SAFETY PUBLICATION SERIES

GOOD PRACTICE GUIDE

Management of Shoring in Excavations

PART 2 - HAZARD IDENTIFICATION for RISK ASSESSMENT

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Good Practice Guide for the Management of Shoring in Excavations

Part 2 - Hazard Identification for Risk Assessment

CPA Good Practice Guide

Working in Partnership

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Contents

Hazard Identification for Risk Assessment is the second of a series of documents to be published by the CPA on the subject of shoring in excavations and supplements Part 1 on *Management Process*. Future parts will include available shoring systems, shoring documentation and examples of current practice. Details of any future publication will be available on www.cpa.uk.net

1.0 Introduction

This document is Part 2 of a suite of publications on the topic of excavation safety. Part 1 deals with the Management of Shoring in Excavations and provides guidance on decision making, planning and control of work. This document provides expanded guidance to assist with preparations for excavation work on site.

Risk management is a vital part of every construction project or task. The Management of Health & Safety at Work Regulations (1999) requires each organisation to assess activities that will be taking place under their control. This involves deciding which hazards are present; selecting control measures; and ensuring the resultant risk of an incident is sufficiently low for the work to go ahead. Records of this process are generally termed 'Risk Assessments'.

Where several parties are involved with a task the main contractor may allocate aspects of the risk assessment to one or more of the parties and include this in the contract/s. There is no requirement for assessments to be repeated by each contractor but they may need to be modified or updated as the work progresses.

The initial and major hazard with excavation work is ground movement which can result in workers being buried e.g. when the side of a trench collapses. In some cases one or more of the main hazards can be removed by using a different procedure. For example, use of directional drilling for service installation can avoid the need to excavate. And foundations can be installed by piling without the need to excavate.

In most cases selection of a control measure to deal with the initial or major hazard will introduce new hazards that need to be assessed and controlled - e.g. entanglement on directional drill string: or falls from height into an excavation or from plant. Selection of control measures and preparations for carrying out work usually involve reviewing the list of hazards that will be present several times so that the final mix of equipment, worker skills and agreed procedures deals with all the significant hazards involved.

This safety guidance document contains a generic list of possible hazards that may be present when planning and executing excavation and shoring related operations. The list is not site specific, nor does it attempt to be exhaustive.

Employers are required to undertake risk assessments for their activities prior to work being carried out. The list has been provided to assist the user of shoring equipment to produce site-specific risk assessments for excavation and shoring operations to determine what measures should be taken to fulfil their statutory obligations. There may be other hazards that they will need to add to the list and evaluate.

A common control measure is to select a shoring system capable of preventing ground movement. When selecting a shoring system it is vital to fully risk assess the assembly, installation and removal sequences. Understanding how the systems are to be safely assembled and at which stages of installation they are safe to load, enter and how to dismantle and remove is essential. A site specific Safe System of Work (SSoW) should be produced for all excavations. Included within the SSoW should be easy to follow assembly, installation, maintenance and removal instructions, together with relevant plans of the works and residual risks to be managed on site.

Remember that the most important part of the risk management process is the thought given to identifying hazards and deciding which mix of control measures will provide the overall best way of doing the work. Out of all the various control measures that could be used this process needs to weigh up the optimum mix to enable the work to be carried out in a healthy, safe, timely and cost effective way. Recording the conclusions of the risk assessment is a legal requirement (unless fewer than 5 persons are employed).

A common mistake is to think that ‘risk assessment’ is only about recording what has already been decided. Correct use of risk management procedures begins at the early planning stages of a project and leads to a safe working environment as well as helping a project to complete on time and on budget. Often the risk assessment and method statement for each stage of the work can be placed in one document but the title must make clear that it contains both elements.

2.0 Scope

The Hazards listed are limited to those activities related to shoring including the installation of trench sheets or light piles.

The suggested precautions and other control measures are based on the requirements of the Construction Design & Management Regulations 2015 (CDM 2015) and BS5975: 2008 +A1:2011.

3.0 List of Hazards

The following tables list generic hazards and are divided into four different activities:

Activity 1 Excavation Work – General;

Activity 2 Excavation Support Systems – Management;

Activity 2a Excavation Support Systems – Frames;

Activity 2b Excavation Support Systems – Trench Lining Systems;

Activity 3 Temporary Works Design for Excavations;

Activity 4a Installation of Trench sheets and light Piles – Vibratory Hammers;

Activity 4b Installation of Trench sheets and light Piles – Air Hammers

Figure 1 - Safe Access into an Excavation

ACTIVITY/ HAZARD	CONSIDERATIONS	PRECAUTIONS TO BE TAKEN TO REDUCE THE RISK	POSSIBLE FURTHER CONTROL MEASURES
ACTIVITY 1 – EXCAVATION WORK – GENERAL			
Planning	All excavation work must be planned before work commences. Hazards should be identified, control measures selected so that the risk of an incident is acceptably low. Sufficient resources must be made available throughout the works.	Appoint a Temporary Works Co-ordinator (or responsible person), to supervise the whole of the works, ensuring that the final 'end-user' (if not the co-ordinator) is fully briefed and conversant with the equipment, scheme layout & installation method. Appoint a Temporary Works Designer when excavations are deemed to require a support system.	A detailed design brief must be compiled for the designing organisation. The length and detail in this will be dependent on the scale and complexity of the work. Consider the design checking regime (does the design need to be checked by an independent engineer?) Plans, drawings, assumptions, etc. must be conveyed to the TWC/TWS to ensure that personnel undertaking the work are fully aware of the risks and the control measures.
Information gathering	Obtain and collate all available and relevant existing information - e.g. site soil reports, previous site use information and as-left demolition reports, service layouts, scheme plans and draft preferred sequence and timescale arrangements.	Where the available information does not appear sufficient to allow excavations to be designed and made safe in a cost effective manner it may be necessary to commission further work, including deep soil surveying by excavation or drilling with samples laboratory tested and reported.	Early investment in detailed survey work may allow a simpler or cheaper excavation scheme to be designed. Checking across the site may turn up unexpected geological or old features that can be planned for rather than requiring expensive changes should they be found once work has started.
Collapse of excavation sides	Selection of installation method for foundations and services. Can installation be carried out without opening the ground?	Options may include e.g. • Use of surface or shallow foundations; • Use of shallow services (i.e. not deeper than minimum utility requirements) and gravity drainage design that utilises e.g. back drop manholes. • Piling or directional drilling.	This aspect may require detailed discussion between the permanent works designer and the contractor to ensure the best mix is achieved to the satisfaction of all parties. Designer duties under CDM 2015 encourages the permanent works designer(s) to get involved.
Collapse of excavation sides	Selection of system of work for the excavation of ground - e.g. benching work or basement digs. It may be possible to use the permanent works for temporary ground support. It may be possible to use a design and a sequence that minimises extent of faces that need support.	Where the task to be carried out requires excavation and removal of bulk materials the decision is limited to sequential: • Support and dig; or • Batter / dig; Where support and dig methods are used the choice extends to: Use temporary support; or Install permanent support before excavation - eg by piling. Where batter / dig is used decisions include: • Can a reduced batter become part of the permanent works? • If a retaining wall is needed how will its foundation be placed at the foot of the batter? and • If environmentally friendly retaining systems are used (eg gabion walls), can they be completed early and allow work to continue safely at their base?	As above.

