



## **CPA Safety Guidance**

# **Selection of Proprietary Shoring Equipment**

## **Introduction**

Every contractor involved with groundwork must ensure the safe support of trenches and excavations as part of their risk assessment. Not only is protection required for the safety of the operatives working below ground level, but also an adequately designed support system is needed to prevent excessive ground movement that could cause damage to buried services and adjacent structures.

A wide range of specialised equipment has been developed in recent years to help deal with specific problems of excavation support. The aim of this guidance is to describe the application of the most commonly available ground support equipment, as well as providing brief guidance on its use.

In the UK, plant hire companies supply most of the shoring equipment to construction sites. Contractors must be aware that all systems need to be installed by suitably trained and competent personnel.

The chart at the back of this guidance is designed to be a quick reference to help with the selection of the most appropriate shoring equipment for each different of application.

# Types and Applications of Shoring Equipment

Shoring equipment used for excavation support includes the following generic types:

1. trench and manhole boxes;
2. drag boxes;
3. slide rail systems;
4. vertical shores;
5. waler frames;
6. manhole braces;
7. heavy-duty bracing frames;
8. hydraulic or mechanical struts.

## 1. Trench Boxes

**Trench and manhole boxes are generally the first choice for the rapid shoring of trench runs in non-urban environments.**

- Used for linear shoring of trenches generally up to 4m wide x 6m deep in reasonable ground conditions.
- Not recommended in waterlogged ground.
- Used in multiples to continuously support a length of trench.
- Available in a wide variety of sizes and weights and usually comprise a base box, typically around 2.5m high, and up to two top extension boxes.
- Although rubber tyred 180 degree excavators can handle the smaller "backhoe" type boxes, generally a 360 degree excavator is required, particularly as large pulling forces can be required to extract boxes in cohesive ground.
- Larger 4m high boxes can weigh over 4 tonnes.



- Where manholes are to be constructed within the trench run, necessitating a local widening of the trench, a special type of trench box is recommended. These are called "manhole" boxes and are commonly available in 2.5m, 3m, 3.5m and 4m panel lengths. The panels of a manhole box incorporate typically 0.5m long return sections at each end. These 'shoulders' provide additional support and protection in the widened section of trench. The panels are strutted apart by identical struts to those used in a Trench box.

## 2. Drag Boxes (shields)

**Used for short-term protection of the work force in non-urban environments typically for pipeline installation.**

- Generally used as a single unit to support trenches up to 4m wide x 4m deep in good stable ground conditions.
- They are available up to 7.5m long and the larger drag boxes are very heavy and can weigh in excess of 6 tonnes.
- They are designed to be pulled or dragged through the trench by the excavator as work proceeds.
- They are not suitable in urban environments.
- Drag boxes are intended to provide a secure working area for operatives rather than providing an effective means of preventing ground movement, hence they are often referred to as "shields".
- Operatives should ensure they enter the trench within the area protected by the shield – not from front or rear, where protection is not present.



### 3. Slide Rail Systems

**A specialist linear shoring system where positive ground support is required.**

- These are specialist linear shoring systems comprising posts, sliding panels and struts.
- When assembled the system forms a continuous line of support and can be used to support trenches typically up to 7m wide x 7m deep in most types of ground conditions.
- The advantages of these systems over 'box' systems is that much greater trench depths and widths can be shored with greater strut clearance for pipe installation, whilst reducing potential settlement inducing ground movement.
- However, greater skill and larger plant is required to install this equipment, for example, a 40 tonne excavator.



### 4. Vertical Shore

**Vertical shores can be rapidly installed to provide short-term intermittent support of relatively shallow trenches in good ground conditions.**

- A hydraulically operated intermittent system comprising of vertical aluminium rails strutted apart by two hydraulic rams.
- They are used for short-term support of relatively narrow/shallow trenches, typically up to 2m wide x 2m deep.
- The units are designed for manual installation from outside the trench, being activated by a manual hand pump.
- In suitable ground the units are installed



