventilation; emergency stretcher and SCBA are available if required for rescue as detailed in the plan. Mechanical ventilation or other adequate and consistent ventilation is supplied to the confined space at all times.
7. Ensure that a means of retrieval is available for the confined space worker, in the event of an emergency.
8. Obtain and post at the entrance to the confined space the "Confined Space Entry Permit System" from the supervisor, or have it available for inspection. Return permits to Supervisor at end of shift.
9. If worker reports headaches, dizziness, irritation or other ill-effects then stop work and assist worker in a non-entry rescue (do not go into the confined space

Note: Rescue considerations must be made prior to working in a confine space.

Note: At no time will the Stand By Attendant enter into the confined space. The attendant's role is to monitor the safety of workers inside the confined space, provide assistance and summon an adequate rescue response as required.

<u>Confined Space Worker</u>

1. Ensure a "Confined Space Permit System" is posted at the entrance to the confined space.
2. You have signed the permit.
3. Ensure to wear and use in accordance with the designed and training all personal protective equipment required while working inside the confined space.
4. Review to ensure that all energy systems are de-energized or lockout out and any process equipment is blocked and blanked and secured against any movement or process material flow.
5. Wear other personal protective clothing and/or equipment required.
6. If compressed gas is required in the confined space:
    a. The bottles are to be left outside the space
    b. Prior to entering a leak test is conducted on the equipment (torch and hoses etc),
7. Ensure your equipment/tools are in good working condition prior to entry (e.g. good insulation on welding electrodes and grounding on tools and equipment).

<u>Supervisor</u>

1. Ensure that the confined space entry system is initiated including the relevant training before allowing employees to enter into a confine space. When in doubt always contact the H&S Department for assistance.

2. Prior to allowing any worker(s) to enter into the confined space, review with all workers all the information in the Confined Space Entry System including the hazard assessment, the plan, the rescue and permit.
3. Consult with the H&S Department for guidance as needed
4. Ensure this procedure is complied with and provide his/her workers with the appropriate training.
5. All workers working in the confined space shall be trained as per the "Confined Space Entry System"
6. React to any emergency
7. Maintain confined space entry permits for 1 year after entry

Coordination Document Standard

A Coordination Document will be completed whenever multiple employers will enter the same confined space either simultaneously and/or consecutively. Employers performing related work around confined spaces must also be involved in this assessment.

Purpose

- To ensure that all employers of workers in a confined space are aware of potential or existing hazards and any other hazards that may be introduced in to the confined space by any of the employers because of the nature of the work they are performing in the confined space.
- To ensure employers communicate with one another
- To ensure employers fulfill their duties/responsibilities to their workers
- To reduce duplication of with respect to plans, entry permits, etc
- To ensure that workers of the various employer's work in compliance with confined space requirements

Responsibility

It is the role of the constructor / prime contractor to identify when the Multiple Employer Coordination Document is required and to ensure that confined space work activities that involve multiple employers is properly assessed to ensure that adequate plans are in place for the protection of workers.

23.3 Electrical, Mechanical and Other Energy Sources - Tagand Lock-Out

Standard

The purpose of this procedure is to establish the requirements for the isolation of electrical, mechanical and other energy sources. Isolation shall be used to ensure the health and safety of workers where the unexpected start up or release of stored or residual energy could cause injury.

Six steps to effectively Lockout and Tag-out energy sources:

1. Identify all energy sources.
2. Isolate or neutralize all energy sources.

3. Verify zero energy state.
4. Attach lockout devices and tags.
5. Complete work and remove locks.
6. Only power up or re-energize after everyone is clear.

Procedure

1. The Electrical Supervisor involved in the electrical work, shall determine where isolation of electrical sources is required. The supervisor involved in the isolation of mechanical energy sources shall determine where isolation of mechanical sources is required.
2. Workers and Supervisors involved with lockout / tag out must be trained in this procedure, and their roles & responsibilities as outlined in this procedure.
3. Notify all other supervision working in the vicinity of the systems requiring electrical or mechanical isolation.
4. The Electrical and/or Mechanical Supervisor shall test and try to engage the equipment to confirm the isolation
5. The Electrical Supervisor or Mechanical Supervisor shall tag and lock-out the disconnect device. The supervisor will maintain control using a scissor-type device (if required) or a lock box to allow for the multiple installations of locks for other trades.
6. ALL SUPERVISION of trades working on the isolated electrical or mechanical system shall ensure that each of their workers install locks and tags for their protection. If the same work continues into the next shift, the incoming crew shall follow the same procedure after the first crew has removed their locks.

23.4 LOCK-OUT & TAG-OUT

Lock-out Tag-out is required when equipment or tools and are being serviced or cleaned, the power to the equipment is shut off and the machine is made incapable of moving. All energy sources (electrical, hydraulic, pressure, etc.) are de-energized. The goal is to make sure no one is hurt while working on or near the machine.

Lock-out is meant to ensure that once the equipment is de-energized it stays that way. Lockout helps prevent someone from inadvertently energizing the equipment and causing injury or death.

Tag-out: Lock-out should be accompanied by a tag out. A tag, if required, must be attached to the lock indicating the name of the person working on the equipment and the date.

Electrical Isolation
The ELECTRICAL CREW locks shall be the first on and the last off.

Mechanical Isolation
The MECHANICAL CREW locks shall be the first on isolation, and last off.

- Locks used for isolation shall be individually keyed, numbered and shall not be used for any other purpose
- The locks and keys shall be stored in a lock box or other suitable arrangement with the Lock-Out Log, H&S_FORM_042.
- Access to the locks shall be controlled by the Electrical Supervisor in the workplace.
- Electrical department locks shall not be removed or power restored to a service until all other trade locks are removed and the supervisor who requested the isolation signs off in the log.
- All locks and disconnects must have a "DANGER - DO NOT ENERGIZE OR OPERATE" tag securely attached.

23.5 Delinquent Locks

In the event that a lock is left on, tags are missing or an emergency occurs, and the system must be energized, CF Manager/Superintendent may authorize the removal of the delinquent lock using the following procedure:

- Every effort shall be made to identify and contact the lock owner, including phone calls to the residence, see Delinquent/Abandoned Lock Removal Form H&S_FORM_043.
- The **Electrical / Mechanical Authority** shall identify systems or equipment affected by the lock-out and verifies workers will not be affected by re-energizing.
- Disciplinary action taken if warranted.

23.6 Turnovers

During the turnover phase of a project extra care must be taken when isolating electrical equipment as some systems and equipment may be under client and construction control.

- Prior to attempting to isolate any electrical installation or equipment during the turnover phase ownership must be verified.
- Client operations shall sign the log for any isolations completed under CF procedures and controlled by both parties.

23.7 Operating Systems

Systems turned over or under client, control shall be isolated in accordance with the client's procedures. If the client does not have any procedures, further discussions with the client must take place to plan out a safe isolation turnover.

23.8 Trenching and Excavations

Standard

When workers are required to enter a trench or excavation, adequate precautions shall be taken to prevent injury. Consult your local jurisdiction for regulatory requirements.

Definitions

Excavation
Means the removal of soil or other ground material where the resulting hole's width exceeds the depth

Trench
Means an excavation where the depth exceeds the excavation width.

Soil Types

Type 1 Soil
Hard and very dense and can only be penetrated with difficulty by a small sharp object or mechanical equipment

Type 2 Soil
Is very stiff, dense and can be penetrated with moderate difficulty. It will have a damp appearance after it is excavated.

Type 3 Soil
Is stiff to firm and compact to loose in consistency or is previously excavated soil. It exhibits signs of surface cracking and water seepage. It has a low degree of internal strength.

Type 4 Soil
Is soft to very soft and very loose in consistency. It has almost no internal strength and is wet or muddy. Sand would also fall into this category.

Any excavation containing more than one soil type will be classified as the type with the highest number.

Procedure

Use the following for excavations less than 1.2 m (4') deep. If the jurisdiction of work requires a written checklist before workers enter excavations or trenches, regardless of the depth, then refer to Section B of this procedure.

A. Before a worker enters or conducts work in a trench, the supervisor or his/her designate shall ensure that all applicable requirements have been met.

B. The supervisor shall visually inspect and ensure that:
   a) when a worker is in the trench, another worker is close at hand;

b) underground utilities have been located and marked;
c) the excavation/trench is kept reasonably free of water;
d) a level area extending 1 m (3') from each wall is clear of spoils, equipment and materials;
e) the walls of the excavation are supported and/or sloped to ensure compliance with the applicable legislation and worker safety;
f) every prefabricated, hydraulic or engineered support system is designed by a professional engineer and the drawings are available for inspection;
g) every prefabricated, hydraulic or engineered support system is installed, removed and inspected as specified;
h) means of access and egress are located at various locations in the excavation/trench; and
i) Ladders extend 1 m (3') above the grade level. Use the following for

Excavations of more than 1.2 m (4') deep.

1. When the excavation/trench exceeds 1.2 m (4') in depth, the supervisor shall ensure that the Trenching & Excavation Checklist, see H&S_FORM_044, is completed.
2. All applicable requirements must be in place before a worker enters a trench or excavation.

The following procedure will be used to provide security to excavations that may be a hazard to pedestrians on a public way.

1. Before the excavation starts, establish a work area protection zone in accordance with the Traffic Control Manual for Roadway Operations, Field Edition (for Ontario, or equivalent standard for outside Ontario).
2. Establish a work area protection zone for the protection of pedestrians and other users of the public way. Most common methods include the use of barricades and/or cones. Always ensure that a clear passage way is provided for the user of the sidewalk or similar walkway.
3. Excavate and perform the work in accordance with the procedures of the owner utility, applicable legislation, and CF procedures.
4. If the excavation must be left open at the completion of the work day, the work crew must provide a secure physical barrier enclosing the excavation.

Trench Boxes

Trench boxes are not usually intended to shore up or otherwise support trench walls. They are meant to protect workers in case of a cave-in.

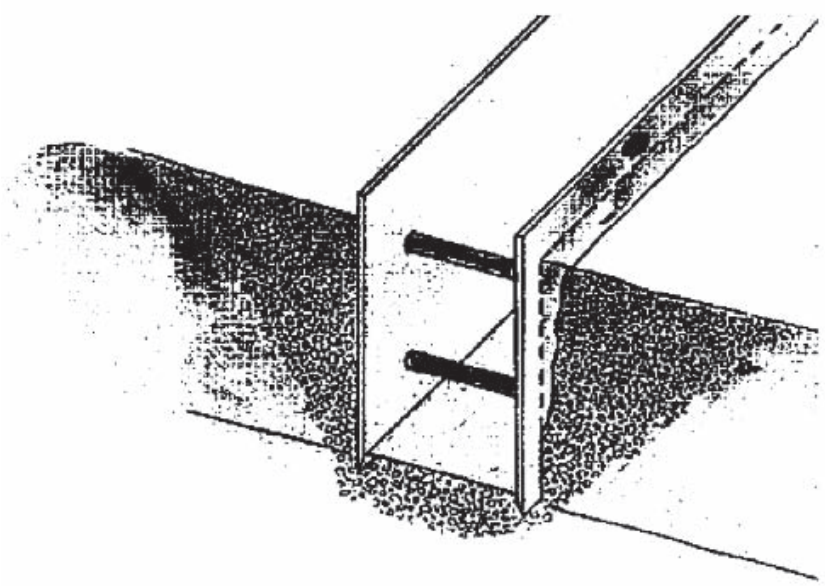
Design drawings and specifications for trench boxes must be signed and sealed by the professional engineer who designed the system and must be kept on site by the constructor. Boxes are normally placed in an excavated but unshored trench and used to protect personnel.

A properly designed trench box is capable of withstanding the maximum lateral load expected at a given depth in a particular soil condition. Trenches near utilities, streets, and buildings may require a shoring system. As long as workers are in the trench they should remain inside the box. Workers must not be inside the trench or the box when the box is being moved. A ladder must be set up in them trench box at all times.

Excavation should be done so that the space between the trench box and the excavation is minimized.

The two reasons for this are:

1. Allowing Closer Access To The Top Of The Box
2. Limiting Soil Movement In Case Of A Cave-In.



Check the drawings and specifications for the trench box to see if the space between the box and the trench wall needs to be backfilled and the soil compacted.

Shoring

Shoring is a system which "shores" up or supports trench walls to prevent movement of soil, underground utilities, roadways, and foundations.
Shoring should not be confused with trench boxes. A trench box provides worker safety but gives little or no support to trench walls or existing structures such as foundations and manholes.

The two types of shoring most commonly used are timber and hydraulic. Both consist of posts, wales, struts, and sheathing.

