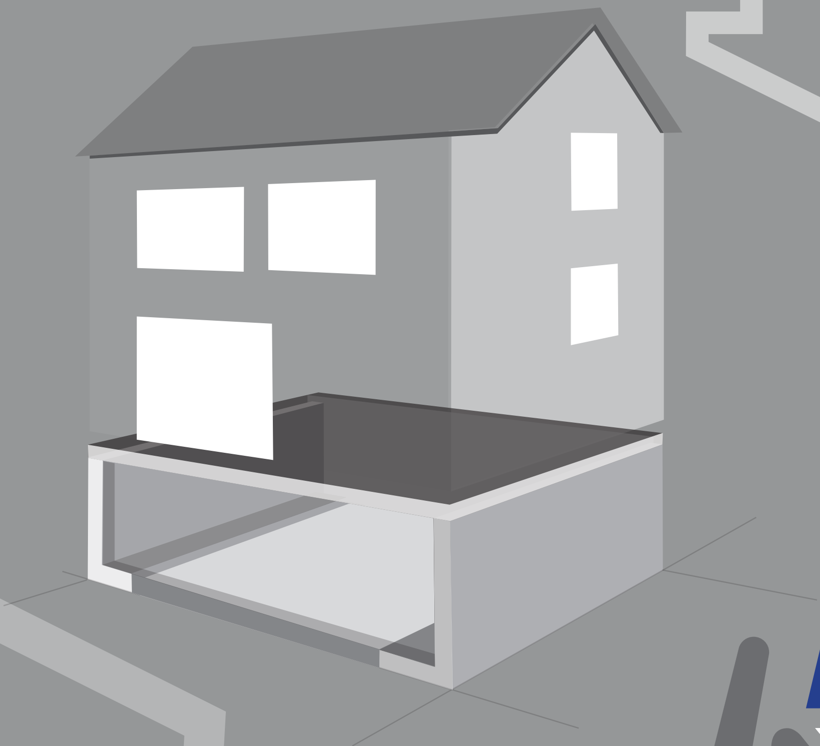
ASUC | Guidelines on

SAFE AND EFFICIENT BASEMENT CONSTRUCTION DIRECTLY BELOW OR NEAR TO EXISTING STRUCTURES



ASUC

Underpinning & Subsidence Repair Techniques | Engineered Foundation Solutions | Retro Fit Basement Construction

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ASUC

ASUC is an independent trade association formed by a number of leading contractors to promote professional and technical competence within the underpinning industry. Members offer a comprehensive range of subsidence repair techniques, engineered foundation and retrofit basement construction solutions. It publishes a number of useful documents on underpinning and related activities and a comprehensive directory of members all of which are freely available to download via the website. ASUC members offer 10 or 12 year, depending on the nature of the works, insurance backed latent defects guarantees.

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GUIDELINES ON SAFE AND EFFICIENT BASEMENT CONSTRUCTION DIRECTLY BELOW OR NEAR TO EXISTING STRUCTURES

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CONTENTS

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HEALTH AND SAFETY EXECUTIVE (HSE) FORWARD TO ASUC BASEMENT GUIDELINES 2ND EDITION

Building a basement directly below or next to an existing building has become a popular means to extend a house. However, compared to a conventional above ground extension, basement construction is more complicated both in the design and preparation work needed, and in how the work needs to be carried out. This creates significant safety risks for workers and the public.

Any failure to correctly plan or conduct the work can lead to ground movement in excavations and the collapse of existing buildings onto workers and people nearby. Costly repair work or demolition of the original building, and sometimes adjacent properties, may also result.

I welcome that the industry has recognised that management and control of the risks involved in basement construction has frequently been poor and has put significant effort into producing this advice to assist all of those involved.

The Health and Safety Executive was consulted in the production of the sensible and proportionate guidance covering health and safety issues that form a large part of this publication. I would like to thank everyone from industry who has contributed and ask that the advice it contains is now turned into action.

Peter Baker

Chief Inspector of Construction

1 EXECUTIVE SUMMARY

1.1 There has been a marked increase in the number of domestic basement construction projects undertaken below or near to existing structures. There has also been a significant rise in the number of health and safety incidents linked to basement construction including fatalities, injuries, and damage to buildings, as well as negative impact on people not involved in the works, notably local residents.

1.2 The Association of Specialist Underpinning Contractors (ASUC) is publishing these guidelines to improve the safety and efficiency of basement construction below or near to existing structures and to reduce negative impact on others, especially people living or working near to basement construction projects.

1.3 This document will consider basements which are built either directly below the footprint of an existing structure or where the basement will structurally undermine the foundations of an existing structure.

1.4 The objective of these guidelines is to enable clients, designers, engineers and others involved in basement construction projects below or near to existing structures to instruct safe and efficient work.

1.5 Basement construction is a complex form of building involving geotechnical, hydrological, structural and civil engineering, health and safety and waterproofing expertise that even those with significant construction experience may not have encountered previously.

1.6 The single leading principle throughout these guidelines is the absolute priority that health and safety has over all other aspects of a project.

1.7 Temporary works (support to existing buildings and to the ground around excavations) is critical and is often overlooked or addressed superficially.

1.8 Basement works can be classified as cellar extensions, single level basements or multi-level basements.

1.9 The main construction techniques used to build the supporting and retaining walls of basement structures are underpinning and piling.

1.9.1 There are two main types of underpinning: mass concrete underpinning and reinforced concrete (RC) underpinning.

a. Mass concrete underpins provide vertical support underneath existing walls but usually require an inner RC retaining wall to provide additional horizontal strength as on their own they are usually unable to retain the ground outside the basement.

b. RC underpins can usually provide vertical support underneath existing walls and retain the ground outside the basement without an additional inner retaining wall.

1.9.2 In basement construction two main types of piles are used to build retaining walls; reinforced concrete (RC) bored piles and steel sheet piles.

a. RC bored pile walls are constructed of either a series of side by side columns formed vertically in the ground (called contiguous piles) with a small gap between each pile or by a series of overlapping soft and hard piles (called secant piles). For secant piles the soft piles are constructed first followed by the hard piles. The bores for the hard pile should penetrate the edges of the initial soft piles resulting in the piled structure being a continuous wall with no gaps between any of the piles.

b. Steel sheet piles are constructed using thin interlocking sheets of steel which are driven into the ground. The edges of the steel sheets can be welded to limit water ingress.

1.10 Building below the groundwater level adds complication and cost to any basement construction project. There are several methods for building below the groundwater level. Careful consideration of the most appropriate method will be needed for each project where groundwater is encountered.

1.11 Temporary works in basement construction are used to support excavations, existing structures, partially built new structures, equipment and plant, and site facilities. Support for excavations and existing structures are critical. Temporary works for excavations covers support for individual underpin excavations and for the whole site during the main bulk excavation after the basement walls have been built.

1.12 Temporary works should be designed by a suitably qualified and experienced engineer called the Temporary Works Engineer (TWE). In addition to the TWE a named person must be appointed to coordinate temporary works. The person responsible for this function is often known as the Temporary Works Coordinator (TWC) and may be a dedicated person on larger sites or, on smaller sites, be the site manager or another manager. The TWC must be suitably qualified and experienced for that project.

1.13 Basements are generally constructed from the ground level down (the existing floor at the lowest level is removed and the basement is built from the ground level downwards) or by tunnelling underneath the existing floor which remains in place.

1.14 Ground level down construction can be completed from the bottom up (the ground is excavated and the ground slab is constructed before the upper level slabs) or from the top down (the upper level slab is constructed before the main excavation and construction of the ground slab).

1.15 The most appropriate construction method must be assessed on a case by case basis.

1.16 Basement construction can have a significant negative impact on people not involved with the work, especially local residents. The main negative impacts come from:

- Damage to surrounding buildings and structures
- Noise, vibration and dust
- Traffic

1.17 There will always be some negative impact but this should be minimised through early engagement, imaginative planning and considerate execution.

1.18 In addition to health and safety, which is the single most important priority, the other main factors to consider when choosing the construction technique and sequence are:

- Architectural design
- Occupier's desire to live in the existing building during the works
- Structure and condition of the existing building
- Party wall matters
- Soils and geology
- Hydrogeology especially groundwater which, if present, has a significant impact
- Surrounding structures
- Site access
- Impact on others

1.19 Basement construction under or near existing structures has a high level of construction hazard. Collapse of excavations, collapse of existing buildings and falls from height, including into excavations, are the three safety hazards most likely to lead to death or serious injury. Exposure to asbestos and to dust containing silica are the two health hazards most likely to cause death or serious injury.

1.20 Business clients, designers and contractors all have extensive duties under the Construction (Design and Management) Regulations 2015 (CDM 2015). Domestic clients also have duties under CDM 2015 but these are usually automatically transferred to the principal contractor or contractor or by arrangement to the principal designer.

1.21 Designers and contractors must manage risk by:

- Assessing hazards
- Avoiding risk where possible preferably by design
- Reducing risk throughout by selection of suitable control measures
- Developing safe methods and systems of work
- Managing and monitoring risk throughout
- Using only suitably trained and experienced personnel
- Having effective emergency plans and procedures

1.22 Only responsible, competent and experienced designers and contractors should be appointed.

1.23 Waterproofing ensures the usefulness of a basement and preserves the integrity of the structure. Waterproofing risk is assessed from low to high where a basement with any part below the permanent groundwater level is classified as high risk. All basements should be constructed to cope with groundwater levels up to the full retained height of the basement.

1.24 There are three types of basement waterproofing:

- Barrier protection using watertight membranes installed during or after construction
- Structurally integral protection where the material that forms the structure is waterproof
- Drained cavity protection where most of the water is held out by the structure but any water that penetrates is drained away and usually removed by pumps in a collection sump below the basement floor or, less commonly, flows away from the site by gravity

1.25 In high risk situations protection using more than one type of waterproofing can be considered. This is known as combined protection.

1.26 The basement structure and waterproofing should be considered as a whole rather than being considered separately.

1.27 Most problems with basement waterproofing are due to poor design or installation rather than with the failure of a waterproofing product. Manufacturers' warranties and guarantees for waterproofing are usually limited and will generally only cover a fault with the product and will not cover design or installation. In addition manufacturer's warranties and guarantees will usually only cover repair of the faulty product and will usually not cover the work needed to identify or uncover the repair or pay for any consequential losses such as the cost of repair of any damage caused by the water ingress.

1.28 Comprehensive first party indemnity latent defects insurance provides the best form of waterproofing guarantee cover. The waterproofing cover for the ASUC Basement Insurance Guarantee (BIG) is this type of guarantee.

1.29 The composition of the project team will vary by project. Apart from the Client the project team can include a Principal Designer (a health and safety requirement under CDM 2015), Architect, Structural or Design Engineer, Temporary Works Engineer, Temporary Works Coordinator, Principal Contractor, Party Wall Surveyor, Quantity Surveyor and others. A Structural or Design Engineer will always be needed in the design team. The Structural or Design Engineer can be an independent consultant or can be retained by a design and build contractor.

1.30 Basement construction work can be procured by any of the four main procurement methods: traditional design then tender, design and build, management or integrated. There is no single best method and they each have advantages and disadvantages. It is important to choose a form of procurement that incentivises safe and efficient construction.