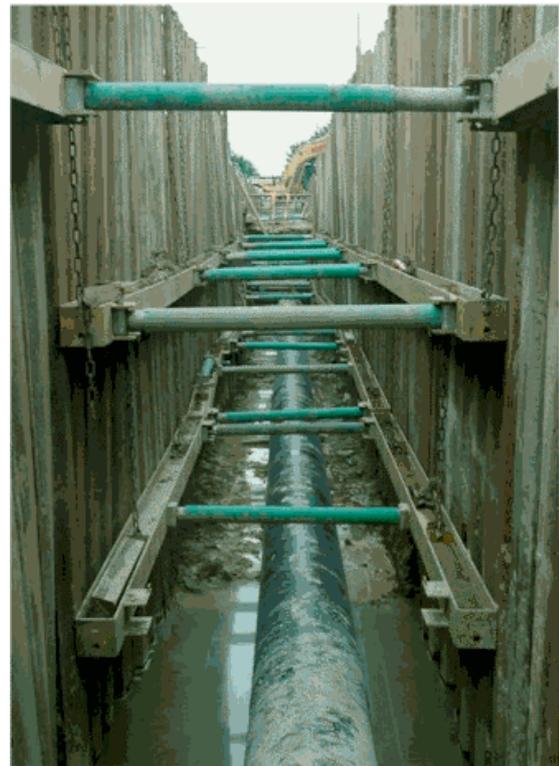
typically at 1.2m horizontal centres along the trench.

- If there is any doubt about the stability of the ground between the supports, a system that provides full support should be selected.
- The trench must be pre-dug to depth prior to installing the unit; therefore they are only suitable for use in stable, non-water bearing ground conditions.

## 5. Waler Frames

**Waler frames and sheeting provide a very versatile means of supporting medium sized trenches, giving very positive ground support, particularly in urban environments.**

- These are hydraulically operated frames, installed horizontally for two-sided trench support.
- A waler frame comprises two fixed lengths; aluminium or steel rails strutted apart by a pair of hydraulic rams. Longer rails can incorporate a centre strut for additional strength.
- Waler frames are used in conjunction with steel trench sheets, to form a system of trench support.
- This type of system can be used to support trenches generally up to 4m wide x 6m deep in all types of ground conditions.
- In trenches greater than 3.5m deep, or if ground conditions are poor, or if surcharge loading are likely to be high e.g. adjacent to buildings, it is advisable to have the system designed by a qualified engineer to determine the strength and spacing requirement.
- The relatively small weight and versatility of the system makes it ideal for use in urban environments where underground services and obstructions are likely to be encountered.
- The need to pitch and drive trench sheets can result in a longer installation period than with a 'box system'.
- Very positive support to the surrounding ground is provided by the hydraulic installation forces exerted by the pressurised Waler frames.



## 6. Light Duty Bracing Frames - Manhole Braces

For smaller excavations where support is required on all 4-sides, manhole braces and trench sheeting provide the safest, quickest and most economical solution for positive earth support.

- These are hydraulically operated frames that provide support on 4- sides, used for supporting smaller relatively shallow excavations and shafts.
- The frames comprise four individual telescopic legs, usually of steel construction. The legs can be either single or double acting; that is, the latter type can be both expanded and retracted hydraulically.
- "Manhole brace" is the generic term for frames used in excavations up to 6m square x 6m deep.
- In excavations greater than 3.5m deep, or if ground conditions are poor, or if surcharge loading are likely to be high e.g. adjacent to buildings, it is advisable to have the system designed by a qualified engineer to determine the strength and spacing requirement.
- A series of manhole brace frames are used in conjunction with trench sheeting to support the depth of the excavation.
- Positive support to the surrounding ground is provided by the hydraulic forces exerted on installation by the pressurised manhole brace legs.



## 7. Heavy-duty Bracing Frames

**Heavy-duty bracing frames and legs can be combined to provide support for larger excavations and cofferdams.**

- These are hydraulically operated structural frames, used for supporting larger and deeper excavations and shafts providing support to all sides.
- A frame comprises four or more individual legs or leg assemblies that are combined to form square, rectangular or multi-sided frames. Each leg or leg assembly incorporates a hydraulic adjustment/pressurising facility. These are usually double acting, i.e. pump both in and out.
- The longer modular legs can incorporate extension sections and coarse adjustment units for greater versatility.
- Heavy-duty bracing legs are available in lengths exceeding 20m; however, these would generally need to be combined with cross-strutting for greater strength and reduced deflection.
- With these systems it is essential that a qualified and experienced engineer design the supporting systems. Most proprietary shoring equipment suppliers can offer a design service.
- Due to the length and weight of individual leg components, installation is usually carried out leg by leg at reduced excavation levels, unlike manhole braces that are generally installed as a frame.



