GUIDELINES

FOR EXCAVATION WORK

Manitoba
Labour

Introduction

This guideline provides a standard for proper sloping and shoring of trenches and excavations. It is intended to give excavation contractors and workers practical information relating to the requirements of the regulations pertaining to excavation work.

This guideline contains general information about excavation work. For specific regulatory requirements regarding excavation work please consult the regulations adopted under the Workplace Safety and Health Act.

Manitoba Labour
Workplace Safety and health
Room 200-401 York Avenue
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PART I
DEFINITIONS

Deep Foundation means a foundation unit that provides support for a building by transferring loads either by end bearing to soil or rock at considerable depth below the building, or by adhesion or friction or both, in the soil or rock in which it is placed.

Excavation means a man-made cavity or depression in the earth's surface formed by earth removal, and includes a trench, deep foundation, tunnel, shaft, or open excavation, but does not include borrow pits, gravel pits and quarries, unless specified by a safety and health officer.

Open Excavation means an excavation where the width is equal to or greater than the depth.

Pile or Caisson means a slender, deep foundation unit made of materials such as wood, steel or concrete or combination thereof, which is either pre-manufactured and placed by driving, jacking, jetting or screwing, or cast-in-place in a hole formed by driving, excavation or boring.

Professional engineer means a person who is a member of the Association of professional Engineers of Manitoba and registered as a professional engineer under The Engineering Profession Act or who, being a non-resident, is in possession of a subsisting license granted under The Engineering Profession Act.

Shaft means a vertical or inclined opening excavated below ground level.

Sheathing means a continuous row of wood or steel sheets in close contact to provide a tight wall to resist the pressure of the walls of an excavation.

Shoring means a construction procedure used specifically to maintain the stability of the walls of an excavation and provide protection to workers whom may enter the excavation.

Strut means a horizontal cross-member of a shoring system that directly resists pressure from a wale or upright.

Support Structure means a shoring system required to maintain the stability of the walls and ceiling of an excavation and includes a trench cage.

Trench means an excavation having a depth which exceeds its width measured at the bottom.

Trench Cage means an approved steel support structure designed to resist the pressure from the walls of a trench and capable of being moved as a unit.

Trench Jack means a screw or hydraulic jack used as a brace in a shoring support structure.
Tunnel means a generally horizontal excavation more than one metre in length located below ground level.

Upright means the vertical members of shoring that are placed up against and directly resist pressure from a wall of a trench.

Waler means a shoring member that is placed against and directly resists pressure from sheathing or uprights.

PART II
HAZARDS TO EXCAVATION WORKERS

Why do serious injuries and fatalities to workers continue to occur in the excavation industry?

It is because both employers and workers often forget that when they remove earth from the ground, they are creating a situation where extreme pressures may be generated at the face of an excavation. There is no longer material available to support the walls of the excavation. Engineering controls must be utilized to provide a safe and healthy workplace within the excavation.

REMEMBER

No one can predict accurately if an excavation is safe to enter without a proper support structure being provided.

A worker does not have to be completely buried in soil to be seriously injured or killed. Workers who have been only buried up to their waist have died as a result of the pressures exerted by the soil on their bodies.

Excavations in, or near, "back-filled" or previously excavated ground are especially dangerous since the soil is "loose," and does not support itself well.

Water increases the possibility of a cave in. The increased water pressure exerted on the soil can be the final factor in causing the walls to collapse.

Clay can be extremely treacherous if dried by the sun. Large chunks of material can break off a trench wall after having been stable and solid for a long period of time.

It is not safe to assume that because the walls of an excavation are frozen that it is safe to enter. Frozen ground is not an alternative to proper shoring.

An excavation should be considered a confined space and appropriate evaluation and controls undertaken to ensure workers are not exposed to contaminated atmospheres.
Shoring must be adequate to overcome additional pressures from piles of excavated material, adjoining structures, vehicular traffic, and nearby equipment.

PART III
WHAT TO DO PRIOR TO EXCAVATING?

1. MAKE SURE YOU ARE A REGISTERED CONTRACTOR

All employers undertaking excavation work are required to notify the Workplace Safety and Health Division and obtain a registration number. Once this number is obtained, the employer is considered a **registered excavation contractor**. If an employer is not performing excavation work safely, then a Safety and Health Officer may revoke the registration and the employer cannot do any more excavation work.

An employer may re-apply for registration, but must prove to the satisfaction of a Safety and Health Officer that he/she understands the requirements of the excavation regulation and will perform excavation work safely. **Contact the Division if you are not registered!**

2. NOTIFY THE DIVISION PRIOR TO EXCAVATING

Every excavator who intends to make trench excavation in excess of 1.8 metres (6 feet) or an open excavation exceeding 2.4 metres (8 feet) in which a worker may enter must notify the Division not more than 48 hours prior to beginning the excavation. The Division will assign a serial number for that excavation.

The following information must be provided to the Division at the time of notification:

- the excavation contractors registration number
- the name and address of the owner of the land where the proposed excavation is to be made
- the name and address of the employer, principal contractor, municipality, public utility, or agency of the government proposing to excavate
- the location of the proposed excavation and the date of the commencement of the work
- a description of the proposed depth, length, and width of the excavation
- a description of the proposed method of shoring, including the type of shoring materials to be used
- verification that the appropriate utilities have been notified and that the location of any pipes, conduits, or previous excavations in or adjacent to the proposed site has been determined and
- the name of the on-site worker supervising the excavation.

3. OBTAIN CLEARANCE FROM THE PUBLIC UTILITIES

Serious accidents have occurred in the past when excavators have made contact with a gas or energized electrical line causing fires, explosions, and injuries.

An excavation cannot be started until all the public utilities (including telephone, hydro, gas, steam, etc.) have been notified and the accurate location of all underground facilities has been determined.

If damage to any pipe, cable, or other underground facility occurs once the excavation has started, the employer must contact the utility immediately and advise them of the contact. No further excavation work should proceed until the utility has undertaken an on-site inspection. The workers must be evacuated from the work-site if an energized cable is exposed or dangerous fluid or gases are released.

Where a worker or any portion of excavating machinery or equipment may come closer than 3 metres (10 feet) to an overhead or underground electrical power line, the public utility must be contacted and permit authorization obtained.

4. OBTAIN ENGINEERING APPROVALS

An employer must engage a professional engineer to provide design information and approvals for shoring support structures where a worker or workers are required to enter an excavation:

a) where a straight-cut trench excavation exceeds 4.5 metres (15 feet) in depth or 1.5 metres (5 feet) in width

b) where, in the opinion of a Safety and Health Officer, a shoring support structure is required to be designed due to the nature of the excavation or soil conditions

c) where a trench cage is to be used as a shoring support structure;

d) for all shaft and tunnel excavations

e) for all deep foundation (caisson, pile) excavations or
f) where the excavation may affect the structural integrity of an adjacent building, foundation, utility pole or other structure

5. PLAN FOR DANGEROUS CONDITIONS

A hazard assessment must be undertaken to determine the risks associated with workers entering an excavation. Possible hazards includes:
a) explosive and toxic atmospheres

b) lack of oxygen

c) restricted access and egress

d) flooding

e) utility contacts (electrical. gas, steam, etc.) and

f) human factors (phobias, mental and physical conditions)

If a risk assessment reveals that there is a confined entry hazard in an excavation, then a proper work plan must be developed.

For example, in cases where a toxic or hazardous atmosphere may exist or could reasonably be expected to exist in an excavation, the employer must test the atmosphere and control worker exposure to the hazard. (For example, this may occur in excavations where there are accumulations of gasoline vapors due to leaking underground tanks. There are also situations where there may be elevated carbon monoxide (CO) levels or a lack of sufficient oxygen in the excavation).

What to do:

1) The employer must test the atmosphere prior to entry into the excavation If an unsafe. atmosphere exists ventilation must be provided to maintain safe working conditions.

2) If it is impossible to maintain a safe atmosphere by providing engineering controls and a worker must enter the excavation. then a proper supplied air respirator and emergency evacuation procedures must be provided.

3) If other hazardous conditions such as potential flooding of the excavation exist, then the employer must establish a safe working procedure. This may include provision of safety harnesses and lifelines to allow workers to be removed from the excavation immediately, should the hazardous condition develop.