ACTIVITY/ HAZARD	CONSIDERATIONS	PRECAUTIONS TO BE TAKEN TO REDUCE THE RISK	POSSIBLE FURTHER CONTROL MEASURES
Transport involving site plant & road going vehicles	Unless a machine has all round visibility or movement is controlled by a trained banksman, pedestrians should be excluded from the working area.	A traffic management plan should set out haul routes including access onto site, waiting area/s, turning area/s, unloading area/s and working area/s. Where possible separate pedestrian routes should be laid out away from vehicle routes.	Workers and visitors should be briefed and able to follow the traffic arrangements. The arrangements need to be updated as the site progresses and changes.
Lifting Operations	A carefully considered lift plan should be produced that ensures the excavator or crane and the ground conditions are assessed to be adequate for the lifting requirements associated with the works.	Appointed person to prepare lift plan in accordance with LOLER regulations. Lift plans for larger lifts should be detailed on a drawing. Allocate a lift supervisor. Ensure that loads and radii are accurately assessed. Identify siting areas for crane (nearest edge of outrigger pad to excavation should be a minimum distance away from the excavation equal to depth of excavation unless specifically allowed for in the design). Plan your safe system of work. Site procedures should be drawn up to establish which type of lifting equipment will be needed on site and their limitations of use. E.g. a telehandler may be present on site for the duration but what are the limits on using it for unloading or carrying very long loads which could be transported more safely on a trailer.	Ensure that all lifting plant and equipment has the correct certification. Only use lifting gear as designated by the manufacturer. Ensure that all relevant personnel are aware of the loads. Use a competent slinger/signaller. Slinger/signallers' should be recognisable and be visible to the excavator or crane operator. Standard hand signals should be used. Consider environmental conditions (such as wind). ***Note 1:*** hanging chains supplied by shoring suppliers **must not** be used for lifting. Refer to supplier's instructions. ***Note 2:*** equipment covered with spoil or concrete will weigh more than stated. ***Note 3:*** break free adhesion forces may significantly increase load where items are stuck in wet ground or jammed in place. Support equipment should be broken free before being lifted unless the lifting appliance is designed - or has been assessed - to be capable of dealing with breakout forces.
Confined Spaces	Identify any confined spaces and deal with them in accordance with the Confined Spaces Regulations 1997.	Most excavation work should be treated as a confined space (if an "open topped chamber") unless assessed otherwise. Prepare detailed method statement which should include: • air monitoring; • rescue plan; • training.	Permit/authorisation to work. Confined Space Trained operatives. Ensure that all operatives are aware of the rescue plan.
Work at Height	Working adjacent to an excavation is considered to be working at height and is covered by the Work at Height Regulations 2005.	Consider proprietary or other edge protection in the planning of the work. Working off ladders should be limited to short duration light work. Three points of contact should be maintained.	Consider the use of a safety harness as a backup measure. Inspect edge protection daily. Edge protection to be modified by authorised persons only.

ACTIVITY/ HAZARD	CONSIDERATIONS	PRECAUTIONS TO BE TAKEN TO REDUCE THE RISK	POSSIBLE FURTHER CONTROL MEASURES
Safe access and egress	Access to and egress from the excavation should be considered during the planning and design process.	Access to an excavation must be by a suitably safe method, e.g. ladders or stairs. Personnel must not use the trench support system as a climbing frame. Appropriate provisions for access and rescue in emergencies should be made. If ladders are to be used – they should be fixed at 75° to the horizontal (1 in 4). Tie securely at the top and ensure a firm and level footing to prevent slip. Consider the use of proprietary systems of access/edge protection. Adequate provision must be made to prevent unauthorised access. In large or deep excavations use of stair or stair tower/s may be more appropriate and may help to simplify the rescue plan.	Ladders must be secured to prevent movement and must project about 1 metre above the access point at the top. Gated access to the top of ladders should be considered. Consider security outside normal working hours. In larger or longer term excavations (especially shafts) the emergency procedure should include consideration of need for a manual winch - e.g. on a davit and a rescue cage.
Contaminated Ground	The planning process should identify any areas of the site that may have contaminated ground. A site investigation may be necessary.	Identify, assess, and clearly mark areas of contaminated ground. Ensure no degradation of equipment (e.g. shoring) by contamination contact.	Consider Permit to work. Provision of suitable protective clothing and changing and washing facilities (consult equipment supplier – keep equipment clean). No eating, drinking or smoking in designated areas. Wear protective clothing. Consider Occupational Health surveillance.
Spoil Storage	Spoil storage areas must be identified in the design brief.	Spoil storage areas must be clearly identified on site.	Toe of nearest edge of spoil heap should be a minimum of depth of excavation away from the excavation unless specifically allowed for in the design.
Unauthorised access	Consider both unauthorised persons entering the site and local fall prevention measures adjacent to the excavation.	Provide adequate fencing, barriers, signs and warning lights to prevent unauthorised persons entering the site. Edge protection around the excavation.	Inspect daily.
Storage and Stacking - safe lifting, stability of stacks and surcharging of excavation	Consider all loading and unloading operations for shoring equipment being delivered or returned. Storage areas should be assigned and safe, stable stacking arrangements in place.	Lifting plans must be in place taking into account ground conditions, slinging / de-slinging of equipment, stack stability and height. Locate storage areas on flat ground well away from the edge of the excavation. Use tag lines to keep workers away from suspended loads.	Segregate storage areas away from site traffic / pedestrian routes. Don't mix different sizes or types of equipment within same stack. To prevent slippage where items do not interlock, never stack metal on metal - always use timber skids/ packers. Restrict max stack heights to 1.0m. Store equipment in its most stable position.

