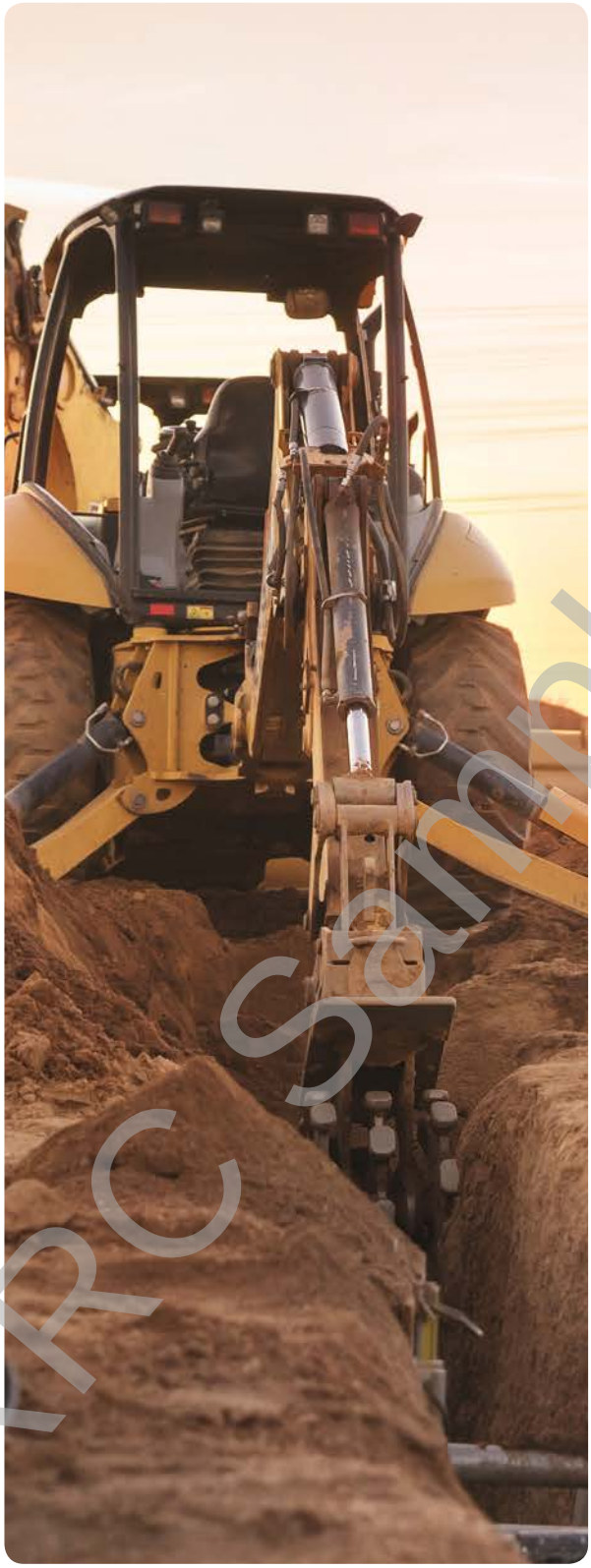
Element 4

Excavation



Learning Objectives

Once you've studied this element, you should be able to:

1. Explain the hazards and risk assessment of excavation work.
2. Explain the control measures for excavation work.
3. Explain the hazards and risks associated with confined space working and safe working.

Contents

Excavation Work Hazards and Assessment

IN THIS SECTION...

- The hazards of excavations include: striking buried services; people, objects or materials falling in; collapsing of sides; collapsing of adjacent structures; flooding; using cofferdams and caissons; contaminated ground; toxic and asphyxiating atmospheres; and mechanical hazards.
- Consideration should be given to overhead hazards, including power lines.
- Risk assessment factors to consider are: depth, type of soil, type of work, use of mechanical equipment, proximity of roadways and structures, the presence of the public and weather conditions.

The Hazards of Work in and around Excavations

The following are hazards associated with excavation work.

Buried Services

Striking services such as high-voltage electricity cables, gas pipes, mains water or other buried services (e.g. telephone and cable TV lines) can lead to electric shock, arcing, burns, fire, gas explosion or rapid flooding of the excavation, as well as major business disruption to service users in the area.

A shallow excavation revealing a collection of buried services

Falls of People/Equipment/Material into Excavation

Falls can happen:

- Because of an unfenced edge.
- While people are climbing in or out from ladders or other access equipment.
- When tools or materials (bricks, timber, etc.) fall into an excavation onto persons, from an unprotected edge.
- When vehicles drive too close to the side of an excavation, collapsing the sides or tipping in.
- When spoil (loose soil) or stacked, loose sand is piled too close to the sides of an excavation.
- When adjacent structures (e.g. wall or scaffold) are undermined by an excavation and collapse in.