1.31 The right insurances should be in place to protect all parties. The main insurances are: Professional Indemnity (PI), Employer's Liability (EL), Public Liability (PL), Contractors All Risks (CAR), non-negligent for third party property (JCT 21.2.1 / 6.2.4 / 6.5.1 insurance), existing buildings, and non-negligent damage to the client's property. Insurance cover for basement construction projects is complex and advice from experienced parties should usually be sought.

1.32 Guarantees for building work, like many guarantees, often promise much but deliver little. The detailed wording for each guarantee must be understood in order to know the true level of protection. The main types of guarantees are: company, product, insurance backed, latent defects insurance and indemnity latent defects insurance. The best protection is provided by a comprehensive indemnity latent defects insurance underwritten by a financially strong insurance company. The ASUC Basement Insurance Guarantee (BIG) is this type of indemnity latent defects insurance guarantee.

1.33 Basement developments will probably be the most complex structural work that a domestic property owner will undertake. The main areas for a domestic owner to consider at the outset are:

- Property rights and rights of access
- Planning permission
- Existing trees and their protection
- Listed building consent if relevant
- Building regulations particularly for fire safety and ventilation
- Health and safety
- Impact on neighbours
- The economics of the project
- The option of living in the building during the construction work
- Party wall matters
- Legal responsibilities and liabilities
- Choosing whether to instruct an architect or other designers, or to move forward with a design and build contractor

1.34 Basement construction is complex and should only be undertaken by suitably qualified and experienced teams.

1.35 Instructing an ASUC member to undertake a project should increase confidence that the work will be completed safely and efficiently.

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2 INTRODUCTION

2.1 Outline

In the last decade there has been a significant increase in the number of domestic basement construction projects undertaken below or near to existing structures. This has been driven by increasing property prices especially in London and advances in waterproofing technology.

Alongside this increase in domestic basement construction activity there have been several health and safety problems including fatalities, injuries, building collapses, partial building collapses and other damage to structures. There has also been significant negative impact on people not involved in the works notably residents living near basement construction projects. The Association of Specialist Underpinning Contractors (ASUC) is publishing these guidelines in order to support efforts to:

- Improve the safety and efficiency of basement construction below or near to existing structures

- Reduce negative impact on others, especially people living or working near to basement construction projects

2.2 Scope

Basements vary greatly in size, construction, complexity and end use. This document will consider basements which are built either:

- Directly below the footprint of an existing structure, or

- Where the construction will structurally undermine the foundations of an existing structure

In general the document is written with domestic basements in mind but the techniques and issues considered are largely the same for commercial basements.

Standard construction methods can generally be used on open sites where the ground can be excavated back at a shallow angle without affecting the foundations of surrounding buildings. This type of open site basement will not be considered further.

2.3 Objective

The objective of these guidelines is to enable clients, designers, engineers and others involved in basement construction projects below or near to existing structures to instruct or oversee safe and efficient work.

2.4 Overview

Basement construction is a complex form of building and involves a combination of geotechnical, hydrological, structural and civil engineering, health and safety and waterproofing expertise. Even those with many years of above ground construction experience may not have faced the issues that are met when building a basement underneath or near to the foundations of existing structures.

This document is intended to be used as an outline guide by property owners, developers, architects, engineers, contractors, quantity surveyors, building surveyors and anyone else involved in basement construction. It should provide a basis of understanding of the techniques used in basement construction and assist the informed consideration of the many factors and issues faced when considering a basement construction project. A summary of these factors is given below.

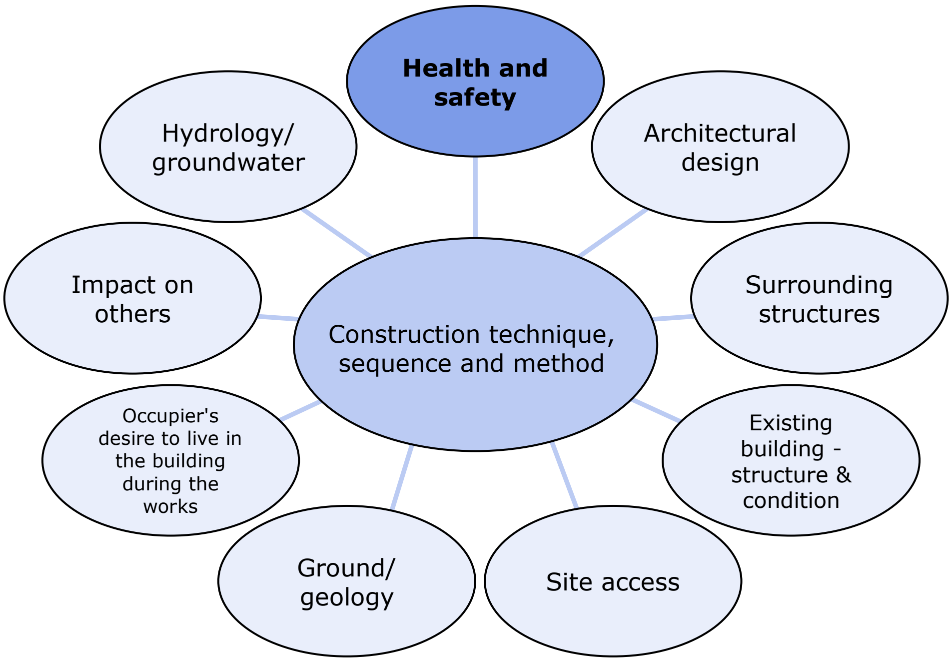


Fig 1. Main factors for consideration

The guide has been set out in a logical order however all of the areas covered are heavily interrelated so, to some extent, they cannot be viewed in isolation and need to be considered collectively.

This guideline is not intended as a code of practice, set of design rules, engineering specification or building code and does not provide a single answer for the complex question of what design or method is best for any individual project.

2.5 **Health and safety**

The single leading principle throughout these guidelines is the absolute priority that health and safety has over all other aspects of a project. Health and safety is covered in a dedicated section later in the document but at all times it is a fundamental consideration.

2.6 Key points

The key points in the guideline are:

- Health and Safety is paramount

- Temporary works (support to existing buildings and to the ground around excavations) are critical and is often overlooked or addressed superficially

- Environmental consequences and any negative impact on others should be minimised

- A well-managed safe project will be an efficient project - this applies both to the design and to the implementation of the works

- Basement design and construction is complex - all of the interdependent factors need to be considered at the design stage. Involving an experienced contractor as early as possible reduces the risk that early design choices will have subsequent negative safety and cost consequences

- The property owner will always bear some risk from third parties - involving an experienced team early will help to minimise these risks

- Proper risk management is not the same as wholesale risk transfer to the contractor - risks, both physical and commercial, should be considered early and each risk addressed appropriately

- Designers and contractors involved in the complicated business of basement construction should have relevant competence, qualifications and experience

- All parties involved in basement construction need to understand their own responsibilities and the responsibilities of the other parties

- Appointing suitably qualified and experienced parties early in the process is critical - once an inexperienced designer and/or an inexperienced contractor has started work it can be very difficult to bring a project back on track:

  - Once extensive structural work has started it is often too late to adopt a more durable design and usually too late to change to a more experienced contractor without considerable rectification cost

  - There have been several instances where the only way of stabilising the building has been to fill the new basement with foam concrete and either abandon the project or start again. In some instances demolition of the house has been the only safe solution to a poorly planned and executed basement project

- Members of the Association of Specialist Underpinning Contractors (ASUC) are committed to working in accordance with these guidelines

2.7 The Association of Specialist Underpinning Contractors (ASUC)

ASUC *plus* (The Association of Specialist Underpinning Contractors) is a trade association founded in 1992 by a group of specialist contractors whose main business was foundation repair by underpinning and piling. The association's intention was to raise standards of health, safety and quality across the sector. Domestic basement construction now faces similar challenges.

Standards in the foundation repair industry were improved by ASUC members being audited on health and safety, technical competence, financial strength and the completeness of their insurance cover. The increase in standards achieved by ASUC members enabled the association to introduce an insurance-backed latent defects guarantee scheme in 2002. This cover is provided by a major insurance company directly to the homeowner and covers any problem with the foundation repair work. An ASUC guarantee is now frequently demanded by insurers as a prerequisite for foundation repair work.

Basement construction uses underpinning, piling and other structural techniques that are similar to those used in traditional foundation repair. This has led to several ASUC members being at the forefront of the growing basement construction industry.

In 2013 ASUC introduced a new class of membership for basement contractors. This class of membership is open to existing ASUC members and to contractors who have not been involved in the foundation repair sector.

The new basement category of membership has more stringent levels of audit across all areas with only those showing excellent health and safety, technical ability, financial strength and appropriate insurances being admitted. In addition a new tailored insurance-backed defective works guarantee scheme has been introduced. The new guarantee scheme is called the Basement Insurance Guarantee (BIG).

2.8 Summary

It is hoped that these guidelines will assist those involved in basement construction to achieve the best possible outcome for their project with the work completed safely, efficiently and with the minimum negative impact on others.

In conclusion it is suggested that a property owner will increase the likelihood of achieving a safe and successful project by inviting an ASUC member, who will operate in line with the spirit of these guidelines, to be involved at the earliest opportunity.

3 TYPES OF BASEMENT

3.1 Introduction

Basement types can be classified in multiple ways. In these guidelines the following classification will be used:

a. Cellar extensions.

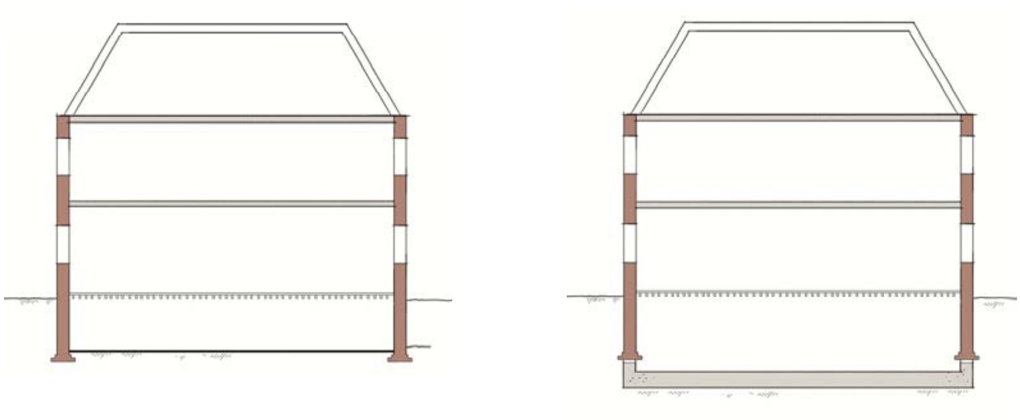
b. Single level basements.

c. Multi-level basements.

3.2 Cellar extensions

This is the least complex form of retro-fit construction. Generally the existing walls are underpinned to extend the existing foundations downwards, increasing the head height of the existing cellar or vaults.

A new floor slab is constructed and an appropriate waterproofing system is installed to protect the new basement from water ingress through both the existing and new structures.