ACTIVITY/ HAZARD	CONSIDERATIONS	PRECAUTIONS TO BE TAKEN TO REDUCE THE RISK	POSSIBLE FURTHER CONTROL MEASURES
Damage to existing under-ground services during excavation	Excavation work can damage underground services. Workers, especially those using hand held breakers, can receive severe burns and electric shock or be electrocuted should they strike an electrical service. Damaged gas supply pipes can leak underground causing gas to track and build up in cellars and cavities where a small spark can lead to explosion and fire. Water main damage can quickly flood an occupied excavation. Existing services should be investigated with the statutory undertakers at the planning stage. Whilst the client may have drawings showing the location of services, the position of the services may not be accurate.	All known services must be located and marked prior to commencement of the excavation work. This may need a specialist contractor using eg Cable Avoidance Tools (CAT) & Signal Generator (genny) and radar based equipment. If additional services are discovered during excavation, the scheme should be reworked. Even where the entire run of a service across the site has been identified and proven by digging, it can still be hard to determine whether a service is live or used intermittently.	Trial holes. Formal authorisation such as a "Permit to Dig" should be issued by the relevant party/authority, prior to the start of any excavation work. Final location of buried services should be by hand digging. Machines should not dig closer than 500mm from buried services. The statutory undertaker should be approached at an early stage to relocate sensitive services that are 'in the way'. Services that would have been moved anyway as part of the project should be moved early. Services that will remain but pose a risk to groundworks operations should also be considered for relocation where this would speed the job and substantially reduce risk. It may be possible to turn off an electrical supply to enable a short term job to be carried out.
Contact with overhead power lines	Contact with overhead power lines causes electrocution and serious burn injuries. Overhead power lines often run along the public road boundary with a site - especially where plant deliveries tend to be unloaded.	Overhead power lines above longer term work areas should be considered for early relocation. Overhead power lines above short duration work areas - the utility owner should be approach to see whether the power can be turned off for a specified period. Live over head lines in work areas or traffic areas must be barriered off and e.g. 'goal post' arrangements installed at crossing points under the lines.	Site layout to keep operations away from overhead lines. Lighting to warn of their presence during working hours of darkness. Briefing of plant & lorry drivers and banksmen etc.
Deterioration in condition of excavation	Inspections must be carried out by a competent person and in accordance CDM 2015 Regulations 22, 23 & 24 Any urgent remedial work should be arranged and carried out before other work continues.	The excavation should be inspected: • at the start of the shift in which the work is to be carried out; • after an event likely to have affected the strength or stability of the excavation e.g. after rain; after any material unintentionally falls or is dislodged. The results should be entered into an inspection report / register or similar.	Consider whether the repair task is sufficiently complex to benefit from a Permit to Work; or whether the excavation should be backfilled to prevent a larger collapse. Instrumented monitoring of the dimensions of large or complex excavations can include automated, real time monitoring with radio signal alerts sent to key personnel. In complex works planning may include drawing up procedures to be used in the event of movement or failure of supports.
Damage to adjacent structures	Provide a detailed design brief which should include the proximity of adjacent structures.	Assess the likelihood and degree by which adjacent structures or other features might be affected by the excavation – vibration, subsidence, noise and dust. Consult a specialist if necessary.	Provision must be made to prevent loose material falling. An assessment should be made of the effects of groundwater, i.e. settlement of adjacent structures including buildings, services, foundations, slopes, bridges, highways, railways, and watercourses.

ACTIVITY/ HAZARD	CONSIDERATIONS	PRECAUTIONS TO BE TAKEN TO REDUCE THE RISK	POSSIBLE FURTHER CONTROL MEASURES
Contact Injury	Consider how materials are to be handled and the location of personnel and plant.	Dependant on the excavation size, persons should be prohibited from entry during excavation work. Personnel should not work or stand directly under materials or plant being placed within the excavation.	High-visibility clothing and helmets and other appropriate PPE should be worn. The system of work and/or sequence should be arranged to ensure slew traps do not occur. Additional fencing may be needed to separate workers from tight areas.
Falling Objects	Plan the layout of the site, the excavation and any adjacent traffic routes and walkways to keep traffic and pedestrians away from the works where possible.	Trench sheets or boxes should be left proud of the sides of the trench, or handrail edge protection and proprietary ladder access used. Avoid the use of intermittent (hit and miss) sheeting as material can fall through the gaps between the sheets.	Edge protection to an excavation may need to be kept away from the sides of the excavation to prevent material being knocked into the trench but consider the risks that may be caused by distant edge protection which may encourage wrong side working.
Pneumatic breakers	Identify persons at risk from an adequate risk assessment. Consider: • eye injuries from flying debris; • excess Noise; • excessive dust; • excessive vibration; • contact with live services.	Suitable eye protection (identified from the risk assessment) to be worn. Noise assessment and provision of suitable ear protection if required. Where there is a likelihood of dust it should be suppressed at source using clean water spray. In addition if the dust contains free silica or other harmful materials, appropriate respiratory protective masks should be provided where necessary. Breakers can have some of the worst vibration levels. Prevent vibration white finger by: selecting other methods of working; using a small excavator or remote controlled machine fitted with a pecker; measure vibration levels on the tool; select a low vibration tool; limit time per shift on the machine by rotating the workforce.	Keep work area segregated. Work area may need to be ventilated.
Protection of the Public	The planning process must consider the proximity of the public and should include safe measures to protect the public if work is being undertaken near to areas that the public may have access to.	Public access must be clearly marked and kept free from debris and materials. Excavation on or near public access pathways must be guarded or cordoned.	2m high fence (or hoarding) securely fixed with warning signs clearly displayed. (Note: consider wind loading on the fencing/ hoarding and safe anchorage). Temporary reinstatement of areas then opened to the public should have a surface suitable for public use.