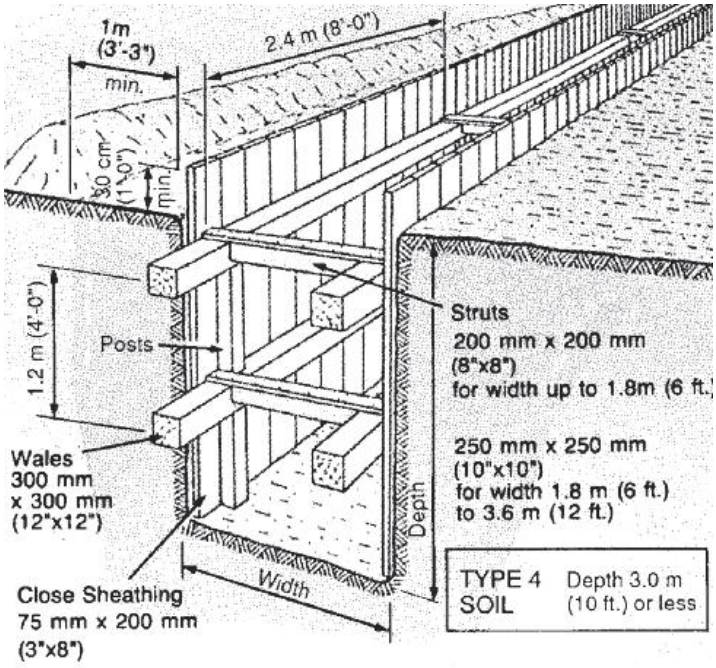
"Hydraulic shoring" refers to prefabricated strut and/or wale systems in aluminum or steel. Strictly speaking, these may not operate hydraulically.
Some are air-operated or manually jacked. Design drawings and specifications for prefabricated shoring systems must be kept on site.

One major advantage of hydraulic shoring over some applications of timber shoring is safety during installation. Workers do not have to enter the trench to install the system. Installation can be done from the top of the trench.

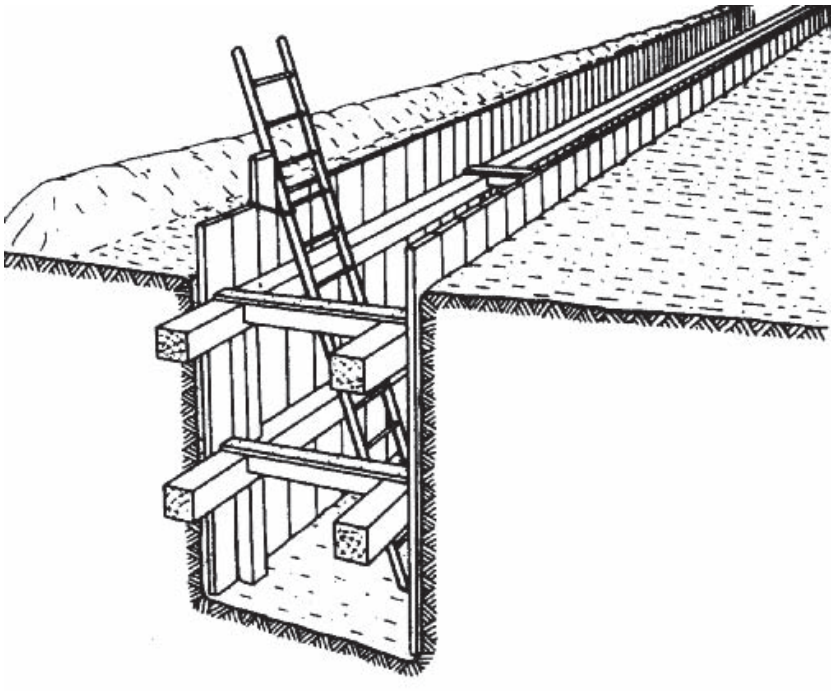
Most hydraulic systems are:

- Light enough to be installed by one worker
- Gauge-regulated to ensure even distribution of pressure along the trench line
- Able to "pre-load" trench walls, thereby using the soil's natural cohesion to prevent movement.
- Easily adapted to suit various trench depths and widths.

Wherever possible, shoring should be installed as excavation proceeds. If there is a delay between digging and shoring, no one must be allowed to enter the unprotected trench.
All shoring should be installed from the top down and removed from the bottom up.



Access/Egress
Whether protected by sloping, boxes, or shoring, trenches must be provided with ladders so that workers can enter and exit safely.



Ladders must:

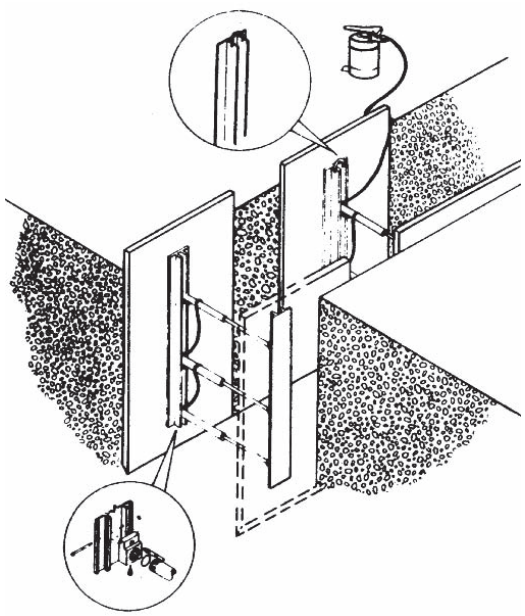
- Be placed within the area protected by the shoring or trench box
- Be securely tied off at the top
- Extend above the shoring or box by at least 1 metre (3 feet)
- Be inspected regularly for damage

Ladders should be placed as close as possible to the area where personnel are working and never more than 7.5 metres (25 feet) away.

Anyone climbing up or down must always face the ladder and maintain 3-point contact. This means that two hands and one foot or two feet and one hand must be on the ladder at all times.

Maintaining 3-point contact also means hands must be free for climbing. Tools and materials should not be carried up or down ladders. Pumps, small compactors, and other equipment should be lifted and lowered by methods that prevent injury from overexertion and falling objects.

Inspection
Inspection is every one's responsibility. Whatever the protective system, it should be inspected regularly.
Check hydraulic shoring for leaks in hoses and cylinders, bent bases, broken or cracked nipples, and other damaged or defective parts.



Check timber shoring before installation. Discard damaged or defective lumber. After installation, inspect wales for signs of crushing. Crushing indicates structural inadequacy and calls for more struts.

Inspect trench boxes for structural damage, cracks in welds, and other defects during use, check the box regularly and often to make sure that it is not shifting or settling much more on one side than the other. If it is, leave the trench and ask the supervisor to check for stability.

Check ground surface for tension cracks which may develop parallel to the trench at a distance one-half to three-quarters of the trench depth. If cracks are detected, alert the crew and check all protective systems carefully.

Check areas adjacent to shoring where water may have entered the trench. A combination of water flow and granular soils can lead to undermining of the trench wall. Such conditions have caused fatalities.

Finally, make sure that tools, equipment, material, and spoil are kept at least 1 metre (3 feet) back from the edge of the trench to prevent falling objects from striking workers.

Trenching Summary

Sloping, trench boxes, and shoring are meant to protect workers from the hazards of cave-ins.

The method chosen must meet the specific requirements of the job at hand. Depending on application, one method may be better suited to certain conditions than another.

Whatever the system, inspect it regularly to make sure that it remains sound and reliable.

Remember: Never enter a trench more than 1.2 metres (4 feet) deep unless it is sloped, shored, or protected by a trench box.

Excavation Security

To ensure excavation security, follow the procedures below.

- All vertical supports will be of standard weight or heavy-duty T-bar.
- Fencing will be 1.2 m (4') wide orange PVC fence or similar construction, in good condition.
- T-bars will be driven into the ground, approximately .6 m (2') deep, at the corners of the excavation.
- The edge of the excavation that borders onto the sidewalk, public or private, will have T- bars driven into the ground at no more than 1 m (3') intervals. T-bars of 3 m (10') lengths will be used at these points to ensure that they are securely driven.
- The PVC fencing will be pulled snugly around the posts and securely attached to the posts. As best as possible, the T-bar will extend to the full height of the fencing.
- If access to the excavation is required, e.g. Bell Line Splicer, an access point will be provided at a corner or edge of the fence, which is not adjacent to the sidewalk.
- Before leaving the site, workers must test to ensure that the posts are secure and the fence is snug.
- If the excavation is required to be left open and unattended, it will be the responsibility of the supervisor to inspect the barrier fencing on a regular basis. When required, the fencing must be repaired to provide a secure physical barrier between the public way and the excavation.

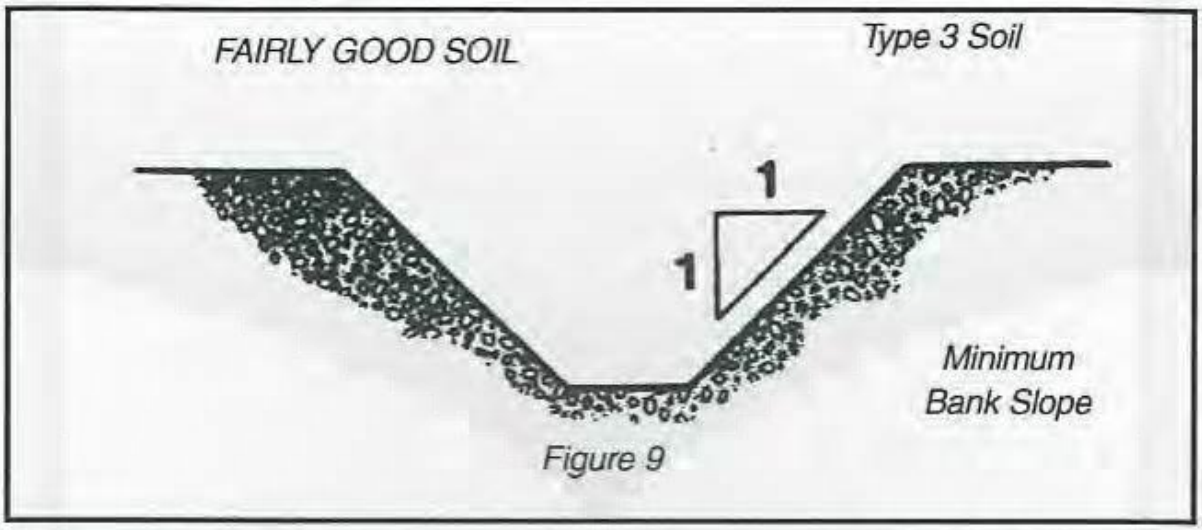


Figure 9

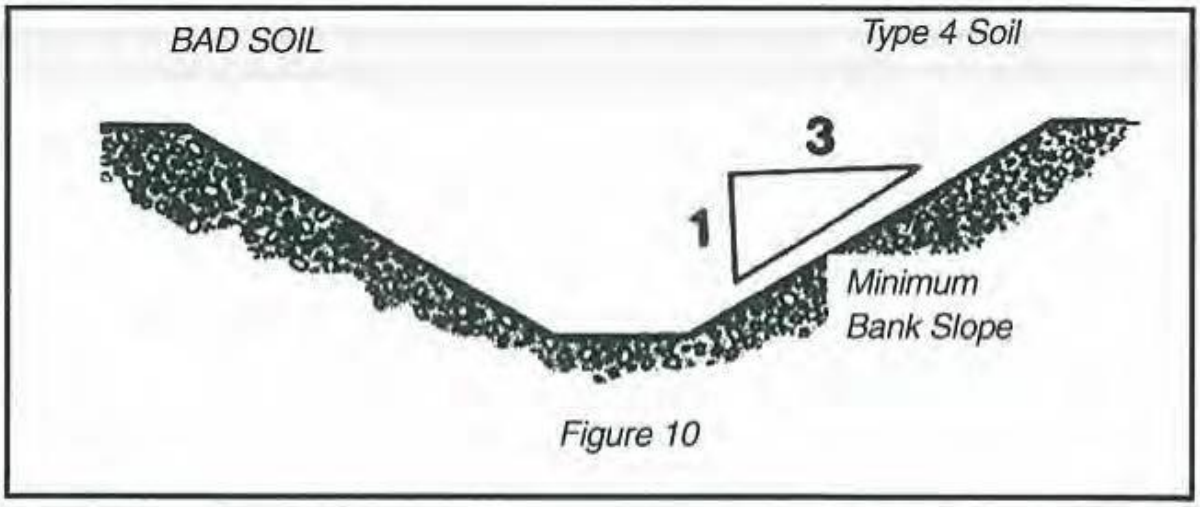


Figure 10

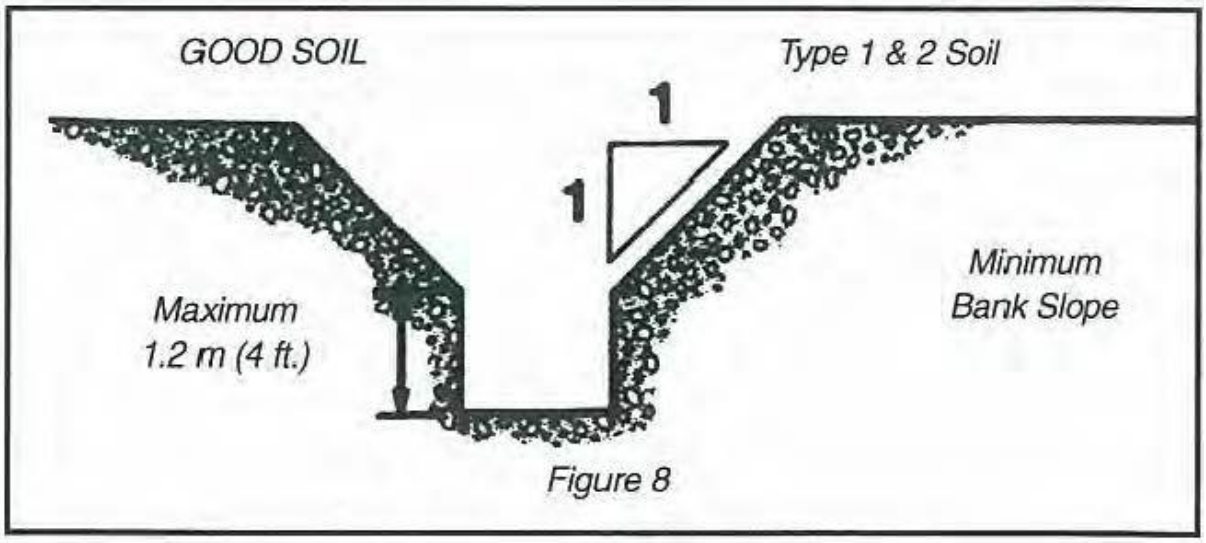


Figure 8

23.9 Working Over/Around Water

Standard

Construction over and around water presents dangers. Precautions specifically developed for such construction must be taken before work begins.

