What is a Code of Practice?

The term 'Code of Practice' has a particular meaning under the Victorian Occupational Health and Safety Act 1985. Other Codes of Practice, such as the advisory codes developed by the National Occupational Health and Safety Commission, voluntary codes agreed in an industry, or codes adopted by other states or countries do not come within the meaning of the term used in the Victorian Act.

Codes of Practice are developed by the Victorian Occupational Health and Safety Commission with assistance from the Department of Labour.

The Commission is made up of employer, union, expert and government representatives. The Commission recommends the Code of Practice to the Minister for Labour for approval after a period of public review of the draft, and consideration of any comment received.

The Victorian Occupational Health and Safety Act 1985 provides for Codes of Practice "for the purpose of providing practical guidance to employers, self- employed persons and employees,..." (S.55[1]).

A Code of Practice approved by the Minister for Labour comes into effect when "notice of approval is published in the Government Gazette or on such later day as may be specified in the notice,..." (S.55[6]).

A Code of Practice does not have the same legal force as Regulations. Contravention of, or failure to comply with, Regulations made under the Act is an Offence (S.47[l]). Failure to observe a provision of an approved Code of Practice is not in itself a breach of the Act (S.55[8]).

However, in proceedings under the Act, where it is alleged that a person contravened or failed to comply with a provision of the Act or the regulations, a relevant approved Code of Practice is admissible as evidence. The court is required to take the matter as proved unless the person is able to show that compliance with the Act or regulations was achieved in some way other than that provided in the approved Code of Practice (S.56).

A Health and Safety Representative is able to cite an approved Code of Practice in a Provisional Improvement Notice as a means by which the alleged non-compliance may be overcome. Similarly, an Inspector may cite an approved Code of Practice together with the relevant Section of the Act or regulations when issuing an Improvement Notice or Prohibition Notice.

In situations where it is impracticable to comply with the literal provisions of a Code the employer must be able to show that an equivalent or better level of health and safety results from the alternative action taken. In summary, an approved Code of Practice:

- provides practical guidance;
- should be followed, unless there is another solution which achieves the same result, or a better solution;
- is able to be used in support of the Act's preventive enforcement provisions; and
- can be used to support prosecution.

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1. Authority

This Code of Practice is approved pursuant to Section 55 of the Occupational Health and Safety Act l985 (the Act) and shall have effect from September 1st, 1988.

2. Section 21 of the Act requires an employer, among other things, to 'provide and maintain so far as is practicable for employees a working environment that is safe and without risks to health' and "to provide and maintain plant and systems of work that are so far as is practicable safe and without risks to health".

3. Purpose

The purpose of this Code of Practice is to provide practical guidance on measures to be taken to prevent injury to persons engaged in trenching work.

4. Scope

The planning, preparation, and conduct of work practices in connection with the excavation, maintenance and backfilling of trenches.

5. Mines (Trenches) Regulations 1982

Users of this Code of Practice should note that unless specifically exempted any trench more than 1.5 metres in depth in which a pipe or cable is to be laid is subject to the provisions of the Mines Act 1958 and the Mines (Trenches) Regulations 1982.

Those regulations contain provisions relating to the duties and responsibilities of persons in charge of the trenching activities.

Under the Occupational Health and Safety Act 1985 the employer has primary responsibility to "provide and maintain so far as is practicable for employees a working environment that is safe and without risks to health". In acknowledgment of the mandatory requirement for compliance with the Mines (Trenches) Regulations 1982 under the prescribed circumstances, the Code of Practice does not imply any delegation of that primary employer responsibility.

It is important to note that non-compliance with the Mines Act or the Mines (Trenches) Regulations can lead to prosecutions under both the Mines Act 1958 and the Occupational Health and Safety Act 1985.

1. Site Investigations

1.1 Before commencing work, contractors and constructing authorities should obtain as much information as possible about the ground conditions of a work site.

1.2 Source of Information

1.2.1 Natural features such as rock outcrops, water-courses, creeks and swamps should be inspected. The surface drainage system should also be studied in relation to the line of the proposed excavation.

1.2.2 Information on ground conditions may be available from nearby works such as existing railway cuttings, roadways, and foundation works.

1.2.3 Results of any test bores are usually available from the appropriate authorities. When they are not available, unsupported test excavations using a backhoe should be dug in doubtful areas to observe ground conditions and determine suitable ground support systems.

1.3 Factors To Consider

1.3.1 When deciding upon a system of support, the employer in charge of an excavation should consider the following factors:

(a) Nature of the ground:

- soil or rock type;
- moisture content of the rock or soil: is it wet or dry? If dry, will its cohesive characteristics deteriorate when it becomes wet? If wet, will water control be required?;
- water table level;
- faults and bedding planes.

(b) Possibility of flooding from any water source:

- storm water drain;
- surface run-off after heavy rain;
- swamp, dam, reservoir or lake;
- river.

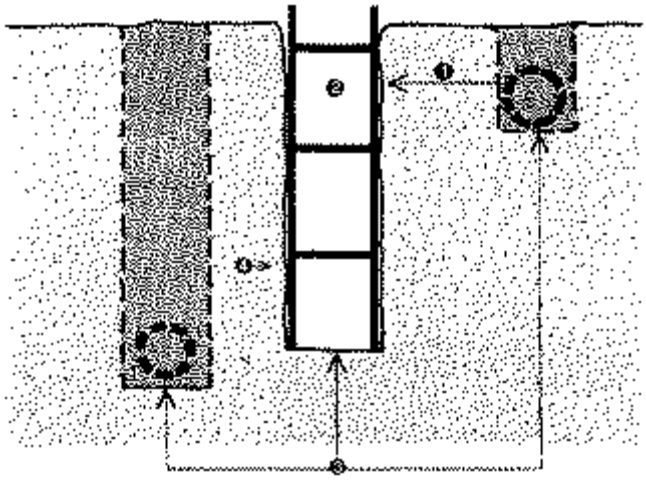
Flooding can be sudden and tragic, so precautions should be taken, which could include drainage run-off control and availability of pumps on site.

(c) Proximity of underground services such as gas, electricity, sewer, water mains or telephone cables. Enquires should be made to the appropriate authority in regard to location of services prior to excavation, or refer to the booklet "Dial Before You Dig" obtainable from the Local Government Department on 602 9411. Previously dug excavations have a weakening effect on a trench wall if they are in close proximity, close sheeting may therefore be necessary. (See Figure 1.)

(d) Point sources of instability which may require additional local support. Close sheeting should be used in unstable ground, reverting to soldier sets when the excavation has progressed to more stable ground.

(e) Hazards, natural or artificial (Fig. 1):

- intersecting old service excavations;
- telephone and electricity supply poles;
- Manholes and other shafts;
- bends in an excavation;
- leaking services;
- corners created by the joining of pipe systems, ie. "T", "Y", or "+" junctions
- trees;
- the threat to health and safety from the past dumping of chemicals



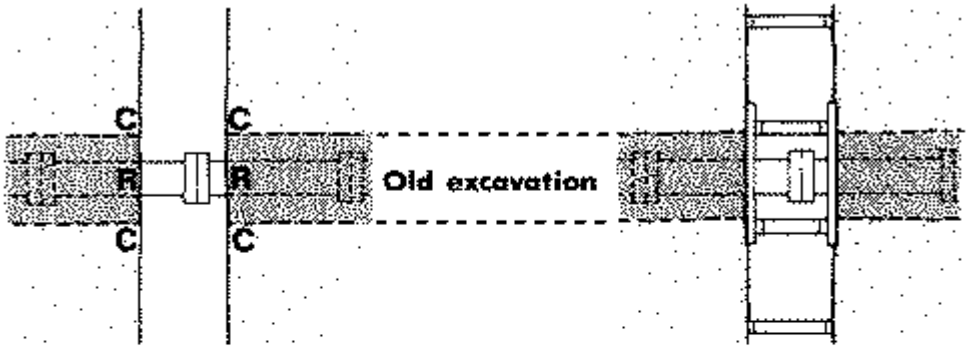
(a) Sectional view of old and new excavation. Old Excavation may be waterlogged or the fill my not have consolidated. Where only a relatively thin wall of undisturbed material separates the two excavations, this barrier may be under increased side pressure and, therefore, more likely to collapse.

1) Side pressure from higher pipe
2) Current open excavation
3) Trench depths may differ
4) Side pressure from thin section of undisturbed wall.

Figure 1

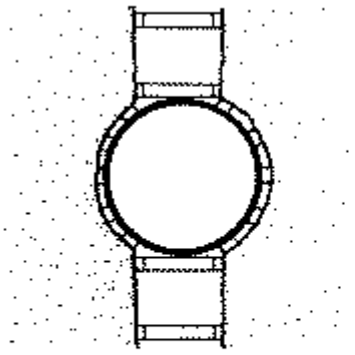
Working Close to Disturbed Ground.

Additional care should be taken where disturbed ground may exist due to previously worked trenches or shafts. In such cases, it is essential to increase the excavation ground supports or use a correctly designed and fabricated shield.

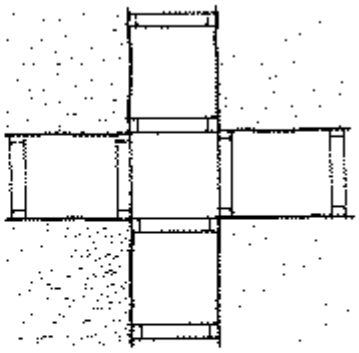


(b) Four separate corners (C) of undisturbed material may be created, and the refill (R) in the older excavation may present a further hazard if the refill is waterlogged or comprised of unconsolidated material. This junction should be close lagged horizontally, or close sheeted vertically.