ACTIVITY/ HAZARD	CONSIDERATIONS	PRECAUTIONS TO BE TAKEN TO REDUCE THE RISK	POSSIBLE FURTHER CONTROL MEASURES
Hazardous Substances	Refer to COSHH Regulations.	Identify and assess any hazardous substances likely to be encountered or used. Consider testing samples of made ground which may be contaminated. Consider: • substances brought to site; • substances produced on site - e.g. diesel exhaust fume; • substances already present on site - including occupation debris such as needles and sewage, chemical contaminants including buried drums and containers and fire debris, biohazards including anthrax if large animal carcasses found and contaminated water - leptospirosis from rats.	Authorisation or a permit to work may be required in heavily contaminated ground. Consider the correct PPE which should be identified in the risk assessment.
Fire and Explosion	Desk top study to consider likely presence of live ordnance - aerial bombs, land mines, incendiary bombs. If former military MOD land especially airfields, may include buried demolition charges or items 'lost' in mud.	Incendiary devices often contain white phosphorous which can oxidise and erupt on exposure to air.	High risk sites may need specialist survey. Induction briefing to groundworkers may need to include talk and use of photos and drawings to show the kind of items they need to report and not disturb.
Entanglement	Plant such as mini piling rigs and directional drill rigs that have rotating parts such as drive shafts, drill strings, augers etc. that are within reach can cause clothing or limbs to become caught and wound onto the shaft or dragged into a narrow gap.	Rotating parts that are within reach need to be guarded. Where access is needed to change tools or extend the drill string, the guard will need to be interlocked so it can be opened. With the guard open rotation should be at a restricted speed (less than 30rpm).	Larger plant such as full size piling rigs carrying out auger piling need to be operated using an exclusion principle whereby workers are out of the area during rotation of the auger and slewing of the machine.
Pedestrians run over by site plant or road going vehicles	Unless a machine has all round visibility or movement is controlled by a trained banksman, pedestrians should be excluded from the working area.	A traffic management plan should set out haul routes including access onto site, waiting area/s, turning area/s, unloading area/s and working area/s. Where possible separate pedestrian routes should be laid out and separate from vehicle routes.	Workers and visitors should be briefed and able to follow the traffic arrangements. The arrangements need to be updated as the site progresses and changes.

Figure 2 - Trench Box

Figure 3 - End Panel Installation

Figure 4 Proprietary Strut System

ACTIVITY/ HAZARD	CONSIDERATIONS	PRECAUTIONS TO BE TAKEN TO REDUCE THE RISK	POSSIBLE FURTHER CONTROL MEASURES
ACTIVITY 2 – EXCAVATION SUPPORT SYSTEM – MANAGEMENT			
Collapse of Excavation	Suitable shoring systems must be determined by an initial risk assessment. Consideration should be given to depth, soil strata, groundwater characteristics, location, surcharge loading, proximity of slopes or batters, duration of excavation, preferred method of installation, whether man entry needed, nature of work to be carried out either in or near to the excavation, etc. A detailed design brief should be compiled. Referral to suitably qualified and competent design personnel may be necessary. Supervision of the works must be by authorised persons (TWC or TWS) who are adequately trained, competent and familiar with excavation activities.	Suitable and sufficient steps shall be taken to prevent a fall or dislodgement of any material into or from within the excavation. Spoil, plant or work materials should not be placed close to the edge of the excavation. Provide appropriate barriers, treat as a surcharge. No material, vehicle or plant shall be placed near excavations where it could cause collapse unless allowed for in the design of the support systems i.e. treat as a surcharge (consult the Temporary Works Designer). Support systems must be installed without delay as work proceeds. The method of installation should be stated in the temporary works design. The system of work for shoring installation and removal should not expose workers to risk being trapped by collapse or struck by falling material or falling from height.	Use close sheeting or panelling (i.e. trench boxes). Avoid the use of intermittent (hit and miss) sheeting as material can fall through the gaps between the sheets/soldiers. Do not enter unsupported areas of the excavation in order to install or remove support. The system of work should ensure this is unnecessary by allowing either remote working; or that workers in the excavation stand and work within the supported section of the excavation. Note section on groundwater below
Change in site conditions	Any deviations from the conditions used in the preparation of the temporary works design must be referred back to the designer for checking. e.g. • different soil conditions; • change in groundwater levels; • change of size of excavation; • change of depth of excavation; • additional surcharge loading; • change in method of installation.	Competent supervision of the works (TWC / TWS). Regular inspection regime.	