(Refer to Workplace Safety and Support Services Division "Guidelines for Confined Entry Work" for more detailed information).

TRAIN THE WORKERS

An effective training program must be developed and delivered to excavation workers. Prior to a worker beginning excavation work, the employer must instruct each worker in proper and safe work procedures. This includes making the worker aware of the hazards associated with excavations and any emergency procedures or rescue methods that may have to be utilized.

7. **APPOINT AN EXPERIENCED SUPERVISOR**

The employer must ensure that an experienced and trained worker is designated to directly supervise each excavation project. This worker must be familiar with all aspects of excavation work, from shoring requirements to emergency rescue procedures. The supervisor must directly supervise all excavation work during the entire period the workers are in the excavation.

PART IV
GENERAL SHORING REQUIREMENTS

1. PERSONAL PROTECTIVE EQUIPMENT (PPE)

All workers doing excavation work must wear CSA approved Grade 1 safety footwear and safety headwear. Additional personal protective equipment may be required, depending on the risk assessment for the work to be undertaken (i.e. hearing protection, hand protection, etc.).

2. "OBSERVER" TO BE ON THE JOB

The employer is required to ensure that there are always an experienced worker designated to be the "observer" for trench excavations. This worker is responsible to remain on the surface and keep the trench and workers under observation for unsafe conditions.

3. **PROVISION FOR ACCESS/EGRESS**

A suitable means of access and egress must be provided for workers entering an excavation. This is usually provided by means of a ladder or stairway. Ladders must extend 1 metre (3 feet) above the top of the excavation. In a trench excavation, a ladder must be located within 3 metres (10 feet) of a worker's working position.
If workers are required to cross over an excavation, then a proper walkway with suitable guardrails on all exposed sides must be provided.

4. LOCATION OF EXCAVATED MATERIALS & EQUIPMENT

All excavated materials must be piled in a manner so that the material cannot roll back into the excavation. The material must never be closer than 1 metre (3 feet) from the edge of the excavation, and should be placed as far away from the excavation as possible.

Tools, equipment, and heavy machinery shall not be placed or used near an excavation where they may fall into the excavation or affect the structural stability of the walls of the excavation.

5. PUBLIC PROTECTION & TRAFFIC CONTROL

All excavations, where the public has access, shall have a means provided to guard the public from the hazards of the excavation project. This includes barriers and signage to protect the public from falls, falling material, and excavating equipment. Proper covers or fencing must be provided to prevent the public from access to the excavation during "off" hours.

In public traffic areas, adequate signage and barricades meeting the requirements of the municipal or provincial highway authorities must be provided.

6. FIRST AID

First aid and emergency supplies must be kept at the excavation project at all times. It is recommended that at least one worker per shift be a trained first aider with CPR certification.

7. ENGINEERING INFORMATION

Engineered design specifications for shorting support structures, including trench cages, must be forwarded to the Division before using the structures, and made available at the excavation site to a Safety and Health Officer.

Design specifications shall include:

a) the size of the component members of the structure

b) the loads and types of soil conditions for which the structure is designed

c) how the system is to be constructed and utilized

> The employer is required to construct all shoring systems in accordance with the engineering design information provided.

PART V

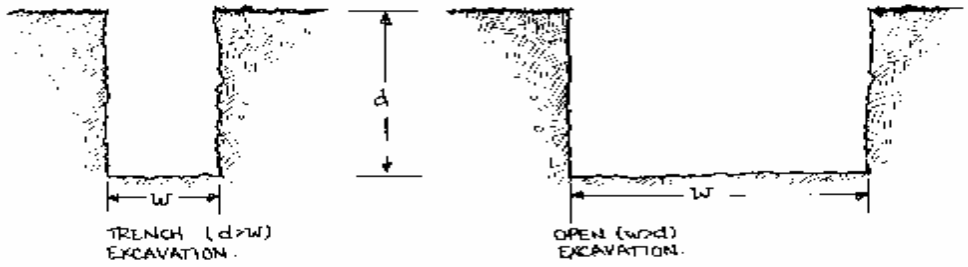
TRENCH AND OPEN EXCAVATIONS

Shoring, or the proper sloping of an excavation must be provided where a worker is to enter an excavation that is considered to be:

A. An open excavation exceeding 2.4 metres (8 feet) in depth. (An open excavation is any excavation that does not meet the criteria of being a trench, shaft, caisson, or tunnel)

OR

B. A trench excavation exceeding 1.8 metres (6 feet) in depth.



The shoring support structure must be designed to withstand all external forces that may be caused by:

a) soil pressures;
b) nearby structures;
c) additional loadings and vibrations (heavy equipment, traffic, piled materials near the excavation, etc.)

Unless approved by a professional engineer, shoring support structures must be installed so that they are in firm contact with the walls of the excavation. This may require backfilling of voids in the excavation up to the shoring support structure.

FROZEN GROUND IS NOT CONSIDERED AN ALTERNATIVE TO PROPER SHORING

1. TRENCH EXCAVATIONS

A.SOIL CATEGORIES

For purposes of establishing shoring tables for trench excavations, soils in Manitoba have been categorized into three main types:

Category I-**stiff and firm soils** - solid soils with substantial cohesion and no water table present. (i.e. good clay, stiff clay till, medium till)

Category II-**soils likely to crack or crumble** - soil that can be excavated by hand tools, show signs of cracking after excavating, and possess a low to medium moisture content (i.e heavily seamed silty clays, compacted clay fill, and mixtures of clays and silts); and

Category III-soft and loose soils - soils easily excavated by hand with little or no cohesion (i.e. sand, gravel, silt, organic soil, soft and wet clay, and loose fill).

MANITOBA SOIL TYPES

The following is a list of soil types generally encountered in the Province of Manitoba:

Peat and organic soil are generally wet and soft. They are usually encountered in alow-lying flood plain or wetland areas.

Fill can be one or a mixture of different soil materials such as: silts, silty clay sand and gravel, organic soil and rubble, etc. It can be hard, dense, loose or soft.

Silt can be classified as cohesive of non-cohesive depending on the percentage of clay and sand content. It can be firm of soft in consistency. Upon saturation, it generally loses its strength and becomes unstable in a vertical cut.

Lacustrine silty clays are generally brown and grey colour, ;medium t highly plastic and contain numerous silt and oxide inclusions, stones, and occasional pebbles. The silty clays generally have stiff to firm consistency and become softer with increased depth. In the top 10-15 feet, the silty clays generally are highly fissured and nuggety in structure. Upon saturation, the fissured silty clays usually become unstable in a vertical cut.

Sand and gravel can be classified as cohesionless material. These can be found in a dense or loose state.

Glacial till generally consists of clay, silt, sand, gravel stones, cobbles, and occasional boulders. Both soft and dense glacial till are common.

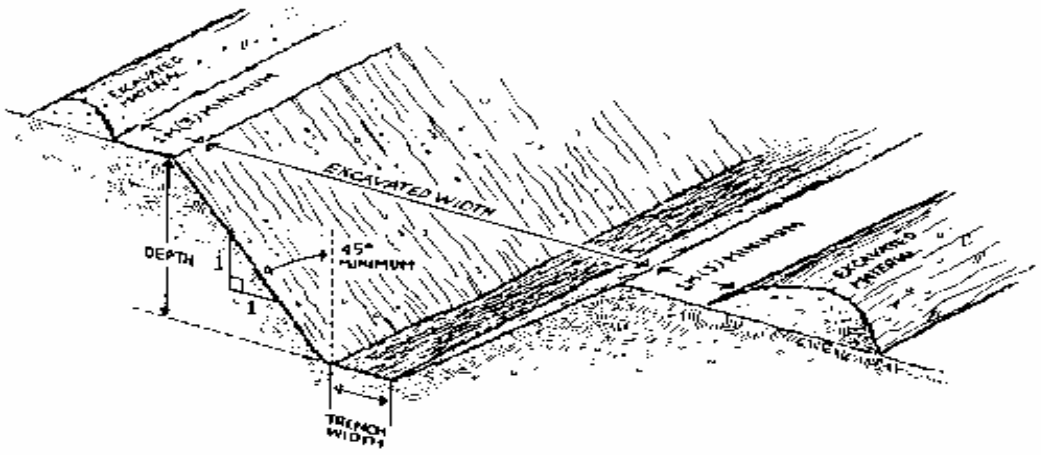
Limestone and granite bedrocks are found in Manitoba. They can be fractured or intact.