(c) Correctly located soldier sets, supporting corner of intersection, and the old refill using closed horizontal lagging or closed vertical sheeting.



(d) Correctly located soldier sets, steel rings and shaft timber supporting the weakened area where the trench intersects the shaft.



(e) Correctly positioned soldier sets supporting corner of intersection, preventing its collapse into either excavation.

(f) Static loads near an excavation, including:

- the spoil pile;
- an excavation in wet clay, 3.0 metres deep by 1.0 metre wide, will create a spoil pile having a mass of approximately 6 tonnes per metre of excavation. This must be considered when designing a support system if the spoil pile is located near the trench (see Section 7, Cohesive Strength and Earth Pressures);
- buildings, including garages and outbuildings;
- water tanks or towers;
- brick or stone walls;
- embankments;
- dams.

In case of static loads nearby, additional timber supports should be installed.

(g) Dynamic loads near an excavation, such as:

- traffic (highway and rail);
- excavation equipment.

(h) Ground vibration. Occasionally, the collapse of a trench is caused nor by dynamic loads but by the accompanying ground vibration. Such vibration may come from:

- heavy traffic;
- rail stock passing close to an excavation;
- excavation machinery;
- construction works in the immediate vicinity (eg. pile driving);
- explosives use.

1.3.2 The hazards of working close to previously disturbed ground are considerably increased when the ground is either very wet or very dry. Under these conditions it may be necessary to use sheet piling or employ a shield or cage to ensure safe working conditions.

1.4 Better Safe Than Sorry

1.4.1 Where the trenching work is at a remote location effective means of communication such as a telephone or two-way radio should be available to call for advice in case of problems or to call for help in emergencies.

1.4.2 In all cases, if there is any uncertainty about the minimum amount of safe trenching support, it is better to play safe and:

- batter the excavation;
- over-design the support;
- obtain competent professional advice.

1.4.3 It will pay in the long run to build extra safety features into the support system rather than to under-design the supports and increase the risk of accidents.

1.5 Excavation Support

1.5.1 After deciding on the most appropriate method of ground support, the employer should ensure that it is installed safely and as soon as practicable. It is important that the support system is installed with the minimum possible delay.

1.5.2 There is a difference between a ground support system and a shield (See Section 6, Ground Support Systems). A ground support system supports the sides of an excavation, preventing collapse and ensuring the safety of workmen. A shield does not always support the ground, but protects workers inside the shield if the wall collapses.

1.5.3 Shields however, can be used as ground support systems. If they are fabricated to the width of the excavator bucket they may be placed in an excavation and pressed down. This provides firm side support, however, it should be emphasised that the only safe section is that which is actually supported by the shield.

1.5.4 All ground support systems, including timbering and shields, should be regularly inspected by the employer directly in charge of an excavation. This is particularly important when an excavation enters different ground conditions or is subjected to heavy rains or flooding. Ground supports should be inspected, repaired and reinforced as necessary.

1.5.5 No ground support should be removed from the section of a trench where persons are working. Ground support systems should only be removed using a predetermined safe method under the direction of a competent person. It is sometimes better to abandon the support material if its removal is dangerous. (Refer Section 6.5.8, Removal).

2. Placing the Spoil Pile

2.1 During excavation the toe of a spoil heap should never be less than 0.5 metres from the edge of the trench to ensure safe access along both sides of a trench. If a trench runs across sloping ground, spoil should be placed on the downhill side of the excavation.

2.2 When a trench is being excavated beside an old service line, spoil should be placed on the side opposite the old line, to prevent excessive loading on previously weakened ground.

2.3 When it is necessary to place spoil close to a trench due to restrictions such as fences, buildings, trees, etc., toe boards in the form of close sheeting could be used. It must be remembered that the weight of a spoil pile may overload the sides of a trench; the supporting system should, therefore, be strengthened at these locations.

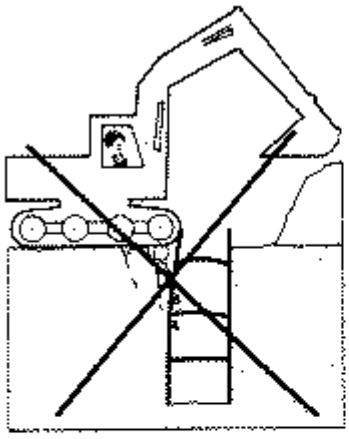
2.4 If a spoil pile is very close to a trench, material on the spoil pile may roll into the excavation. To prevent this, toe boards should protrude at least 300 mm above the toe of the spoil pile.

3. Daily Inspections: What to Watch For

3.1 In the course of daily routine inspections the employer in charge should watch for certain unsafe situations which are common during excavating, pipe laying and backfilling. Surveillance of trench walls and support systems should be carried out frequently to ensure that:

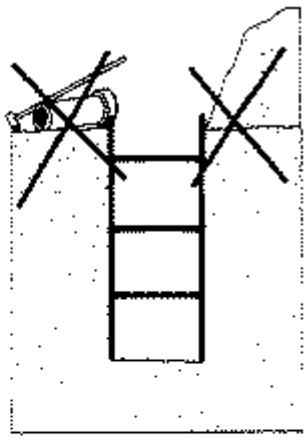
- the trench sides are not being undercut by the excavator bucket;
- the supports are not being overstressed;
- the ground is not fretting or beginning to collapse into the trench;
- tension cracks do not appear along the trench top
- the trench walls do not sag under the increased pressure of the excavator (Fig. 2)

3.2 Pipes, which are to be laid, and equipment for laying pipes (shovels, hunching materials, etc) should be placed away from the top of the trench to ensure that they do not fall in (Fig. 3)



Do not allow machinery close to the edge of an excavation. If this is unavoidable because of buildings or other obstructions, use either a stronger ground support system or a method of excavation other than trenching.

Figure 2.



Do not allow pipes, tools, or a spoil pile too close to a trench.

Figure 3.

3.3 Safety Helmets

3.3.1 It is important for persons in and around trenches to wear safety helmets. The absence of a safety helmet is not only a breach of the Mines (Trenching) Regulations, but a dangerous practice. A falling hammer, weighing only 500 g will hit a worker three metres below in less than a second, with an average impulsive force of 50 kg: enough to cause serious concussion or even death if they are not wearing a safety helmet. The Mines (Trenching) Regulations require all persons on site to wear a safety helmet, whether they are involved in the work directly, inspecting the excavation or simply touring the area.

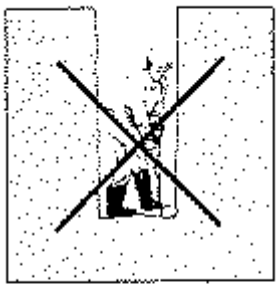
3.4 Treading in Dangerous Ground

3.4.1 Work must never proceed in potentially unstable, unsupported ground (Fig 4). Working without installing supports may appear to hasten the excavation process, but a substantial fall of ground will delay operations, and, if a fall of earth results in the injury or death of a worker, further delays will occur during investigations.

3.4.2 If workers are required to enter a trench before permanent support have been correctly installed (eg. to drill and place explosives), temporary protection in the form of timber supports or shields should be used. These supports are necessary because vibration from drilling equipment may cause the ground to collapses.

3.4.3 Another common and dangerous procedure is the practice of entering an unsupported section of trench to erect or dismantle a ground support system prior to backfilling it is a mistake to believe that trench walls will not collapse during the short time needed to erect or dismantle support. Numerous deaths and injuries have occurred at such times.

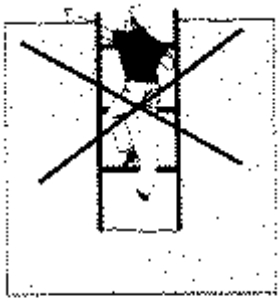
WRONG



In an excavation requiring ground support, workers should not enter an unsupported section.

Figure 4.

WRONG



Do not climb toms. They may not be secure. Use ladders installed no further apart than 30 metres.

Figure 5.

In fact, a trench wall is most insecure when the ground support are being erected and dismantle. During the erection of supports, the trench has just been excavated, and the ability of the trench walls to support the load may be decreasing with time.

There is no guarantee that the trench sides will not collapse at this time. If ground does fall, it may collapse back to the last set; when workers stand in front of this last set they are standing in unsupported ground and are taking a considerable risk.

When a ground support system is being dismantled and the excavation has not been properly backfilled, the trench walls may not withstand the increase in side pressure that was previously borne by the ground supports. This may cause the trench to collapse.

3.5 Use Ladders, not Soldiers

3.5.1 Some workers may be in the habit of using soldiers sets as a means of entering or leaving an excavation (Fig 5). This is an unsafe practice and should be avoided.

3.5.2 When climbing up a soldier set, a worker assumes that all the toms are securely in place and will not shift or pull out, however, there is no guarantee of this. The trench walls may have shifted, thereby loosening the top tom, or the soldier set may have been erected incorrectly. In either case, the worker, when climbing out of the trench, may use a loose tom to lift themselves up and fall back into the trench and be injured. Should the soldier set become damaged and weakened during such an accident, the trench may collapse and cause additional injury.

3.5.3 Access ladders should be provided in all trenches where employees are working.

3.6 Do Not Work Alone

Persons should not work alone in a trench unless there is another person close by who can render aid if necessary. Working alone in a trench is a breach of the Mines (Trenches) Regulations 1982.

4. Danger Signs

4.1 All workers in and around a trench should be continually alert to the following danger signs:

(a) If the top edge of a trench is fretting away and dropping into a trench (Fig. 6) it could create a hazardous situation:

- rocks may fall onto workers below;
- the fretting may indicate that a more serious wall collapse is imminent;
- small material rolling into the trench may cause eye damage.