Procedure

- Warning signs shall be posted on the project to warn public and workers of the hazards around water (danger deep or icy water, keep out).
- Where there is current in the water, a line extending across the water, with floating objects attached to it that are capable of supporting the heaviest person on site in case he/she falls into the water shall be installed.
- All workers must be alert and aware of their fellow workers at all times.
- Workers in proximity to a water hazard who may drown will be protected by a flotation device. This device will provide buoyancy adequate to keep a worker's head above water, face up without effort by the worker (see requirements below).
- All workers wearing a floatation device will visually inspect it to ensure it is free from defects prior to use.
- Before starting work each day a designated worker will make sure that, the rescue equipment is as close to the work area as possible.
- Rescue equipment such as boats must be stored on or near the project ready for use.
- All workers working at this location will be required to attend a safety orientation and safety meeting on the use of lifejackets, PPE.
- At least two workers will be appointed and trained for rescue procedure.
- The names posted in the workplace.

Rescue Equipment

- A ring buoy attached to 15 meters (50 feet) of 9.5-millimeter diameter (5/8" dia) polypropylene rope.
- Lifejackets available for each person involved in the rescue.
- A boat (where applicable) equipped with a motor if the water is likely to be rough or swift.
- A boat hook (which is a short shaft with a fitting on one end shaped to help in rescuing a person or recovering an object.)
- An ALARM (horn) system must be maintained to alert workers to the need for an emergency rescue.

Life Jacket / Personal Flotation Device (PFD) requirements

PFDs or Personal Flotation Devices must be Canadian Coast Guard, Department of Fisheries and Oceans approved or equivalent. The PFD information must state that it is designed to keep the wearer face up in the water.

These are common features that help keep the wearer face up. Styles may vary by manufacturer.

Note: These are EXAMPLES of PFD's intended to keep the wearer face up in the water; Actual styles may vary and change. Check with your local jurisdictions and H&S Department for further information.

Rescue Procedure

1. If a worker falls into the water--- SOUND ALARM---, two workers trained in rescue, immediately put on life jackets and proceed to rescue worker.
2. Once the worker has been retrieved to shore, ensure there are no injuries and perform first aid if necessary.
3. If required prepare for medical attention and transportation to the hospital.
4. Stay with the injured worker at all times and keep them calm.
5. Ensure the worker is kept warm until the appropriate medical attention is given.

To eliminate any hazardous conditions and dangers associated with working around water the following safe work procedures are to be implemented.

Floating Work Platforms

When used on a construction project, rafts, scows, barges and similar vessels are considered work platforms. As such, they are subjected to certain requirements.

- Guardrails must be provided along open edges. The guard rails may be removed at the working side of the platform, provided workers are protected by alternate measures of fall protection.
- Workers on the floating platform must wear lifejackets. A life jacket provides enough buoyancy to keep the wearer's head above water, face up, without effort by the wearer.
- Appropriate rescue measures must be prepared.

Transporting Workers by Boat

When navigating any waterway, boats and other floating vessels must comply with the legislative requirements. Consult the H&S Department.

Boats that are not longer than 6 meters (20 ft) must be equipped with at least:

- One approved lifejacket for each person on board
- One paddle or an anchor with at least 15m of cable, rope, or chain
- One bailer or one manual pump
- One class 5bc fire extinguisher if the craft has an inboard engine, fixed fuel tank
- One sound signaling device

All powerboats require navigation lights if operated after sunset or before sunrise. All boats also require radio communication that is compatible to the radio used on site and or barge.

Spill Procedure

To prevent a spill or accident release of hazardous material and contamination of the water all heavy equipment and tools must be fueled on land. When in proper position and secured for work a floating platform must be surrounded by floating absorbent socks attached to the vessel in the event of an accidental release/spill. Additional socks and absorbent pads & waste containment disposal bags must be available on site.

23.10 Establishing Safe Work Zones - Flagging and Tagging

Standard

Yellow or Red ribbon with proper identification tags will be used to create a warning barrier when hazards exist within that work area.

Procedure / Practice

- Determining the risk of a particular hazard within a work area will determine the color of ribbon used.
- The supervision/workers performing the work will be responsible for choosing the color of ribbon to be used and the right amount of area needed to adequately safe out the job area.
- Yellow ribbon shall be used to identify to others that hazards exist but are not considered to be of a critical nature but caution still needs to be taken within the ribboned area.
- When an area is to be protected or hazards are identified as serious and could cause severe injuries to those not directly involved in the work, Red ribbon will be used.
- If Red ribbon is being used it shall fully surround the hazardous/protected area so that no one can mistakenly enter the area.
- Where Yellow ribbon is being used it will be placed in such a way to warn people entering from any direction that hazards do exist in that work area.
- All flagging must be tagged on all sides with information of the time and date the ribbon was placed, a contact number and/or person, and the reason for the area being ribboned off.
- All ribboning must be removed and disposed of at the end of the work day or when work is completed.
- In the case that Red ribbon is to be left up for a following shift, supervision of the following shift shall be advised of the hazards within the ribboned area, tagging must also be up dated to reflect these changes.
- Red ribbon shall not be removed by anyone outside of the crew that placed it unless two (2) acting supervisors take the responsibility to ensure it is safe to do so.

NOTE: When anyone is asking or invited to enter into a Red ribboned area and is not directly involved in the job under way they must read and sign onto the FLRA/JSA on the outside of the Red ribboning before entering. That person does not now have the right to come and go but must resign if gone for any period of time that the hazardous conditions may have changed.
Those entering or invited into a red ribboned area will be the responsibility of supervision of that job.

23.11 Asbestos - Hazardous Substance (Designated Substances)

General Information

Likely locations of asbestos are; Deck/structural fireproofing, pipe covering, AC valve insulation, gasket material, sprayed on fireproofing, floor tile, roofing felts, drywall joint filling compounds, boiler installations, electrical insulator boards whose manufacture and installation predate the early 1980's. The owner of the premises containing asbestos is obligated to inform the Constructor/Prime Contractor as part of the bid process, that asbestos containing materials may be present.

Standard

At no time will CF employees engage in work activities involving handling or disturbance of friable asbestos containing materials. Workers who are required to remove, disturb, or install asbestos containing materials must be adequately trained in safe work practices, health effects, as well as use, care and limitations of Personal Protective Equipment.

Procedure

Note: Check with local jurisdictions on designated substances, for specific work procedures involving asbestos containing materials.

Managers shall consider the following prior to undertaking work with asbestos:

1. All asbestos related work should be sub-contracted out to reputable asbestos removal company that has been prequalified (see section Subcontractor/Supplier) to perform asbestos handling/abatement activities.
2. All tasks where CF employees may be exposed to airborne asbestos must be assessed and adequate work methods that address removal and cleanup activities will be developed in consultation with CF H&S Department. All employees involved in this work activity, must be trained in the procedures to be followed.
3. These work activities will be designed to ensure workers are not exposed beyond the occupational exposure limit as per the jurisdiction.
4. CF employees required to handle, or that may be exposed to airborne Asbestos fibers must wear Respiratory protection. Protection must be adequate to prevent exposures greater than permissible exposure levels, as specified in legislation applicable to the local jurisdiction where the work will be performed. (See Personal Protective Equipment Section for Guidance)
5. CF employees required to handle or that may be exposed to airborne Asbestos fibers must wear impervious clothing (Tyvek coveralls) which must be removed, prior to leaving the exclusion area. A wash up area must be provided within or in close proximity to the exclusion area and used by all employees leaving the work area.
6. Disposal of asbestos containing material and impervious clothing shall be as follows; Double bag and seal in yellow plastic bags labeled "Caution Asbestos Dust Hazard" and have disposed of in accordance to local jurisdictional requirements Consult CF H&S Department prior to disposal of Asbestos containing waste & materials).

7. Likely locations of asbestos are:
   - Deck fireproofing
   - Pipe covering
   - Ac valve insulation
   - Gasket material
   - Sprayed on fireproofing
   - Vinyl asbestos floor tile
   - Asbestos roofing felts
   - Joint filling compounds
   - Asbestos boiler installations

8. The owner of the premises containing asbestos is obligated to inform the Constructor prior to the bid process.

Workers that encounter materials labeled as Asbestos Containing Material (ACM), or Presumed Asbestos Containing Material (PACM) will not disturb the material. If workers suspect material to contain asbestos they are to contact their supervisor.

Workers that are exposed to asbestos beyond the occupational exposure limits may require additional health assessments and surveillance as per the jurisdiction. Consult with the H&S Department for specific programs and obligations.

Health Effects of Asbestos

Chronic high-level exposure (beyond occupational exposure limits) to asbestos fibers increases the potential for an individual to develop specific cancers known to be associated with asbestos. Inhalation of these fibers is the primary cause of asbestos related disease.

Inhaled asbestos is associated with three primary diseases:

1. Asbestosis: Asbestos causes scarring of lung tissue that eventually restricts one's ability to inhale
2. Lung Cancer: Asbestos increases the risk of lung cancer, especially in combination with exposure to tobacco smoke.
3. Mesothelioma: Asbestos is thought to be the primary cause of this rare and deadly type of cancer of the lung lining and chest wall

Direct Buried Duct – Suspected of Containing Asbestos

Procedure
The following procedure is for removing direct buried or concrete encased fibre duct suspected of containing asbestos.

Identification
Underground White Fibre Duct

Manufactured asbestos-cement products (also referred to as "Transit" products) were used from 1935 to 1970. The discovery of these conduits may occur during any conduit break out or demolition work.

Material & Equipment

- 9 mm clear plastic bags
- Disposable suits
- 6 mm yellow plastic bags
- Rags
- Pail (5 gal.)
- Mineral oil
- Water
- Water softener
- Half-face respirators
- High efficiency particulate aerosol (H.E.P.A), filters
- Rubber gloves (disposable)
- Disposable rubber boot covers
- Work tent
- Barriers
- Caution tape
- "Hazardous Asbestos Material" warning sign
- H.E.P.A. vacuum cleaner
- Duct tape

Asbestos Procedure

1. Establish a work area protection zone.
2. Following normal work methods, remove the overburden to expose the duct or the concrete encased duct structure.
3. Following exposure of the concrete encased duct structure, use a hydraulic hammer to begin removal of concrete from the duct.
4. When duct is visible, determine if it is the fibre duct suspected of containing asbestos.
5. If it is a suspected asbestos fibre duct, set up a work tent around the work area and post "Warning Asbestos Material" signs.
6. In addition to the hard hat, safety boots, and eye protection, put on the following:
    - Disposable suits (coveralls),
    - Half-mask respirator equipped with H.E.P.A filters,
    - Disposable rubber boot covers,

- Disposable rubber gloves,
- Seal the cuffs (pants & sleeves) of the suits with duct tape.

7. If the duct structure is contained in concrete, use high-voltage gloves instead of disposable rubber gloves. Using the hydraulic hammer, continue to remove concrete from the fiber duct.
8. Following removal of the concrete encasing the fibre duct, remove high voltage rubber gloves, dispose of leather covers as waste, and clean the rubber gloves. Put on disposable rubber gloves. Moisten the fibre duct by swabbing the surface with a rag saturated with mineral oil. Used rags must be treated as asbestos waste.
9. Using a small hammer carefully break the fiber duct. Place the broken duct into a clear 9 mm plastic bags and seal with duct tape. Place clear plastic bags in 6 mm yellow plastic bags and seal with duct tape.
10. Using H.E.P.A. vacuum, clean the sidewalk or roadway covered by the work tent Vacuum the work area inside trench, around the duct.
11. Remove material from vacuum and dispose as asbestos waste.
12. After removing and bagging the fiber duct, and cleaning the work area, wash all hand tools with water to which a small amount of water softener was added. Rags generated must be considered asbestos waste.
13. Remove disposal rubber boot covers, disposable suits, and disposable gloves. Place in plastic bags containing asbestos waste.
14. Remove respirator. Detach filter and discard as asbestos waste. Rinse respirator in water containing water softener.
15. Pass any contaminated wastewater generated during removal through an H.E.P.A. filter prior to disposal. Contaminated water is to be disposed of at the asbestos waste dump.
16. Transport the 6 mm yellow bags of waste to a designated asbestos waste dumpsite. Ensure the load is secured and covered with tarp during transport.
17. Using normal work methods restore the duct bank.