In general, thepore water pressure in the soil varies seasonally. Soil can become saturated by snow melt or after a period of heavy precipitation. Silty clays and compacted clay clay till at shallow depths are likely to be heavily fissured as a result of frost actions and desiccation. Fissured silty clays and clay fill can have firm to stiff consistency in-situ. They are readily softened upon saturation and likely to crack or crumble. Loose silt, fill, sand and gravel, organic soil, and soft glacial till are readily weakened and have no strength upon saturation. Dense glacial till becomes soft upon saturation.

B. VEE-TYPE (SLOPED) EXCAVATIONS

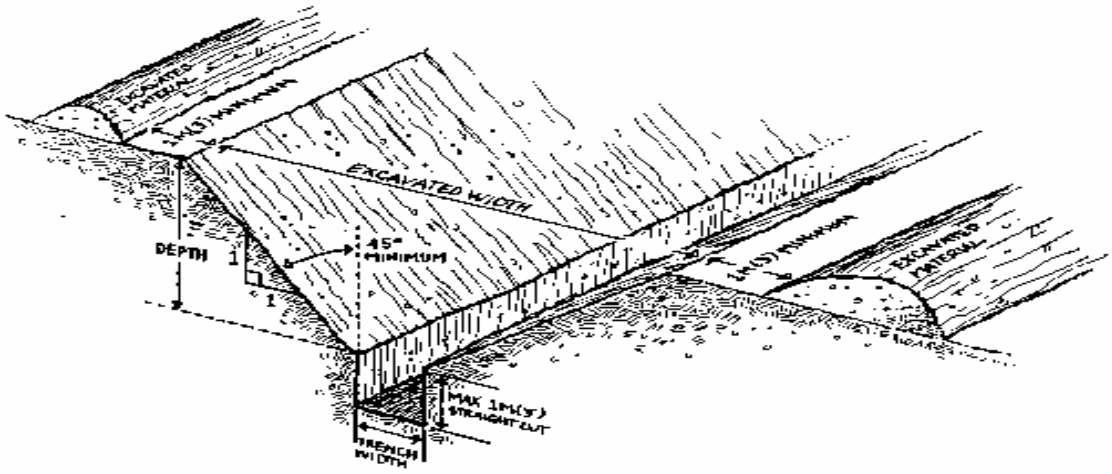
Instead of a shoring support structure, a safe method to protect workers in an excavation is to **slope the walls of the excavations at a grade of 1:1 (45°)** or flatter. The 45° slope is required no matter what type of soil conditions exist.

FULLY SLOPED (VEE'D) EXCAVATION



A combination 1:1 (45°) slope and vertical face may be used, as long as the vertical face does not exceed 1 metre (3 feet) and the overall depth of the excavation is not greater than 5 metres (15 feet).

COMBINATION SLOPE AND VERTICAL FACE.



To calculate the overall width of a sloped excavation, use the following formula:

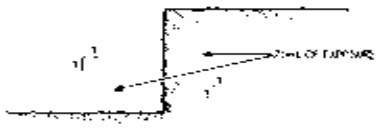
WIDTH = (2 X DEPTH) + BOTTOM TRENCH WIDTH

C. TYPE OF SHORING MATERIAL

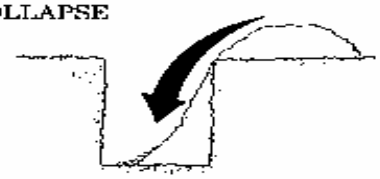
The majority of wood shoring used in trenches in Manitoba is comprised of full dimension poplar planks and timbers. Spruce lumber is also acceptable as shoring material provided it meets the shoring table requirements. The lumber must be construction grade No. 2 or better. Plywood used as sheathing material in loose soils must be a minimum of 20mm (3/4 inch).

Steel trench jacks may be used as struts, as long as they are equivalent in strength to the wood struts specified in the shoring tables. The longer dimension of the trench jack "foot" must be located perpendicular to the grain of the wood on the upright. (see diagram p.14.)

TYPES OF SOIL COLLAPSE



1) **general zone of exposure** - the area where workers are exposed to mass soil/rock movement.



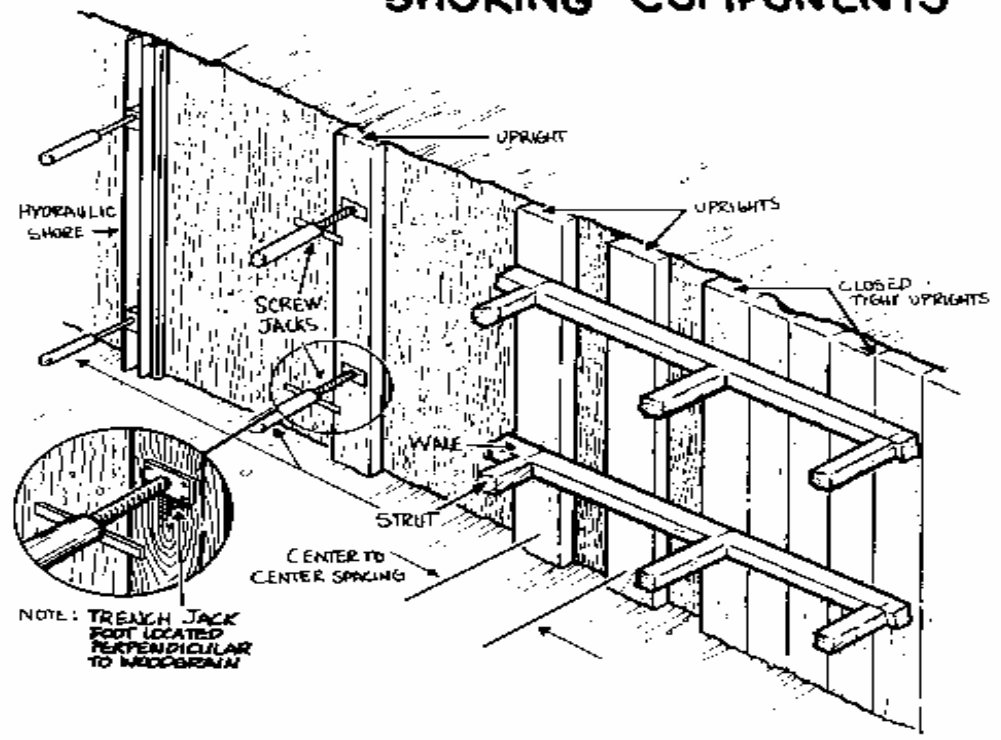
2) **spoil pile slide** - poor excavating procedures where the excavated material is not placed far enough away from the edge of the excavation

3) **side wall shear** - common to clay-type soils which are exposed to drying

4) **slough-in (cave-in)** - common to previously excavated material, sand and gravel mix

5) **rotation** - clay type soils when saturated with water

SHORING COMPONENTS



D. TRENCH SHORING TABLES

The shoring tables following indicate the allowable size and spacing of wood shoring for particular classifications of soil in Manitoba.