(b) A slump in the surface near an excavation (Fig. 7) indicates that the wall is subsiding behind the ground support system. Ground subsidence behind the supports is also indicated by:

ground swelling up from the bottom of a trench;
water running into an excavation from the bottom of trench supports or from between sheet piling.

These two indications of subsidence behind ground supports must be investigated to determine whether the trench support system is being undermined. If material is being washed away from behind, the supports will become loose, resulting in an unsupported trench wall which can lead to a serious trench collapse.

(c) Tension cracks opening in the surface ground and running parallel to the sides of a trench.

(d) Support timbers bowing or creaking (Fig. 8).

(e) Intersected joints in the walls of a trench, which create local unsupported wedges.

Danger Signs

Notify the employer in charge prior to taking remedial action if any of these situations are noticed:

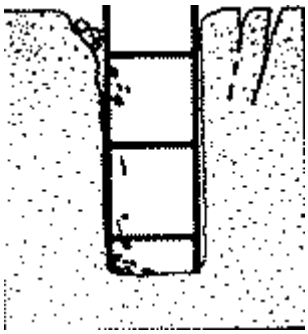


Figure 6
EARTH FRETTING OR BEING WASHED AWAY FROM THE SIDES OF AN EXCAVATION. Tension cracks indicate that the ground support system is shifting under load because it was wither under-designed or incorrectly installed. A collapse may be imminent.

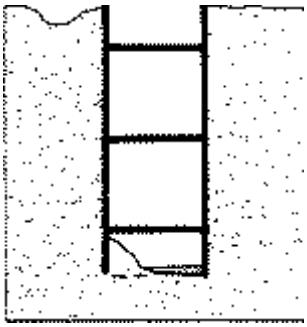


Figure 7
SLUMPING ALONG THE TOP OF A TRENCH. Wat entering a trench may be eroding ground from behind t ground support system. Ground swell along the botton trench may mean that supports are being undermined.

These illustrations are examples of under-designed, unsafe support systems where stability cannot be guaranteed. The systems should either be strengthe or changed.

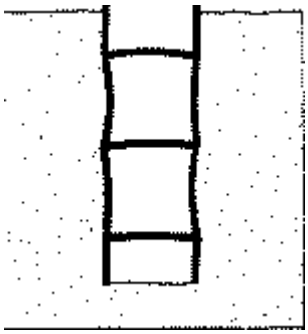


Figure 8
Timber, bowing, deflecting or creaking as a result of swelling ground indicated a weak system which must be strengthened to prevent ground collapse..

5. Battered Excavations

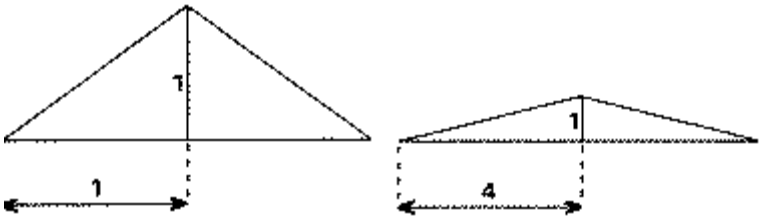
5.1 When shields or a ground support system are not used to support an excavation in unstable ground conditions, the sides should be battered to the angle of repose of the spoil pile.

5.2 If the battered angle is higher than the angle of repose of the spoil pile, a soil mechanics analysis should be undertaken before excavation work commences.

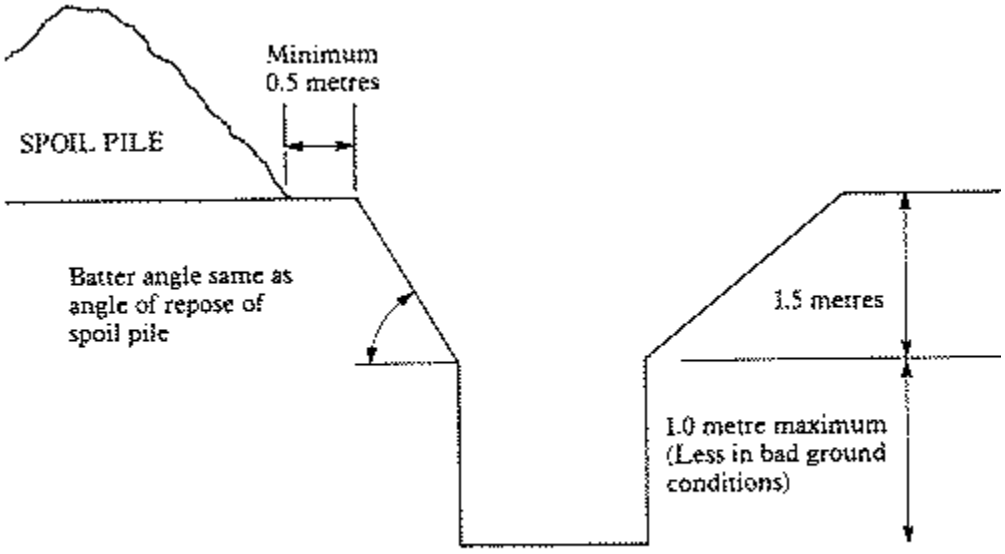
5.3 A mound of loose soil assumes a characteristic shape. The mound has sloping sides which vary for different materials. The angle which a sloping face of loose earth makes with the horizontal is known as the angle of repose. Approximate values of this angle for different materials are:

Clay (dry) 1: 1 Sand (clean) 1.5 : 1
Clay (wet) 4: 1 Rock (decomposed) 1: 1

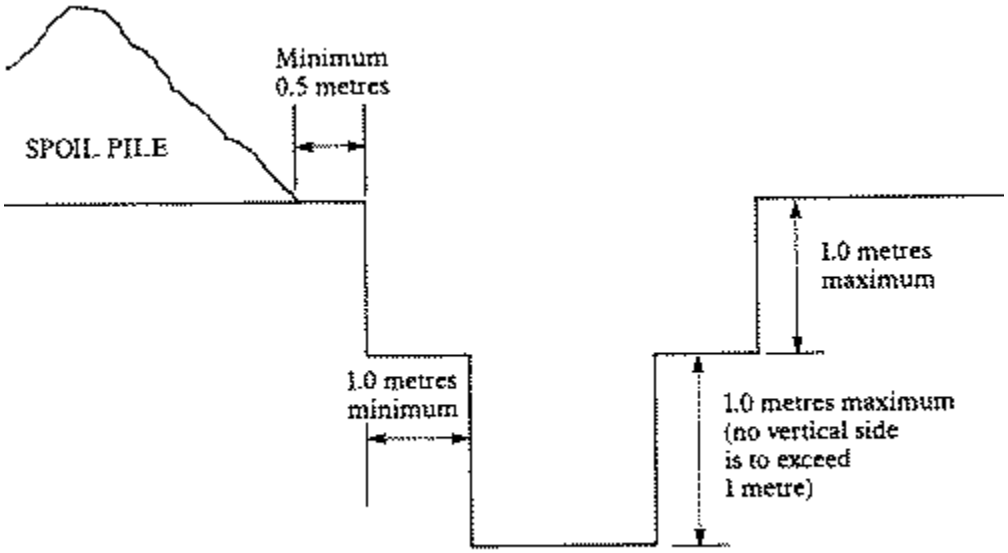
The presence of water has a substantial effect on the angle of repose of any material. The density of different classes of soils only varies from approximately 14 to 19 kN/m^3, but the angle of repose for materials can vary considerably.



Dry Clay Wet Clay



BATTERING THE SIDES OF TRENCHES
EXAMPLE 2.5 METRES DEEP IN STIFF CLAY



STEP BATTERING VERTICAL SIDED TRENCHES
EXAMPLE 2.0 METRES DEEP STIFF CLAY

6. Ground Support Systems

6.1 **Under no circumstances should any person enter an unsupported trench and install toms, working from the bottom up.**

6.2 All ground support equipment should be on site before excavation work commences.

6.3 Three principal types of support system are discussed here:

- Soldier sets 6.5
- Close sheeting 6.6
- Shields 6.7

6.4 Timber used in ground support systems should be hardwood, minimum F8 grade.

6.5 Soldier Set

6.5.1 The most common form of trench support is the timber soldier set (Fig. 9). This system is mostly used in stiff clays and in other soil types having similar properties.

6.5.2 If the excavation is timbered to achieve the required safety level, it should be remembered that the dimensions relating to timber sizes and the positioning of supports which are given here are the **minimum requirements** necessary to support a vertical sided excavation 1.0 metre wide.

6.5.3 When trenching is deeper than 3.5 m, in similar ground, it is necessary to use horizontal members known as walers. This is particularly important when an increase in pressure on the walls of a trench is likely and/or when transverse pressures along the side of a trench occur, ie. when excavating deeper than, but alongside, an older existing service.