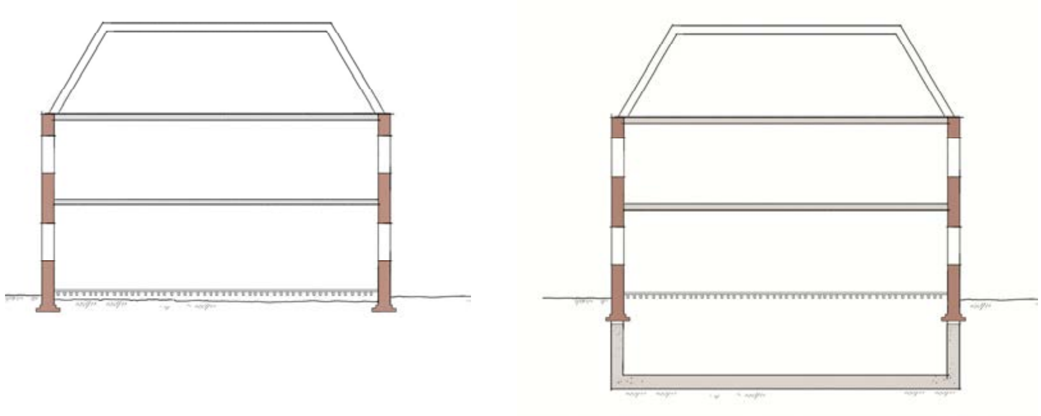
Original property with existing cellar

Property with basement

Figure 2. Cellar extension

3.3 **Single level basements**

Single level basements involve creating one new level of basement below the level of the lowest internal floor or below a garden.

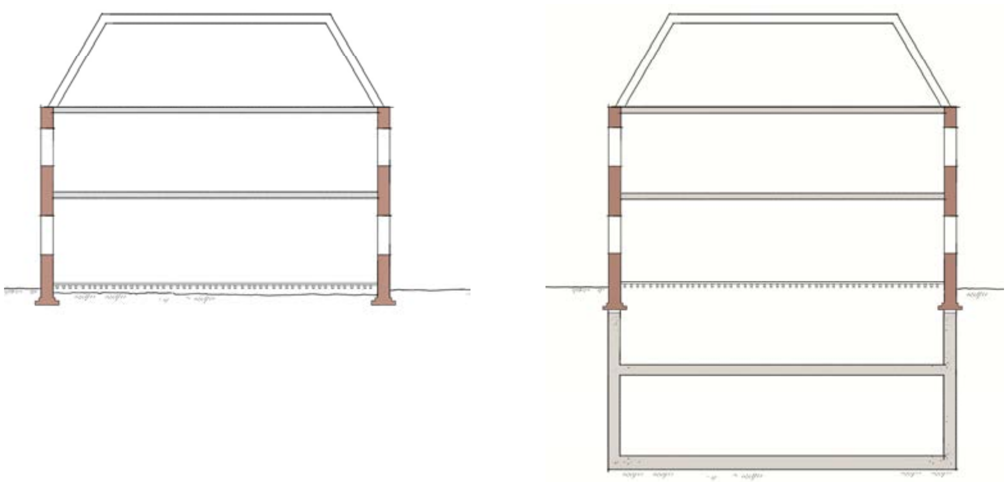


Original property Property with basement

Figure 3. Single level basement

3.4 **Multi-level basements**

Multi-level basements involve creating more than one new level of basement below the existing lowest floor level of a building or below the garden.



Original property Property with basement

Figure 4. Multi-level basement

3.5 **Summary**

In these guidelines basements have been classified as cellar extensions, single level basements and multi-level basements.

4 TECHNIQUES USED IN BASEMENT CONSTRUCTION

4.1 **Introduction**

This section describes techniques used to build the main structural elements of a basement.

The main techniques covered are:

a. Underpinning

b. Piling

Underpinning and piling are by far the most common techniques used for basements built underneath or close to existing structures. King post retaining walls are occasionally used in certain situations but will not be considered further in these guidelines

An additional section outlining the challenges faced when building below the groundwater level is also included.

4.2 **Underpinning**

4.2.1 General

Underpinning is the technique by which an existing foundation is provided with increased depth. Historically this technique was used for foundation repair and strengthening.

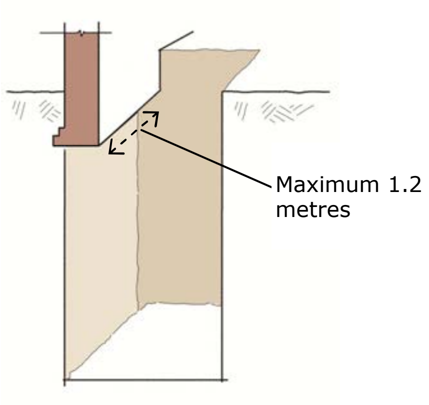
Underpinning relies on the ability of a wall to span unsupported for a short length. This allows a section of wall to be undermined and a new structure to be built directly underneath. In this way new sections of lower level basement foundation and wall can be built in a sequence until the existing wall is supported for its full length.

There are several types of underpinning used in basement construction, each of which will be covered further in this section. At the broadest level they can be considered as either:

a. Mass concrete underpins - they are constructed of concrete and do not contain significant steel reinforcement. Structurally they can be considered as being made only of concrete.

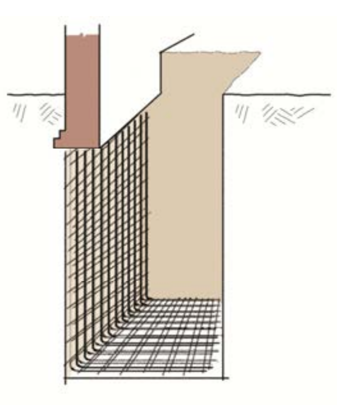
b. Reinforced concrete (RC) underpins - these contain steel reinforcement that is designed to work structurally.

The general method for building all underpins is very similar. The construction stages for a reinforced concrete underpin are given on the next page.



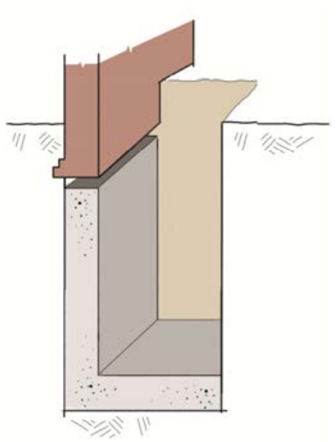
1. Excavation must be fully supported by props and shoring.
2. Edge protection to prevent falls into the excavation must be installed.
3. A temporary vertical prop or support may be placed under the wall to keep any loose bricks or masonry in place.
4. The main load from the existing wall will span onto the wall and foundations on either side of the excavation.

Stage 1. Excavation



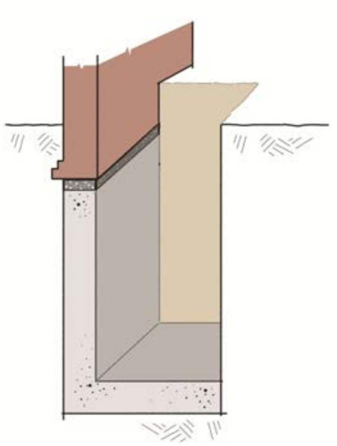
1. Reinforcement is fixed into position.
2. Reinforcement details are given in the engineering design. It is critical that the reinforcement is installed as detailed in the design
3. The design will usually require a shear connection between adjacent underpins. This is generally achieved using dowel bars between adjacent pins or by building sheer keys in the concrete underpin walls.

Stage 2. Reinforcement



1. Concrete is placed in the toe first.
2. Once the toe is sufficiently cured the concrete wall is poured.
3. Shuttering, usually timber, is used to hold the concrete for the wall in place while it is placed.
4. Gap of approximately 75mm left between the top of the concrete and the underside of the existing foundation.

Stage 3. Concrete placement



1. After a minimum of 24 hours dry-pack is rammed into the 75mm void that has been left above the new underpin.
2. Dry-pack is a mix of sharp sand and cement. It is easy to handle and has a low shrink volume, minimising settlement of the wall onto the new underpin foundation.
3. The completed underpin must be supported horizontally either by horizontal propping or by backfilling the excavation until the ground slab and possibly other permanent works are constructed.

Stage 4. Dry packing

Figure 5. Typical underpin construction sequence

Reinforcement bars - remaining upper reinforcement yet to be installed and tied

NB. The importance of good health and safety is evident from this picture

Figure 6. Underpinning - Access shaft used to construct a single underpin – note the small work area and the temptation to limit the amount of shoring materials. The foot of the pin has been cast and steel reinforcement for the pin is being installed. Contrast the less than ideal support arrangement with the standards shown in Fig 28 on page 37.

Underpinning is a tried and tested technique that has been used for many years for foundation repair. Historically for foundation repair the underpins were transferring vertical load from the existing foundations down to a lower level where the ground was stronger or more stable. The underpins were usually built of concrete with no reinforcement.

In basement construction there is a structural requirement to:

- Transfer the vertical load on the existing wall down to the new lower foundation level, and

- Hold back the horizontal load of the ground, hydrostatic pressure and any other surcharge loads acting on the outside walls of the basement.

The horizontal force from the ground or other surcharge from outside the basement must be considered in the permanent design of the final completed basement (the permanent condition) and at all stages during construction (the temporary condition). The horizontal force of ground is real and powerful.

The strength of the horizontal force from the ground is shown by the movement seen on the basement wall in the picture on the next page. The bottom of the basement wall was not restrained by temporary works during the basement excavation. The horizontal force of the ground caused the base of the wall to slide resulting in collapse of the building above.

Figure 7. Wandsworth, South London during construction of a basement - effect of horizontal force from the ground on unrestrained basement wall

The picture above was taken after the collapse of an existing building in Wandsworth, South London. The building had collapsed due to inward horizontal movement of the basement walls. At the time of the photograph the debris from the collapsed building above had largely been removed exposing the extent of the movement.

The subsequent investigation found that the bulk excavation had been completed to the full depth of the underpins without horizontal temporary works being installed. The horizontal force of the retained ground had caused the bottom section of the basement walls to move inwards leading to the collapse of the building above.

Source: Wandsworth Building Control.

4.2.2 Traditional mass concrete underpinning

Mass concrete underpins can sometimes be used to form the walls of basement structures. This will need to be determined by the structural engineer. Commonly, on their own, mass concrete underpins will not have sufficient horizontal strength to act as the basement walls and to retain the ground.

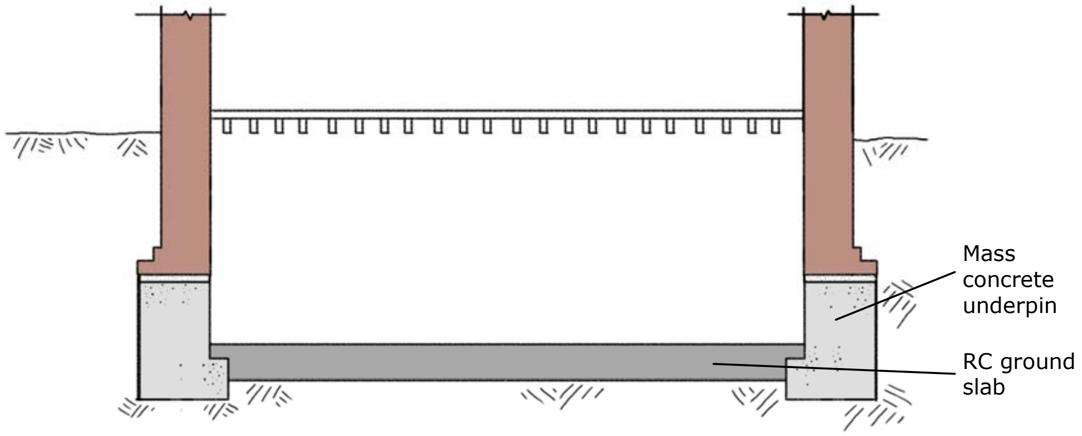


Figure 8. Mass concrete underpinning

Mass concrete underpins are quite often used to transfer vertical loads of various elements to deeper levels either temporarily or permanently.