Collapse of Sides

Collapse occurs when the unsupported sides of an excavation slip and cave in (often due to poor support systems of the excavation sides). Severe crush injuries can result from even relatively small collapses because soil is very heavy, especially when wet. Workers buried or trapped in soil can asphyxiate in minutes, and do not have to be completely buried for this to occur; being buried up to the chest can lock the rib cage and have the same effect.

Collapse of Adjacent Structures

Digging too close to, or under, the foundations which support nearby buildings or structures may undermine their support and cause collapse of the building or structure into the excavation. This would be even more dangerous if the excavation itself were also to collapse.

Water Ingress

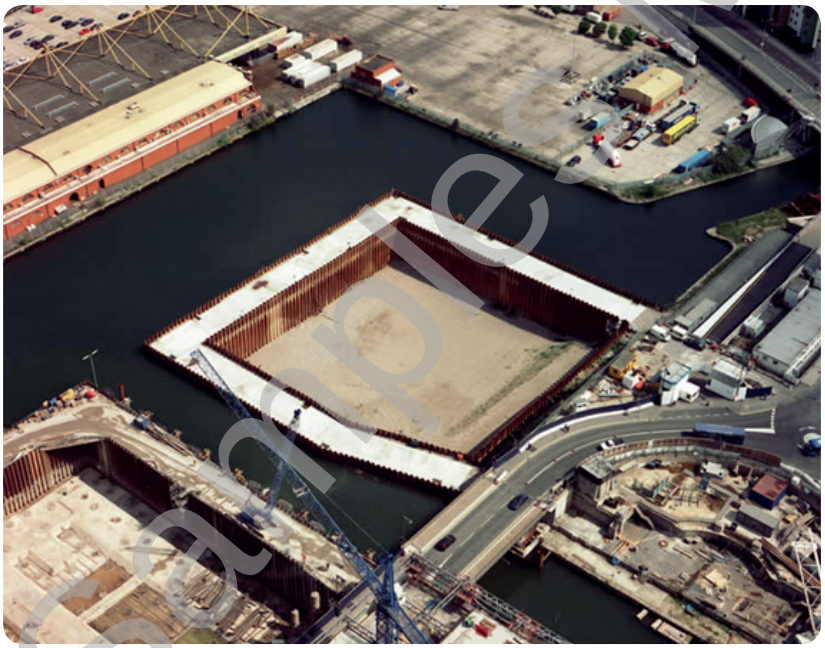
Flooding can occur from:

- Surface water, during heavy rain or snow.
- Groundwater (a high-area water table), nearby rivers, streams and watercourses (especially if breached).
- A burst water main caused by the excavation activities.

Use of Cofferdams and Caissons

These are structures (usually watertight enclosures) which are pumped dry to allow work to be carried out inside them below the waterline on bridge building, etc.

They must be suitably designed and constructed to prevent the ingress of water (or other materials), or appropriately equipped to pump out water, and provide shelter and escape should water or materials enter it. The cofferdam or caisson must be inspected by a competent person at the start of every shift or after any event likely to have affected its strength or stability.



Cofferdams or caissons constructed to prevent the ingress of water

Contaminated Ground

Contaminated ground can:

- Be found on sites that previously housed chemical works or storage areas.
- Contain methane or hydrogen sulphide gas (both from microbial decay).

Contaminants can be varied in range and include the following:

Industry	Possible Contaminant
Petrochemicals	Hydrocarbons, benzene, phenol, acids, alkalis
Steel/iron works	Iron, copper, zinc, asbestos
Gasworks/power stations	Coal, sulphur, phenol, asbestos, cyanides
Pits/quarries	Leachates, copper, zinc, lead, methane
Tanneries	Anthrax
Miscellaneous industries	Polychlorinated biphenyls, sulphates, metals, micro-organisms

Toxic and Asphyxiating Atmospheres

Toxic and asphyxiating atmosphere are created from the industries mentioned in the table above and from gases used on site. The hazards are that:

- Heavier than air, gas such as Liquefied Petroleum Gas (LPG) and carbon dioxide, can infiltrate an excavation.
- The combustion gases from nearby construction equipment, such as diesel generators and motor vehicles, can seep into excavations with the same effect.

Mechanical Hazards

Mainly from the use of plant and equipment around or in the excavation:

- Vibration from plant operation may cause collapse.
- Excavating machinery itself may create hazards, such as striking persons in or around excavations.

Overhead Hazards Including Power Lines

Work beneath overhead services and power lines in particular should be avoided.

Before excavation work starts, all overhead services should be identified and any diversions or disconnections ensured before excavation work begins. Service providers should be contacted to obtain accurate plans of supplies.

Three situations arise in construction work at overhead power lines:

- No scheduled excavation work or passage of plant to take place under the lines.
- Excavation plant and equipment will pass beneath the power lines.
- Excavation work will take place beneath the power lines.

These situations, and appropriate controls, are discussed in detail in Element 10 'Electricity'.

Risk Assessment

Factors to Consider

Risk assessments should be carried out in accordance with the **Management of Health and Safety at Work Regulations 1999 (MHSWR)**, with due consideration to the excavation under the **Construction (Design and Management) (CDM) Regulations 2015**.