6.5.4 A practical extension of this method of ground support is where fretting may occur and timber soldiers sets with plyboard bearer sheets nailed to the soldiers are used. Such a system may need either over-sized toms (ie. 100 mm x l00 mm) or steel jacks (Fig. 10), to support the load,

6.5.5 There are two safe methods of erecting soldier sets.

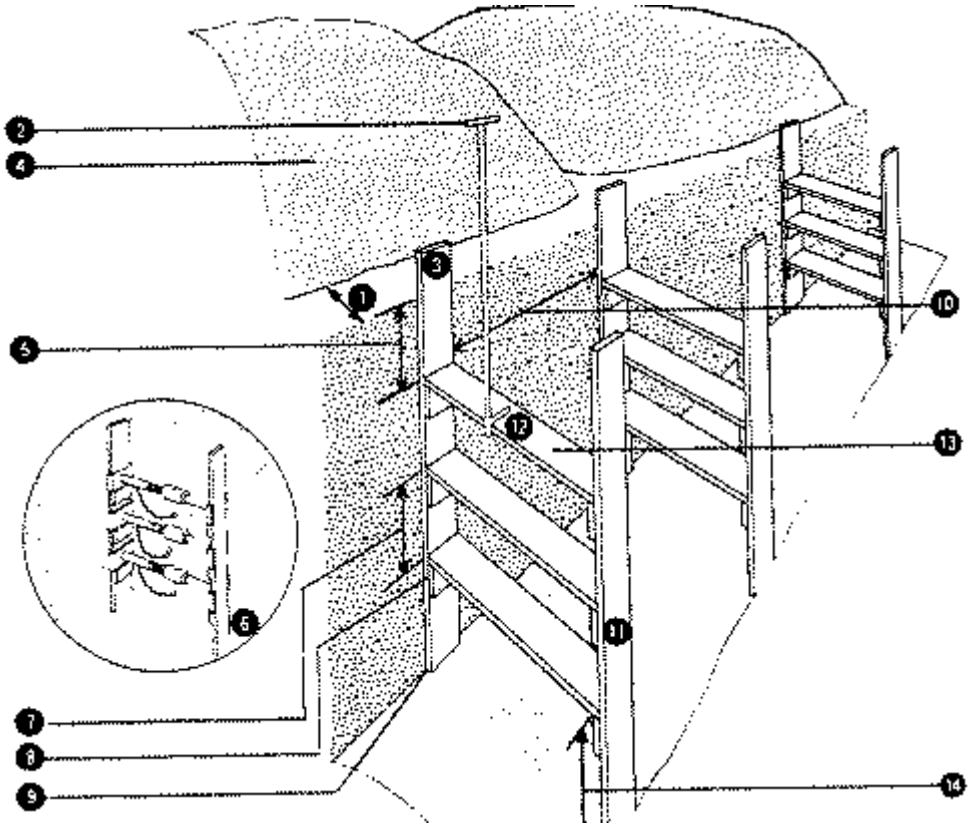
6.5.6 **Method 1: Timber tongs**

The most common method is the use of timber tongs (Fig. 11) as shown in Fig. 9. The following steps should be taken for safe installation of soldier sets with timber tongs.

(a) After measuring the depth of a trench, two soldiers are cut to length. The minimum length of the soldiers should be the depth of the trench plus 500 mm. If the length of the soldiers is the same as the depth of the trench, it is extremely difficult to position them properly during assembly or extract them after backfilling the trench.

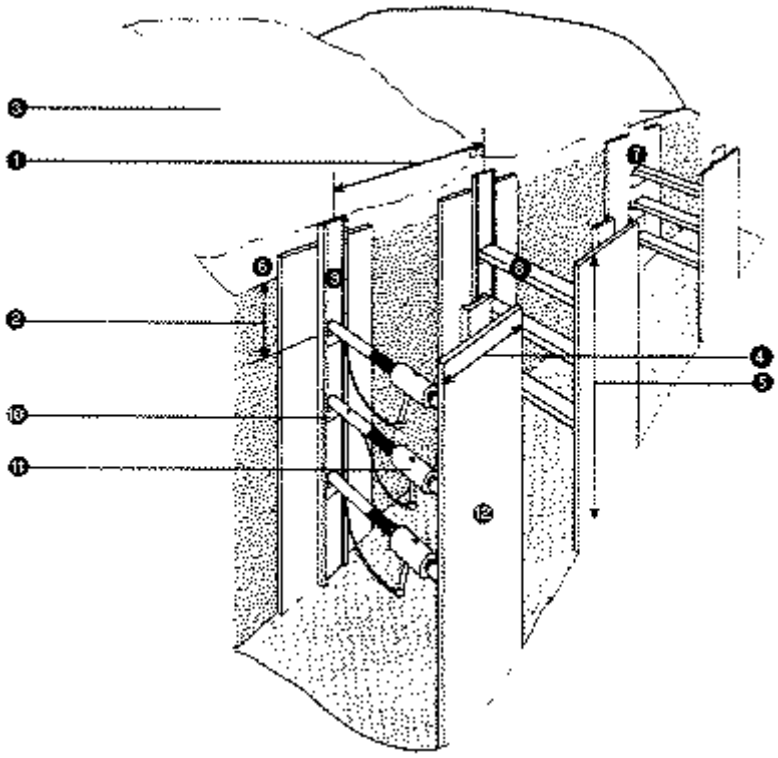
(b) After cutting two soldiers to the correct length, cleats are nailed to them no more than 750 mm apart. The top cleat should be no more than 300 mm below the top of the trench when the soldier is in place; the bottom cleat should be no higher than 1000 mm above the trench floor.

(c) After the cleats have been faced to the soldiers, the width of the trench is measured and the necessary number of toms for that soldier set are cut to length. This ensures that the toms press the soldiers firmly against the excavation walls.



(1) Spoil heap at least 500 mm clear of excavation allows access along both sides of the trench top and prevents material from the heap rolling into the trench.
(2) Toms placed from the surface with special timbering tongs.
(3) Soldiers must protrude 500 mm above the top of the trench.
(4) Spoil heap or pile
(5) Top tom no lower than 300 mm from the trench top.
(6) For added side support, steel jacks may replace timber toms. Maximum spacing of steel jacks to be no more than 1.0m if timber soldiers used.
(7) Maximum spacing of toms no more than 750 mm.
(8) Cleats securely nailed to soldiers before placing soldiers in trench.
(9) Soldier resting securely on trench bottom
(10) Maximum spacing between solider sets 1.50 m.
(11) Soldier, minimum size 150 mm x 38 mm.
(12) Tom, minimum size 150 mm x 39 mm.
(13) Tom should be long enough to force soldiers firmly against trench sides. To prevent excessive bowing of soldiers against irregular trench sides, wood packing, between the trench wall and the solider, may be used.
(14) Space between the bottom tom and trench floor should be sufficient to allow installation of a pipe: nominally, no more than 1000 mm.

Figure 9
TYPICAL USE OF TIMBER SOLDIER SETS IN A TRENCH NO MORE THAN 3.5 m DEEP. This figure shows the minimum support required for a trench being driven through ground of compact, stiff clays, or unweathered, silurian sediments. These support dimensions must be increased in trenches wider than 1.0 metre, or where the supports shows signs of being overloaded.



Plywood panels (sandwich sheets) should be used in variable ground conditions. In unstable ground, the panelling should be continuous (closed sheeting). The panelling and soldiers must be pressed firmly against the trench sides by either expanding the steel jacks - or cutting toms of appropriate length and forcing them in place.

(1) Maximum spacing between soldiers sets, 1.25 mm
(2) Top jack or tom to be no more than 300 mm from the trench top.
(3) Spoil heap or pile
(4) 600 mm (up to 1250 mm)
(5) Depth of trench plus 300 mm
(6) Spoil heap at least 500 mm clear of excavation allows access along both sides of the trench top and prevents material from the heap rolling into the trench.
(7) Timber soldier set, minimum size with plywood sheeting, 150 mm x 38 mm
(8) Timber tom., minimum size, 150 mm x 38 mm
(9) Steel channel soldiers, 150 mm x 50 mm
(10) Steel cleats welded onto soldiers before placement in trench
(11) Steel trench strut replacing wood tom. Spacing between steel jacks should be no more than 1000 mm
(12) Plywood panel of 20 mm minimum thickness, bolted to steel soldiers or nailed to timber soldiers.

Figure 10
TYPICAL USE OF STEEL/TIMBER SOLDIER SETS WITH TIMBER PANELS IN A TRENCH NO MORE THAN 3.5 mm DEEP. This figure shows the different steel/timber soldier set combinations with minimum requirements for shallow trenches.

(d) The two soldiers are placed opposite each other in the trench with the cleats at the same height to ensure the tom will be horizontal. Timber tongs are used to lower the tom into the trench with the lower end of the tom being placed on top of the far side bottom cleat. The upper end of the tom is then placed against the opposite soldier, above the near side bottom cleat. This upper end is finally driven down onto the bottom cleat causing the lower section of the two soldiers to press against the trench.

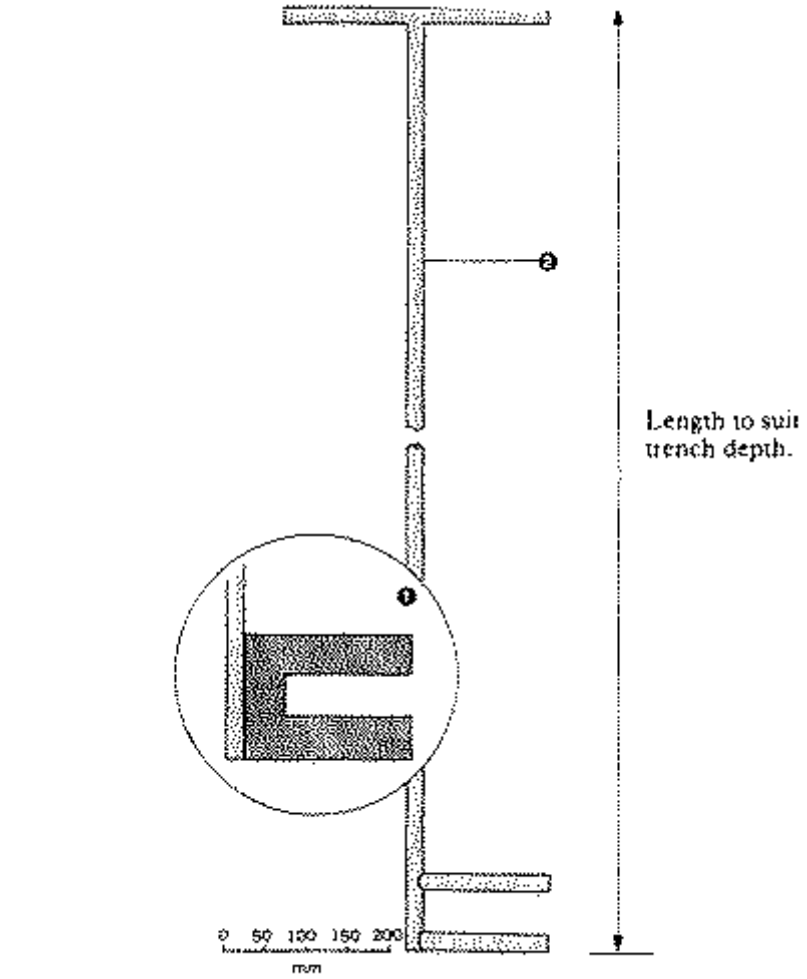


Figure 11
TIMBER TONGS

(e) The fourth step should be repeated for the other cleats, from the bottom up, until the soldier set is complete.