4.2.3 Traditional mass concrete underpinning with inner reinforced concrete (RC) lining wall

Mass concrete underpinning can be used in conjunction with an inner reinforced concrete (RC) retaining wall as part of the permanent design. The inner RC wall can also be part of a strong complete inner RC box.

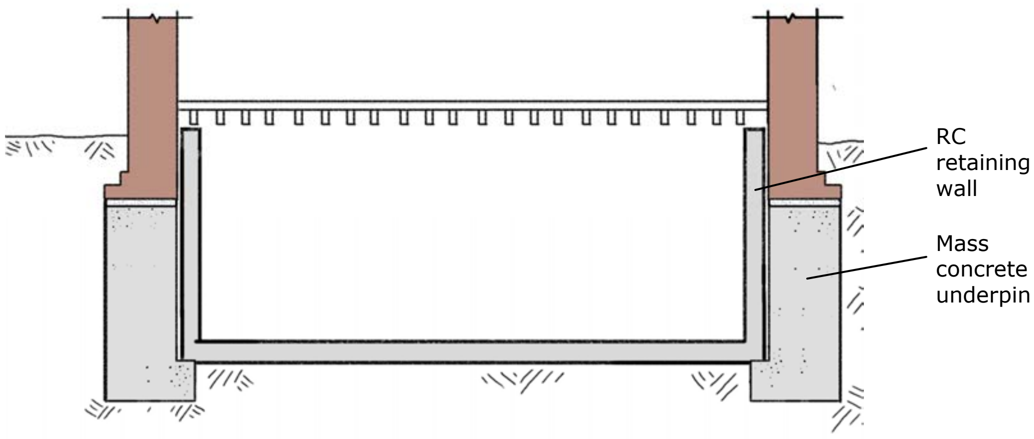


Figure 9. Mass concrete underpinning with RC lining wall

In this design the mass concrete underpin will not be sufficiently strong to act as a retaining wall in the temporary condition so horizontal temporary propping and a somewhat complicated construction sequence is usually needed to provide support until the inner RC retaining wall or box is built and has gained strength.

NB. In this instance a piled wall is retaining the ground allowing the inner RC wall construction to proceed unhindered by temporary works

Figure 10. RC retaining wall

This mass concrete underpin with an RC inner lining wall is generally not seen as an efficient design but does overcome one issue that can arise from the Party Wall Act.

Reinforced concrete underpinning, under the Party Wall Act, is called a 'Special Foundation'. Under the Party Wall Act the adjoining owner's agreement, 'Special Foundations Consent', is required in order to build reinforced concrete underpinning under a party wall.

Conversely the Party Wall Act allows a building owner to build a mass concrete underpin underneath the party wall without the consent of the adjoining owner. So a design with a mass concrete underpin and an inner RC retaining wall or box avoids the need for special foundations consent.

It is now fairly rare for Special Foundations Consent not to be given. There are several reasons why the Adjoining Owner can benefit from giving Special Foundations Consent. In the few cases where consent is not forthcoming a mass concrete underpin with an RC lining wall can be built anyway.

4.2.4 Reinforced Concrete Underpinning

As discussed basement walls need to support the vertical loads from the existing structure and resist the horizontal forces from the ground, hydrostatic pressure and from any other surcharge loads such as the foundations of nearby structures or vehicles on roads.

A reinforced concrete underpin can be designed to achieve both of these functions in one of two main ways, as either:

- A vertical cantilever with a turning moment acting around the end of the toe of the base, in other words the lower section of the underpin is held firmly in place and the vertical wall is sufficiently strong to prevent the soil outside the basement or any other outside horizontal forces from pushing the underpin foundation wall out of vertical, or as

- A vertical beam restrained at the bottom by the basement ground slab and restrained at the top by an RC basement roof slab or other structural arrangement.

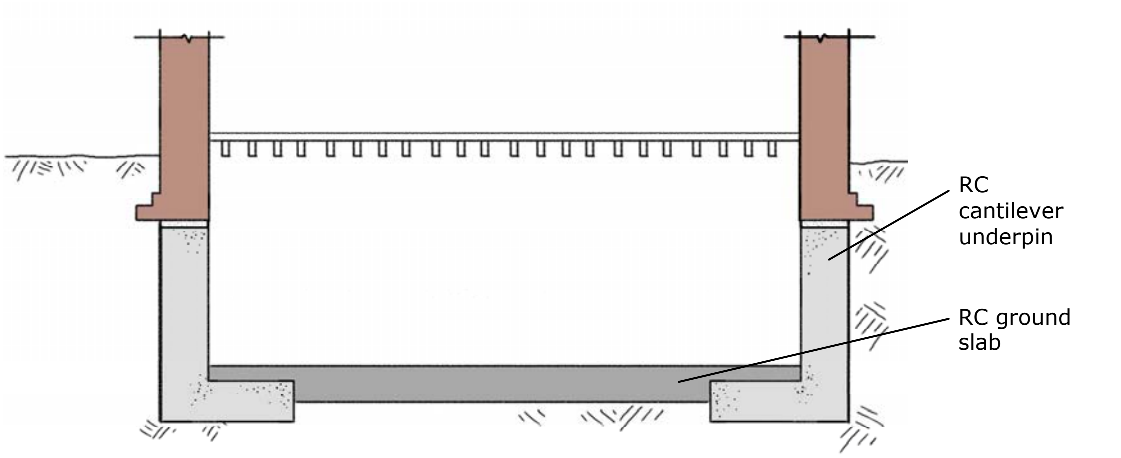


Figure 11. RC underpinning

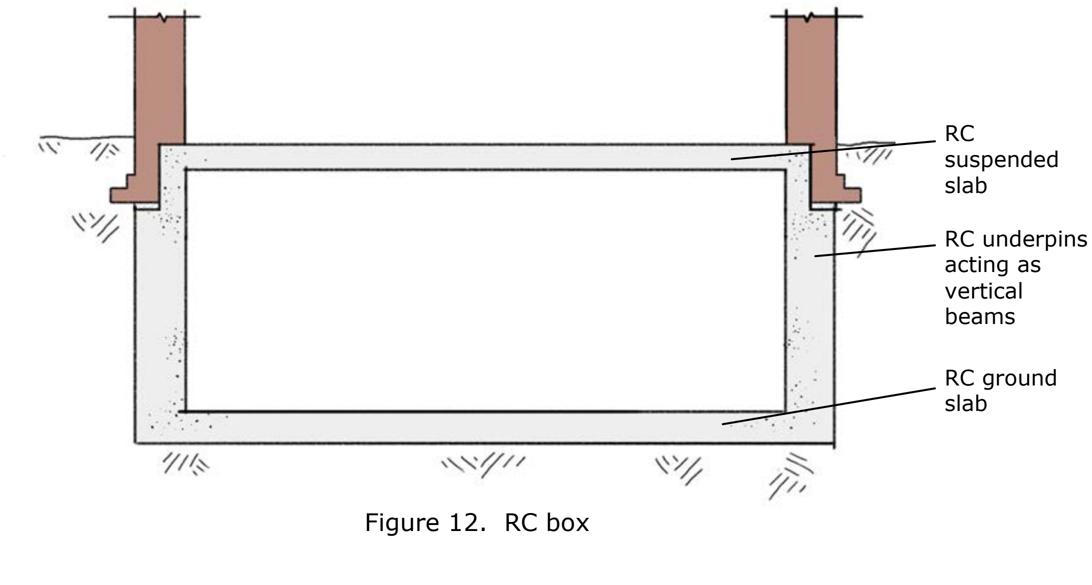


Figure 12. RC box

These sorts of RC underpin are generally viewed as efficient underneath a building as they maximise space, can be built in a low number of construction operations and, from a structural point of view, are low risk as they involve only one transfer of vertical loads.

4.2.5 Multi-stage underpinning

Multi-stage underpinning can be used to build deep RC walls either as part of a deep single level basement or when constructing multi-level basements.

Multi-stage underpins allow shallower individual underpin excavations which can be advantageous from a health and safety point of view especially in unstable soils.

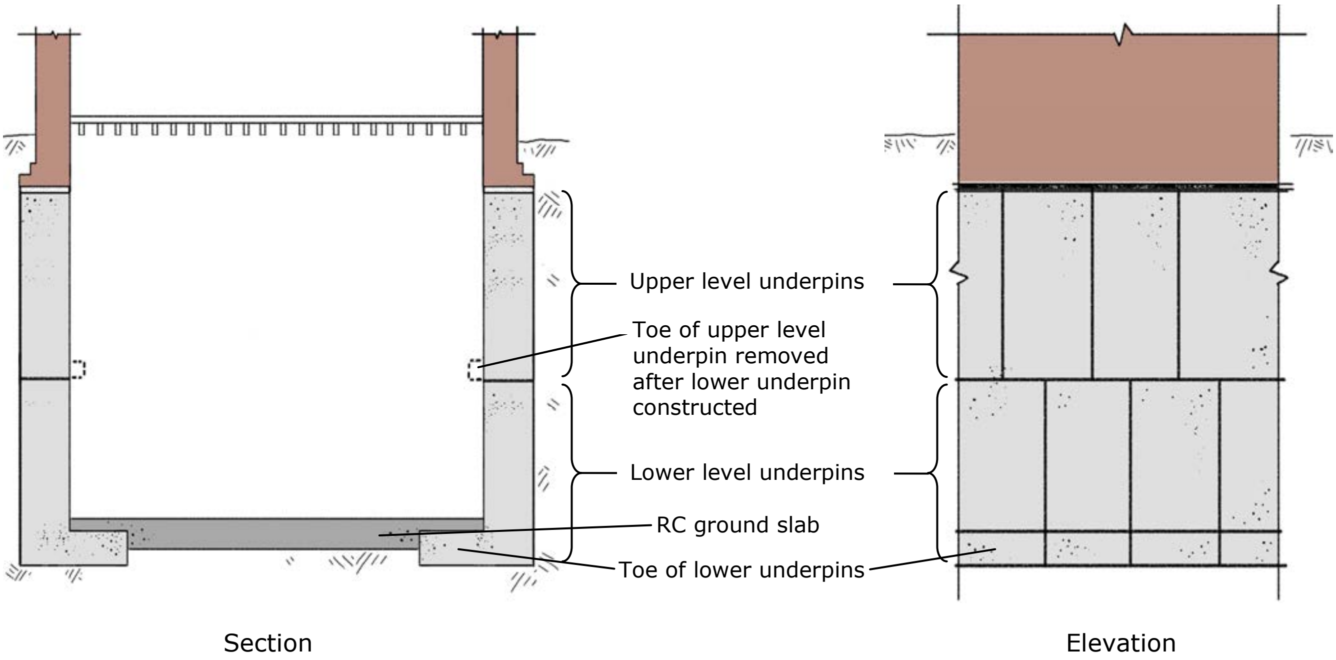


Figure 13. Multi-stage underpinning

There are several important points to note when undertaking multi-stage underpinning:

- Temporary propping - vertical and horizontal propping must be designed and in place at all times
- There must be reinforcement continuity between the different vertical stages of underpinning plus usually there will be, as a minimum, shear connections working horizontally between underpins
- The vertical load of the building must be supported by each stage of the underpinning - the base of each intermediate stage of underpinning will often need to be thickened in order to avoid increasing the temporary foundation's bearing pressure. Any intermediate stage base thickening will usually be trimmed off later to leave a flat vertical wall.
- The underpins at each stage should be offset horizontally to avoid a continuous bottom to top vertical construction joint

4.3 **Piling**

4.3.1 Outline

Piles are structural elements introduced into the ground from the surface.