## 8. Hydraulic or mechanical struts

Hydraulic or mechanical struts are generally used for high axial load propping applications such as cross strutting to supporting frames or horizontal or raking support to pile caps.

- These are hydraulically or mechanically operated telescopic members used for supporting high axial loads such as is generated in cross-strutting applications, corner or 'knee' bracing or in raking support to pile caps.
- Proprietary equipment is available up to 250 tonnes axial load capacity.
- Each strut or strut assembly incorporates a hydraulic adjustment/ pressurising facility or means of mechanical adjustment. Hydraulic struts are usually double acting, i.e. pump both in and out.
- This type of equipment is usually modular incorporating fixed length extension sections for greater versatility. Some units are able to incorporate cruciform pieces to facilitate strutting in both directions
- Struts assemblies are available in unsupported lengths exceeding 25m,
- It is essential that a qualified and experienced engineer design these supporting systems. Most proprietary shoring equipment suppliers can offer a design service.



## Guidance on the Use of Proprietary Shoring Equipment

1. It is a legal requirement that all excavation work should be carried out in accordance with The Construction (Health, Safety and Welfare) Regulations 1996. Regulation 12 relates specifically to excavation work and Schedules 7 & 8 cover inspection and the report of inspection of excavations.
2. Before work begins, the contractor undertaking the work should carry out a risk assessment. The purpose being to identify those hazards likely to be encountered and to determine the control measures required in order to minimise the risk to persons, for example, confined spaces.
3. All personnel should be familiar with the equipment supplier's safety and operation instructions.
4. Assessment should be carried out to ensure that the equipment capacity is not exceeded by ground pressure likely to occur within the excavation.
5. When selecting support equipment, as a minimum the following factors should be considered:
  - the nature of the soil(s) through which the excavation will proceed;
  - the required size and depth of the excavation or trench;
  - depth and flow potential of any groundwater present;
  - the presence of services and obstructions near the excavation;
  - size of the equipment to be installed or structure to be built within the excavation to assess any limitations for cross-strutting;
  - the presence of any surcharges, for example:
    - (a) Adjacent buildings - check proximity, type of building, and foundation details.
    - (b) Spoil heaps - is the excavated material going to be stored next to the excavation?
    - (c) Construction materials - are there to be quantities of bricks, imported fill etc. stored near the excavation?
    - (d) Adjacent highways - are public roads near the excavation?
    - (e) Site traffic - do lorries or site plant pass close to the excavation?
    - (f) Railway embankments - will rail loads and vibrations affect the excavation?

6. The provision of a good standard of access is also important for emergency use should it be necessary to vacate an excavation quickly due to flooding, build-up of fumes, etc. Emergency arrangements need to address how an injured person, unable to use a ladder access, will be recovered.
7. A competent person should always supervise the installation of shoring equipment and carry out regular inspections in accordance with statutory requirements.
8. Personnel should use appropriate personnel protective equipment e.g. hard hat, protective footwear, high visibility clothing, gloves etc.
9. Appropriate fencing should surround the excavation or barriers provided to prevent unwanted access.
10. Lifting equipment should be suitable and sufficient to adequately handle the weight of the shoring equipment.
11. Personnel should never step out of the safely shored area into an unprotected or incompletely shored area.
12. When the excavator driver has limited visibility in the work area, a banksman should always be provided.
13. Suitable firm dry level areas should be made available for on-site stacking and pre-assembly work.
14. Equipment should be cleaned and dismantled according to the supplier's recommendations prior to collection from site. Care must be taken not to overload collection vehicles. Weight of equipment can be obtained from supplier's information sheets. An allowance should be made for the weight of any accumulated debris e.g. concrete.