SIZE AND SPACING OF SHORING MEMBERS

FOR TRENCHES UP TO 60" WIDE

IMPERIAL UNITS

TRENCH DEPTH (FEET)	UPRIGHTS		STRUTS			WALES			
	MINIMUM DIMENSION (INCHES)	MAXIMUM SPACING (FEET)	MINIMUM DIMENSIONS (INCHES)	MAXIMUM SPACING (FEET) VERT	HORIZ	MINIMUM WALE DIMENSIONS (INCHES)	MAXIMUM VERTICAL WALE SPACING (FEET)	MAXIMUM HORIZONTAL STRUT SPACING (FEET)	MINIMUM STRUT DIMENSION (INCHES)
CATEGORY I - STIFF & FIRM SOILS (30 psf/ft.)									
0 - 10	2 X 8	3	4 X 4	4	3	6 X 8	4	6	4 X 6
10 - 15	2 X 8	2	4 X 4	3	2	6 X 10	3	6	4 X 6
CATEGORY II - SOILS LIKELY TO CRACK & CRUMBLE (50 psf/ft.)									
0 - 10	2 X 8	2	4 X 4	4	2	6 X 10	4	6	6 X 6
10 - 15	2 X 8	2	4 X 4	3	2	8 X 10	3	6	6 X 8
CATEGORY III - LOOSE & SOFT SOILS (75 psf/ft.)									
0 - 10	2 X 8	2	4 X 4	3	2	8 X 10	3	6	6 X 8

FOR TRENCHES UP TO 1.5 M

S.I. (METRIC) UNITS

TRENCH DEPTH (METRES)	UPRIGHTS		STRUTS			WALES			
	MINIMUM DIMENSION (MM)	MAXIMUM SPACING (METRES)	MINIMUM DIMENSIONS (MM)	MAXIMUM SPACING (METRES) VERT	HORIZ	MINIMUM WALE DIMENSIONS (MM)	MAXIMUM VERTICAL WALE SPACING (METRES)	MAXIMUM HORIZONTAL STRUT SPACING (METRES)	MINIMUM STRUT DIMENSION (MM)
CATEGORY I - STIFF & FIRM SOILS (4.71 kpa/m)									
0 - 3	38 X 191	0.9	89 X 89	1.2	0.9	140 X 191	1.2	1.8	89 X 140
3 - 4.5	38 X 191	0.6	89 X 89	0.9	0.6	140 X 235	1	1.8	89 X 140
CATEGORY II - SOILS LIKELY TO CRACK & CRUMBLE (7.85 kpa/m)									
0 - 3	38 X 191	0.6	89 X 89	1.2	0.6	140 X 235	1.2	1.8	140 X 140
3 - 4.5	38 X 191	0.6	89 X 89	0.9	0.6	191 X 235	1	1.8	140 X 191
CATEGORY III - LOOSE & SOFT SOILS (11.78 kpa/m)									
0 - 3	38 X 191	0.6	89 X 89	0.9	0.6	191 X 235	1	1.8	140 X 191

Important: see notes on next page

NOTES TO BE USED WITH TABLES AND DIAGRAMS

1. Over 10' (3m) in loose soils use vee trench not less than 45 from vertical or semi-vee with an approved trench cage.

2. Members must be at least SPF Species D, Aspen Species Group F, No. 2 Grade or better.

3. The above tables are based on graded nominal lumber dimension. Ungraded full dimension poplar is considered equal.
4. Trenches less than 5' (1.5m) deep must be shored when dangerous ground movement is likely, as in ground subject t hydrostatic pressure or vibration.

5. At least two struts must be installed in each vertical plane where struts are required.

6. Steel trench jacks may be substituted for timber struts as follows:

IMPERIAL

Nominal Strut Size (inches)	Nominal Pipe I.D. Size (inches)
4X4	1 ½ Standard
4X6, 6X6	2 Standard
6X8, 8X8	3 Standard

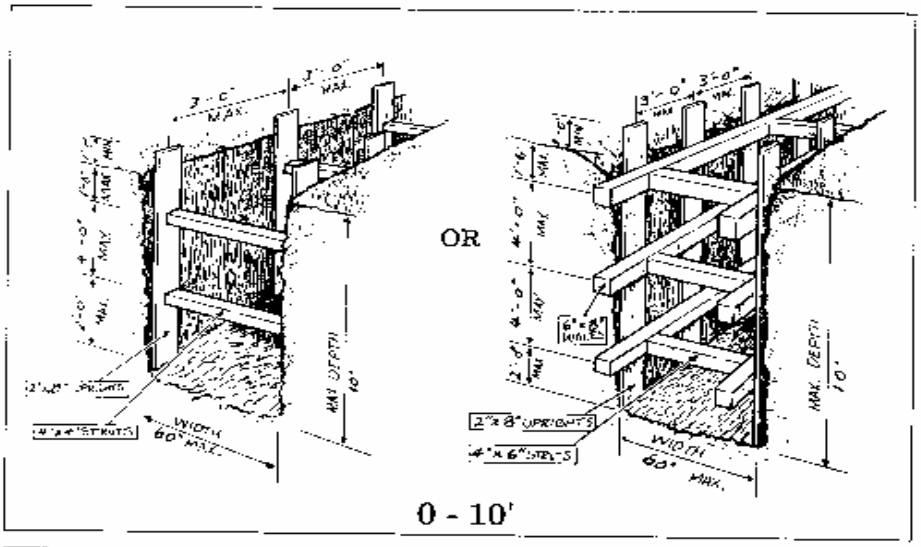
METRIC

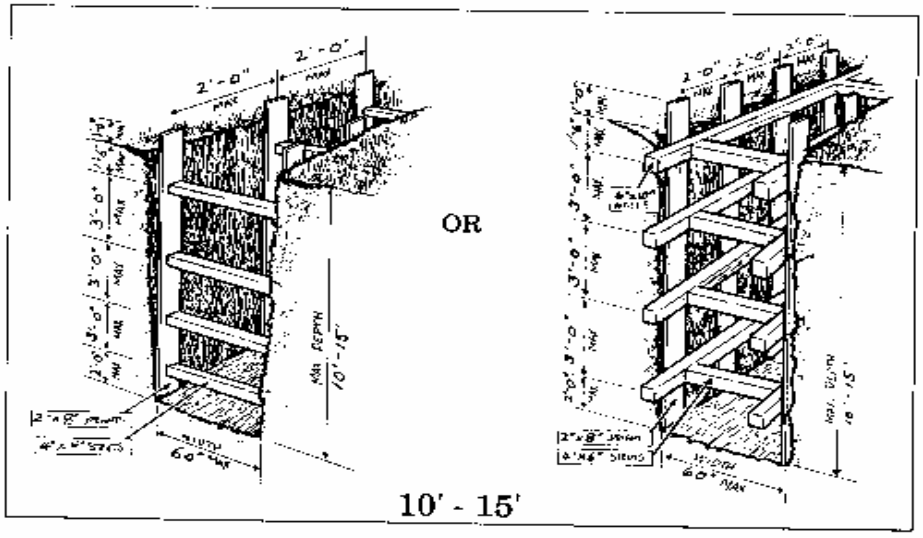
Nominal Strut Size (mm)	Nominal Pipe I.D. Size (mm)
89X89	40 Standard
89X140, 140X140	50 Standard
140X191, 191X191	75 Standard

The jacks must have a bearing area equal to the wood struts.

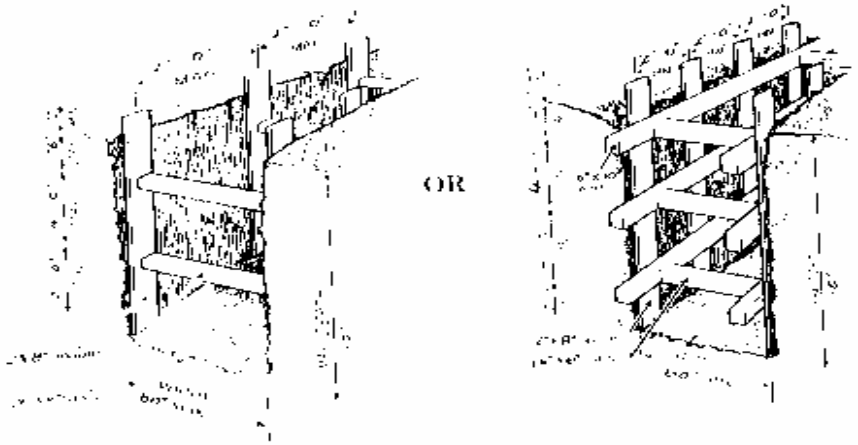
7. Shoring for sand and gravel (loose and soft soils) may be sized for soils likely to crack and crumble (50 psf/ft. pf 7.85 kpa/m.)