In basement construction two main types of piles are used:

- Reinforced concrete (RC) bored piles - constructed by a hole being bored (drilled) into the ground then being filled with concrete and reinforcement.
- Steel sheet piles - constructed by thin interlocking sheets of steel being driven into the ground

They can be used to:

- Form the structural basement walls though they cannot usually be constructed below the walls of the existing building
- Support vertical loads in the temporary or permanent condition (RC piles only)
- Anchor the basement ground slab against uplift from hydrostatic pressure or clay heave (again RC piles only)

Piled retaining walls, both reinforced concrete bored piles and steel sheet piles, need an inner RC wall or box in the permanent condition to provide horizontal strength and for waterproofing.

Piling equipment needs space around the drilling head so there will always be a gap between the edge of the pile and the inner face of the existing wall. In terraced properties this results in the usable basement space being reduced when compared to the existing area immediately above.

The pile size can be limited by the size of the piling rig which can be used given the size of the site, available working height and access. In general faster and lower cost piling is achieved using larger piling rigs.

Figure 14. Restricted access mini piling rig

Figure 15. Piling rig in rear garden

The choice of which piling technique is used will be governed by the site layout, site restrictions, access, geology and hydrology. The possible and likely lateral loading from earth pressure and adjacent building surcharges must also be taken into account in the design.

4.3.2 Reinforced concrete (RC) bored piles

There are two main types of RC bored pile retaining walls used in basement construction:

- Contiguous bored pile retaining wall
- Secant bored pile retaining wall

4.3.2.1 Contiguous bored pile retaining wall

A contiguous bored pile wall is formed by constructing a series of individual vertical RC piles. The diameter of each pile in a contiguous piled wall is usually not less than 300mm diameter.

A small space, usually around one hundred millimetres, is left between adjacent piles.

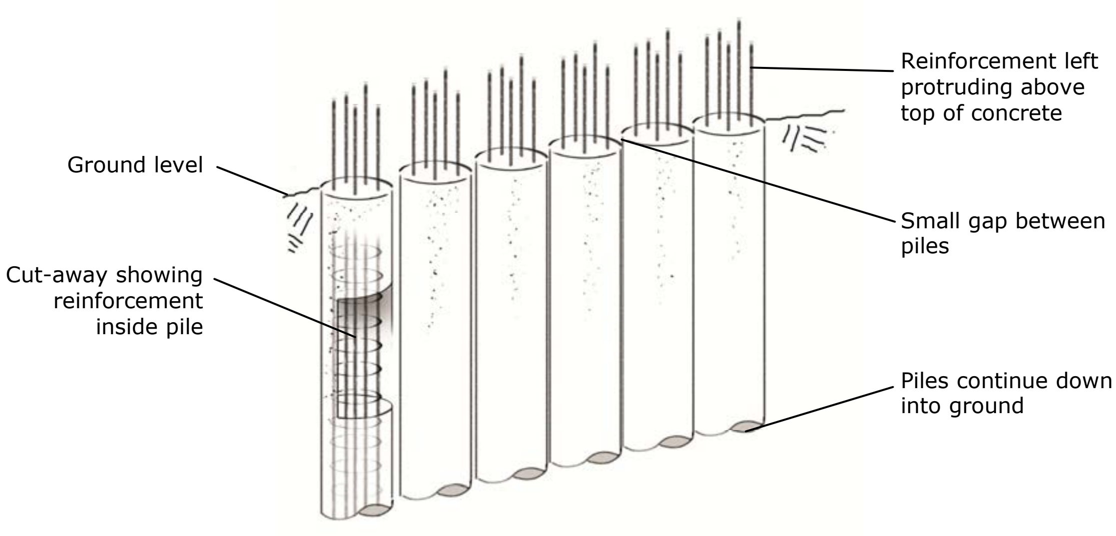


Figure 16. Contiguous bored piles

Once all of the piles have been constructed the top of the piles are usually joined together by an RC capping beam.

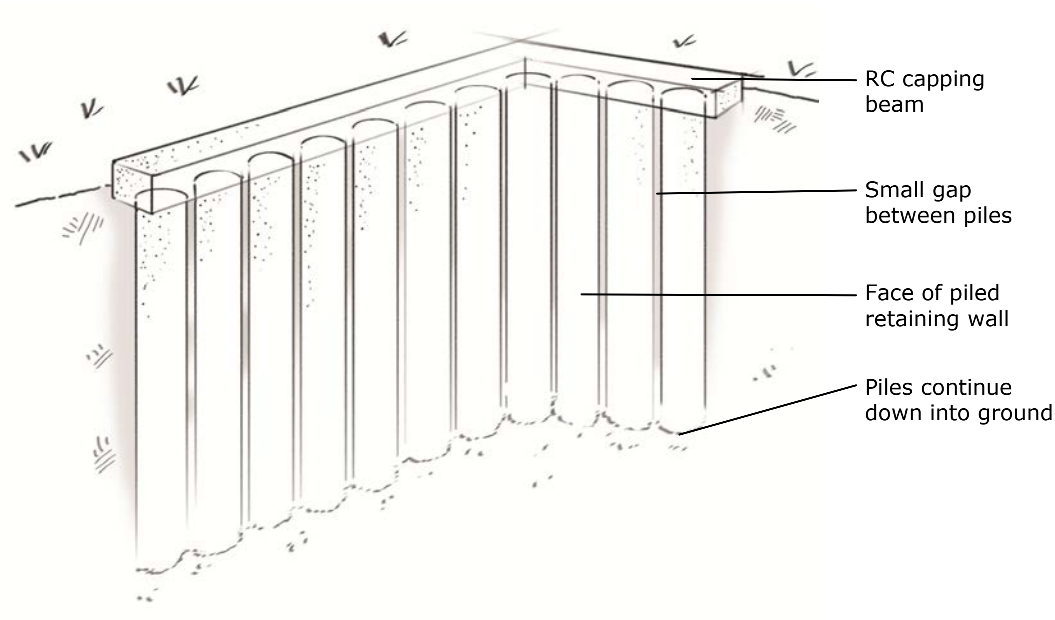


Figure 17. Contiguous bored piled wall with RC capping beam

Figure 18. Contiguous bored pile wall

In self-supporting soils such as stiff clays the sides of the holes will normally remain stable and can be concreted or grouted without the need for temporary casing. The ground between the completed piles will naturally span the gaps.

In non self-supporting ground, such as sands and gravels, the bored holes are generally temporarily cased. Where cased the effective diameter of the completed pile will be that of the casing. Therefore a nominal 450mm diameter pile with a casing will have an effective diameter in the order of 510mm. This is an important consideration when determining the plan dimensions of a proposed new basement.

Hollow augers (drill bits) can be used as an alternative to casing. The ground is temporarily supported by the flight of the auger and spoil on it and concrete or grout is pumped to the base of the pile through the auger string. The auger should be withdrawn slowly enough to ensure the rate of flow of concrete or grout fills the drilled void. Unless carefully controlled there is potential for 'necking' of the pile or possible bulging in looser ground to occur. Once the drill string is fully withdrawn the reinforcing cage is then lowered into the concrete/grout.

4.3.2.2 Secant bored pile retaining wall

Secant bored pile walls are made using two types of piles: a soft unreinforced pile and a hard, strong reinforced concrete pile. The minimum diameter of each pile in a secant piled wall is usually 450mm.

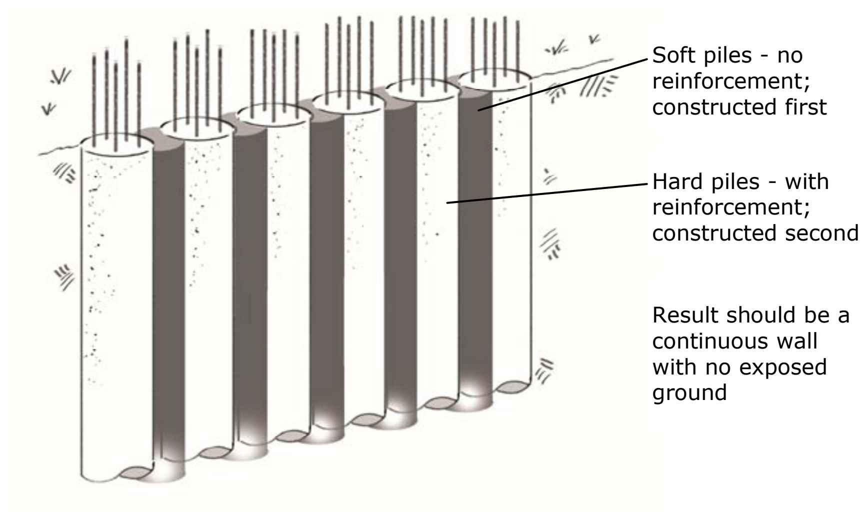


Figure 19. Secant bored piled wall

Figure 20. Secant piled wall

The construction sequence is:

a. A line of unreinforced piles is constructed using low strength concrete. These are the soft piles.

b. Then a second line of piles is constructed between and overlapping with the soft piles. The second line of piles is reinforced and uses high strength structural grade concrete. These are the hard piles.

The hard piles provide the structural strength. The soft piles act to fill the gap between the hard piles and hold back any ground or water that would otherwise be able to flow between the hard piles.

Secant piling is used where the ground has a perceived risk of becoming fluid, commonly due to the combination of non-cohesive deposits and water. This technique will reduce ground water ingress if designed and constructed correctly. Vertical pile tolerance needs to be considered as any gaps in the completed wall will allow water or ground ingress. The completed wall is rarely waterproof but water penetration is usually reduced to an extent which allows construction within the piled perimeter to continue safely.

4.3.3 Steel sheet piles

Sheet piled retaining walls are made using interlocking steel piles.