(f) These five steps are repeated for all soldier sets in the trench.

g) The distance between soldier sets, if they are used as the only ground support, should not exceed 1.5 metres; this is the maximum distance between soldier sets in stable soils. If ground conditions are not stable, soldier sets should be placed closer together.

6.5.7 **Method 2: Hydraulic support systems.**

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6.5.7.1 Due to their relatively high cost, hydraulic support systems are mainly used to provide mobile ground support while soldier sets are being installed.

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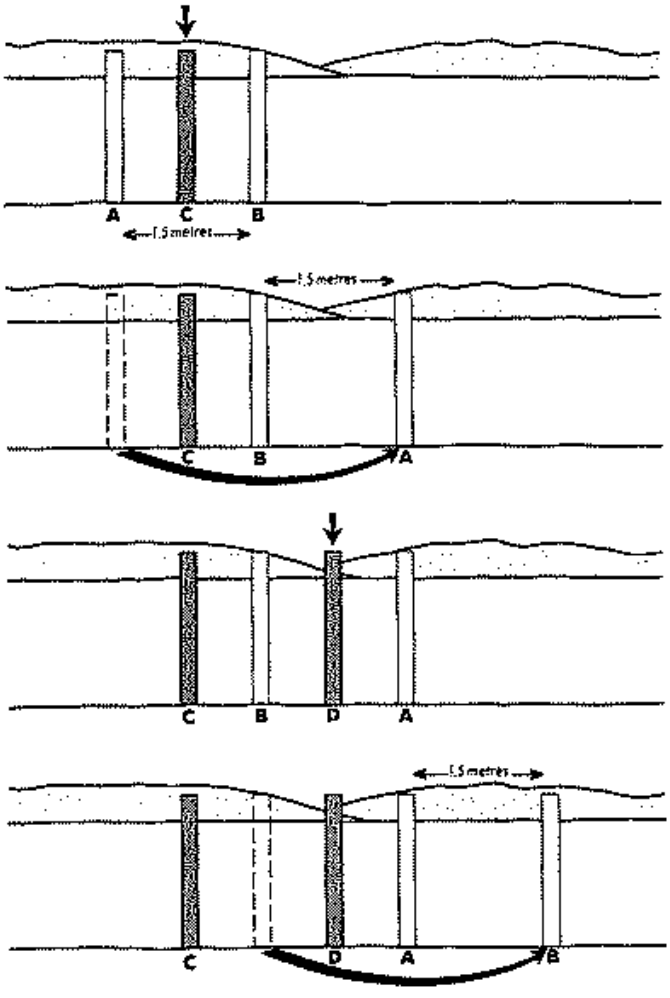
6.5.7.2 It should be noted that these travelling support systems may become unreliable if not properly maintained and properly used. Frequent inspections of pressure hoses and rams are necessary to detect abrasion, fatigue or damage such as buckled or notched rams. Ground pressures should be considered prior to installation of these supports: it is dangerous to rely on a hydraulic support system which is under-designed in relation to the ground pressure. If this situation is likely, ground supports should be doubled.

6.5.7.3 When two hydraulic ground support sets (A and B) are installed no more than 1.5 metres apart (Fig. 12), the area between these sets may be considered to be supported; men may enter this area to erect a timber soldier set (C) midway between sets A and B.



A,B = Travelling hydraulic set.
C,D = Timber soldier Set.

Figure 12.
HOW THE HYDRAULIC SUPPORT SYSTEM WORKS

6.5.7.4 One of the travelling sets (A) may then be removed and placed on the other side of set B, no further than 1.5 metres away. Three ground support sets are then operational in the trench in this order: timber soldier set C, travelling support set B, travelling support set A. The ground between travelling sets B and A is supported and workers may enter this area of excavation to erect another timber soldier set (D) ensuring that the distance between timber sets C and D is no more than 1.5 metres. There are now four ground support sets, in this order: timber soldier set C, travelling support set B, timber soldier set D, and travelling support set A. Travelling support set B may then be lifted out and placed on the other side of travelling support set A, whereupon another timber soldier set may be erected between A and B. This leap-frogging of the two travelling support sets is continued down the length of the trench, leaving behind a timber soldier set each time a travelling support set moves.

6.5.7.5 When a trench has been fully supported by timber soldier sets, the travelling support sets should be dismantled to prevent costly damage. After they have been inspected, the hydraulic supports should be repaired, if necessary, and carefully stored away.

6.5.8 Removal

Removal of sets should also be done from the surface or from a supported area of trench. There are two recommended methods of removal, both of which require workers in the trench during dismantling.

In any event, consideration should be given to compaction of backfill material as the work progresses.

6.5.8.1 Method 1 (Fig. 13)

This is the preferred method. Without entering the excavation, workers push the spoil back into the trench along the entire length so that it is level with the bottom set of toms. They then enter the trench and remove all bottom toms. When they leave the trench, it is backfilled to the next level of toms. The lowest toms are again removed in the same way. This is repeated until all the toms have been recovered, after which it is safe to remove the soldiers by means of back-hoe and chains or lifting lug. Backfilling is then completed.

6.5.8.2 Method 2 (Fig. 14)

With this method, backfilling progresses from one end of the trench to the other: a useful practice when a trench has restricted access.

Backfill is placed in the trench until it begins to run over the bottom tom. A worker then approaches and removes this bottom tom. After the worker has left the trench or has gone behind a complete soldier set, more backfill is added until it reaches the next tom in the set being dismantled; this tom is then removed. The procedure is repeated until all the toms of the set have been recovered. The two soldiers are then removed and the excavation is backfilled until the fill reaches the bottom tom of the next set. The process is repeated along the whole length of the trench.

Method 2 is less satisfactory than Method 1 because the area in front of the set being dismantled has uncompacted spoil to stabilise its walls, and these walls must frequently withstand the additional weight of the excavator which backfills the trench.

The second method is also less efficient because backfill does not extend along the whole length of the trench, from bottom tom to bottom tom. This means that the area of partially unsupported ground around a worker in the trench, is increased after the bottom tom has been removed.

6.6 Closed Sheeting

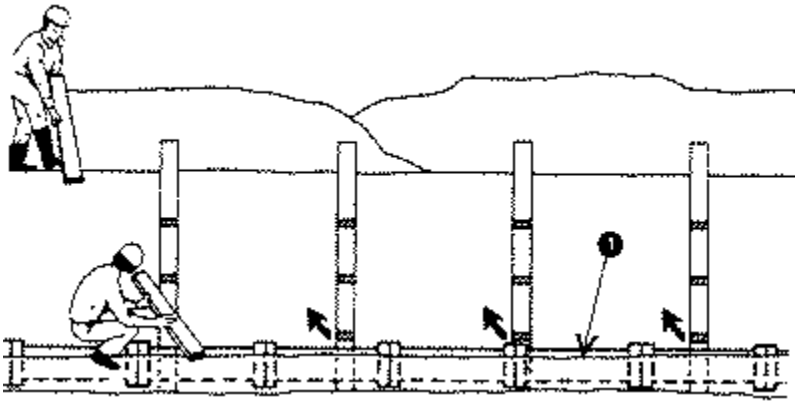
6.6.1 This alternative method of ground support (Fig. 15) is useful when unstable ground conditions (such as wet sand) are encountered, ie. when there is danger of the ground running or collapsing. Walers and toms are installed as soon as practicable during the excavation process. Vertical closed sheeting is then inserted. When using this method of excavation, capping over the toms should extend to the full width of the trench, as these support the timber toms.

6.6.2 Bearers are used to support the collar set of toms and walers. To ensure that walers are correctly located, timbers called 'lacing' are secured to the walers

6.6.3 When unstable ground, such as wet sand or 'greasyback' clay, is being excavated, and the excavation exceeds five metres in depth, it may be necessary to excavate the trench in two stages, upper and lower (Fig. 16). A section of the upper stage being excavated and supported first. The lower section should then be sheet piled, excavated and supported through the interior of the upper support system without damaging the upper system or creating a dangerous situation in the lower level. Considerable expertise is needed to do this properly; a person unpractised in this double support system should obtain expert assistance

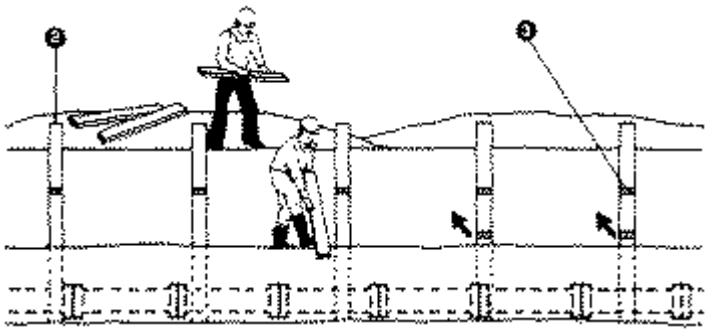
6.6.4 This method of trench support is also slow and costly, requiring great care to ensure the correct degree of support and safety. If a deep trench collapses on a person, the result could be fatal. The method should only be used after consultation which contractors and authorities who have experience in timber close excavations.