Note: DO NOT USE compressed air tools during any of this work.

23.12 Winter Preparedness

Standard

CF is aware of and committed to controlling all workplace hazards that are associated with winter weather. Management will consider winter weather related hazards through the planning of the work and all other work activities and implement controls to maintain workplace safety.

Raise Awareness

Prior to the winter months workplaces that may be affected by winter weather should consider raising awareness of potential hazards and prepare for work activities using the following best practices:

- Raise overall awareness of the potential hazards of winter season work and conditions.

- Provide comprehensive guidance on Winter Work awareness, preparedness and implementation for management and supervisory personnel working within CF work areas, and for partner and contractor management personnel conducting activities under CF stewardship.
- Create a selection of processes, practices, tools and equipment specifications that have previously been successful in supporting winter workplace safety and health.
- Provide recommendations for the timing of pre-winter activities to allow workplaces to prepare in advance for winter work.
- Promote a pre-season readiness process and a post-season review process to establish the priorities for "this year's" Winter Work program.
- Implement winter-weather campaigns to address ongoing hazards and seasonal changes such as:
    - Cold Stress Awareness
    - Adapting your workplace
    - Awareness and use of approved walkways
    - Proper PPE

Responsibilities
Project management will have overall responsibility and accountability to prepare and plan for winter conditions.

Planning the Work
Working in winter weather creates unique hazards in each workplace and management will be responsible to take proactive steps to plan the work safely including, but not limited to:

- Ensure execution schedules are developed in a manner considering winter conditions and associated hazards
- Consider winter constructability issues in terms of equipment reliability and reduced productivity of personnel
- Be aware of work effectiveness between sheltered and non-sheltered work areas
- Perform as much exterior work activity as possible during non-winter months
- Assess subcontractor's readiness for winter operations in accordance with site expectations and plans
- Prepare a site plan that will identify walkways, sand/salt locations
- Prepare a snow removal plan that includes managing any ongoing freeze / thaw cycles and the buildup of ice
- Coordinate all winter wok plans with any site or client plans that may currently be in place

Roadways/Walkways
As the main focal points for snow removal activities, snow maintenance on roadways and walkways is best managed when appropriate planning has been put into place to

refine transit way layout and construction. Poor transit way planning can result in work inefficiencies without a snow-load, and work effectiveness can be impacted even more when snow removal activities on poorly planned roads/walks interfere with productivity.

In preparation for winter work, planners should take the following points into

consideration: Design of roadway/walkway routings (transit ways):

- Review work breakdown structure and identify work schedule (determining timing of onsite materials).
- Define size of working and lay down areas to accommodate tasks, considering snow management/clearance needs for winter work (adequate space between 'piles'/modules to permit snow clearing equipment to pass through area).
- Determine vehicular and pedestrian traffic needs.
- Develop traffic flow patterns among work areas and identify main traffic routes (primary and limited alternative routes allowing for both operational work and worker transit needs such as lunch rooms, sanitary facilities, warm up locations).
- Consider physical segregation of walkways and vehicle routes (along parallel transit ways).
- Consider location, structure and building materials of personnel walkways, constructing walkways of level areas, free of water, use of gratings, expended metal walkways, raised walkways, etc. Plan walkways on level areas, free of water.
- Determine snow temporary/seasonal storage location and plan snow clearance routes to facilitate snow removal/storage.
- During pre-snowfall activities, observe workforce traffic flow, making route adjustments (or enforce compliance) to established transit ways.

Marking delineation of approved transit ways:

- Mark routing corners with permanent markers, taller than anticipated snowfall (may be illuminated during hours of darkness).
- Observe workforce traffic flow. Use barrier tape or rigid barriers to limit access to alternate routes used by individuals ("shortcuts, goat paths", etc.).
- Evaluate opportunities to run service cabling/hoses parallel to approve transit ways (may be suspended above ground/anticipated snowfall level if appropriate arrangements are made).
- Delineate and mark approved transit ways prior to first snowfall so that the workforce can become used to the transit routes and continue to use them when snow covered.

Building steps and entrances:

- Plan for winter operations when constructing steps and entrances (selection of appropriate material such as expanded metal grating, avoiding sheet steel or plywood surfaces)
- Provide handrails for stairways, even if only two or three steps.

- At or near each entrance, provide for storage or non-skid materials for traction assistance during snowy or icy conditions.
- Provide for roof/overhead cover at the top level of the access stairways to keep the area immediately in front of the doors clear of snow accumulation or ice slippery patches.
- Prior to first snowfall, place signage at the bottom of the entrance steps cautioning personnel to remove ice-grip footwear prior to entering the facility (or climbing the stairs, depending upon the construction materials).

Snow clearance and transit way maintenance:

- Ensure that the appropriate types of equipment and an adequate number of personnel are assigned to snow clearing, including where necessary, designated workers on the current shift.
- Conduct a pre-snowfall survey of potential obstructions along each route, remove where possible or establish a vertical visual marker where necessary.
- Where a day shift only is operated, establish a contract for pre-shift snow/ice clearance of designated transit ways.
- Where weather conditions require, provide for snow-clearing activities during the shift.
- During heavy snowfall, establish a traffic priority to snow clearance operations.
- For locations employing 24-hour operations, where weather conditions allow, pre-schedule snow clearing activities for designated times during the shift (meal breaks, etc.).
- Consider ceasing work during in-shift snow clearing to avoid traffic conflict with normal work flow and snow clearing activities (traffic conflict will enforce workers to create alternative pathways).
- Keep the route to the snow storage location free of traffic and obstructions to facilitate effective snow removal.
- In periods of heavy snowfall, identify vehicle routes with secondary temporary markers to assist traffic flow and to assist snow clearance crews in identifying the routes.
- Where alternative non-approved transit routes become apparent, as soon as possible establish or re-establish barriers to close that pathway.
- As working and lay down areas have been sized to accommodate snow clearing, during normal operations in snow enforce the restriction that no objects, tools or materials are permitted outside of the designated working or lay down areas.

Monitoring the Workplace

In support of all winter preparedness activities the established programs, walkways, transit ways and overall site conditions must be continuously monitored. Workplace inspections and audits should include the winter preparedness plans and activities. Due to the nature of winter work and changing site conditions the site must be constantly monitored for:

- Any conditions or obstructions that would result in the workforce taking alternative or unclear pathways to get to their work location or complete their work
- Incorporate winter preparedness plans into work planning activities such as the FLRA or JSA
- Manage non-conformance to winter work plans similar to other H&S infractions up to and including disciplinary action
- Encourage frequent reporting of unsafe conditions and or areas that should be cordoned off

Lighting

Depending upon the size of the workplace and the relative complexity of the roadway and walkway layout, roadway and task lighting must be appropriately positioned to maximize visibility, minimize 'dark areas' and identify specific hazards to vehicles or personnel.

- Once facility layout design has been completed, establish lighting requirements by considering planned work activities in periods of darkness or reduced visibility.
- Lighting must be assigned to illuminate vehicle critical intersections. This may be accomplished through fixed area lighting or through lighting being assigned to illuminate the specific location.
- Fixed lighting for work areas, particularly around structures or field buildings, is to be planned to reduce shadowing. Areas that are temporarily shadowed may be illuminated through the use of portable self-powered lighting sets/standards/
- Pre-plan the lighting needs prior to hours of extended darkness and arrange for the necessary lighting equipment to be available in advance

Pedestrian and Traffic Interface

Pedestrian and traffic control measures are important to increase safety awareness of both pedestrians and vehicle/mobile equipment operators. The following controls should be considered:

- Segregation of designated walkways and vehicle roadways.
- Crosswalks to be clearly marked, visible and enforced.
- Pedestrian/worker visibility (high visibility vests at all times when near traffic and personal lights during hours of darkness).
- Speed restrictions (may have to change with seasonal conditions, where snow buildup reduces road clearance limits).
- Safety barriers.
- Restricted parking along roadsides and encroaching on walkways.
- Roadside demarcation markers and marker visibility in winter.
- Flagmen/Route Spotters to work with moving machinery, check for snow-buried equipment and other obstructions.

Winter Work Personal Protective Equipment
The effectiveness of winter work wear is primarily based upon the balance between efficient thermal protection and the bulk or weight of the protective clothing. The most widely used approach to dressing for work in cold environments is to use multiple layers of clothing

Generally, three layers of clothing are used:

- An inner layer that absorbs moisture and keeps it away from the skin.
- A second insulating layer that helps keep a layer of air trapped around the body.
- An outer layer that keeps dust, dirt, wind and moisture away from the previous layer and that can be easily removed to prevent the buildup of body heat. In wet environments, the outer layer should be waterproof.

Spring and Freeze/Thaw Cycles
As the winter months near to an end there will be freeze / thaw cycles that will change how hazards need to be addressed.

23.13 Formwork & Falsework

Definitions
The following definitions are used in the forming industry. Some terms may be used by other trades as well, but their meanings may be different from these depending upon the application.

Falsework, in relation to a form or structure, means the structural supports and bracing used to support all or part of the form or structure until the concrete is poured and is strong enough to support loads.

Flying formwork is a designed floor formwork system that can be hoisted between levels as a unit.

Forms are the moulds into which concrete or another material is poured.

Formwork is a system of forms connected together.

Gangforms are large panels designed to be hoisted as a unit, and to be erected, stripped, and re-used.

Knock-down forms are traditional formwork supported by falsework and shoring, assembled from bulk materials, used once, and then dismantled.

Panels are sections of form intended to be connected together.

Sheathing is the material directly supported by wales, and against which concrete is to be placed.

Specialty formwork is designed specifically for a particular structure or placing technique.

Struts are vertical members of shoring that directly resist pressure from wales.

Wales are horizontal members of shoring that are placed against sheathing to directly resist pressure from the sheathing.

Introduction

In most cases, the formwork required for concrete construction is built by carpenters. Shoring and bracing support the forms that contain the wet concrete. Formwork must also support the temporary weight of material such as bundles of reinforcing steel and live loads of workers and equipment.
There are three stages in formwork operations:

1. Assembly and erection
2. Concrete placement
3. Stripping and dismantling.

To be done safely, each of these jobs requires planning, knowledge, and skill from both supervisors and workers. Design and planning are a supervisory function that may also legally require a professional engineer's involvement. Small construction and renovation jobs, however, sometimes call for typical design work (e.g., specific heights and sizes from the manufacturer), which can be done on site by workers.

Where design drawings are provided, it is important to construct the formwork as designed. Any confusion regarding the design should be approved by the designer.

If site conditions require changes or the design does not seem to suit the situation, changes and approval should also be obtained from the designer. Formwork failures frequently involve deviations from the original design that were done without consulting the designer. They may also involve human error. For these reasons, formwork and shoring must always be inspected before concrete is placed.

All large formwork installations in Ontario must be designed by a professional engineer. But there are always smaller jobs of moderate height or depth— basements, footings, stairs—that may include formwork with typical design arrangements from a form tie manufacturer, which is installed and constructed on the site.

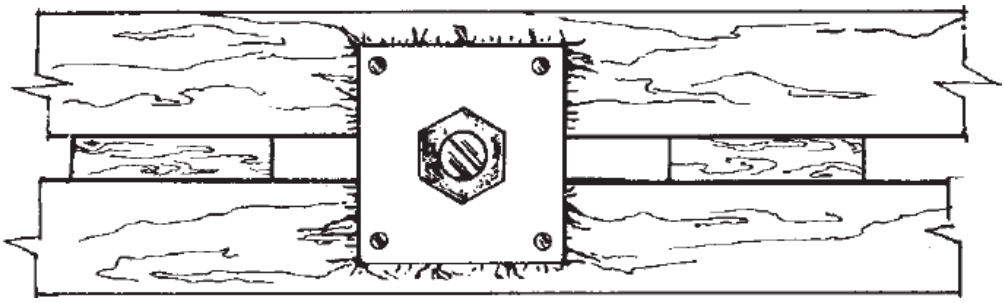
Every carpenter should therefore know the type of formwork needed and how to build, install, and dismantle it safely.

Formwork must always be constructed according to good, safe, and sound carpentry practice. It must have the following:

- Adequate braces and supports
- Reliable bearing surfaces, especially where wood structures are involved
- Adequate ties, bolts, or bracing to prevent movement or bulging.

Because wood is relatively soft, it will crush under heavy loads such as concrete when the bearing surface of joists on stringers, or studs on wales, is not adequate. Crushing can be avoided by increasing the bearing area between members, using spreader washers, or increasing the number of joists or studs.

Spreader Washer on Wooden Wale System



Hazards

The following are the main hazard areas in formwork operations.

Falls – They are the major hazard because they are potentially fatal. Cramped work areas, inadequate access, failure to install guardrails, failure to use fall arrest systems, tools or material left underfoot, and surfaces slippery from form oil can all lead to falls. Ladders are also frequently involved in falls. All workers in Ontario who may be exposed to a fall hazard and who may use a fall protection system must have working at heights training that has been approved by the Chief Prevention Officer.