ACTIVITY/ HAZARD	CONSIDERATIONS	PRECAUTIONS TO BE TAKEN TO REDUCE THE RISK	POSSIBLE FURTHER CONTROL MEASURES
Unsupported excavations			
Non man entry, short duration excavations where the intention is to avoid using support	There is still a hazard from work at height, Is the excavation stable? Is there groundwater present? Are there any structures nearby that could be affected by a collapse.	To be assessed by a competent person / engineer.	Adequate fencing. Adequate and prominent signage. Agreed procedure in the event of ground movement. Agreed procedure in the event that man entry becomes necessary.
Unsupported ends of linear excavations		Batter the ends back to a safe slope. Prevent access – use fencing.	Where e.g. trench box design allows side loading onto struts use trench sheets to prevent the ground falling into the trench. Won't stop failure but allows escape.
Excavations where only part of the run is supported or Excavations where support doesn't extend right to end	There is still a hazard from work at height, Is the excavation stable? Is there groundwater present? Are there any structures nearby that could be affected by a collapse	Can the sides be battered to a safe slope? Ensure all personnel are aware that they must not move or work right at the end of the support and must not stray into unsupported areas - even momentarily.	Consider physical barrier or other means to prevent access into the unsupported part of the trench.
Hit and Miss shoring	Is the side of the excavation capable of being self supporting between uprights? Have surcharges, groundwater and vibration been considered? Is it made ground (which tends to be more likely to fail without warning)?	Obtain an appropriate temporary works design. Ensure close monitoring and inspections. Plan and bring the correct amount of equipment to site. If limited equipment is available then only a short excavation can be dug.	Don't be tempted to use 'hit and miss, miss, miss'. Gaps between sheets should be small.
ACTIVITY 2A – EXCAVATION SUPPORT SYSTEM – FRAMES			
Shoring Installation	All shoring systems must be assembled and installed in accordance with the manufacturer's instructions and site specific method statement. All shoring systems must be checked regularly and maintained properly for the duration of the work. Check for visible over-stress, damage, leakage and non-alignment of all equipment.	Installers to be trained and competent. Ensure all relevant User Guides, drawings, installation instructions and method statement are passed on to the site supervisor. Ensure all support work is secure and that props and wedges are tight Ensure that all hanging chains or other support means are in place as specified in the shoring design. Note: These chains must not be used for lifting operations	Inspections must be by a competent person and in accordance with CDM 2015 Regs 22 & 24.

ACTIVITY/ HAZARD	CONSIDERATIONS	PRECAUTIONS TO BE TAKEN TO REDUCE THE RISK	POSSIBLE FURTHER CONTROL MEASURES
Groundwater making excavation inaccessible or unstable	The presence of Groundwater can have a significant effect on the stability of an excavation and will affect the loadings on the shoring systems. Many shoring systems are not suitable in areas where retained ground could become fluid. Design of excavation support in areas prone to rapid or seasonal change in groundwater level should take account of this issue and procedures should include monitoring of levels and a contingency plan for action in the event of the ground or support integrity being compromised.	Good quality site investigation. When necessary or specified, suitable and properly maintained pumping systems and equipment must be provided. In critical areas and critical operations standby equipment should be available in the event of breakdown. Type and extent of groundwater control must be assessed prior to excavation work. A suitable location for the discharge of pumped water must be agreed.	Assessment may be necessary by a specialist supplier or organisation. Refer to the design of support system for any assumptions made regarding de-watering. Effect of groundwater removal on settlement of adjacent structures must be assessed. Refer to the local authority if in doubt.
ACTIVITY 2b – EXCAVATION SUPPORT SYSTEM – TRENCH LINING SYSTEMS			
Pre-Assembly of Equipment	Poorly planned/executed slinging and or lifting operations. Unstable or top-heavy components or vulnerable stage of assembly or installation or removal.	All trench boxes / shields must be assembled and installed in accordance with the manufacturer's instructions and site specific method statement. The lifting of trench boxes (or shields) requires careful consideration due to their size and weight. An appropriate lift plan should be carried out. The same applies to the installation of large struts.	Ensure that handling and lifting points are identified by the site team.
Installation of Equipment	Lateral movement and or box failure due to trench wall collapse against box in an over wide dig. Side loading and /or damage to rear struts. Bolts/Pins becoming loose during use. Limited field of view of excavator driver. Working outside the shielded zone / inadequate batter at front face of box.	The excavation should be inspected: • at the start of the shift in which the work is to be carried out; • after an event likely to have affected the strength or stability of the excavation; • after any material unintentionally falls or is dislodged. The results should be entered into an inspection report / register or similar.	Inspections must be by a competent person and in accordance with the Construction CDM 2015 Regs 22, 23 & 24. Consider need for separate authorisation or 'permit to work' where checks following installation of equipment or pre-shift inspection reveals eg overdig that needs remedial work prior to continuing.
Equipment Extraction	Poorly planned/executed slinging and or lifting operations. Workers tempted or expected to go into unsupported areas or work close to open edges.	Lift Plan. Agreed safe sequence of work. Step back and review process if difficulties arise.	

Figure 5 - Excavation with Proprietary Bracing system and Edge Protection

ACTIVITY/ HAZARD	CONSIDERATIONS	PRECAUTIONS TO BE TAKEN TO REDUCE THE RISK	POSSIBLE FURTHER CONTROL MEASURES
ACTIVITY 3 - TEMPORARY WORKS DESIGN FOR EXCAVATIONS			
Inadequate design	Appoint a suitably qualified and experienced designer.	Essential to provide the designer with a comprehensive design brief including representative borehole or trial pit soils results.	Check actual soil conditions match those in the design brief.
Lack of coordination and communication between all parties	Appoint a Temporary Works Co-ordinator (responsible person) in accordance with BS5975: 2008. Vital that the person coordinating the temporary conditions and temporary works is made fully aware and kept up to date with the desired build sequence; other works to be undertaken in the same area; any changes to plans; any issues encountered; etc.	Temporary Works Coordinator to: • compile the design brief; • check submitted temporary works design; • co-ordinate the various segments of the scheme design and temporary works to ensure they interface correctly and safely • assess the risk and monitor; • ensure compliance with temporary works design; • ensure kit is assembled and installed according to manufacturer's instructions; • monitor changes in site conditions when compared to the design brief.	Check, frames and struts are positioned as specified. Check required 'toe-in' of sheets/piles. Check that excavated ground and the groundwater regime is as assumed in the design. Check location of spoil and other possible surcharges onto the excavation. Monitor activities. Discussion with the permanent works designer (CDM 2015)
Excavation is re-located after design has been submitted	Change in soil parameters and groundwater levels. Potential effects on adjacent structures including buildings and e.g. slope stability.	Check if appropriate borehole log has been used. Check if surcharge details have changed. Check if depth has changed. Check proximity to structures that could be affected. Refer back to temporary works designer to re-work design.	Review access and installation/lifting requirements.
Exposure to contaminants in ground	Check with CDM site information / Principal Designer / Lead Designer whether contaminated ground is to be expected in location of excavation. Review existing information if concerns arise and request sampling / assessment if concern not alleviated. If the type or level of contamination will create wider problems consider redesign of works to avoid excavation. E.g. driven or compaction piling, directional drilled services.	Seek specialist chemical advice to ascertain degree of problem to workforce, subsequent users of site and environmental issues. This will help you to devise most cost effective approach for short and long term. If excavation is known to be in contaminated land, check with shoring supplier that structural integrity of shoring equipment will not be compromised through contact. Check cleaning requirement for equipment before return to supplier.	Method of work to be specified to accommodate contamination. Where appropriate plan for: • Briefing of workforce; • Minimising contact with dug materials - avoid working in wet excavations; • Selection and use of appropriate PPE; • Sufficient welfare provision possibly including showers; • Worker decontamination procedures including demarcation of clean / dirty areas; • Removal or stockpile or soil decontamination in a manner that will not spread contamination or exacerbate situation.
Soil profile encountered different to that used in temporary works design	Temporary works co-ordinator to check 'actual' profile against 'design' profile as works progress.	Continually monitor soil profile. If 'actual' varies from design immediately, inform temporary works designer to check design stability.	If variance in profile is deemed to be significant stop work until design has been re-checked. If situation unstable during delay consider backfilling excavation.