6.6.5 The use of steel sheet piling (Fig. 17) is a similar method of trench support, but does not need as much expertise and time as the use of timber close sheeting. However, some skill is still necessary to safely install walers and toms which support the steel piling.



Trench must be filled to the level of the bottom toms before workers can be allowed into the excavation to remove the bottom row of toms.

(1) Backfill must reach the level of the bottom tom.

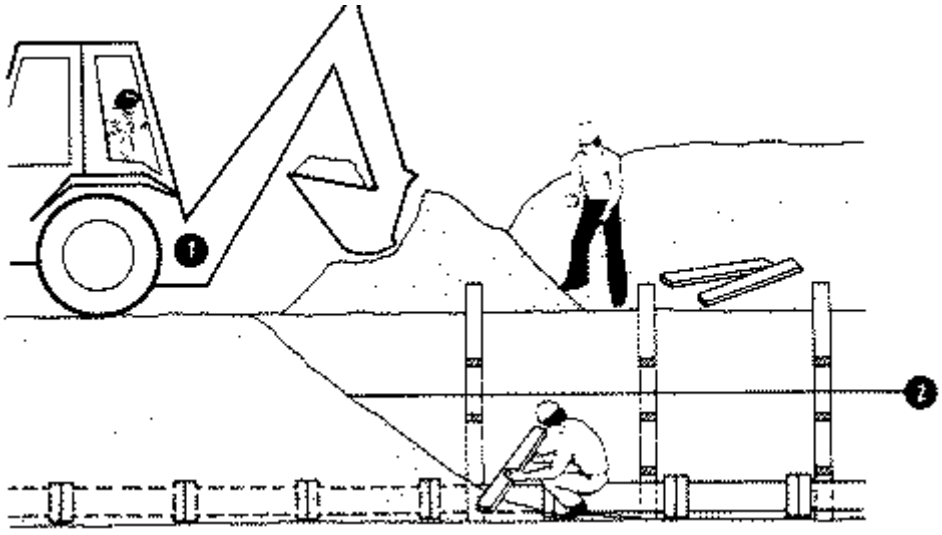


For added side support during the removal process, while workers are still in the trench, the soldiers should be left in place until all the toms have been removed, and then extracted with the backhoe.

(2) Soldiers are pulled out last, after the removal of the top tom.

(3) The top tom is removed from the surface or from the trench after backfill has been placed tot he level of the top tom.

Figure 13.
REMOVING SOLDIER SET GROUND SUPPORTS, METHOD 1



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The trench must be backfilled to the level of the bottom tom before the tom is removed.

(1) A small mobile front end loader should be used for backfilling. Heavy excavators should be avoided as they place an enormous load on the trench walls and cause excessive vibration.

(2) Partially unsupported ground.

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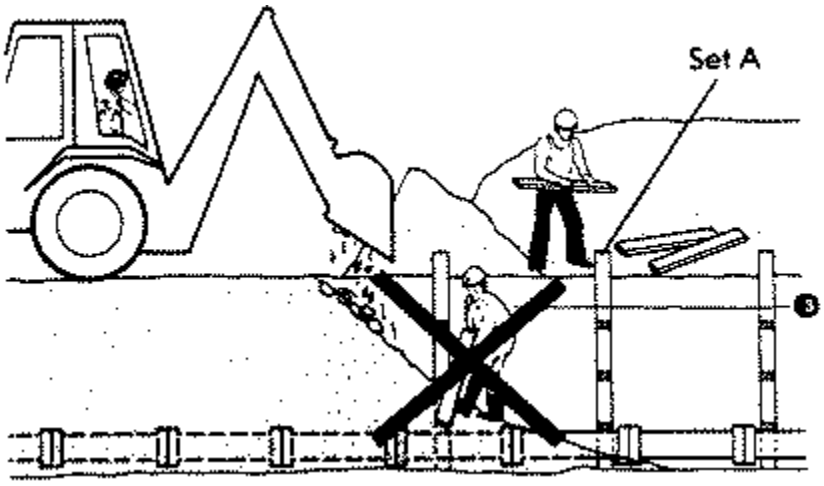

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Since the soldier provides side-support near the set being dismantled, the set should be removed by the excavator only after the trench has been completely backfilled.

(3) The worker is in a dangerous situation. Workers should not be in front of a set A while an excavator is backfilling

Figure 14
REMOVING SOLDIER SET GROUND SUPPORTS, METHOD 2
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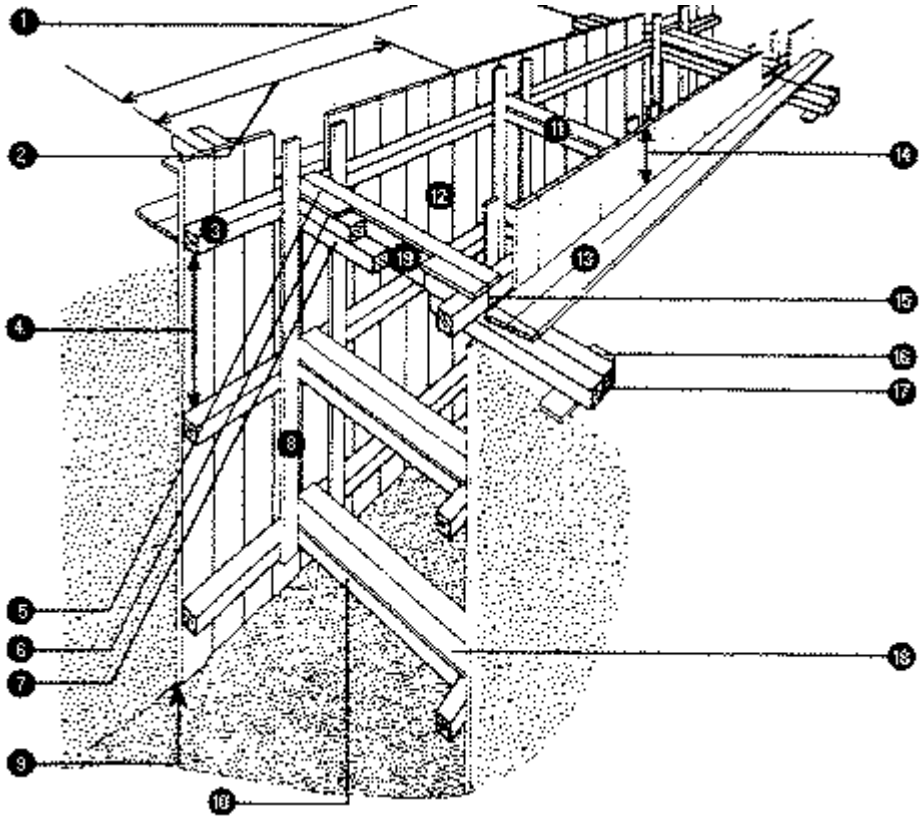
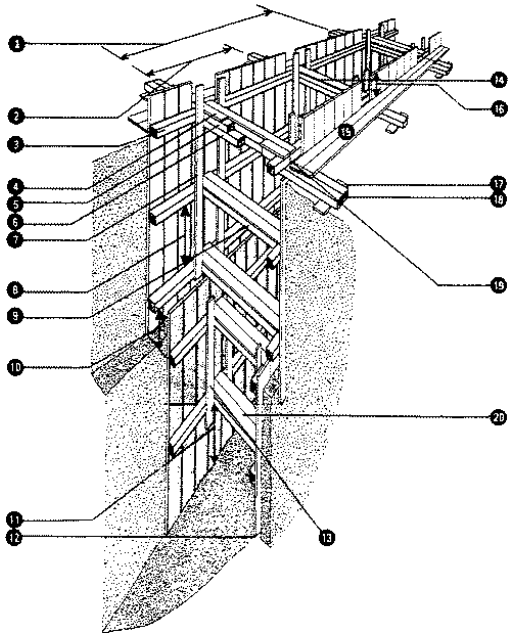