SOIL CATEGORY 1 - STIFF AND FIRM SOILS



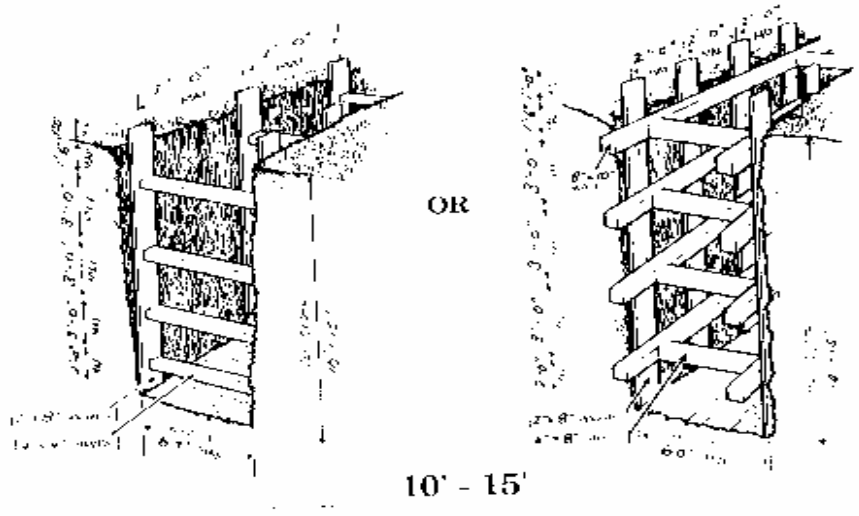


SOIL CATEGORY II - SOILS LIKELY TO CRACK & CRUMBLE



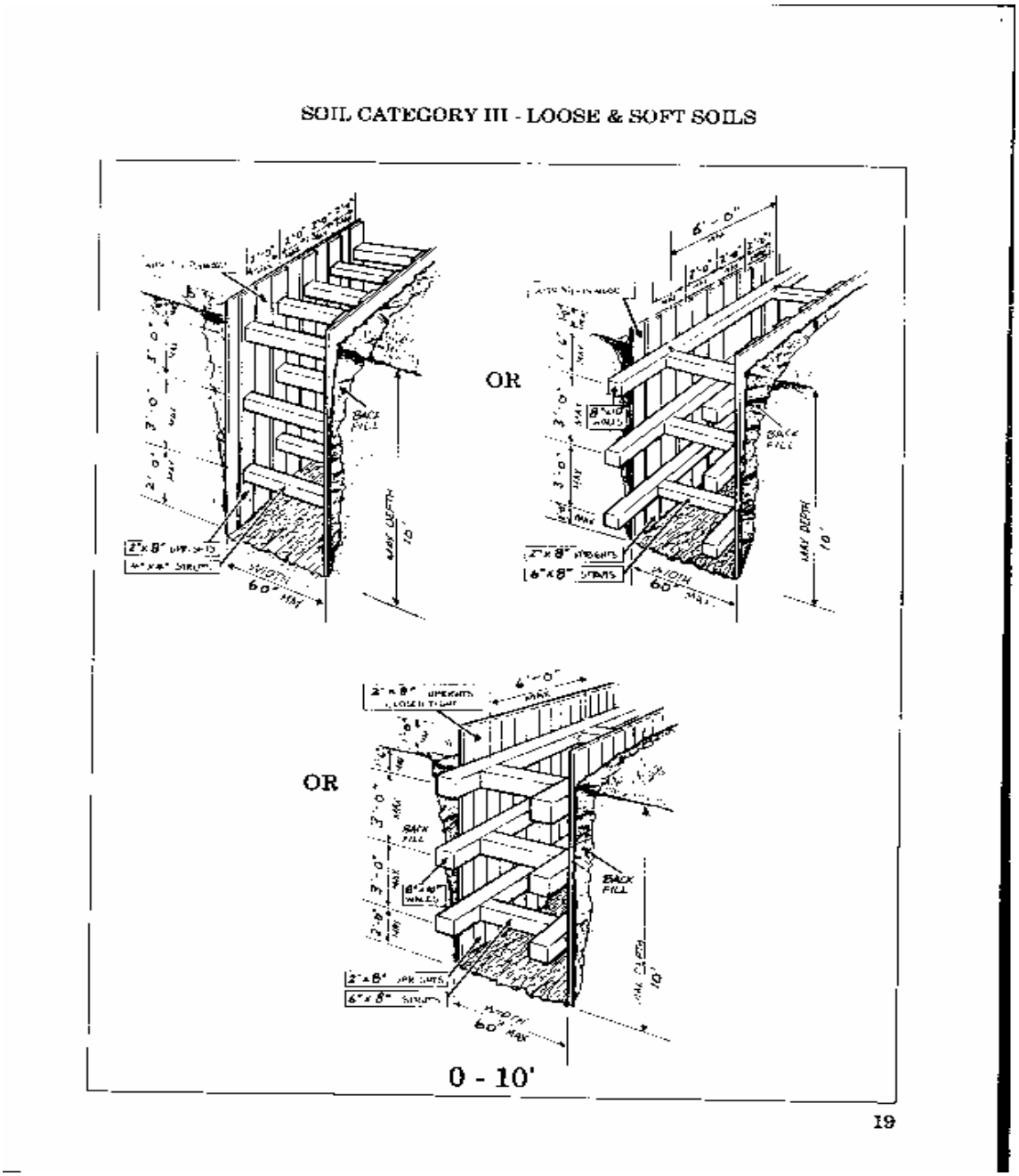
OR

0 - 10'



OR

10' - 15'



E. **SHORING OF TRENCH EXCAVATIONS**
When installing shoring within a trench type excavation, proper methods and procedures must be followed to provide for a safe excavation.

Uprights, struts (screw jacks), wales, and plywood must be installed in accordance with the shoring tables based on the soil conditions, depth, and width of the trench excavation.

Installation of Shoring

When shoring is in progress, the bucket of the excavation machine must be placed in the trench directly in front of the shoring being installed. The bucket will serve as additional protection if a cave-in occurs.

A proper ladder must be provided in a trench or open excavation. The ladder must extend at least 1 metre (3 feet) above ground level and be within 3 metres (10 feet) of a worker's working position.

It is essential that shoring struts/jacks be installed from the top down. It is important that the top (first) strut/jack be placed approximately 0.5 metres (18 inches) below the surface, then the second strut/jack placed according to the shoring table. The installation of the first and second strut/jack to support the vertical uprights is very important as it stabilizes the excavation walls.

When plywood is used, the jacks or struts must never be installed directly on to the plywood. (If the walls move, the jack or strut could push through the plywood). Where plywood is used, the jacks must be placed on the uprights that support the plywood.

Once the worker has a minimum of two struts/jacks placed on each set of uprights, the worker can proceed to install the bottom strut/jack. There must never be less than two struts/jacks used on each set of shoring.

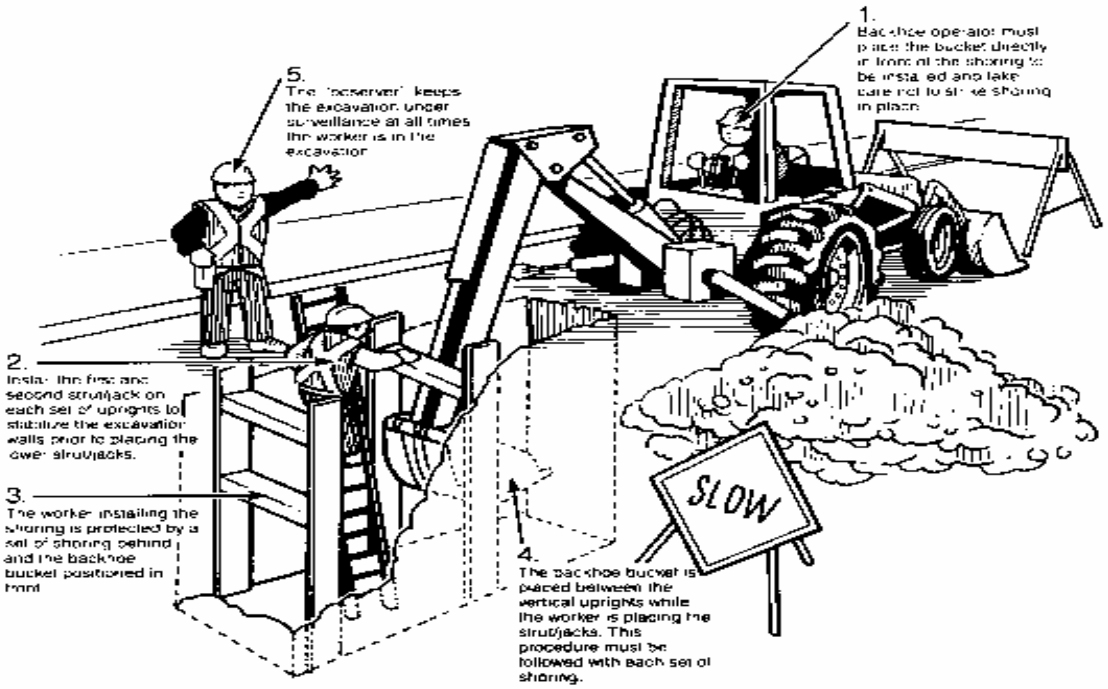
This procedure is to be followed with each set of shoring. Using this method, the worker is protected by the bucket of the digging machine and the shoring already installed.
Removal of Shoring

When removing shoring, the reverse procedure is used. That is, the struts are removed from the bottom to the top. Remember, there must never be less than two sets of uprights in place and the worker must always remain within the shoring in place for protection.