Materials handling – The activity most frequently connected with injury. Improper or excessive materials handling can result in sprains, strains, and overexertion in shoulders, arms, and back, as well as bruises, abrasions, and crushed fingers.

Struck against – Common because formwork operations are constantly changing and involve the movement of heavy, awkward, and pointed components. Wales, beams, panels, snap-ties, nails, bolts, and rebar can cause punctures, cuts, contusions, and abrasions.

Struck by – Another common cause of injury. Rebar, formwork panels, concrete buckets, and other material hoisted overhead can strike workers. Struck-by injuries can also be caused by hammers, pry bars, stakes, wedges, and material such as joists and panels during stripping.

Electrical contact – Power tools, extension cords, and temporary supply and wiring systems, used under less-than-ideal conditions – mud, ground water, wet excavations, fresh concrete – can lead to ground faults, short-circuits, and shock hazards. Ground fault circuit interrupters are legally required for portable tools used outdoors or in wet locations.

Collapses – Even with advanced methods of design and installation, there is always the risk that formwork, slab forms, wall forms, and other large components can come loose, slip out of place, or fall over, striking or crushing workers underneath.

Health hazards – The spraying of form oils and curing compounds can irritate the lungs. Contact with these chemicals can irritate the skin, leading to redness, inflammation, or dermatitis. The same conditions can result from the abrasive/ corrosive

effect of skin contact with concrete or cement, especially when inadvertently left inside boots all day.

Environmental conditions – Ice, snow, and rain create slippery conditions. Wind can be a major hazard. Handling sheets of plywood becomes more difficult, panels may require more bracing, and hoisting gets harder, especially with large panels or tables.

Dust and concrete – Blowing dust and flying concrete particles during the chipping or cleaning of formwork can injure unprotected eyes.

Access equipment – Access equipment such as ladders and scaffolds are involved not only in falls but in slips, trips, and other accidents. Hazards include ladders not tied off, workers carrying materials while climbing, ladders obstructed at top or bottom, scaffolds not completely decked in, and scaffolds erected or dismantled without fall protection.

Lighting – Inadequate lighting can create or aggravate hazards when workers install or strip forms in dark areas or place concrete at night.

Injuries

Formwork hazards can lead to the injuries described below. Follow the safety tips to prevent such injuries.

Eye injuries – These are quite common in formwork operations. Most result from particles of wood or concrete that fall or are blown into the eye during chipping and cleaning. The injuries may not be severe but most can be prevented by wearing eye protection. It is strongly recommended that everyone on site wear eye protection at all times.

Cuts, scrapes, punctures – The manhandling necessary to install and strip formwork can lead to cut hands, arms, and legs, as well as pinched or crushed fingers. Gloves help to prevent injuries from rough or sharp edges on formwork components. But workers must also have the knowledge, skill, and physical ability necessary for safe materials handling. That means knowing your limitations and asking for help when needed. Formwork involves protruding objects such as nails, snap ties, conduit, and bolts that can give you cuts and punctures. Where possible, these objects should not be left sticking out or should be covered over.

Back injuries – These injuries are frequently related to materials handling. The most important preventive measure is back care. Exercise programs, warm-ups before work, and knowing your limitations can help to prevent sprains and strains. Wherever necessary, get help or use dollies, carts, or other mechanical devices.

Ankle sprains and fractures – Working in close quarters, stepping over debris and material, climbing into excavations, turning with awkward loads, jumping down from scaffolds or benches—these can lead to ankle and other foot or leg injuries. Prevention starts with proper housekeeping and materials handling.

Bruises and contusions – Handling formwork under rushed, cramped, or slippery conditions or beyond a person's physical limitations can lead to bruises. Bruises and contusions also result from contact with protruding formwork components. More serious are contusions from falling formwork materials. Formwork must be braced to ensure stability, especially under windy conditions. Try to avoid areas where work such as hoisting or stripping is being done overhead.

Fall injuries – All of the injuries above, and many others, can result from falls. Most falls are caused by missing or inadequate guardrails, failure to use fall-arrest equipment, failure to completely plank scaffolds and other work platforms, and standing or climbing on surfaces not meant to be used as such – the tops of wall forms or 2 x 4 wales, for example. Installing and stripping formwork often requires the use of a fall-arrest system. Falls also result from holes left unguarded or uncovered in formwork. These should be covered up or fitted with guardrails as quickly as possible. Where this cannot be done, the area should be roped off and posted with warning signs to prevent unauthorized entry.

Planning

Planning is the first and most important step in reducing hazards and preventing injuries. Because formwork operations must often be carried out in congested areas where other trades are also working, planning is essential in making the most of the time and space available to improve safety and efficiency.

Planning is a must for fall protection, work platforms, material staging areas, housekeeping, and material handling and movement.

Planning should take place at every level from manager to supervisor to worker. Planning labour, materials, equipment, and work schedules to meet design requirements is the responsibility of management and supervision. But supervisors and workers should come together to plan the details of their assigned tasks based on the most effective work methods and safety measures.

Design

Safety and economy are the main factors in design. Both have to be considered because adjustments in one affect the other.

For example, reducing the support structure for wall forms in expectation of reduced pouring rates should not be considered if the rate of pour is not going to be controlled on the job.

Fresh concrete exerts a pressure on formwork similar to liquids. Concrete starts to set when poured. So if the pour rate is slow, the maximum formwork design pressure can be reduced, since concrete at the bottom will be set before concrete at the top is poured. Similarly, if the forms are filled to the top immediately, they must be able to withstand the pressure of the full liquid head.

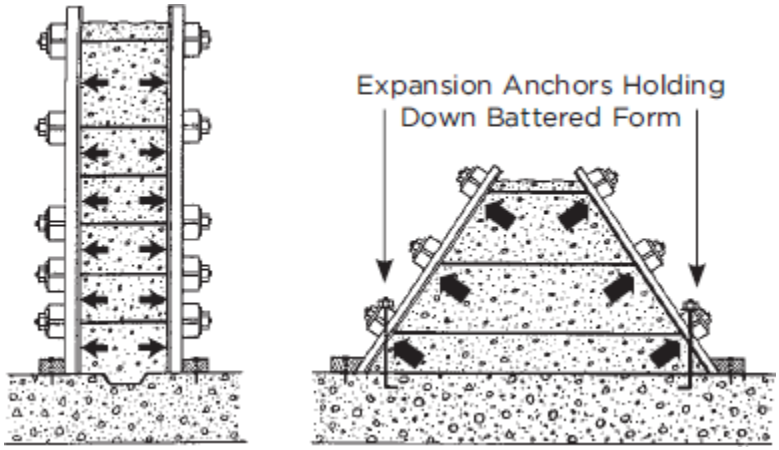
For example, the normal weight of liquid concrete is 150 lb per cubic foot (2,403 kg per cubic metre). So a form designed to withstand 600 lb per square feet (2929 kg per square metre) of pressure will be able to support liquid concrete up to a height of 4 feet

(1.2 metres).
600 lb/ft2 ÷ 150 lb/ft3 = 4 ft
2929 kg/m2 ÷ 2403 kg/m3 = 1.2 m

Other factors determine how long concrete will remain liquid, such as temperature, slump, vibration, and admixtures. For example, concrete will set much more quickly in hot summer weather than in cold winter weather. As a result, the same form filled at the same pour rate may be subjected to greater pressure in winter than in summer. Concrete pumping may cause additional pressure, as well as vibration, on forms and must be considered at the design stage. The action of the pump sends surges of pressure through the piping system which are often transmitted directly to the forms, especially for narrow walls or columns. Vibration may move the forms or loosen bracing, ties, or spreaders.

Pressure acts perpendicular to formwork surfaces. This causes an outward thrust for typical wall or column forms. However, it can also cause uplift for battered or sloping forms. These require hold-down anchors or tie-down braces. The anchors will prevent the forms from lifting up or floating on the concrete.

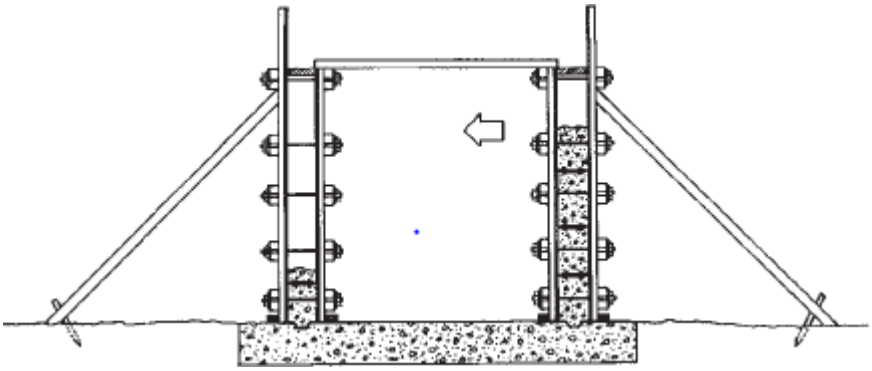
Pressure of Concrete on Vertical and Battered Formwork



Consider using bracing systems and spreaders for wall forms. Concrete filling the bottom of the form may cause forces at the top to push the two sides together unless they are properly braced and/ or separated with spreaders. Formwork has to be designed to resist such forces. During pouring, ensure that spreaders are not removed until concrete has reached at least two-thirds of the form height.

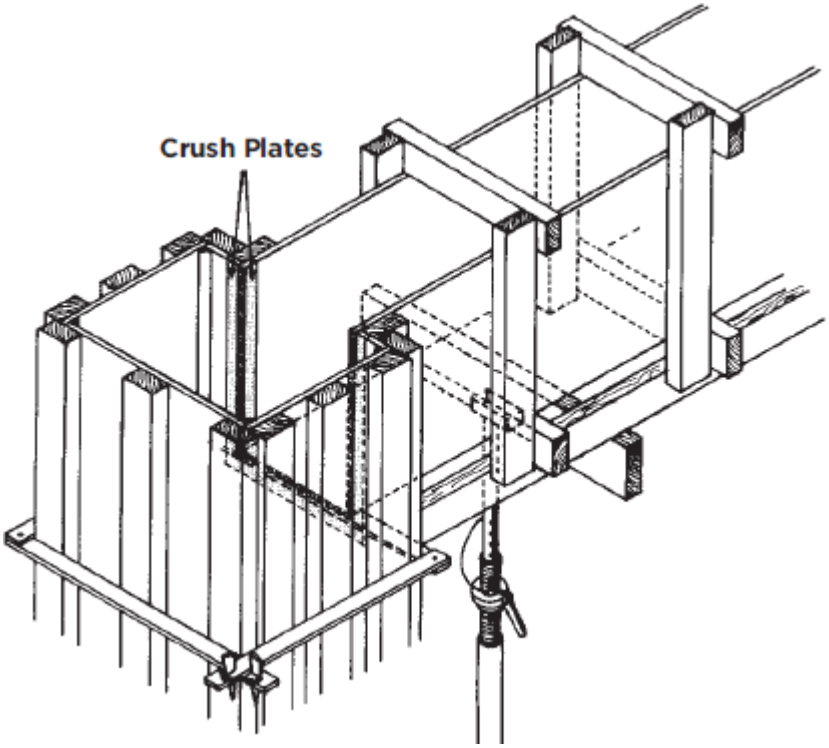
Where box forms are used—for instance, on one-piece covers for open-cut tunnels—you must use bracing against the side thrusts caused by the uneven pouring rates of the walls. Resisting these forces requires that the system be tied together and securely braced.

Open-Cut Tunnel Formwork with Bracing and Spreaders on Each Side



Formwork should be designed and constructed with stripping and removing as well as pouring in mind. On wooden forms, crush plates or filler strips should be used at corners such as slab-and-column or slab-and-wall intersections. The plates or strips are easily removed with a wrecking bar and, once removed, make the stripping of adjacent panels much easier.

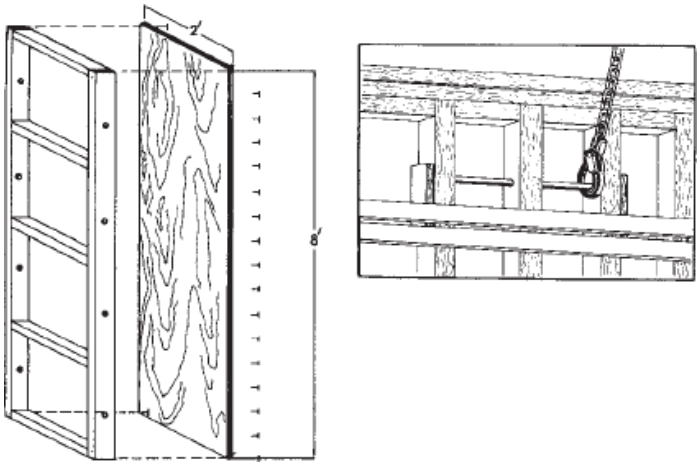
Crush Plates



The strips should be big enough to leave space at the edges of the panels to accommodate wrecking bars.