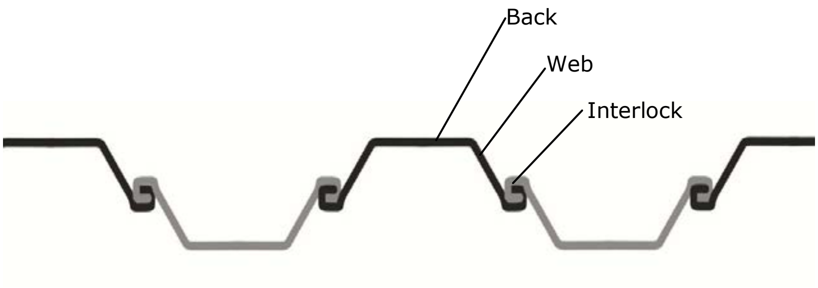


Figure 21. Section through steel sheet piles

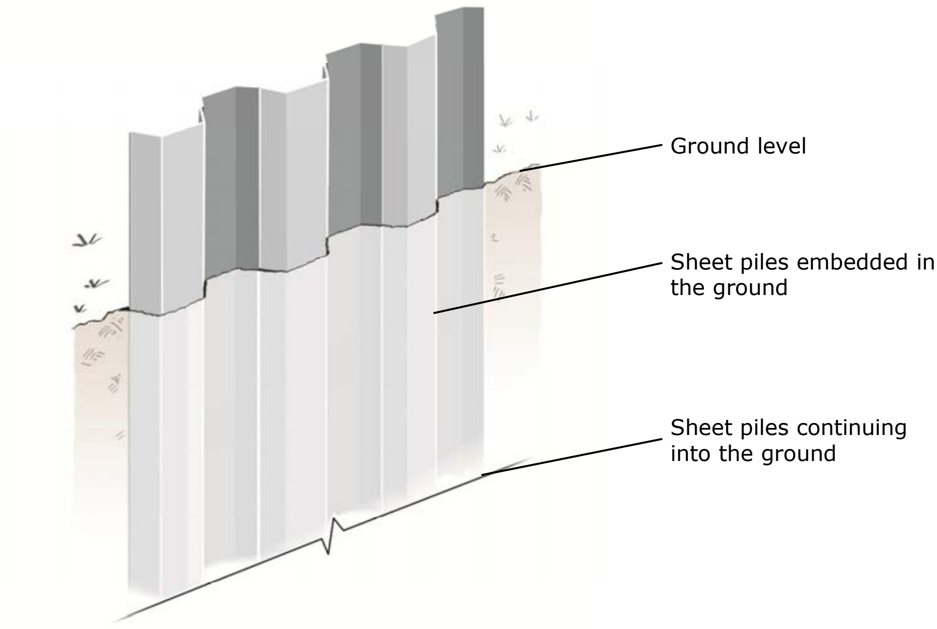


Figure 22. Steel sheet piles in the ground

Figure 23. Steel sheet piled wall

The steel sheet piles are generally driven or jacked into the ground using specialist plant. The plant is usually comparatively large which can be a limiting factor on their use. In addition head height clearance of at least the length of the steel sheet pile is required to allow installation.

As a result steel sheet piles usually cannot be used underneath buildings and are often restricted in their use close to structures. They are generally more suitable for open sites with good access. In these situations they are a credible alternative to RC bored piles

Steel sheet pile retaining walls are not generally used to support vertical loads.

Sheet piles are usually installed by either:

- Percussive methods - hammering the sheet piles into the ground. This is generally not acceptable in urban areas due to excessive noise and the vibration damaging adjacent structures.

- Jacking - forcing the sheet piles into the ground using heavy hydraulic drivers. The drivers often grip onto several neighbouring piles that are partially in the ground in order to force one pile further down. This sequence of gripping and forcing is alternated to steadily install a row of piles. This technique is often not acceptable in urban areas as water is required to assist the driving process and leads to heave and shrinkage in cohesive soils.

Ground conditions need to be considered when using sheet piling:

- Old foundations or natural obstructions such as boulders and stones within clays and silts can obstruct sheet piles and stop their penetration

- Sheet piles are large and heavy and will require either a crane or large excavator to handle them
- Good site access is needed
- A temporary piling mat will be needed to provide sufficiently level and firm ground
- Below the groundwater level welding of the sheets will usually be required to reduce water ingress

4.3.4 Piles to support vertical loads

RC piles can be used to support vertical loads and to resist uplift due to hydrostatic pressure or clay heave. Piles resisting uplift are known as tension piles with the pile effectively working as a ground anchor.

Positive vertical loads can be supported by load bearing piles particularly where there are high point loads. The piles will usually be installed prior to basement ground slab construction and the top of the piles will be tied into the RC basement ground slab.

Bearing piles may be used to support the building load including the new basement if there is low bearing capacity at the proposed formation level.

Piles can be designed to act in tension and bearing.

4.3.5 Bored pile tolerances

Bored piles have a construction tolerance that can be of significance for basement construction particularly in deep basements. Piles that are not vertical can end up straying inside the line of a proposed living area. Pile tolerances should be accounted for within the architectural design.

Pile tolerance should usually be specified in accordance with the Institute of Civil Engineers (ICE) Specification for Piling and Embedded Retaining Walls (SPERW)[1] given below.

	Initial pile position without guide wall	Vertical tolerance	Horizontal radius offset due to vertical tolerance per metre depth
Cast in situ pile	75mm	1 in 75	13.3mm

The table on the next page gives the radius of horizontal offsets from the planned centre of the pile at various depths based on the SPERW tolerances.

[1] ICE (Institution of Civil Engineers) Specification for piling and embedded retaining walls (SPERW) 2nd edition 2007

	Radius of horizontal offset at differing pile depths		
Depth:	3 metres	6 metres	9 metres
Cast in situ pile:	115mm	155mm	195mm

4.4 Building below the groundwater level

4.4.1 Outline

Building below ground water level adds considerable complication to the construction process.

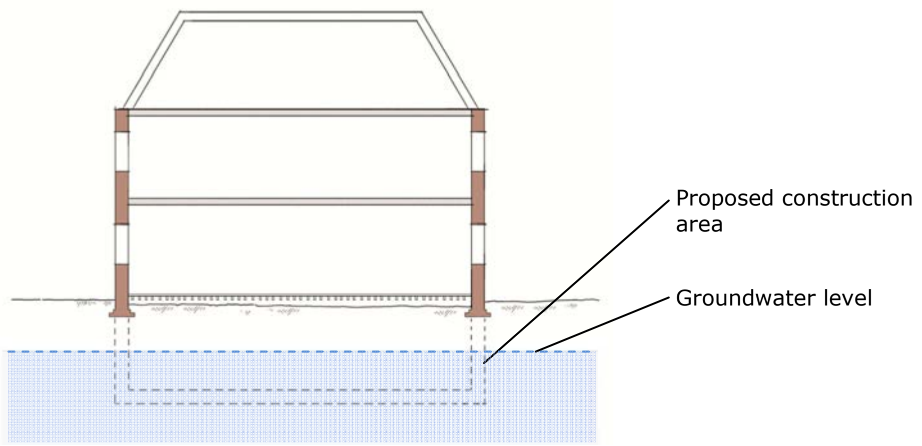


Figure 24. Proposed basement extending below groundwater level

The risk of ground movement and settlement is increased when working below the groundwater level. This is largely due to:

- A reduced bearing capacity of the ground at depth
- Cohesive soils' characteristics of shrinking when they dry and heaving (expanding) when wet
- Removal or migration of fine material from the ground during any dewatering process

The stability of the surrounding ground and existing structures must always be considered.

It is often not appropriate for water to be controlled by standard pumping methods when building below the groundwater level as these do not take account of the stability of the ground.

There are several techniques that have been developed specifically for construction of basements below the ground water level. Broadly these are:

a. Local lowering of the groundwater level.

b. Construction of a perimeter barrier to control water ingress.

c. Soil stabilisation.

Ground freezing is also a recognised technique to enable construction below the water table. It has the disadvantages of causing ground heave due to the expansion of the water and of the frozen ground being difficult to dig through. It is usually limited to large scale commercial projects due to cost and size of plant required. This technique will not be considered further.

4.4.2 Local lowering of the groundwater level

Lowering the water table below the formation level of the basement allows construction within the dewatered area to be completed using standard construction methods. The principal technique for achieving safe local dewatering is to use a specialist well point dewatering system usually installed and operated by a specialist contractor.

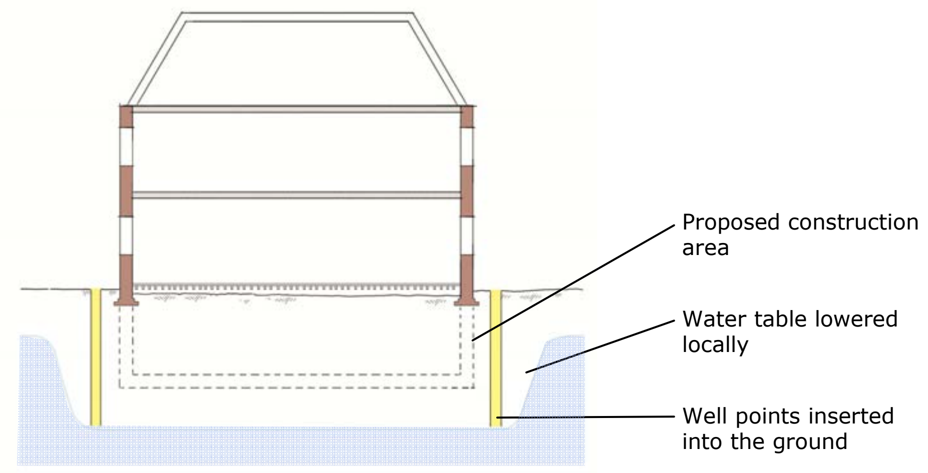


Figure 25. Dewatering for building below groundwater level

In these systems a series of submersible pumps is installed at below basement formation level down drilled well points around the perimeter of the site. The submersible pumps are each installed with a slotted pipe, wrapped in geotextile material and surrounded by a free draining material.

The geotextile material allows water to pass but blocks movement of any ground including fine material suspended in the groundwater. The pumps are usually left running continuously to keep the water table lowered during the work.

The water removed by the pumps should usually be passed through a settlement tank in order to monitor for removed ground and also to ensure that no material is discharged into the drains. A license is usually needed from the water utility company for discharge of groundwater into the drainage system.

Once the water table has been lowered construction work can continue in the now dry ground within the well points. After completion of the basement the dewatering system is removed and the water table will return to its original level.

These systems need to be correctly designed taking account of the specific ground conditions, water levels and proposed construction level. Detailed site investigation including information on the particle size of the ground and specialist geotechnical input will always be needed.

Local lowering of the water table is usually the least expensive of the three main methods though it is sometimes not the most appropriate geotechnical method.

4.4.3 Construction of a perimeter barrier to control water ingress

In this method a physical barrier is constructed into the ground around the perimeter and the water inside the perimeter is removed. The barrier walls block the horizontal flow of new water back into the site.

This method requires that there is a layer of impermeable ground under the site to prevent water flowing up inside the perimeter. This is largely the case in central and west London where a thick layer, in the order of seventy metres, of effectively impermeable London Clay underlies the upper layers of permeable sands and gravels.