TOPIC FOCUS

Risk assessment - factors to consider:

- Depth of the excavation.
- Soil type - this may vary from fine sand which can flow easily, to heavy clay which is much more cohesive.
- Three broad classes of ground exist:
  - Non-cohesive ground or light soil, e.g. sand or gravel, whose natural angle of repose when dry is usually 45° or less.
  - Cohesive ground or heavy soil, e.g. stiff clay, whose natural angle of repose is about 60°.
  - Rock, whose natural angle of repose varies from about 80° for loosely bonded or light rock, to 90° for tightly bonded heavy rock. Rock may, however, have steeply sloping clay planes which may fail, with resulting collapse.
- Type of work involved, e.g. at the side of a road; in a housing development; laying pipes/cables; trenches; pits.
- Use of mechanical equipment - the types being used.
- Proximity of the excavation to roadways, watercourses, structures, schools and hospitals.
- Presence of the public/children.
- Weather.

STUDY QUESTIONS

1. What hazards are associated with work in and around excavations?
2. What factors should be taken into account with regard to risk assessments for excavations?

(Suggested Answers are at the end.)

Control Measures for Excavation Work

IN THIS SECTION...

- Precautions must be taken to prevent persons falling into, or being injured while working in, excavations. General precautions include:
  - Identifying buried services and using safe digging methods to avoid contact with them.
  - Supporting the sides of excavations to prevent collapse, and providing workers with suitable access and egress, and crossing points to pass over excavations.
  - Barriers, lights and signs used to demarcate danger areas.
  - Spoil to be removed to and stored at a safe distance from the excavation to prevent it collapsing back in.
  - De-watering methods used to remove water from excavations.
  - Vehicles and materials on site to have special precautions applied to prevent them falling into or collapsing the excavation.
  - Workers in excavations to wear items of Personal Protective Equipment (PPE) such as hard hats and safety footwear.
- When working in the vicinity of contaminated ground, testing is essential and extra welfare facilities should be provided to accommodate workers (separate from normal site facilities). Health surveillance may be appropriate.
- Excavation supports are to be inspected before each shift and after any event that could affect the integrity of the excavation, and reports to be made and kept.

Controls

In common with other construction activities, control of the risks involved in excavation is based on effective management. The **CDM Regulations 2015** apply in this respect, and excavations must be carried out under the supervision of a competent person.

The Health and Safety Executive (HSE) guide *Avoiding danger from underground services* (HSG47) provides further detailed reading on this subject.

Identification/Detection and Marking of Buried Services

The location and configuration of underground services should be identified prior to work commencing. It may well be possible to avoid cable routes at the planning stage of work. Before work starts, the following action should be taken:

- Check any available plans.
- Contact local service providers and owners, such as electricity, gas, water, telecommunications or TV companies.
- Survey the site and surrounding areas to identify indicators of the existence of cables, etc., e.g. streetlights or junction boxes.
- Use cable locators with trained operators. Plastic and non-metallic underground services cannot be identified by conventional locators, but could be identified by the use of metallic tracer wire laid with the pipe or by using a signal transmitter inserted and pushed along the pipe itself.

The positions of known services should be marked on plans and also on the ground itself. All employees must receive adequate information and instruction about the nature of the risks.

Where appropriate, arrangements must be made with the service providers to isolate the cables/pipes and ensure that it is safe to work in the vicinity of them.

Safe Digging Methods

Safe digging methods include:

- Using locators to determine the position and route of pipes or cables (frequently using them during the course of the work).
- Keeping a careful watch for evidence of pipes or cables. Remember that plastic pipes cannot be detected by normal locating equipment.
- If contact is made with any unidentified service pipe or cable, stopping work until it is safe to proceed.
- Regarding all buried cables as live until disconnected and proven - pot-ended cables cannot be assumed to be dead or disused.
- Not using excavators and power tools within 0.5m of the indicated line of a cable/pipe.
- Using hand digging when nearing the assumed line of the cable/pipe.
- Using spades and shovels (preferably with curved edges to aid scooping) rather than other tools, e.g. forks and picks.
- Reporting any damage to the appropriate services and keeping personnel clear until it is repaired.
- Having an emergency plan to deal with such damage to pipes or cables.
- Supporting exposed cables and pipes and protecting against damage by backfilling. They should never be used as hand- and foot-holds.

Use of a cable detector
(Source: HSG47 *Avoiding Danger from Underground Services*, HSE, 2014 (www.hse.gov.uk/pubns/priced/hsg47.pdf))

Methods of Supporting Excavations

Excavation supports will prevent the collapse of the side walls of the excavation and allow work to continue uninterrupted inside the workings. The type of support structure used will vary, depending on the:

- Type of ground being excavated.
- Length of time the excavation will be open and in use.
- Type of work being carried out.
- Groundwater conditions and potential for flooding.
- Depth of the excavation.
- Number of people in the excavation.

Here are some examples of types of **excavation supports**.