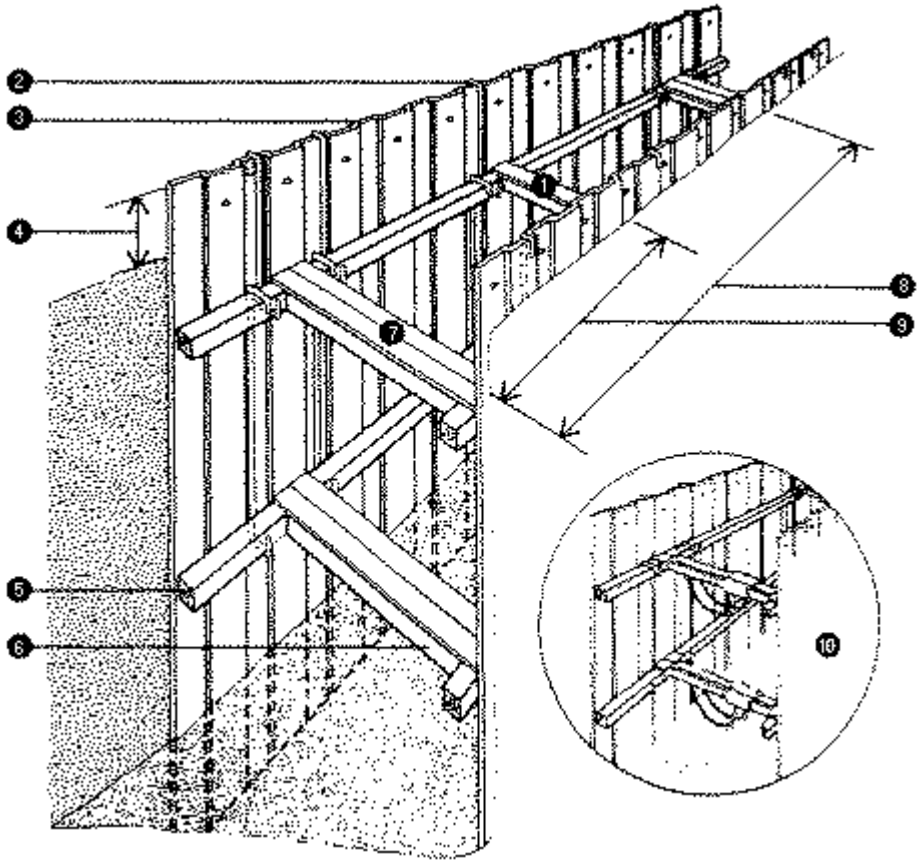
(1) Maximum distance between bearers, 3.5 m
(2) Maximum distance between toms, 1.75 m
(3) Waling minimum size, 100 mm x 100 mm
(4) Maximum spacing between walers, 750 mm
(5) Cap
(6) Tom
(7) Bearer
(8) Lacing to support timber waling minimum size 75 mm x 25 mm
(9) Vertical sheeting driven securely into trench bottom.
10) Twin toms, minimum size 100 mm x 100 mm
(11) Central capped tom
(12) Vertical timber sheeting, minimum size 150 mm x 38 mm
(13) Timber walkway with joins over bearers
(14) minimum height of vertical sheeting above walkways 300 mm
(15) Waling joints over bearers
(16) pressure boards below bearers
(17) Bearers from which all sets are suspended, or on which top set of walings and struts are placed; minimum size 100 mm x 100 mm
(18) Capping over toms and bearers, 100 mm m
(19) Two bearers accompanied by two capped toms should be used to ensure full support of waling joints.

Figure 15
CLOSED SHEETING : VERTICAL TIMBER TRENCH SUPPORT IN LOOSE OR RUNNING GROUND, FOR TRENCHES WITH A MAXIMUM DEPTH OF 5.0 METRES.



(1) Maximum distance between twin bearers, 3.5 m
(2) Maximum distance between toms, 1.75 m
(3) Collar set waling, minimum size, 100 mm x 100 mm
(4) Cap
(5) Tom
(6) Bearer
(7) Lacing to locate timber walings, minimum size 75 mm x 25 mm
(8) Minimum spacing of waling, 750 mm
(9) Twin toms, minimum size, 100 mm x 100mm
(10) Minimum overlap of vertical sheeting, 600 mm
(11) Maximum distance from trench floor to bottom tom, 750 mm
(12) Vertical sheeting driven securely into trench bottom
(13) Ideally, this lower lacing should be replaced with steel bolts
(14) Central capped single bearer with tom
(15) Timber walkway with joints over bearers.
(16) Minimum height of vertical sheeting above walkways, 300 mm
(17) Pressure board below bearers
(18) Bearers support all sets: the top set of walings and struts are placed on bearers, minimum size 100 mm x 100 mm
(19) Waling joints must be over twin bearers
(20) Capping over toms and bearers, 100 mm x 25 mm

F**igure 16.**
DOUBLE VERTICAL SHEETING TIMBERED SUPPORTS IN A TRENCH MORE THAN 5.0 METRES DEEP. This double, vertical sheeted, timbered trench support system requires considerable expertise to safely support a deep excavation. It is recommended only where highly experienced personnel supervise the excavation.



(1) Centre capped single tom

(2) Hanging bar; Minimum diameter, 15 mm mild steel bar

(3) Sheet piling

(4) Minimum height of sheet piling above surface, 300 mm

(5) Walling; minimum size, 3.5 m x 100 mm x 100 mm

(6) Twin toms; minimum size 100 mm x 100 mm

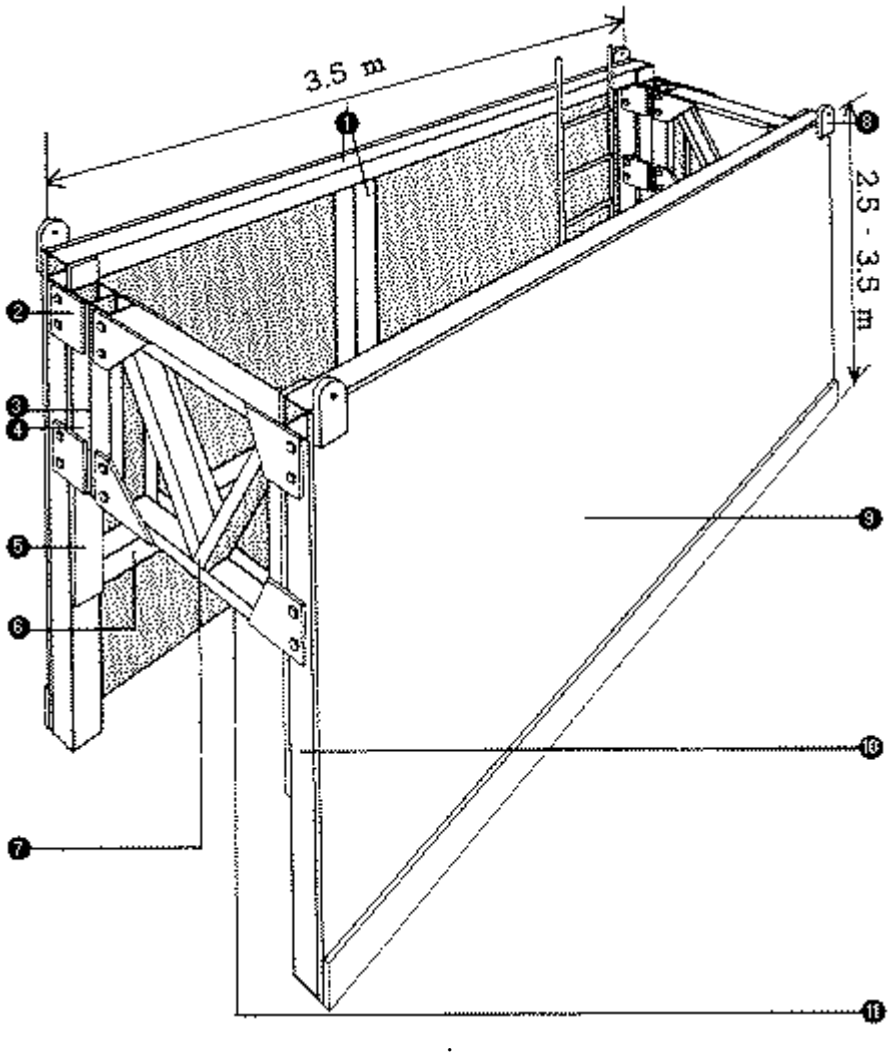
(7) Twin capping; minimum size 100 mm x 25 mm

(8) Maximum distance between twin toms, 3.5 mm

(9) Maximum distance between toms 1.75 m

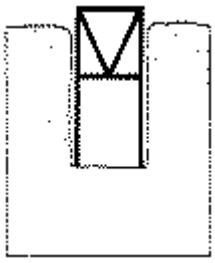
(10) Twin steel jacks should be used where extra strength is required due to heavy loading.

Figure 17
SHEET PILING IN UNSTABLE GROUND. Sheet piling may be used when ground is so unstable that side walls collapses would be likely immediately after excavation, ie. in loose and running sand. In such cases, sheet piling must be carried out before excavating.



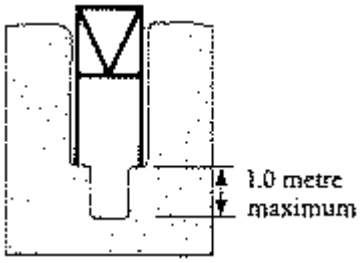
(1) Box section steel frame, 100 mm x 100 mm x 15 mm.
(2) Fixing plates: Minimum size, 15 mm
(3) Fully welded seam
(4) Spacing block welded to cross frame assembly. This extends the width of the shield for use in wider trench systems. Alternatively different size cross frames may be used.
(5) Stiffening for strength
(6) Longitudinal support, 100 mm x 100 mm x 15 mm
(7) Cross frame, 100 mm x 75 mm
(8) Lifting lugs, 25 mm mild steel plate
(9) Side plates, 5 mm mild steel plate.
(10) Legs, 100 mm x 100 mm x 15 mm
(11) Channel construction; this can be fabricated to extend further down the shield legs, depending on shield depth.

Figure 18.
MEDIUM DUTY STEEL SHIELD



The shield is ideal when it rests on the excavation bottom and extends above the surface, giving total protection.

Figure 19.



Alternative method. Trench narrowed and shield supported. When this method is used the shield must be tightly wedged into the trench

Figure 20.

6.7 Shields

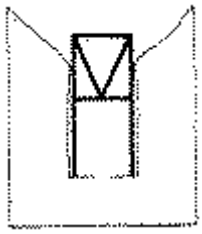
6.7.1 Shields (Fig. 18) are designed to ensure worker safety without actually providing support for the trench sides or preventing the ground from collapsing except where used in the method described in Section 1.5.3. If a trench wall collapses, it does so against the side of the shield, leaving the worker safe inside. Shields are used in all types of ground and are particularly useful where long or large diameter pipes are to be installed and in variable ground conditions where timber supports are difficult to install.