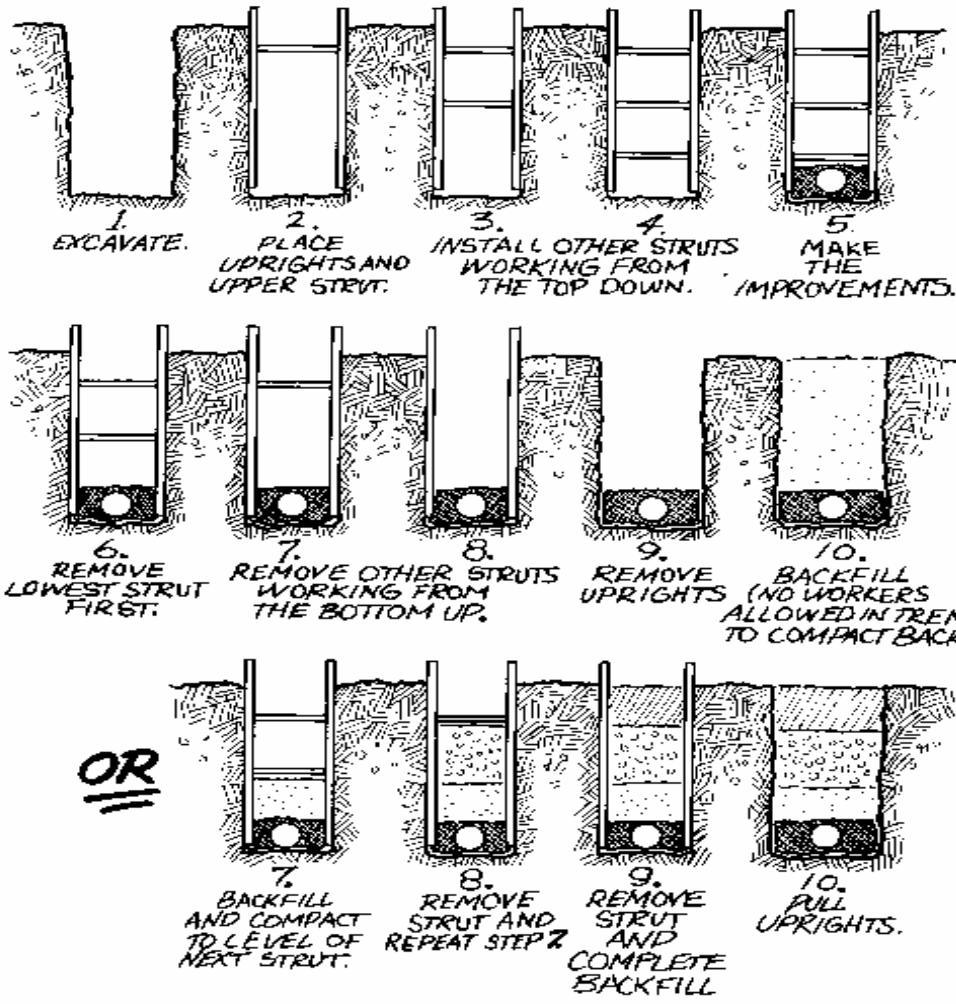
If there is undue pressure felt when removing a strut or jack, it means that the soil has moved and the trench must be backfill led up to the bottom jack before it is removed; then up to the next jack and so forth. Remember, do not try to remove a jack with undue pressure! as it may cause a sudden collapse.

It is preferable to have the worker who installed the struts to be the one who removes them. That worker will know if there has been a change in conditions, undue pressure on struts or other potentially dangerous conditions.

PROPER SHORING PROCEDURE



SEQUENCE FOR THE INSTALLATION AND REMOVAL OF SHORING



F. TRENCH CAGES

A trench cage is a self-contained steel structure placed in an excavation (prior to a worker entering) that is designed to withstand soil pressures and protect the worker(s) against soil cave-ins.

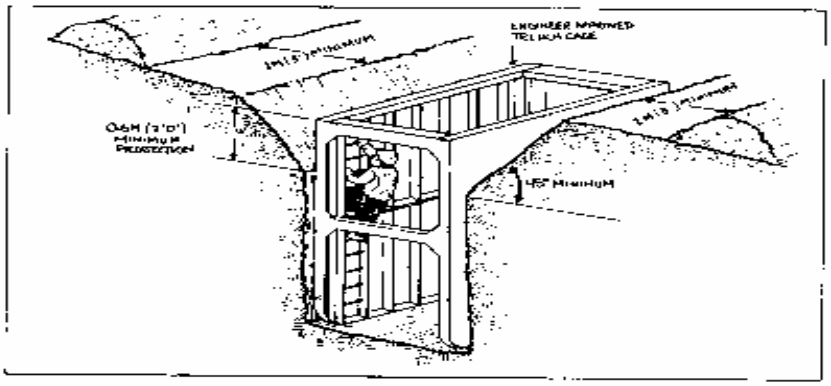
Trench cages **must** be designed by a professional engineer and constructed inspected and maintained in accordance with the engineering specifications. The design criteria for a trench cage is normally based on 75 pounds per square foot of earth pressure, per foot of depth of the excavation.

Where trench cages are designed to be "stacked" in deep excavations, these must be secured in a manner to transmit the loading condition between cages.

Trench cages shall have continuous sides and extend at least 600 mm (24 inches) above the vertical wall of the excavation.

Hoisting hook-up and drag points on trench cages must be designed and engineer approved. Workers working in a trench cage that is to be dragged forward, must be protected against rigging failure by suitable protective screening or other means.

NO WORKER IS TO WORK OUTSIDE THE PROTECTION OF THE TRENCH CAGE!



G. HYDRAULIC/PNEUMATIC SHORING SYSTEMS

Hydraulic and pneumatic shoring systems are advantageous because a worker does not have to enter the excavation in order to put the supports in place. These systems are often made of lighter weight material such as aluminum and can be handled easily. Care must be taken to ensure that the systems are property maintained and not damaged when in use.

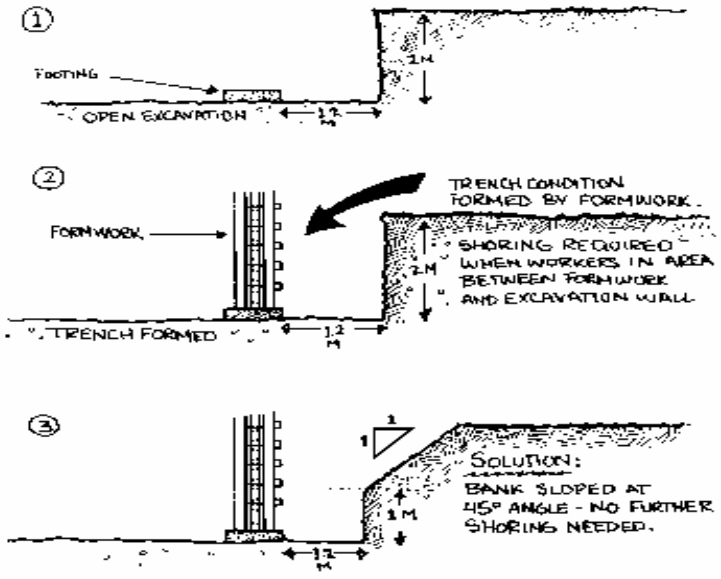
Hydraulic and pneumatic shoring systems must be certified by a professional engineer to be equivalent to the requirements as specified in the trench shoring tables for the particular soil conditions.