# CPA Guidance on Shoring Equipment

			Suitability of Shoring Equipment								
Application	Ground Conditions	Are services present?	Trench Boxes	Manhole Boxes	Drag Boxes	Slide Rail	Vertical Shores	Waler Frames & Sheets	Manhole Braces & Sheets	Heavy Duty Bracing Frames & Sheets	
Trenches up to 2.0m wide & 2.0m deep	Good dry stable ground	Services present	X	X	X	X	✓	✓	X	X	
		No services	✓	X	✓	X	✓	✓	X	X	
Trenches up to 4.0m wide & 6.0m deep <sup>2</sup>	Good stable ground i.e. firm/stiff clay, rock	Services present	X	X	X	X	X	✓	X	X	
		No Service	✓	X	✓	X	X	✓	X	X	
	Dry granular soil	Services present	X	X	X	X	X	✓	X	X	
		No services	✓	X	X	✓	X	✓	X	X	
	Wet granular soil, soft clay	Services present	X	X	X	X	X	✓	X	✓ (used as waler rails c/w heavy duty struts)	
		No services	X <sup>4</sup>	X	X	X	X	✓	X		
Trenches over 4.0m wide & 6.0m deep <sup>2</sup>	Stiff clay/Rock	No services applicable when services are either present or absent	X	X	X	X	X	X	X	✓ (used as waler rails c/w heavy duty struts)	
	Dry granular soil Soft/firm clay		X	X	X	✓	X	X	X		
	Wet granular soil		X	X	X	X	X	X	X		
Manhole excavations up to 6.0m deep <sup>2</sup> & 4.5m square	Dry ground		X	✓	X	X	X	X	X	✓	✓
	Wet ground		X	X <sup>4</sup>	X	X	X	X	X	✓	✓
Manhole excavations over 6.0m deep <sup>2</sup> & up to 6.0m square	All ground conditions		X	X	X	X	X	X	X	✓	✓
Large excavations over 6.0m square <sup>3</sup>	All ground conditions		X	X	X	X	X	X	X	X	✓
Multi-sided excavations <sup>3</sup>	All ground conditions	X	X	X	X	X	X	X	X	✓	

Refer to notes 1 to 6 (over page).

## **CPA Guidance on Shoring Equipment**

### **Notes:**

1. This matrix is intended for guidance only and is not a substitute for good experience.
2. It is advisable to have all excavations greater than 3.5m deep designed by an engineer when using sheets and frames or slide rail systems.
3. It is advisable to have all Large excavations and multi-sided excavations designed by an engineer.
4. Although it is not recommended, Trench/Manhole Boxes can be used in saturated ground.
5. If in doubt, seek advice from a specialist shoring supplier.
6. Vertical shores are only able to provide intermittent support to the trench walls. If there is any possibility of the ground falling between the shores, the system must not be used.

# Bibliography

## Regulations

1. Management of Health and Safety at Work Regulations 1989
2. The Construction (Health, Safety and Welfare) Regulations 1996
3. The Construction (Design and Management) Regulations 1994
4. The Lifting Operations and Lifting equipment Regulations 1998
5. The Provision and Use of Work Equipment Regulations 1998
6. Confined Space Regulations 1997

## HSE ACoPs and Guidance

1. Management of Health and Safety at Work ACOP 1999.
2. Managing Health & Safety in Construction ACOP 2002.
3. The role of the designer (CIS 41)
4. Safe use of lifting equipment. Approved Code of Practice and Guidance (L113)
5. A guide to the Construction (Health, Safety and Welfare) Regulations 1996 (Leaflet - INDG 220)
6. Health and Safety in excavations. Be safe and shore (HSG 185)
7. Health and Safety in construction (HSG 150)
8. Safe work in confined spaces. Approved Code of Practice (L101)

## Other Guidance

1. CIRIA report 97 – Trenching Practice.
2. CIRIA Technical Note 95 – Proprietary trench support systems.
3. CIRIA Special Publication 95 – The design and construction of sheet-piled cofferdams.
4. CIRIA Report 166 CDM Regulation-Worksector Guidance for Designers.
5. CIRIA Report 113 Control of groundwater for temporary works.

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