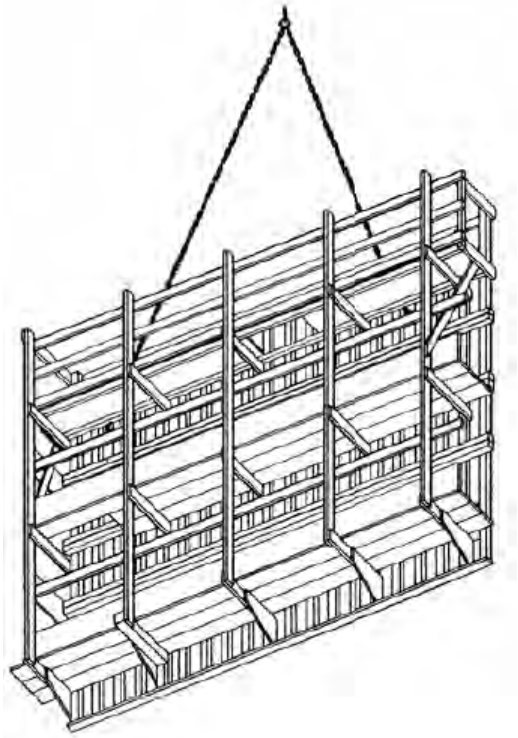
When formwork has to be manhandled during assembly or dismantling, the design should ensure that the components are manageable. Formwork panels are not only heavy but awkward. Realistic design demands consideration of the size as well as the weight of panels.

Formwork Panel



A formwork panel or wall form to be lifted as a single unit must be designed to withstand the loads and forces exerted by hoisting. In most cases, this means designing a more substantial structure. Fastening components may also need more attention at the design stage. For example, simple nailing may not be enough to hold plywood sheets.

Formwork Lifted as Single Unit



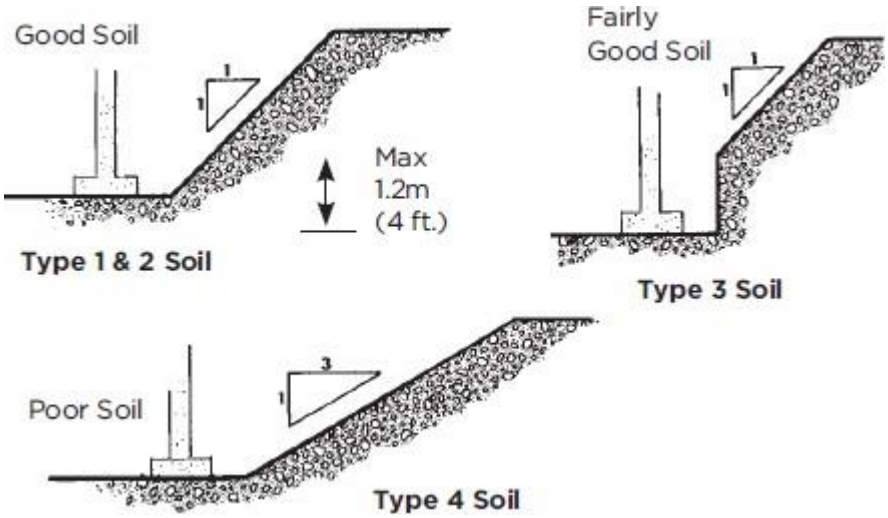
Special attention must also be applied to the design, construction, and use of pick points for hoisting. The strongbacks and wales must be securely attached to the formwork. The pick points must be located so that the panel hangs properly during installation, concrete placement, and removal.

Types of Formwork

Below Grade

The first concern with formwork below grade is the stability of the excavation walls. Walls must be either shored or sloped according to soil type as defined by section 226 of the Construction Projects regulation (O.Reg. 213/91). Below shows typical slopes.

Excavation Slopes for Soil Types



In most cases the shoring must be designed by an engineer. Engineers may also specify slopes for excavations. In both instances the design drawings must be kept on the project.

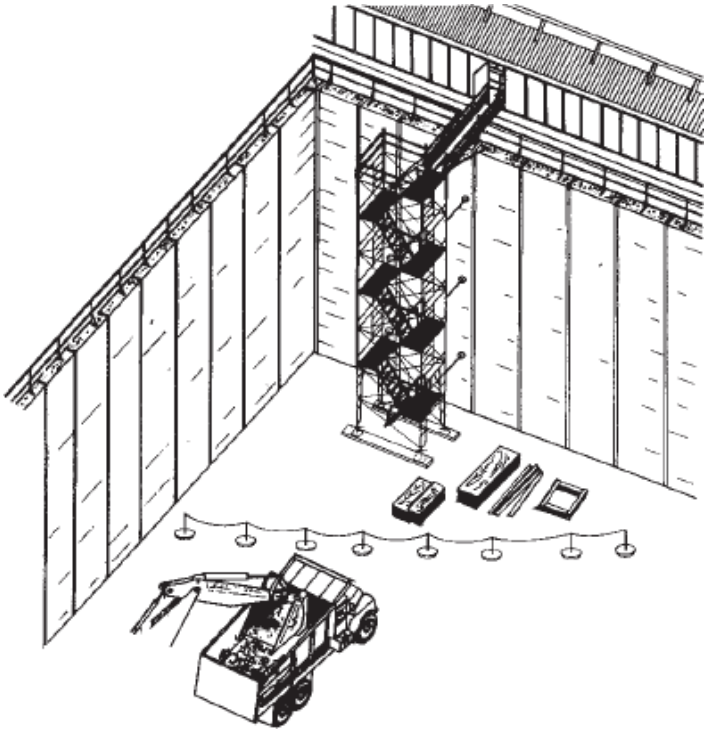
Excavations should be kept essentially dry. Water should be pumped out. Mud should be cleared off and replaced by compacted granular material in work areas and on surfaces where concrete will be placed. Mud presents slipping hazards and can lead to inferior construction if not removed or replaced.

Since mud has to be removed before concrete is placed, it might as well be removed before formwork is constructed, thereby reducing slipping hazards at both stages. Water and mud also contribute to electrical hazards. Grounding and insulation must be effective and intact. Ground fault circuit interrupters (GFCIs) are required by law on all portable tools used outdoors or in wet locations.

Formwork for footings and grade walls frequently begins before excavation in the area is complete. Trucks and excavating equipment put workers on foot at the risk of being struck down or run over.

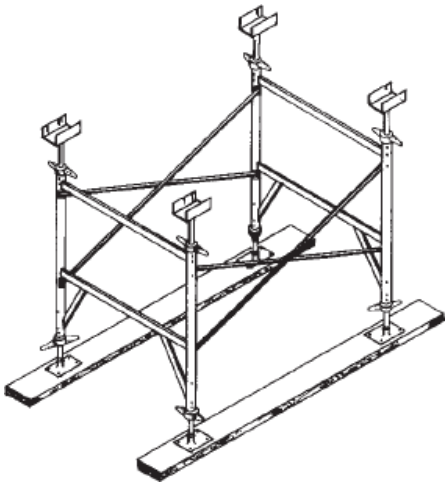
Wherever possible, formwork operations should be roped off from other work such as excavation or pile-driving. Separate access ramps for vehicles and workers are strongly recommended. Stairs are an even better alternative for personnel on foot.

Formwork Roped-Off from Other Operations



Mud sills must be used to support any shoring or bracing that rests on soil in the excavation. The sill must bear on the soil throughout its length. Sills should not be used to bridge holes or irregular surfaces. To ensure uniform bearing, soil should be levelled before sills are set in position.

Mud Sills Under Shoring Frames



The soil must have the capacity to bear whatever loads are applied (Table 42-1). This information may or may not be on the design drawings.

Table 42-1: In Situ Bearing Pressure for Dry Soil Conditions

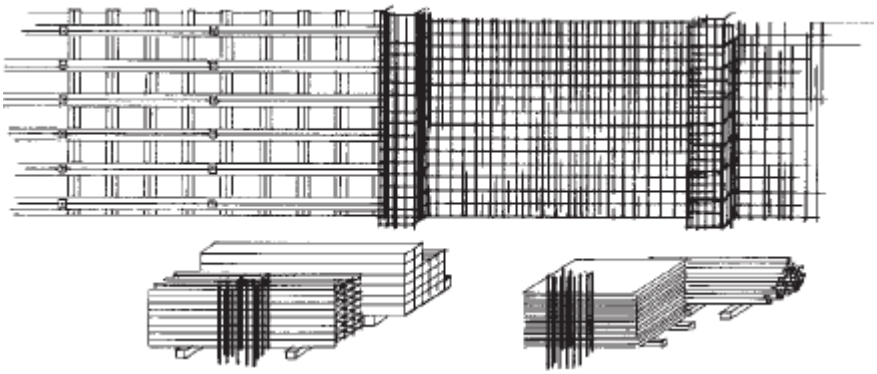
(Conservative Estimates)

Silt and clay	1,200 lb/ft² (5,859 kg/m²)
Sands	4,000 lb/ft² (19,530 kg/m²)
Gravelly sands	6,000 lb/ft² (29,295 kg/m²)
Gravel	8,000 lb/ft² (39,059 kg/m²)

Soil that supports bracing or shoring should be compacted and qualify as good soil at least (cohesive, hard, with no water). Professional advice from a geotechnical engineer may be required for heavy structures such as elevated equipment supports shored at or below grade.

Formwork in these situations is frequently built in place. Planning is required to store material and equipment out of the way, dispose of scrap and debris, and ensure safe, efficient access. Because conditions are often cramped and scrap accumulates quickly, it is important to clean up as work proceeds.

Well Planned Storage, Access, and Setup



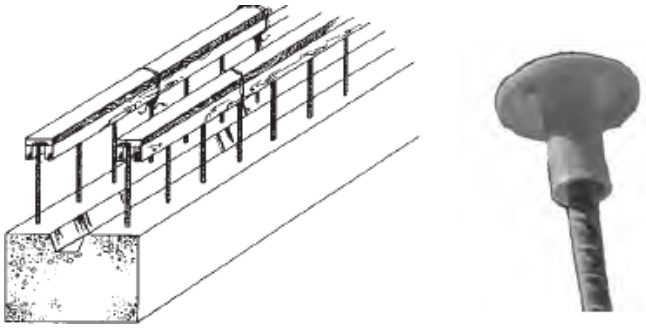
Wall Forms

Wall forms built in place are hazardous to construct. Hazards include

- Dowels sticking up from concrete slabs or footings
- Unstable work surfaces and access created by poor planning
- Manual handling of heavy material such as plywood sheets, panels, wales, and buckets of snap-ties, wedges, and plates
- Slippery surfaces at and below grade
- Inadequate design
- Improper construction.

The best protection against dowels is a wood cover built of lumber at least 1 1/2 inches thick and wired in place or protective caps placed over the exposed ends of rebar.

Protective Covers Over Dowels and Rebar

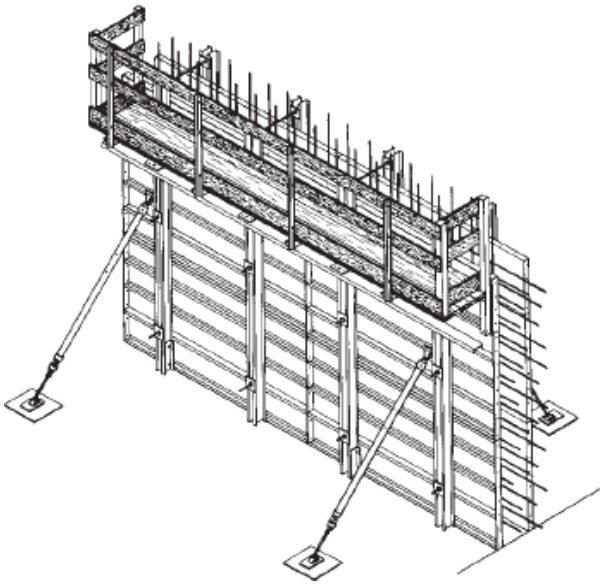


Starting the Form

Setting up the first form is always hard, heavy, manual work. It requires enough workers to do the job without overexertion or injury. Whenever possible, use mechanical assistance such as a boom, truck, or crane for this operation. It will reduce the risk of injury to workers and increase productivity.

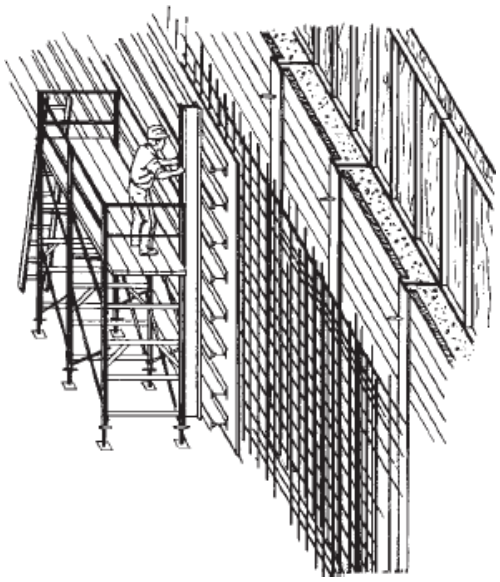
Temporary bracing is needed from the start and at every step to prevent wind loads from toppling the forms—historically the cause of many serious injuries. A wind speed as low as 30 km/h can create a dangerous wind load on formwork.