2. OPEN EXCAVATIONS

Excavations that are **not** considered to be trenches, caissons, shafts, or tunnels may be classified as open excavations. A basement or foundation excavation for a building or structure is a good example of an open excavation. If an open excavation exceeds 2.4 metres (8 feet) in depth, then the walls of the excavation must be vee'd-out or a shoring support structure designed and installed.

A shoring support structure for an open excavation must be designed by a professional engineer. Typical structures consist of heavy wood lagging supported by steel I-beams properly installed into the foundation. The engineering specifications must include complete details on the correct procedures to install the support structure and on-going inspection criteria to ensure the shoring is maintained in a safe condition.

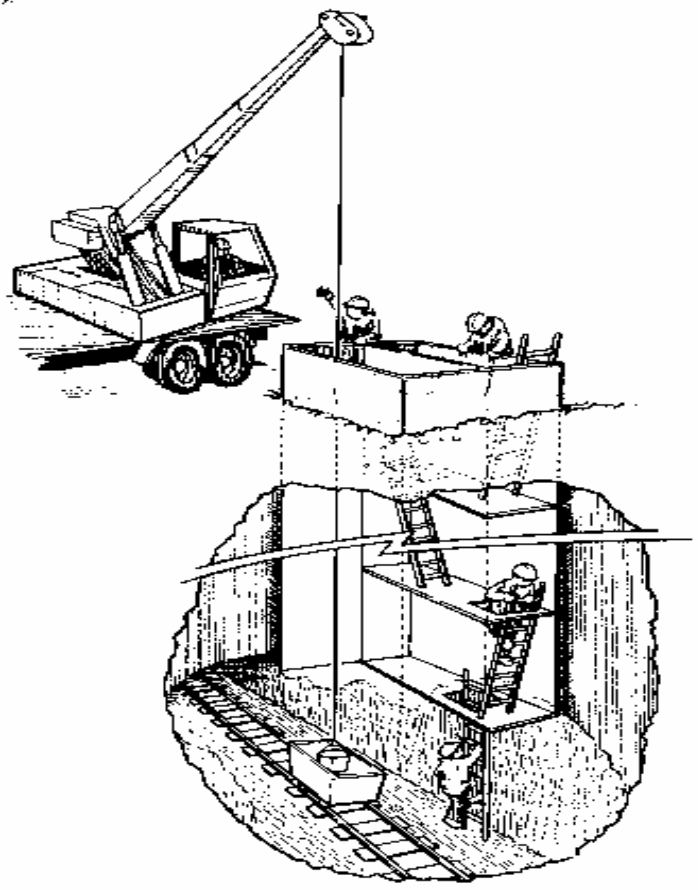
BE AWARE! An open excavation may become a trench excavation as the project proceeds. A concrete basement wall constructed in an open excavation 2.0 metres (6.6 feet) deep, now requires shoring or vee'ing out if workers are required to work on the outside wall between the concrete and earth.



PART VI

SHAFT AND TUNNEL EXCAVATIONS

Shaft and tunnel excavations are used primarily in sewer, water, and other utility work and include such procedures as vertical circular shafts, "hand" tunneling operations and fully mechanized excavating systems ("moles").



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1. GENERAL REQUIREMENTS

The requirements outlined in Part III and Part IV of this guideline apply to shaft and tunnel excavations. It is especially important to ensure that the following requirements are actioned.

A. CONFINED ENTRY

Shaft and tunnel excavations are to be considered confined entry situations and a hazard assessment and risk control analysis must be undertaken.

Where monitoring of hazardous atmospheres is required, the job site supervisor must be equipped with suitable testing equipment (i.e. explosive meter, oxygen, and toxic gas detectors) and be trained in proper monitoring procedures. It is recommended that continuous monitoring devices be used where monitoring is necessary.

Ventilation systems must be put in place to provide a safe atmosphere where there may be a lack of oxygen or unsafe accumulations of toxic vapours, gases, dusts, or other harmful substances.

The ventilation rate at the work face of the tunnel shall not be less than 2.75 cubic metre/second per square metre of face area (50 cubic feet/minute per square foot of face area).

B. FIRST AID FACILITIES/EMERGENCY PROCEDURES

Due to the nature of the work, it is important that proper first aid supplies be provided at the excavation work-site. A first aid kit shall be provided at each shaft location. It is recommended that at least one worker on each shift shall be a certified first aider with CPR training. A basket stretcher and blankets must also be provided at each work-site, as well as a "parachute-type" full body harness for hoisting a worker to the surface, if necessary.

Workers shall be instructed on rescue procedures to be undertaken in case of a serious accident or injury occurring in a shaft or tunnel.

C. SANITARY FACILITIES

The wash-up facilities at excavation work-sites must be kept in a sanitary condition. Provisions must be made to provide a supply of clean and warm running water, hand cleaners, soap, and towels for the workers to use.

D. LIGHTING/ELECTRICAL INSTALLATIONS

Underground excavations must be provided with a source of electrical illumination for the full length of the tunnel and at the working face of the tunnel excavation [minimum 25 lux (2.5 foot-candles) of illumination]. In the event of electrical failure, an emergency lighting system must be in place.
This may consist of battery operated flashlights suitably sized and located to assist workers in exiting the tunnels.

All electrical circuits in underground excavations must be installed in accordance with the Manitoba Electrical Code. Light bulbs shall be caged to protect them from physical damage. Due to the moisture accumulations in such excavations, it is essential that electrical wiring systems be properly grounded. Only electrical equipment and tools that are doubly insulated or

properly grounded can be used. It is recommended that GFCI's (Ground Fault Circuit Interrupters) he used for electrical circuits underground.

E. FIRE PROTECTION

A minimum of two, 2A-1OBC rated multi-purpose type fire extinguishers shall be provided in each shaft and tunnel excavation. Any flammable or combustible liquids must be stored in compliance with the Manitoba Fire Code and dispensed only from safety containers meeting the requirements of CSA Standard B376, "Portable Containers for Gasoline and other Petroleum Fuels."

Combustible scrap materials such as wood shoring components, shall not be allowed to accumulate in the excavation. These shall be removed at least daily.

F. USE OF EXPLOSIVES

All blasting operations must be undertaken by a certified blaster who is qualified to handle and use explosives. Explosives must be stored and transported in accordance with both Transport Canada and Energy Mines and Resources Canada regulations.

G. ACCESS/EGRESS

i. Vertical Circular Shafts

Vertical drilled shafts, shored with steel sleeves, are normally provided access by a straight fixed vertical ladder. Where the ladder exceeds 5 metres (15 feet) in length a rest platform or proper fall protection must be provided. This can be done by providing a worker with a full-body safety harness secured with a lifeline to a fall- arresting device.

ii. Shafts with Hoist ways

In shaft and tunnel operations, the worker access way to a shaft must extend the full length of the shaft and be completely separated from the hoist way in a manner so that the load or hoisting device cannot come in contact with the workers. The access way must he equipped with a vertical ladder having rungs spaced at 300 mm (12 inches) on centre with a clear space of 150 mm behind each rung, and rest platforms (landings) located every 5 metres (15 feet).

Both access ways and hoist ways shall be provided at the surface with proper guardrails having a top rail, mid-rail and toe board. The access way must have a secured cover to prevent unauthorized entry and the cover is to be locked at all times when not in use.

2. SHORING

All shafts and tunnel support structures shall be designed and approved by a professional engineer in accordance with the provisions of Part III and Part IV.

2. SHAFT AND TUNNEL OPERATIONS

A shaft that is to be excavated to a depth of 1.8 metres (6 feet) or more shall have shoring installed continuously from 300 mm (12 inches) above the surface of the excavation to the bottom of the shaft.

Soil shall not be exposed in lifts greater than 1.8 metres (6 feet) where workers may enter, without the immediate installation of proper shoring.

Subject to confirmation by a professional engineer, vertical shoring must be equivalent to full 75 mm x 200 mm (3" x 8") close shored timbers supported by 200 mm x 200 mm (8" x 8") horizontal wales [maximum 2.5 metres (8 feet) span not more than 1.8 metres (6 feet) on center and posted at the corners. For spans greater than 2.5 metres (8 feet), the wales must be increased in size in accordance with engineering specifications.