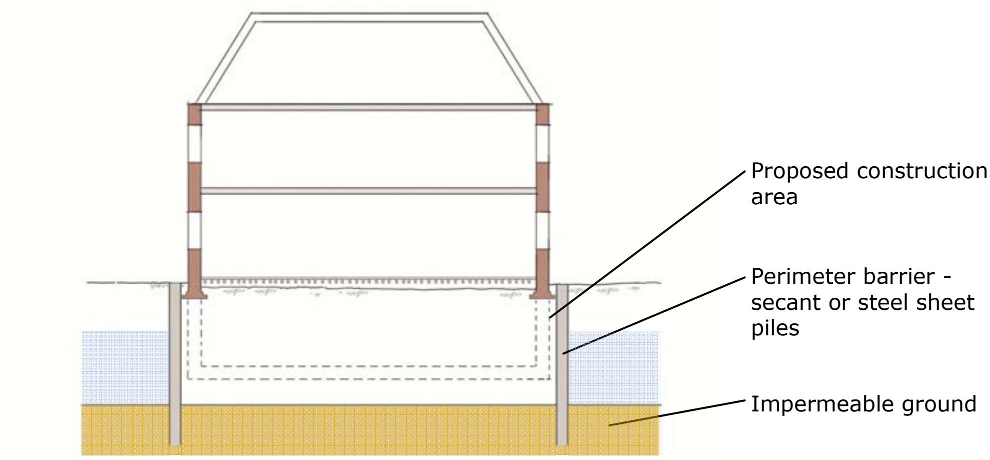


Figure 26. Perimeter barrier to control water ingress during construction

The perimeter barrier is constructed from the ground level and is usually constructed from either:

a. Secant piles, or

b. Steel sheet piles

Achieving a good seal in the barrier wall can be challenging. Misaligned or piles that are not sufficiently vertical will leave gaps in a secant piled wall that will need additional measures to create an effective barrier to water flow. Steel sheet piles will need to be welded at the joints and any leaks will need further post construction sealing.

The barrier walls must be embedded sufficiently into the underlying impermeable ground in order to prevent water flowing into the site.

Constructing a physical barrier to prevent water ingress is usually more expensive than dewatering but less expensive than soil stabilisation. Construction of a perimeter barrier is not always the most appropriate method technically as it requires favourable geological conditions and, as it involves piling, has other construction factors that need to be considered.

4.4.4 Soil Stabilisation

Soil stabilisation involves changing the soil's natural properties by introducing material which mixes or binds the soil. The intention is both to block the flow of water and increase soil stability.

Soil stabilisation can be achieved in a number of ways from large scale compensation grouting to targeted lance injection.

Some soil stabilisation techniques that are widely used in conventional civil engineering can cause ground movement due to the pressure under which the stabilising material is introduced and can also require relatively large associated plant. Therefore these techniques are not usually suitable for basement construction projects directly below or near to existing structures or on restricted sites.

The main technique used in basement construction below or adjacent to existing structures is chemical grouting. Chemical grouting usually requires only small scale plant and low pump injection pressures.

The chemical grout is injected into the ground using lances driven into the ground at specified positions and depths. Each lance injection stabilises a section of ground local to the lance. These bulbs of stabilised ground overlap to form a homogenous zone of improved ground. Once all the chemical grout is placed the basement work can continue with the ground water retained and the soil sufficiently stable to resist hydrostatic collapse.

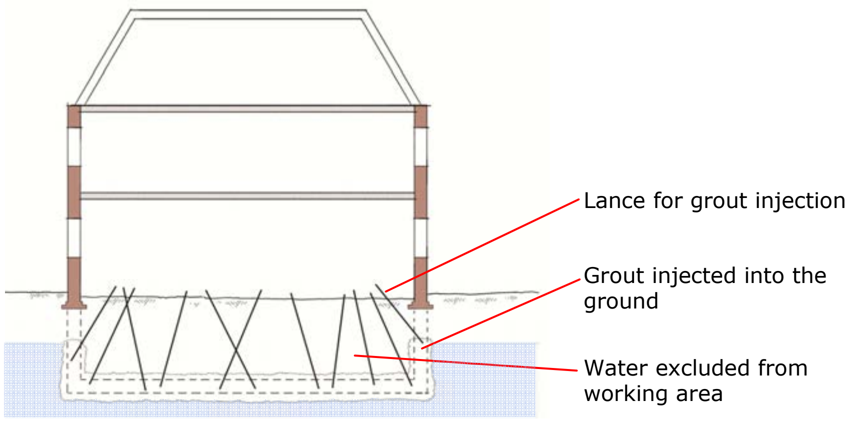


Figure 27. Grout injection for ground stabilisation

Chemical grouting needs to be correctly designed, usually by the specialist contractor, to ensure correct overlap of the bulbs of material. The designer will specify the type of grout to be used, usually a type of resin or acrylic, to give the right flow in the ground and to control any effect the material might have on the ground below adjacent structures.

In many instances stabilised soil does not entirely prevent the passage of water. The improved ground does however prevent the entrainment of fines and collapse of the ground. Although not an impermeable barrier, stabilised soil should allow basement construction to progress.

Soil stabilisation is usually the most expensive of the three main techniques for building below the groundwater level and will only be used when the other main techniques are not appropriate technically. Soil stabilisation can have an added complication with regards to party wall agreements as consent from any adjoining owners will usually be needed if any introduced material is to be placed into the ground belonging to the adjoining owner.

4.4.5 Summary

Building below the groundwater level adds complication and cost to any basement construction project. There is added risk due to the effect of removing ground water and a reduction in ground stability.

There are several practical construction techniques though not all will be technically suitable in every case. The added cost varies by method with ground dewatering generally being the least expensive, followed by construction of a perimeter barrier, and with soil stabilisation being generally the most expensive.

Input from geotechnical, engineering and basement construction specialists should always be sought as early as possible if constructing a basement below or near to existing structures below the groundwater level.

4.5 Summary

Underpinning and piling are the main techniques used in basement construction.

5 TEMPORARY WORKS

5.1 Introduction

Temporary works are the parts of the works that allow or enable construction of, protect, support or provide access to the permanent works. They might or might not remain in place at the completion of the works. Temporary works include horizontal support to excavations and part built permanent works, and vertical support to existing structures. Temporary works will often consist of proprietary propping systems such as Slimshore Soldiers or Maybey Props, and smaller scale Acrow props or timber shoring.

All basement construction projects require temporary works. They are often complex with a mixture of horizontal and vertical temporary works in place at the same time and with different elements of the temporary works being installed, adjusted or removed concurrently.

A major cause of health and safety problems associated with basement construction is poor temporary works especially horizontal temporary works supporting excavations and part built basement structures. The temporary works on projects with problems are often:

- Missing
- Poorly or not designed
- Installed incorrectly
- Inadequate
- Not controlled
- Uncoordinated
- Removed prematurely or out of sequence

Possibly the most critical factor in avoiding serious health and safety problems on basement construction projects is the correct understanding of the function of the temporary works and how they should be installed.

Temporary works must be designed, installed, checked and supervised correctly. A sound process to ensure that nothing is missed must be in place.

Clients can be vulnerable to appointing a contractor who appears to offer a better price for the work when this is achieved by reducing use of temporary works to the point where the work cannot be conducted safely. This can place workers and the public at risk of injury and loss if the structure fails during construction. It is important that the client seeks confirmation at tender assessment stage that the submitted price is based on a sensible method of carrying out the work. Expert advice may be needed to help assess tenders.

5.2 **Types**

5.2.1 Outline

Temporary works in basement construction can be divided into the following main areas:

- Excavations - generally:
  - Individual underpin excavations
  - The main site excavation
- Structures - support to the existing building or adjoining buildings and to the permanent works in the temporary condition
- Equipment and plant - support to equipment and plant that has been brought onto site as part of the works
- Excavated soil - often stored on site temporarily
- Site facilities - hoarding and welfare facilities

5.2.2 Individual underpin excavations

The weight of the ground and of any loads surcharging the sides of an excavation make collapse or movement likely if adequate support is not provided.

Horizontal loads increase with depth so deeper excavations will need greater and more robust shoring than shallow excavations.

There are two aspects to be considered when shoring an underpin excavation.

- Safety of the personnel involved in the excavation
- The degree of relaxation of the ground that is permitted in relation to the potential for movement of effected structures

Excavations for individual underpins must be considered and the risk of collapse or movement assessed. There is no hard and fast rule over the depth at which underpin excavations should be shored but even shallow excavations should be shored if there is anything other than a minimal risk of ground movement.

The shoring must be designed by a suitably qualified and experienced engineer based upon site investigation information which is proven during initial site works. It is incorrect for site staff to decide the level of shoring that is needed. It is not possible to know the strength or stability of ground by visual inspection or experience and ground should always be assumed to be unstable. Site based measurements should usually be taken to prove the ground conditions.

The back face of the underpin excavation must also always be considered as unstable. Below party walls there will be a general requirement that the shoring material used in the back face and that will be left in the ground is non-biodegradable. Generally timber shoring should not be used for the back face of underpin excavations.

Figure 28. Temporary works - individual underpin

Underpin excavations should always have protection around the upper edge to prevent falls into the excavation and toe boards to minimise the risk of material or tools falling onto the people working in the excavations.

In addition a ladder or other means of access and egress must be permanently in place. There should be emergency exit and escape procedures from the excavation, including for an injured person, and these should be practised regularly. Harnesses and winches could be considered for this function.

Workmanship and quality control is vital when supporting underpin excavations. All site operatives must be suitably trained and experienced. In addition there must be continuous management supervision.

5.2.3 Main excavation

The walls of the basement will not be stable in the temporary condition once the main bulk is removed. Horizontal forces will act to cause:

- The basement walls to overturn or collapse
- The bottom of the walls to slide inwards.

A horizontal temporary propping scheme must be designed and installed in line with the construction sequence in order to prevent structural failure.

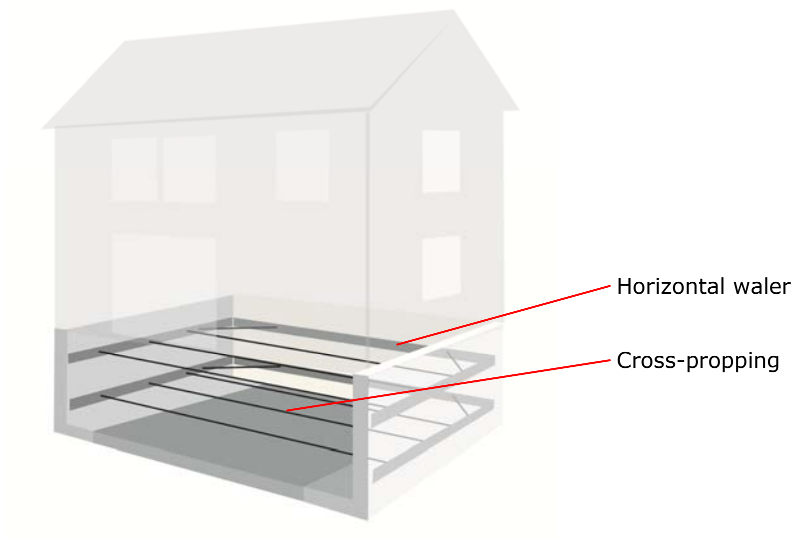


Figure 29. Temporary works to allow main excavation

Figure 30. Temporary works - main excavation

An accurate assessment of all loads that might affect the excavation must be made at an early stage. Loads that should be considered include those coming from:

- Any retained soils
- The existing foundations of the main building and any adjacent structures
- Other temporary works

- Vehicles on nearby roads and on site
- Any stored materials or plant
- Hydrostatic pressure

The main horizontal temporary works should only be removed once the main structural elements for which they are acting have gained adequate strength. Reinforced concrete will take some time, possibly several weeks, to achieve the required permanent strength. This should usually be assessed through sample concrete testing such as cube testing.