6.7.2 As a minimum requirement a shield should be so designed that it remains intact when impacted and pressured by a fall of ground. It must also be firmly wedged into the ground to prevent it from moving when struck by collapsing ground.

6.7.7 When shields are used as the only means of ensuring safety in the trench, workers should not: –

- enter the excavation prior to the installation of a shield
- work inside a trench, outside the protection of a shield
- enter the excavation after shields have been removed
- enter a shield other than by a ladder.

6.7.8 The design of steel shields should be carried out by professional engineers experienced in the work and using relevant Australian Standards. The installation and removal of shields should be entrusted to experienced crane and backhoe operators, and to crane chasers or dogmen who hold appropriate certificates of competency under the Lifts and Cranes Act. Shields can be used very effectively when joining pipes and also when traversing previously disturbed and unstable ground.



Angle of batter equals angle or repose of the spoil pile. Height of shield above the bottom of the batter should not be less than 0.3 metres.

Figure 21.
SHIELD IN SLOPE BATTERED TRENCH.

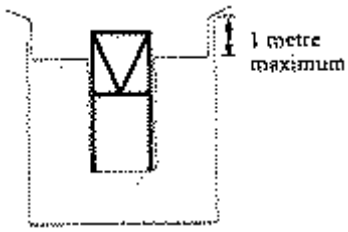


Figure 22
SHIELD IN STEP BATTERED TRENCH

When undersize shields are used, the top of the trench must be stabilised by battering, other wise the sides may collapse, resulting in material spilling over the top of the shield onto workers blow.

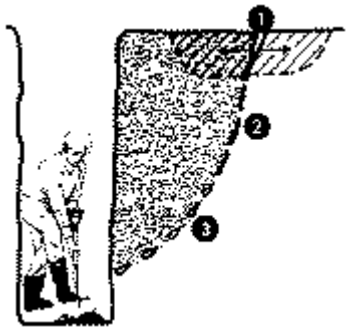
7. Cohesive Strength and Pressure

7.1 In their natural condition, soils have varying degrees of cohesive strength and frictional resistance. Examples of materials with virtually no cohesive strength are dry sand, saturated sand and gravels with minimum clay content.

7.2 Figure 23 shows a typical example of ground failure where a worker is firmly pinned and crushed by the soil, probably causing internal organ damage, back injury or broken bones. These injuries may prove fatal.

7.3 A buried worker is likely to die from suffocation before help arrives, and is in a far more critical situation than a worker suffering only from internal injuries: either the head is buried, or the chest is so restricted by the weight of ground that the worker can no longer breathe.

7.4 Evaluating pressure on a trench wall is a complex matter requiring consideration of a number of factors including soil type, moisture content. effect of spoil pile and adjacent machinery loadings, and should be undertaken only by competent persons experienced in such matters. Other than in the simplest situation of shallow battered trenches, professional advise on the need and application of ground support systems should be sought.



(a) This is a very dangerous situation, requiring ground support. No worker should be in the trench unless support has been installed.

(1) Area of tension, as wall starts to collapse

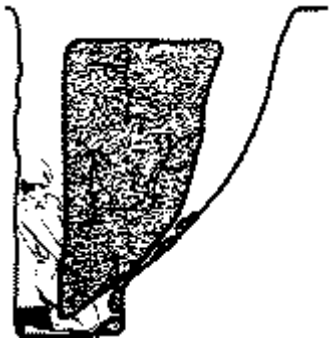
(2) Slipping plane

(3) Seepage along the slippage plane further reduces the stability of the wall.

Water seeping into the excavation, tension cracks on the surface and bulging side walls are all signs of imminent collapse.

(b) Shear plane failure along the seepage (slippage) plane.

Fine rubble or seepage in trench bottom may not be present until the actual collapse.



(c) worker trapped and smashed against the trench wall by quick collapse.

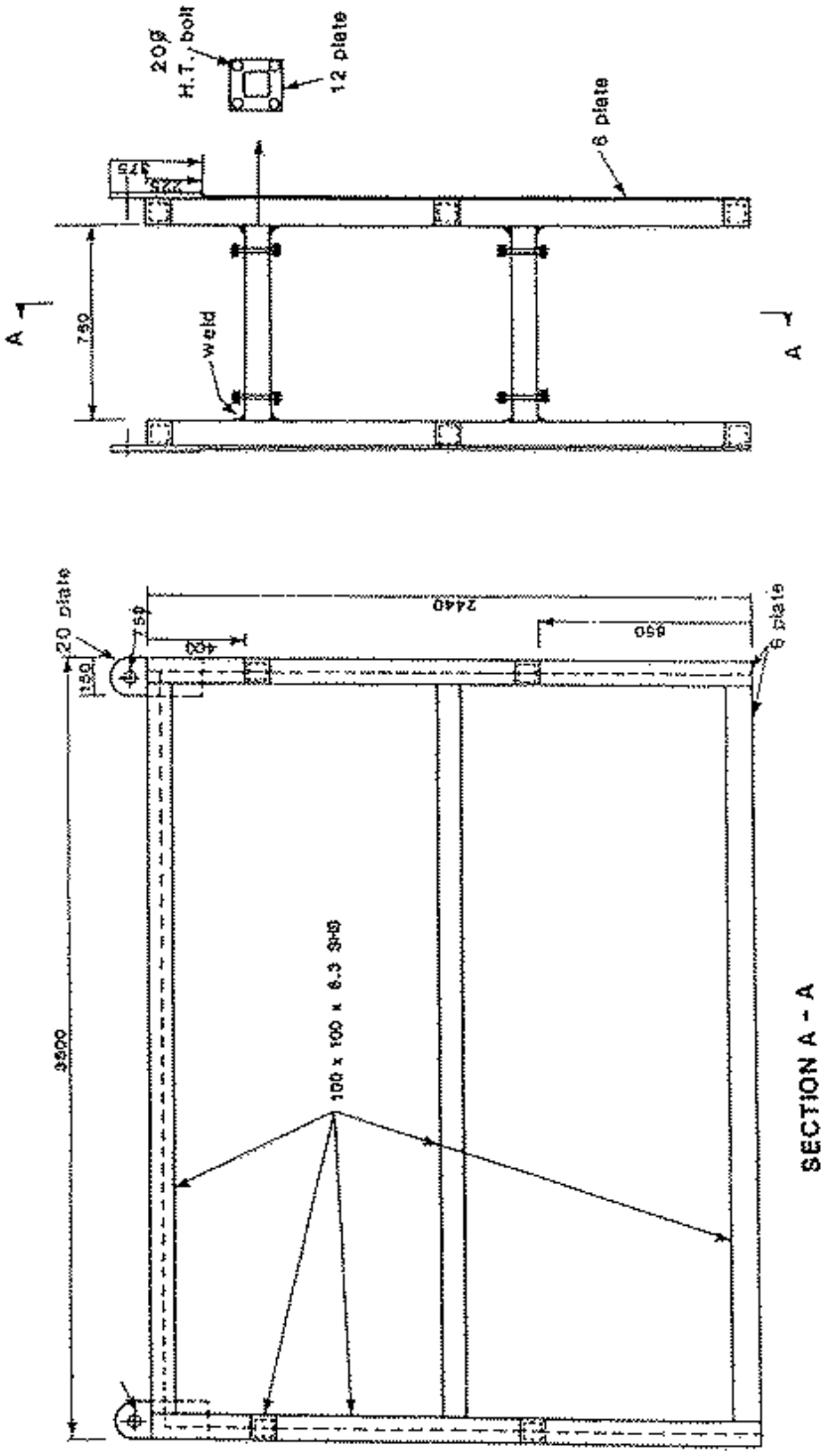
(d) Worker badly injured and probably smothered after being slammed and crushed against the opposite wall by the collapsing ground. The weight of a wedge of sand over a one metre length of trench is about three tonnes; more than enough to crush a worker's chest.

Figure 23
TRENCH COLLAPSE AND ASSOCIATED GROUND FORCES. Trench failure occurs very quickly, giving a worker virtually no time to escape, especially if the collapse is extensive. Normally, the soil involved in trench collapse slabs off the trench sides; the slab topples under its weight and breaks against the opposite wall of the excavation. This often buries and/or crushes a worker, resulting in death by suffocation or internal injuries.

8. Glossary of terms

Backfill	Material used to refill trench.
Bearer	Timber laid across a trench, resting on pressure pads on the surface. Lower toms and walers are suspended from upper walers which in turn are suspended from the bearers.
Capping	Timber nailed to toms to help position the tom between the walers.
Cleat	Block of wood nailed to soldiers to locate and support toms.
Close sheeting	Vertical timbers used to fully cover and support trench wall.
Lacing	Timber used to position and suspend waler
Soldier	Vertical upright timber used for supporting a trench wall
Spoil pile	Excavated material placed beside a trench.
Tom (strut)	Horizontal timber used to hold soldiers against a trench wall or to press walers apart in a close sheeted trench.
Timber Tongs	Tool used for the placing of toms from the surface.
Trench	A trench within the meaning of the Mines (Trenches) Regulations 1982 is one that is deeper than 1.5 metres, longer than its depth and width and is for the purpose of laying a pipe or cable.
Waler	Horizontal timber used to hold close sheeting in position.

9. Diagram


20ø H.T. bolt
12 plate
6 plate
A
A
790
weld
20 plate
150
759
420
2440
650
6 plate
3500
100 x 100 x 6.3 SHS
SECTION A - A
DEPARTMENT OF LABOUR
MEDIUM TRENCH SHIELD