Subject to confirmation by a professional engineer, crown shoring shall not be less than full 75 mm x 200 mm (3" x 8") timbers that extend from the 10 o'clock position around the roof to the 2 o'clock position. The shoring shall be put in place as digging proceeds and as soon as possible after the "monkey hole" has been excavated. Planks shall be fully over lapped at connection points. [75 mm (3") minimum]

Crown shoring shall extend a maximum of 900 mm (3 feet) beyond the concrete framing for the next "push". The maximum length for crown shoring is 3.0 metres (10 feet) under stable soil conditions.

"Face" shoring is to be installed in all tunnels greater than 1.8 metres (6 feet) in diameter and in tunnels at a lesser diameter where soil conditions may be unstable.

B. VERTICAL CIRCULAR SHAFTS

Steel sleeves are often used to shore vertical drilled circular shafts in cohesive soils. The sleeves are usually made from unreinforced steel plate and have proved to successfully prevent local "cave-ins" of blocks of soil and wet silt layers. Subject to confirmation by a professional engineer, the following minimum criteria apply;

i. The steel sleeves must be in good condition, circular in shape when standing upright, and the plates should have no cracks, bends, or buckles.

ii. The shaft must be drilled, and its diameter should not be more than 50 mm (2") greater than the outside diameter of the sleeve.

iii. The sleeve plate thickness should not be less than 10 mm (3/8").

iv. For shafts up to 2.4 m (8 feet) in diameter, adjoining sections of sleeves may be of the same diameter, simply butted at the joints. For holes greater than 2.4 m (8 feet) in diameter, sleeve sections should be of varying diameter, allowing successively lower

sections to be placed inside upper sections in the manner of a telescope. Sections of sleeves should have a minimum overlap of 300 mm (1 foot).

v. The drilling of shafts and installation of sleeves should take place on the same day. Holes should not be left unsleeved overnight.

Note: This type of shoring is temporary and should not be utilized for periods longer than 30 days and should not be used for holes larger in diameter than 4.5 m (15 feet).

C. HOISTING OPERATIONS

All cranes and hoisting equipment used for excavation work shall be inspected and maintained in accordance with the manufacturer's maintenance procedures. Records of such inspection and maintenance shall be kept in a crane log book.

All ropes, cables, chains, blocks, and other hoisting equipment shall be rated as hoisting equipment and regularly inspected to ensure that the equipment is not damaged and can continue to be used safely.

The employer shall establish a system of clearly communicated signals which shall be used for all hoisting operations. Workers appointed by the employer and trained in proper hoisting procedures shall be located at both the top and bottom of a shaft at all times hoisting operations are to be undertaken.

D. HAULAGE EQUIPMENT

A motorized locomotive with an internal combustion engine must be equipped with a properly maintained exhaust conditioner and serviced regularly in order to control hazardous exhaust gases and other emissions (i.e. carbon monoxide, nitrogen oxides).

All haulage locomotives must be equipped with properly maintained braking systems and operator "dead-man" power controls that are operational from the driver's station only. The locomotive must also have an audible horn and warning lights.

No workers shall ride on haulage locomotives, except in seats provided for that purpose. A worker may only ride in a vehicle designed specifically for the transportation of workers. Workers are not allowed to ride in a haulage bucket that is being hoisted to the surface in a shaft.

Haulage buckets shall not be overloaded with mud in a manner where the material is likely to fall out of the bucket.

It is important that rail track placed for haulage locomotives and buckets is constructed in a straight manner, located at a uniform height to the established tunnel grade, and securely fastened to the foundation ties.

PART VII
CAISSON EXCAVATIONS

1. GENERAL REQUIREMENTS

SAFE WORK PROCEDURES

Due to the nature of the risks involved in a worker entering a caisson or similar type of deep foundation excavation, it is essential that the employer develop a documented safe work procedure for this type of confined entry work. A documented method of access and egress for a worker is to be available at the work-site prior to a worker entering the excavation.

It is also essential that the excavation be under constant supervision at all times when a worker is in the caisson. An "observer" must be at the surface near the top opening at all times when a worker is in the caisson

B. CONFINED ENTRY SITUATION

The principles established in Part III and IV of this guideline regarding confined entry apply to caisson excavations. Procedures must be developed to deal with a number of potential hazards. The risk assessment must include, but may not be limited, to the following:

i. the presence of toxic gases, vapours, fumes, or other hazardous materials that maybe in the excavation;

ii. the lack of oxygen;

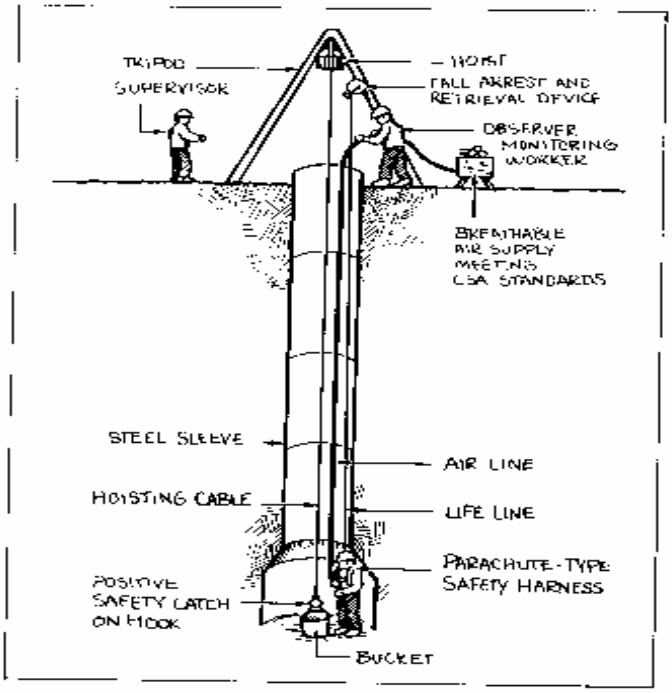
iii. the restrictive dimensions (size) of the excavation; and

iv. the hoisting of materials and workers in a confined space.

A sufficient supply of air suitable for breathing must be provided in a caisson excavation. This is normally provided through a proper piping system from the surface to the working level. An adequate supply of uncontaminated breathable air must be provided throughout the period a worker is working in the excavation. Continuous electronic monitoring of the oxygen content of the air in a caisson must be undertaken prior to a worker entering the excavation and during the time the worker is in the caisson.

Where it is suspected that poisonous or flammable gases may exist in the caisson, continuous testing must also be undertaken.

Precautions must be taken to ensure that exhaust gases from the compressor or other internal combustion engines nearby do not enter the excavation.



2. SHORING SUPPORT STRUCTURE

A. ENGINEERING APPROVAL

The shoring support structure for a caisson excavation must be approved by a professional engineer, prior to a worker entering such an excavation. Steel sleeves of approved dimensions and material are normally used to shore a caisson.

B. DESIGN

The minimum diameter of a shoring support structure in a caisson is 700 mm (28 inches).

The shoring support structure must extend a minimum of 600 mm (2 feet) above ground level to the point where work is to be undertaken.

3 ACCESS/EGRESS TO THE EXCAVATION

HOISTING DEVICE

A worker entering a caisson excavation must be secured to a tripod-type hoist or similar device that is approved by a professional engineer. The tripod hoist must be of a sufficient height to raise the worker completely above the surface of the caisson.

The worker retrieval and fall-arrest device is separate from the "mud bucket hoist and must be capable of supporting a worker with a 4 to 1 factor of safety. The device must be equipped with an adequate braking mechanism capable of arresting the fall of a worker with the same factor of

safety. The retrieval system shall be capable of bringing the worker to the surface of the excavation in 2-1/2 minutes or less.

B. HOISTING COMPONENTS

All cables, hooks, shackles, and other components shall be rated by the manufacturer as hoisting components having a 10:1 safety factor. They shall be inspected on a regular basis to ensure that they are not damaged.

The correct number and spacing of wire clips and thimbles must be used when rigging hoisting components.

All hooks must be equipped with a positively secured safety latch. Simple spring-type safety latches that cannot be secured in a closed position are not acceptable.

C. PERSONAL PROTECTIVE EQUIPMENT

A worker entering a caisson must wear a full-body safety harness attached to an approved lifeline that is secured to a fall-arresting retrieval device located at the surface of the excavation.

The worker must wear CSA approved footwear and headwear at all times. Safety eyewear and other job-specific protective equipment may also be necessary.