Temporary Bracing at Start of Form Construction



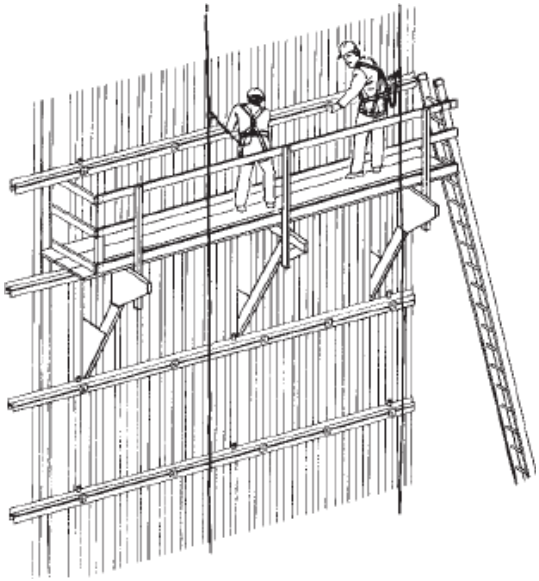
Access to wall forms is not always given enough thought. Forms more than 2 metres high will require access platforms for workers involved in concrete placing. The platforms can also be used to complete the upper portion of the formwork.
An alternative is a frame scaffold, which can also be used to install reinforcing steel.

Scaffolding for Access



Fall arrest systems or scaffolds with guardrails must be used where workers may fall more than 3 m (10 ft), or onto hazards such as projecting dowels. In some circumstances, you must use fall protection when the height is 2.4 m (8 ft) or more.

Workers Wear Fall Arrest While Attaching Wales to Threaded Rods



Materials should be distributed along the work location to minimize further handling. But traffic and work areas must be kept clear for the safe movement and installation of material.

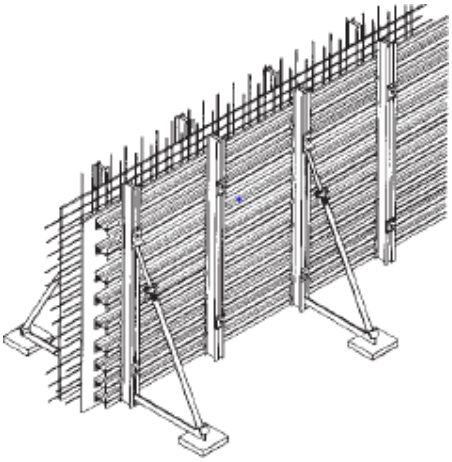
Form Construction
Wall forms must be constructed as designed. The design must indicate clearly what is required. Some wall forms are designed for specific concrete placement rates expressed in metres of height per hour (m/hr). A wall form in which concrete is placed to a height of one metre in one hour would have a placement rate of 1 m/hr. Slower pouring rates result in lower formwork pressure because the bottom concrete has started to set.

Note: Using a concrete vibrator will increase the liquid (hydraulic) pressure on the form in the immediate area of the vibration. Over-vibrating the concrete while increasing the pour rate can cause the formwork to fail.

Ensure that ties and braces are installed where indicated on design drawings. Ties should be snugged up. Braces should be securely fastened to forms and wedged or fastened to a support that will not settle or deform under load.
Formwork platforms must be:

- Capable of bearing at least 50 lb/ft2
- Adequately supported
- Equipped with guardrails
- Secured at the level or levels where work such as pouring and stripping will be done.

Formwork Properly Tied and Braced



Recommended design pressures for various pour rates and environmental conditions are set out in CAN/CSA S269.1-16: *Falsework and Formwork.* The standard defines a number of other design considerations and should be consulted by field staff.

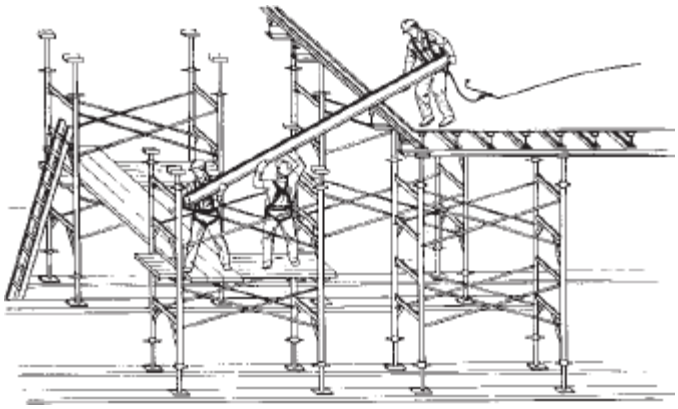
Slab Forms or Falsework Built in Place
With slab forms built in place the major hazard is falls. Injuries are also connected with the manual handling of heavy materials and components.

Forms built in place usually have to be taken down in place after the concrete has hardened sufficiently. This should be considered at the construction stage. Stability may also be a consideration where the structure is high, carries heavy loads, and is placed on grade as in bridge and overpass construction.

Fall protection is difficult to provide for workers building slab forms in place. That's why planning is essential in the design and erection procedure.

Workers should wear a safety harness with the lanyard tied off to the structure of the formwork. This means tying off to the support structure where shoring frame structures are being constructed, tying off to a lifeline when placing plywood panels at a leading edge, constructing a guardrail at the edge of the formwork, or tying off to the support structure when connecting it together with tube and clamp. Don't wait for the structure to be completed before tying-off.

Workers Tie Off to Shoring Frames While Placing Stringers

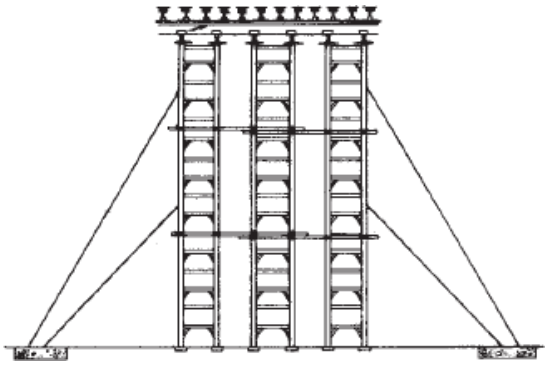


Make sure you have fall protection at all stages of formwork construction. Wherever possible, cranes or other equipment should be used to move material, thereby reducing the amount of manual carrying, lifting, and handling.

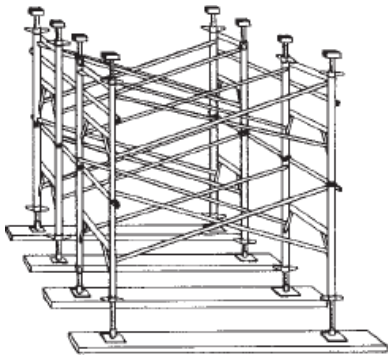
Shoring towers require special consideration.

- Towers must remain stable during construction and dismantling. Guys or other bracing and supports may be necessary to maintain stability.
- If towers are to be tied together and braced horizontally, this should be done as work progresses.
- Shoring towers and shores should be installed so they are plumb to within 1/8 inch in 3 feet.
- Shoring towers should be snugged up under the stringers with adjustable base plates and U-heads.
- If frames do not ride tightly on top of one another after tightening, one or more are out of square and should be replaced.
- With single-post shores, provide adequate lateral bracing. Stairwells and balconies are places where horizontal bracing for single-post shoring systems may be required.

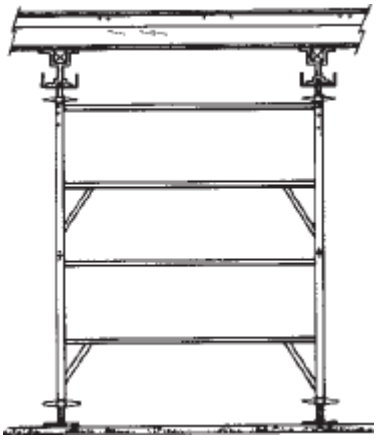
High Towers with Guys for Support



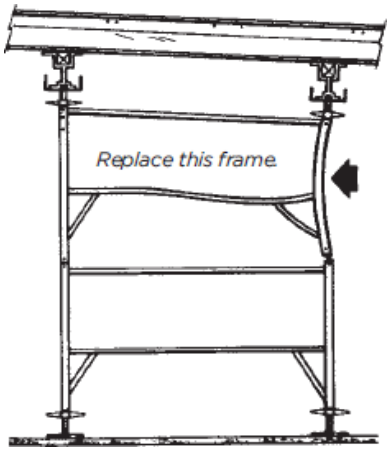
Towers Tied Together and Braced Horizontally



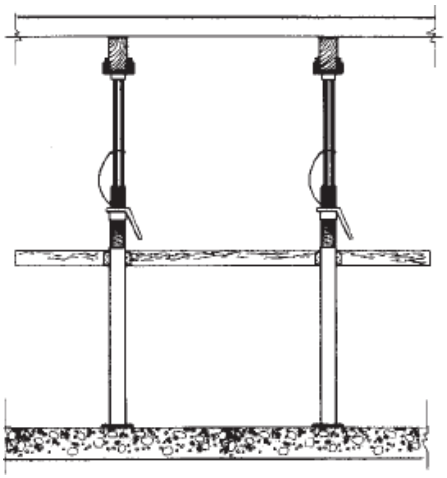
Typical Shoring Tower with Stringers, Adjustable Base Plates, and U-Heads



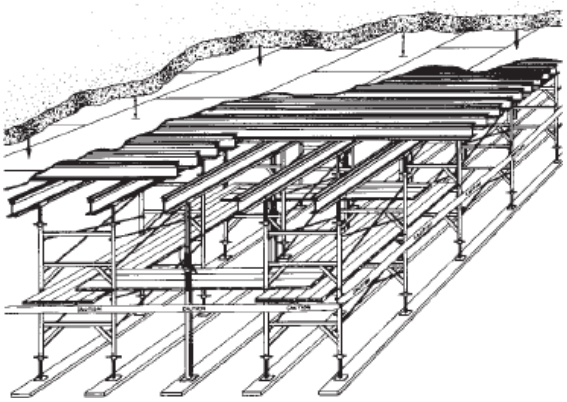
Frame Bent Out of Shape



Single-Post Shores with Lateral Bracing



Two Rows of Shoring Frames with Row of Shoring Posts in Centre



Frequently, supports for built-in-place forms are deliberately left out to allow other work to be done. One example might be a row of single-post shores left out until work below is complete. Or, an area might be supported temporarily during construction by a few single-post shores that will be replaced later by a shoring tower.

In these and other instances of incomplete formwork, heavy temporary loads such as bundles of rebar or stacks of plywood should not be placed on the structure. Even on completed formwork, make sure that landed material will not overload the structure. Before placing concrete, the formwork must be inspected and approved by a professional engineer or their designate. Keep a copy of this inspection and approval on the site in case an inspector asks to see it.

Flying Forms

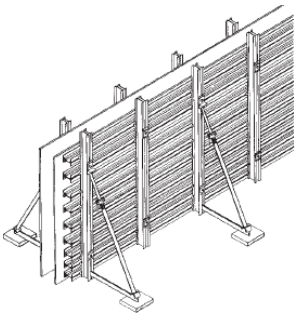
Flying forms must always be designed by a professional engineer and constructed, hoisted, moved, and set strictly according to the instructions of the designer or manufacturer.

Using forms designed for typical floors in non-typical situations has resulted in serious accidents. Before using any flying form under non-typical conditions, consult the designer or manufacturer. Wall forms should not be extended in height or width, for instance, or slab panels cantilevered without the review and approval of a professional engineer. Such situations usually occur with penthouses or mechanical rooms where wall and ceiling heights are greater than for typical floors.

Other hazards with flying forms include the following.
- Stability during initial fabrication
- Fill-in work between slab panels
- Wind and fall hazards during flying operations
- Stripping, flying, and re-setting.

Although a flying form is designed to be stable when complete, it may not be stable during fabrication or erection. Temporary bracing or temporary support by a crane may be necessary to ensure stability during certain phases of the operation.

Temporary Support of Shoring System for Flying Wall Form



One example is setting up trusses for a flying slab formwork table. The trusses must be held upright to be connected or disconnected. If not adequately supported, they can fall over on workers.

Trusses and wall panels have also been blown over by wind during fabrication and dismantling. Set-up procedures should indicate the maximum wind speed where the flying form operation can be done safely. This wind speed should be determined by the professional engineer who designed the system.

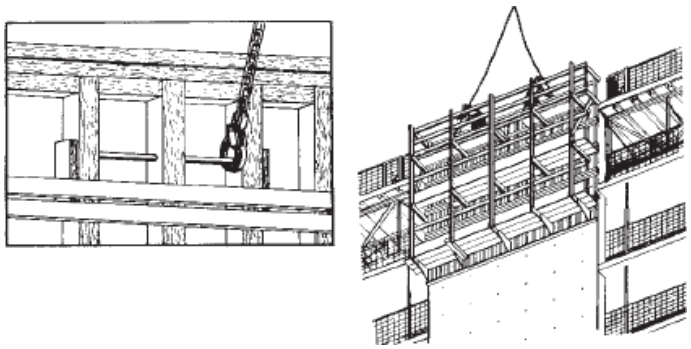
Work with flying forms requires adequate space for stacking materials and components. Working in cramped quarters is not only difficult but hazardous.