ACTIVITY/ HAZARD	CONSIDERATIONS	PRECAUTIONS TO BE TAKEN TO REDUCE THE RISK	POSSIBLE FURTHER CONTROL MEASURES
Groundwater characteristics and control	Temporary works co-ordinator to check 'actual' groundwater regime is consistent with 'design' assumptions i.e. de-watering has been specified.	Regularly monitor and record groundwater characteristics, i.e. rate of flow, strike levels. Ensure the proposed method of groundwater control is that used in the 'basis of design', i.e. do not sump pump when well point. If 'actual' varies from design immediately, inform temporary works designer to check design stability.	If variance in characteristics is deemed to be significant, cease work until design has been re-checked.
Change in depth of excavation	Do not exceed design depth without design being re-worked.	If depth is to be varied, immediately inform temporary works designer to re-work design based on altered depth.	Update system of work and method statement where the new design will affect how the work is carried out.
Change in plan dimensions of excavation	Do not exceed stated dimensions without design being re-worked.	If dimensions are to be varied, immediately inform temporary works designer to re-work design based on altered dimensions.	
Change in surcharge or Introduction of new surcharge	Do not exceed design surcharge without design being re-worked.	Ensure surcharge assumptions are correct, e.g. • weight and position of excavator; • position and size of spoil; • position of adjacent roads and batters. Monitor if new surcharges are introduced, e.g. • new haul road adjacent to dig; • large plant positioned near dig; • spoil dumped near excavation.	Immediately inform Temporary Works Designer of change to plan so design can be re-worked.
Unknown structures / services encountered	The position of existing services or unknown structure may require some of the temporary supports to be repositioned and alternative means of ground support to be used around services.	Note the position and nature of the structure and services and inform Temporary Works Designer to assess impact on design.	If variance in characteristics is deemed to be significant, cease work until design has been re-checked.
Ground reduction details	Failure to carry out the ground reduction has a major effect on the design of the temporary works scheme.	Ensure all ground reduction details (batters, etc) as specified in temporary works design brief are complied with. If this is not possible, inform temporary works designer and request that the design is changed.	Cease affected and knock-on operations until a new design has been prepared and checked.
Stability of shoring system during use	The design of a temporary works solution will include checks on the stability of the design. This stability should be checked throughout the installation and removal process.	Ensure that the system has been installed as per the temporary works design. Continually monitor equipment for signs of overloading e.g. deflection, deformation. If in doubt refer to the equipment supplier.	Do not use the shoring system as a work platform for storage of materials. Do not use the shoring system to lift from. Keep shoring equipment clear of spoil and debris.
Stability of adjacent structure and batters	Have all the adjacent structures been considered in the design brief. Is there accurate data on foundation types and depths of adjacent structures? If excavation is in or around embankments or slopes, carry out a global stability analysis, e.g. slip circle checks.	Continually monitor adjacent structures and batters for movement. A trench dug across a slope is likely to be more unstable than a trench cut down a slope. Where possible design layout to minimise risk.	If in doubt refer back to the Temporary Works Designer.

ACTIVITY/ HAZARD	CONSIDERATIONS	PRECAUTIONS TO BE TAKEN TO REDUCE THE RISK	POSSIBLE FURTHER CONTROL MEASURES
Instability of excavation during extraction of shoring system	Forward planning is essential. TWC should detail in the design brief any specific extraction method.	Work to an approved method of work to ensure stability of excavation during extraction of equipment. Identify where 'short term stability' is being assumed when considering the stability of the excavation during extraction.	Do not remove any cross struts unless specifically allowed for in the temporary works design.
Temporary works design checked by external organisation	Consider checking procedures in accordance with BS5975:2008.	Prior to commencing work ensure all relevant external organisations are issued with temporary works design brief and design for checking purposes.	Ensure any changes/revisions to the design are reviewed by the designer and the checker.
Change of Method Statement	If method statements incorporating temporary works designs are amended, ensure the original design assumptions are not compromised.	Changes to the method statement should only be carried out by authorised personnel under the control of the TWC. If significant changes pass onto the temporary works designer for comment.	Ensure any changes to the method statement are to be briefed to the workforce before work commences.

Figure 6 - Proprietary Shaft Bracing System

Figure 7 - Proprietary Bracing Strut

ACTIVITY/ HAZARD	CONSIDERATIONS	PRECAUTIONS TO BE TAKEN TO REDUCE THE RISK	POSSIBLE FURTHER CONTROL MEASURES
ACTIVITY 4a – INSTALLATION OF TRENCH SHEETS AND LIGHTS PILES – VIBRATORY HAMMERS			
Crushing Hazard	Be aware of swinging loads.	Keep hands clear of the clamping mechanism.	Wear protective gloves.
Pile falling from clamp	Are the personnel trained and competent Equipment should be inspected and maintained User training	Ensure operator is trained and competent and familiar with the operational controls of the specific equipment in use. Ensure that the hydraulic hoses are in good condition. Ensure that the correct safety chain is fitted and is within certification and of sufficient capacity for the pile being lifted. Ensure that the retainer works correctly and is used at all times. Operatives should as far as is reasonably practicable stand clear from the slung pile whilst it is being pitched and traversed into position.	Ensure that the supplier's instructions have been supplied with the equipment. Tool box talk The safety chain clamp should be kept clean (debris may cause the locking device to fail) The safety chain clamping device is also prone to accidental crushing if the equipment is abused.
Excessive Noise	Carry out Noise assessment.	Follow guidance in BS 5228:1 'Code of practice for noise and vibration control on construction and open sites. Noise'. Reduce noise levels where reasonably practicable using engineering controls Where noise level is likely to exceed control limit set up hearing protection zone using eg signs, barriers, instructions . Operatives must wear ear defenders within hearing protection zone at all times.	If power-packs are insulated for sound, keep access doors shut.
Vibration	Consider nearby buildings and other structures.	Follow guidance in BS 5228:2 'Code of practice for noise and vibration control on construction and open sites. Vibration'. Maintain a 15m-exclusion zone as noted above. Use high frequency or resonant free type vibrators (resonant free vibrators can significantly reduce effects of vibrations to personnel and structures during the critical start up period of the vibrator).	Consider use of condition surveys before work starts for surrounding vulnerable buildings. Old and historic buildings can be particularly sensitive to vibration and potential cost of repairs can mean vibration level must be minimised.
Settlement	Consider adjacent structures.	Seek professional advice in sensitive locations.	
High pressure hydraulics failure	High pressure fluid injection. Explosive impact.	Ensure all hydraulic hoses and fittings are in good condition. Fit burst protection guards to hoses. PPE should be worn at all times.	Equipment should be inspected at the start of each shift or if the operator suspects that the hoses have become snagged during piling operations. Ensure that hoses are not pressurised when maintenance is taking place. Emergency procedures include recognising seriousness of injection incident involving eg hydraulic fluid or high pressure grease. Assessment by A+E Department always needed. Must include fully briefing medical team that a high pressure injection injury has occurred.

Failure of swivel components	Failure of the swivel will cause the hammer/sheet to become difficult to manoeuvre and may cause crush injuries.	Regular inspections of the swivel connection including all pins and retaining clips should be carried out.	Equipment should be inspected at the start of each shift.
Refusal	Refusal is the point at which the sheet / pile cannot be driven further without damage to the hammer or the sheet / pile. Vibratory hammers should **not** be used in stiff clays.	Refusal rates for vibratory hammers may vary considerably. For suspended vibrators a rate of 50mm/minute may be accepted by the designer (refer to "Safety in Shoring" published by CPA).	
ACTIVITY 4b – INSTALLATION OF TRENCH SHEETS AND LIGHT PILES – AIR HAMMERS			
Excessive Noise	Carry out Noise assessment.	Follow guidance in BS 5228-1 *Code of practice for noise and vibration control on construction and open sites.* Reduce additional noise levels where reasonably practicable using engineering controls Where noise level is likely to exceed control limit set up hearing protection zone using eg signs, barriers, instructions. Operatives must wear ear defenders within hearing protection zone at all times.	If power-packs are insulated for sound, keep access doors shut.
Fracture and/or failure of components	Are the personnel trained and competent? Equipment should be inspected and maintained. User training.	Inspect the hammer regularly; look particularly for cracking to the anvil and anvil retaining stops. Ensure operator is trained and competent and is familiar with the suppliers operating controls and instructions.	The hammer should never be run off the pile. The operator should ensure that the supporting chain remains slack whilst the pile is being driven down.
Oil Mist	Oil mist in the working area is likely to be inhaled and is hazardous to health. Prevent by: Maintenance and inspection. Exclusion zone.	Correct airline oil lubrication should be maintained. Maintain the personnel exclusion zone when the hammer is operating. Do not stand directly in line with the exhaust ports.	Correct fitting of the oil lubricator is essential – refer to suppliers operating instructions.
Compressed Air	If a hose connection fails the live hose end can flail and cause serious injury if it strikes anyone nearby. High pressure air can pass through clothing and skin or enter the body via the eyes, ears, mouth or other orifices. Pressure injection injuries are life threatening, especially if the air enters the blood stream.	Hose couplings downstream of the compressor outlet should be fitted with whip-check wires or chains. Maintenance and inspection. Systems of work & training. Exclusion zone. Ensure all hoses couplings and clamps are regularly inspected and in good order. Switch off compressor and decompress prior to removing hoses.	Only use in accordance with instructions in the operator's manual for the compressor. Site specific emergency procedures include use of first aider/s, knowing where the nearest A+E Department is, means to contact emergency services. Ensure ambulance or casualty team is fully briefed that air injection has occurred.
Falling components	Risk Assessment	Maintain exclusion zone when hammer is operating.	Ensure adequate PPE

Annex A – Definitions

competent person

a person having sufficient knowledge, ability, training and experience of the work to recognize the hazards and the means to reduce or eliminate the risks

external organisation

an organisation that is independent to the original organisation undertaking the design

global stability analysis

the process that is undertaken to check not only the local stability of the shoring system, but also the surrounding area, which may include an adjacent embankment, buildings etc

hazard

something with the potential to cause harm, (this can include the site situation and layout, substances or machines, and other aspects of work organisation). Hazards where any incident would cause fatalities or major injuries to one or especially several persons need the highest degree of control

permanent works designer

designer responsible for those aspects of the project that on completion will be handed over for the client to use. CDM 2015 projects involving more than one contractor require a Principal Designer (PD) to coordinate and manage all aspects of permanent works design. Note that the PD also has responsibilities to ensure that a temporary works design process is in place and to provide information that will assist temporary works designers.