Fall Protection

A fall arrest system should be used by any worker who is at risk of falling when:
- Installing a panel
- Pushing a panel out toward the slab edge
- Pulling a panel in from the slab edge
- Helping other workers attach rigging hardware such as slings
- Getting on and off
- Bolting and unbolting wall forms for exterior walls and elevator shafts
- Stepping onto a panel to attach slings to pick points

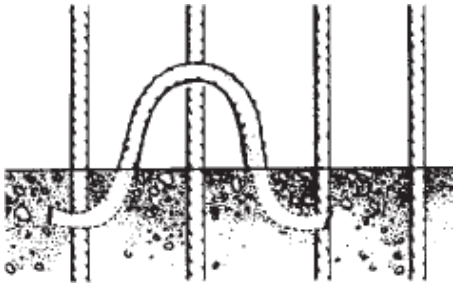
Fall Protection Required when Receiving a Flying Form

Attaching Chain Sling to Wall Form



Each worker's fall-arrest system must be attached to an individual anchor independent of the flying form. Contractors can provide for anchorage by casting rebar anchors in columns or other areas to be covered over or filled in later. This type of anchorage must be approved by a professional engineer.

Rebar Anchor Cast in Concrete



Safety Below Flying Forms

The previous section covered the safety of workers flying the forms. But precautions must also be taken to protect workers below the hoisting operation and the public at large, since forms are often swung out over sidewalks and streets. The Construction Projects regulation (213/91, s. 103(2)) prohibits hoisting a load over the head of a person who is not receiving the load or sinking a shaft.

The most efficient protection for workers is to fence or rope off the area below the flying form to prevent anyone from entering the area. Pedestrian traffic on sidewalks, as well as vehicle traffic if necessary, should be detoured around the area while hoisting is under way.

Communication

Flying forms are heavy, large, and awkward to move. Hoisting and moving them safely requires clear reliable communication. While hand signals are often necessary and are still used, direct radio or cell phone communication between the signaller and the crane operator is more accurate and effective. Relying on hand signals alone is not recommended.

Stripping

Formwork stripping is probably the most hazardous operation in concrete construction. Hazards include the following.

- Falling material
- Waste material and equipment underfoot
- Manual handling of heavy or awkward forms, panels, and other components
- Prying forms loose from concrete presents risk of overexertion, lost balance, and slips and falls.

Hazards can be reduced by

- Planning and providing for stripping when designing and constructing formwork
- Stripping as soon as it is permitted by the engineer

- Supplying facilities and equipment for removing materials as they are stripped
- Providing proper tools and adequate access for the stripping crew
- Training personnel properly for this and other aspects of formwork.

Forms can be designed with crush plates or filler strips to facilitate removal at difficult intersections of columns, beams, and wall forms. Later, formwork oils should be used liberally to make stripping easier.

Wherever possible, waste materials, plywood, and debris should be removed from the area as work proceeds. This will reduce the need to walk over or work around things left on floor or ground.

Providing carts or cradles can help the crew remove material and reduce the need for lifting and carrying. Material on a cart can be rolled away. Material in cradles can be hoisted off by a crane.

Climbing partially stripped formwork is not only hazardous but unnecessary. Safe access such as rolling scaffolds or powered elevating work platforms should be provided for stripping formwork at elevated locations.

Poor lighting may be a hazard in formwork stripping in the early morning or late in the day during certain times of the year. Mobile light stands are probably the best solution, since pigtail stringers can easily be knocked down and damaged during stripping. Wherever possible, stripping crews should be small. This is especially important with knock-down systems. In small crews, the supervisor and each worker can more easily keep track of what the others are doing. Workers are not as likely to create hazards for each other. Crews of two or three are recommended for knock-down systems. If more workers are required, they can still be divided into small crews working in separate areas. Other trades and operations should not be allowed in areas where stripping is under way. Given the many hazards involved, the area should be fenced or roped off and warning signs posted.

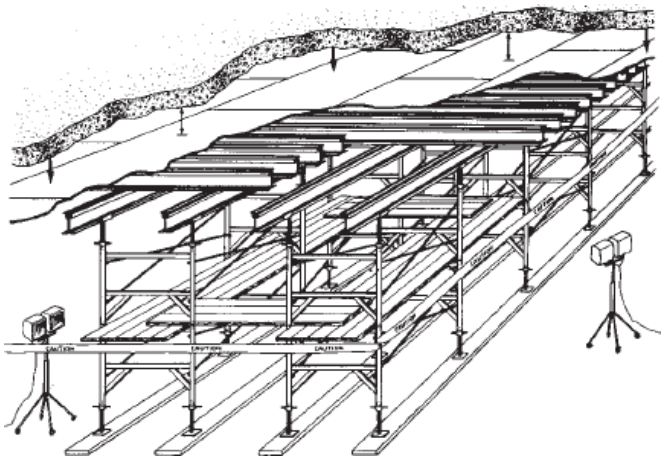
Knock-Down Slab Systems

Stripping these forms is physically difficult because much of the work is overhead. The usual arrangement involves shoring frames or a combination of shoring frames and jacks.

Wherever possible, the work should proceed progressively from one side. That means taking out one row of formwork supported by a row of stringers on shoring frames.

The first step is to back off the adjustable base plates and U-heads in one area, which will in turn lower the stringers, joists, and plywood.

Lowering Base Plates and U-Heads to Release Slab Form

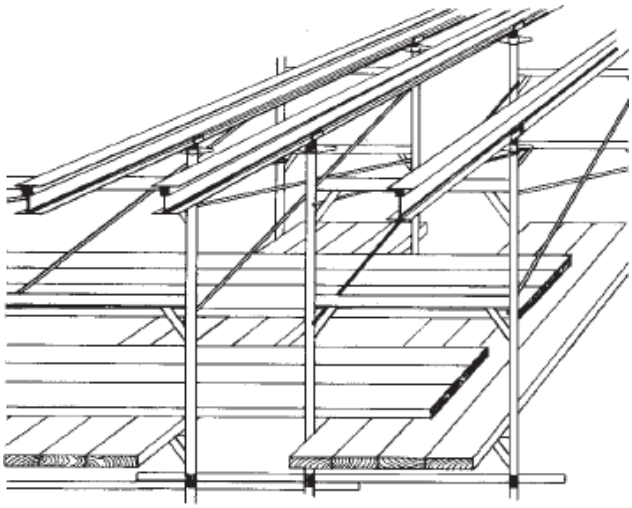


In practice, however, the plywood will stick to the underside of the concrete, especially around beams, column caps, and similar points. Wherever possible, stuck sheets should be loosened and removed before the shoring structure is dismantled.

Stripping should proceed in reverse order to erection. Plywood should be removed first, followed by joists and stringers. The last items to be removed are the shoring frames.

When scaffold or shoring frames are used as a work platform, it should be completely decked in with planks. Otherwise planks can shift and slide as workers pry or pull at stuck pieces of formwork, lose their balance, and fall. This has been a frequent cause of injuries. Temporary guardrails may be required near the edge of the structure or workers will need to use fall protection during this operation.

Shoring Frame Fully Planked for Access



The area where stripping starts should be planned to allow access for taking away material as the form is dismantled.

Sound training, effective supervision, well-designed safe access facilities, and immediate and continuous cleanup can help reduce hazards in stripping knock-down slab forms.

Built-in-Place Wall Forms
These forms are frequently of only moderate height. Taller types usually make use of large panels erected and removed by crane rather than hand. Built-in-place wall forms are usually a stud-and-wale system using some type of formwork ties.

Where workers cannot reach the top of the wall, scaffolding should be provided for removing wales on the upper level. Safe access is essential for the dismantling and manhandling of wales that are frequently long, heavy, and waterlogged.

Material should then be removed immediately to a staging area.

Inspection
Before concrete placing begins, formwork must be inspected and signed off by a professional engineer or a competent person designated by the engineer to ensure that it has been constructed to provide for worker safety and to meet job specifications.

A report must be completed by the person doing the inspection stating whether the formwork has been constructed according to the design. Any discrepancies must be approved by the design engineer before concrete placing proceeds.

It is in everyone's best interest to ensure that the formwork has been inspected by a competent person for workmanship, stability, and adherence to design drawings and specifications. Inspection should begin when the forms are being constructed and continue until concrete placing is complete.

Checking line and grade is best carried out while the formwork is being constructed. Shoring structures should be within the alignment limits specified on the design drawings. Line and grade should also be checked during the pour to determine whether formwork is shifting or deflecting.

Dimensions of special features like beams, column capitals, and inserts are best checked at the time of construction. If inspection is delayed until formwork is completed, some details may be covered up or become more difficult to check.

Columns
Check the following:
- The proper size and type of materials are used
- Column ties or column clamps are spaced according to design drawings
- The spacing of ties or clamps is based on a sound assessment of concrete pressure (generally columns are designed for a full liquid head of 150 lb per cubic foot (2,403 kg per cubic metre) times height)
- Columns are adequately braced where they are not tied in to a slab-form structure.

Note: For more information on column formwork pressures, refer to CAN/CSA S269.1-16: *Falsework and Formwork* or the American Concrete Institute (ACI) standard Formwork for Concrete (SP-4).

Wall Forms
Check the following:
- Materials and any manufactured components are as specified in design drawings (size and spacing of studs, wales, and ties are crucial to safety)
- Ties are snugged up before concrete is placed
- Wedges in wedged systems are tight
- Nuts in threaded systems are tight
- Bracing conforms to design drawings
- Free-standing formwork is braced to ensure stability and resistance to loads during concrete placing
- Specified pour rates are not exceeded (wall forms are often designed for specific pour rates; exceeding these rates can cause failure or collapse).

Slab Forms
From a safety perspective, this is the most critical type of formwork. The collapse of slab forms has caused many injuries and deaths, whether from flawed design (e.g., not considering the effect of wind loading on the design), unauthorized modifications in the field, or the failure to inspect, which would have located and corrected deficiencies.

Competent inspection demands knowledge, experience, and the ability to

1) Distinguish between similar but different materials and shoring equipment
2) Read and interpret design drawings
3) Identify and clear up with the designer any apparent or real discrepancies in components such as shoring frames.

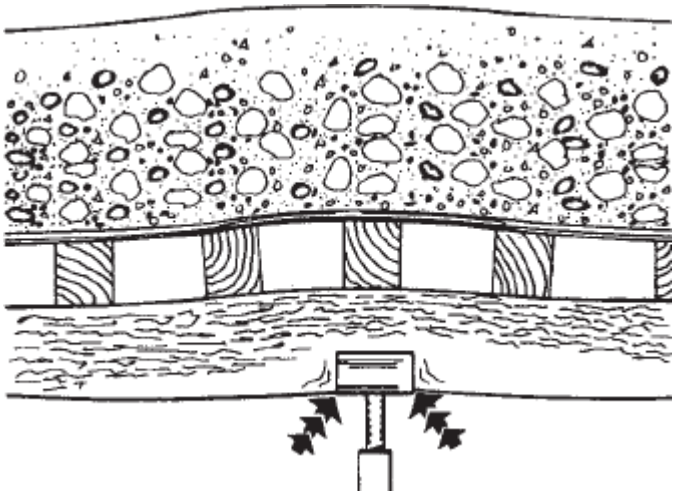
Check the following:
- Grade beams or mud sills supporting shoring are properly sized and located.
- Hazardous soil conditions such as excessive moisture, freezing, and uncompacted soil conditions are reported and discussed with the professional engineer.
- Shoring frames and jacks are located and aligned within tolerances specified on the drawings.
- Shoring frames and jacks are out of plumb no more than 1/8 inch every 3 feet.
- Adjustable base plates for shoring frames and jacks are snugged up.
- U-heads are wedged in place.
- Stringers are the specified size and number, with supports properly spaced.
- Aluminum stringers have no bent flanges or other damage.
- Joists are the specified size and properly spaced.
- Support structures and shoring for beam bottoms and column capitals are constructed according to design.
- Lateral bracing is provided where required (for instance, on freestanding formwork for bridges and overpasses).
- The bearing surface for lateral bracing is adequate—that is, stable footings or well-compacted soil.
- Temporary loads such as rebar are not overloading the system.

Concrete Placing

Forms should continue being observed during concrete placing. Any signs of movement, crushing, cracking, or deflection are cause for alarm. Placing concrete should be suspended until the situation is corrected.

Watch for the following warning signs:
- Lateral displacement or movement of single-post shoring for slab forms
- Movement or deflection of lateral bracing for single-post shores
- Movement of stringers on U-heads
- Crushing of wooden stringers on U-heads (Figure 42-29)
- Gaps or shoring that is not snugged up under stringers
- Deflection of stringers between supports (Figure 42-30)
- Deflection of wales or strongbacks on wall forms
- Wall forms that are bulging or cracking
- Crushing of wales or strongbacks at washers for ties
- Movement of wall forms
- Uplifting of battered forms
- Pour rates that exceed design specifications.

Crushing of Stringer Over U-Head



Deflection of Stringers Between Supports