permit to dig

this provides a formal authorisation and safety control system aimed at the prevention of accidents, damage to property and damage to products, when foreseeable hazardous work is undertaken (See **Annex B**)

risk

the likelihood that harm from a particular hazard will occur

short-term stability

the inherent ability of a soil to stand as a vertical cut without the aid of further support for periods of short duration. This may be as low as the time taken to lift the excavator bucket out of the trench

slip circle checks

the process of checking the stability of sloped ground formed by excavation, natural embankments and earth dams

surcharge

a vertical load or weight caused by spoil, overburden, vehicles, equipment, or activities that may affect stability, incurring additional lateral loading on the shoring system

temporary works co-ordinator

TWC

A competent person appointed by the Main Contractor who co-ordinates all aspects of the temporary works from concept to completion including: design, design checking, installation, work in progress, authorisation/permits to load, completion, removal of temp works etc.

temporary works supervisor

TWS

competent person who is responsible to and assists the temporary works co-ordinator

temporary works designer

TWD

competent person who carries out the design of temporary works

appointed person

a person with sufficient training and experience to enable them to carry out the planning of lifting operations. The appointed person may need assistance with the assessment of ground conditions if mobile lifting plant is to be used

Annex B - Permit to Dig

This provides a formal authorisation and safety control system aimed at the prevention of accidents, damage to property and damage to products, when foreseeable hazardous work is undertaken.

The permit to dig should consist of a document which:

- details the work to be done;
- details the boundaries of the working area;
- details the precautions/control measures to be used by the workforce;
- details the items made safe to allow the work (e.g. services shut off/made dead);
- lists the hazards/features to be avoided;
- states the time period the permit to dig is valid for;

It should be:

- signed by the person issuing and the person receiving it
- withdrawn (signed off) by the issuer and the recipient on completion of the task or at the end of the authorised time period.

NOTE: *permits to dig do not, in themselves, make a job free from risk. They rely upon effective control and coordination in order that hazards are identified and risks are suitably and sufficiently assessed.*

NOTE: *on very small sites a formal permit system may not be in place but the person in control will still need to take steps to ensure harm cannot result plus brief workers on the steps to be taken and when satisfied the work has been properly arranged authorise the intrusive works to start.*

Annex C - Further Information and Guidance

Legislation *(The following can be downloaded free via the HSE website)*

Health and Safety at Work etc. Act 1974. London: The Stationery Office.

The Lifting Operations and Lifting Equipment Regulations 1998 (LOLER).

Provision and Use of Work Equipment Regulations 1998 (PUWER).

L22 Safe use of work equipment, HSE Books.

The Management of Health and Safety at Work Regulations 1999 as amended (MHSWR).

Work at Height Regulations 2005 (WAHR).

The Pressure Systems Safety Regulations 2000.

The Control of Noise at Work Regulations 2005.

The Control of Vibration at Work Regulations 2005.

The Manual Handling Operations Regulations 1992 (as amended).

Electricity at Work Regulations 1989.

The Construction (Design and Management) Regulations 2015 (CDM).

L153 Construction (Design and Management) Regulations 2015. Guidance on Regulations, HSE Books

The Confined Spaces Regulations 1997 (CSR).

L101 Safe work in confined spaces, HSE Books.

Standards *(Priced documents available from BSI)*

BS 5228-1:2009+A1:2014, *Code of practice for noise and vibration control on construction and open sites. Noise.*

BS 5228-2:2009+A1:2014, *Code of practice for noise and vibration control on construction and open sites. Vibration.*

BS 5975:2008 + A1:2011, *Code of practice for temporary works procedures and the permissible stress design of falsework.*

BS EN 16228:2014 (Parts 1 - 7), *Drilling and foundation equipment. Safety.*

Other Publications *(The following can be downloaded free from either the CPA or HSE websites)*

HSE Guidance GS6 - *Avoiding danger from overhead power lines.*

HSE Guidance HSG47 - *Avoiding danger from underground services.*

HSE Guidance HSG150 - *Health and Safety in Construction.*

HSE Leaflet INDG163 – *Risk assessment - A brief guide to controlling risks in the workplace.*

Management of Shoring in Excavations Part 1 - Management, Construction Plant-hire Association

Selection of Proprietary Shoring Equipment, Construction Plant-hire Association

Ground Conditions for Construction Plant, Construction Plant-hire Association

Risk Assessment for Shoring and Piling Operations, Construction Plant-hire Association

Guidance on Lifting Operations in Construction When Using Excavators, Construction Plant-hire Association.

Safe Use of Quickhitches, Strategic Forum for Construction Plant Safety Group.

Safety in Shoring. The proprietary shoring and piling Equipment Manual, Construction Plant-hire Association

Construction Plant-hire Association Shoring Technology Technical Information Notes:-

TIN 201 - *Definition of Engineering Terms Relating to Piling, Excavations and Temporary Works Design;*

TIN 202 - *Schedule of Cold Formed Steel Sheets;*

TIN 203 - *The Use of Restraining Chains to Support Shoring Equipment;*

TIN 204 - *The Correct Use of Lifting and Other Attachment Points for Shoring Equipment*

Useful Websites

Construction Plant-hire Association	www.cpa.uk.net
Build UK	www.builduk.org
CITB	www.citb.co.uk
Health and Safety Executive	www.hse.gov.uk/construction/index.htm
Shoring Technology Interest Group	www.cpa.uk.net/p/Shoring-Technology-Interest-Group/
Strategic Forum for Construction	www.strategicforum.org.uk/report.shtml
Temporary Works Forum	http://twforum.org.uk/pubs.html

Annex D- Working Group Membership

Chairman:

S Hesketh	MGF Ltd

Members:

B Bolton	HSE
J Breen	RMD Kwickform
G daLuz Vieira	Shore and Pour
A Gould	Groundforce
J Grubb	CITB
J Hallows	CITB
J Harris	Consultant
E Jones	Site Equipment Ltd
T Williams	Mabey Hire
H Steele	Construction Plant-hire Association
M Thompson	HSE
J Underwood	HSE

Temporary Works Forum Sub-Group

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S Marchand	Wentworth House Partnership
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