5.2.4 Existing structures

Existing structures must be correctly supported at all times. Generally this support will be vertical but can also be horizontal where side support is being removed or replaced, for example when a facade is to be retained or where a semi-detached house is being demolished.

Vertical temporary works will often be used in basement construction where structural steelwork is being installed into or under existing walls or columns.

Figure 31. Temporary works - support to existing structure

5.2.5 Equipment and plant

Large equipment and plant can be used in basement construction projects. Ground conditions should always be assessed to ensure plant is not vulnerable to overturn and will not overload adjacent structures.

Typical plant includes piling rigs, tower crane bases, crane outriggers, hoists and platforms, excavators, dumpers, lorry loader cranes, tipper lorries, concrete pumps and concrete delivery wagons. These can all require temporary works such as temporary foundations, firm bases, anchors or rigging to provide support.

These sorts of temporary works are not frequently needed in standard basement construction projects but for larger and more complex basement projects they are often required.

5.2.6 Excavated soil

Excavated soil will often be stored on site before it is removed. The excavated soil has considerable weight which needs to be considered in terms of the load acting on any floors or walls, including when placed against walls, and on the surcharge exerted onto any nearby excavations. Each condition must be assessed and appropriate temporary works designed and installed.

5.2.7 Site facilities

Temporary works also covers the stability of site fencing, welfare facilities, access scaffolds, temporary roofs and the use of either the existing or new permanent works to carry construction or temporary loads. Examples include support to suspended floors or basement roof slabs to allow plant to move across or work from them, and support to floors to allow material storage.

The risk posed by all of these must be assessed and suitable temporary works designed and installed.

5.3 Design

All temporary works must be designed, reviewed and approved by a qualified engineer and must be accompanied by risk assessments, drawings, method statements, instructions for installation and ongoing checks, and if required a removal sequence.

The engineer responsible for the design of the temporary works is called the Temporary Works Engineer (TWE). The TWE is often a different person from the structural engineer responsible for the main permanent design. The TWE will often work directly for the Contractor.

5.4 Control of the temporary works

On all construction projects a named person must be appointed to coordinate temporary works. This includes identifying where temporary works are needed, arranging for designs to be prepared and checked; arranging for suitable subcontractors to be appointed and/or suitable workers to be briefed; ensuring the correct equipment is sourced and correctly used; and maintaining site records. This person is known as the Temporary Works Coordinator (TWC).

The site engineer will usually provide detailed advice but will not coordinate the arrangements unless contracted to do so. On larger sites the TWC may be a dedicated role. On smaller sites the site manager or another manager may be trained to take on this function.

The specific responsibilities of the TWC are:

- Co-ordinating all temporary works activities

- Ensuring that various responsibilities have been allocated and accepted (for example designers, design checkers, erectors and site supervisors)
- Ensuring that risks identified at design stage, as well as assumed construction methods and loading constraints, are incorporated into the temporary works design brief
- Ensuring that the temporary works design is satisfactory
- Ensuring that a design check is carried out that covers concept, structural adequacy and compliance with the design brief
- Ensuring that the design is made available to relevant parties
- Maintaining a register or record of all drawings, calculations and other relevant documents relating to the final design
- Ensuring that those responsible for on-site supervision receive full details of the design, including any limitations and guidance notes
- Ensuring that risk assessments and guidance notes are prepared covering the safe erection and dismantling sequence
- Making checks at appropriate stages during construction of temporary works
- Issuing the permit to load after a final physical check
- Monitoring and inspecting the temporary works while they are loaded
- Ensuring that appropriate maintenance is carried out to temporary works for example to facade retention or vertical propping
- Issuing formal permission to dismantle the temporary works and specify any relevant sequence once the permanent works have attained adequate strength

In situations where the temporary works is very complex or extensive trained Temporary Works Supervisor/s (TWS) may be appointed to take on some of the routine work that would otherwise fall to the manager responsible for coordinating temporary works. The TWS is able to oversee the installation and use of the temporary works and assist with maintaining records and other functions as agreed. In situations where either the site manager is also acting as TWC, or where the TWC is looking after more than one site, the TWS can play an important part in ensuring the work proceeds smoothly.

5.5 **Summary**

The Health and Safety Executive report that a frequent cause of major structural failure with basement construction projects is the failure of the contractor to appoint a Temporary Works Engineer and a Temporary Works Coordinator, relying instead on their own perceived experience and an 'it's always worked before' mentality. In particular excavations must be correctly supported.

Contractors must appoint a Temporary Works Engineer and a manager with responsibility for coordinating all temporary works activity. The person responsible for the coordinating function is known as the Temporary Works Coordinator (TWC). The temporary works must be designed, installed, checked, monitored, coordinated and controlled correctly.

6 CONSTRUCTION METHODS

6.1 Introduction

There are two general methods by which basements are constructed:

a. Ground level down - the existing floor at the lowest level is removed and the basement is built from the ground level downwards.

b. Tunnelling - the existing floor is left in place and the basement is built by tunnelling underneath the floor. Access underneath the floor can either be from outside the building or, if that is not practical, by removing a relatively small section of the existing floor.

6.2 Ground level down

6.2.1 Outline

Basement construction from the ground level down is generally more straight forward than tunnelling and will have lower structural construction costs than for the same design if tunnelling. However, unlike for tunnelling, the lowest floor level of the building will:

- Need to be repaired and decorated after the works
- Be part of the work site and uninhabitable during the works.

Ground level down construction further divides into two general methods:

a. Bottom up construction

b. Top down construction

6.2.2 Bottom up construction

In bottom up construction the basement ground slab is usually the first slab to be constructed.

There are many ways of completing bottom up construction. However a general sequence to illustrate bottom up construction is:

a. Existing floor removed.

b. Basement walls constructed working from ground level down. Each section of completed underpin wall is supported horizontally in the temporary condition by short horizontal props or by the excavation being correctly backfilled.

c. Internal structural elements of the building are supported vertically either by permanent or temporary works.

d. Bulk excavation is started.

e. Horizontal propping is installed at high level to resist horizontal forces at this level if required.

f. Bulk excavation continued with, depending on depth, additional levels of horizontal propping being installed.

g. A final level of horizontal propping will usually be installed just above the full basement dig depth.

h. Bulk excavation is completed

i. Basement ground slab, and any drainage under the basement ground slab, is constructed.

j. Any intermediate level slabs will be constructed generally working from bottom upwards. In garden basements the basement roof slab would be constructed last. Underneath a building the slab at the original lowest level floor will be built last, if a structural slab is required.

k. Horizontal propping at each level can be removed once the permanent slab at each level has gained adequate strength.

The drawings on the next page show this general sequence.

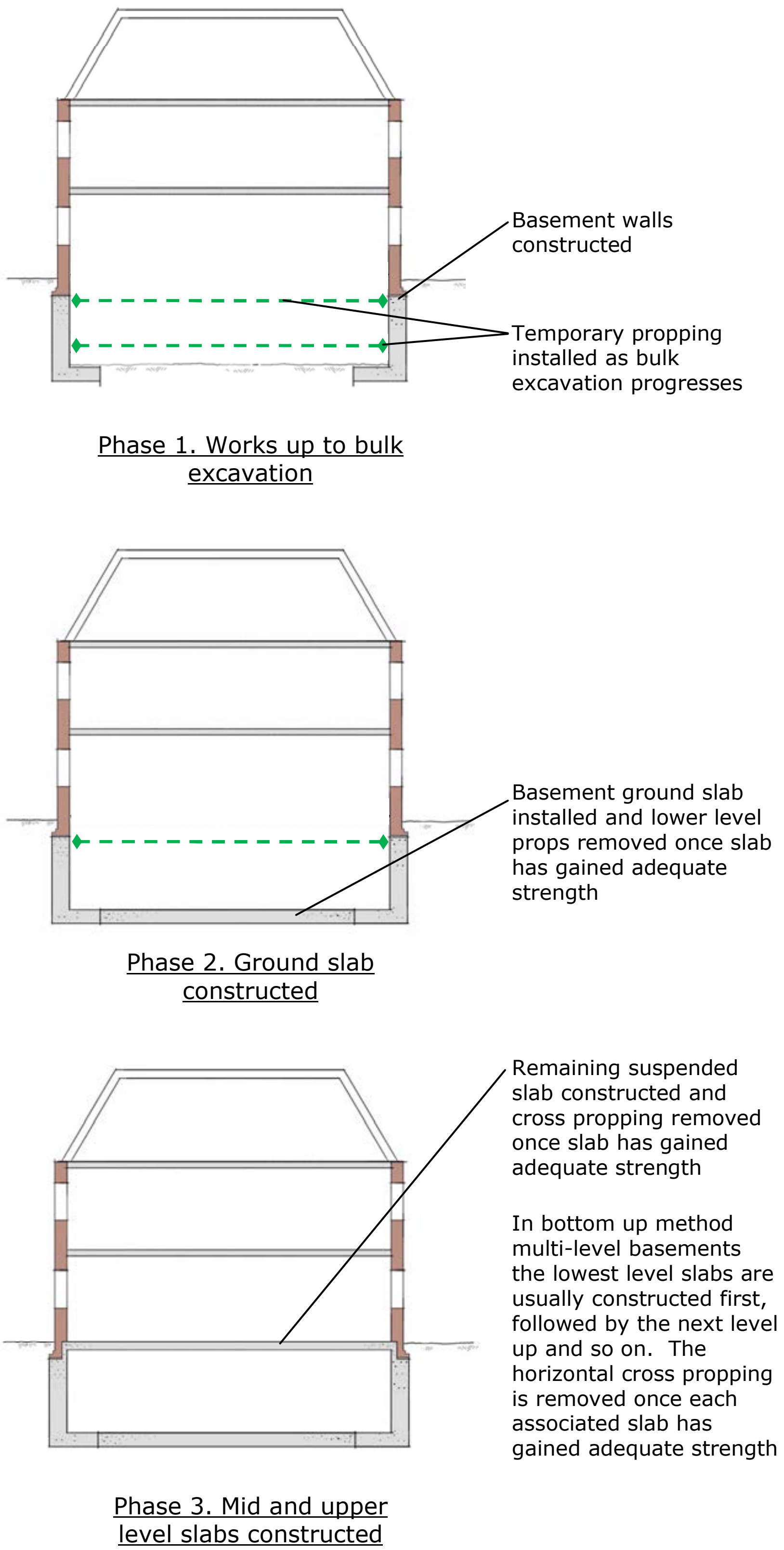


Figure 32. Bottom up construction sequence

The detailed sequencing for these works can be complex, especially for multi-level basements, and must be thoroughly planned and designed.

The temporary works design is critical and the importance of the Temporary Works Engineer and Temporary Works Coordinator is evident. The Structural Engineer, Temporary Works Engineer and the Temporary Works Coordinator must work as a team.

Figure 33. Bottom up construction

6.2.3 Top down construction

In top down construction the upper level slabs, and then each intermediate level slab from top to bottom, are built as the basement is excavated. The basement ground slab will usually be the last slab to be constructed.

A general sequence for top down construction is:

a. Existing floor removed.

b. Basement walls constructed working from ground level down. These will often be piled walls if a multi-level basement is being built.

c. Internal structural elements of the building are supported vertically either by permanent or temporary works.

d. The upper level slabs are built. Access holes will be needed in these slabs to allow the work below to continue.

e. Bulk excavation for the upper level is started.

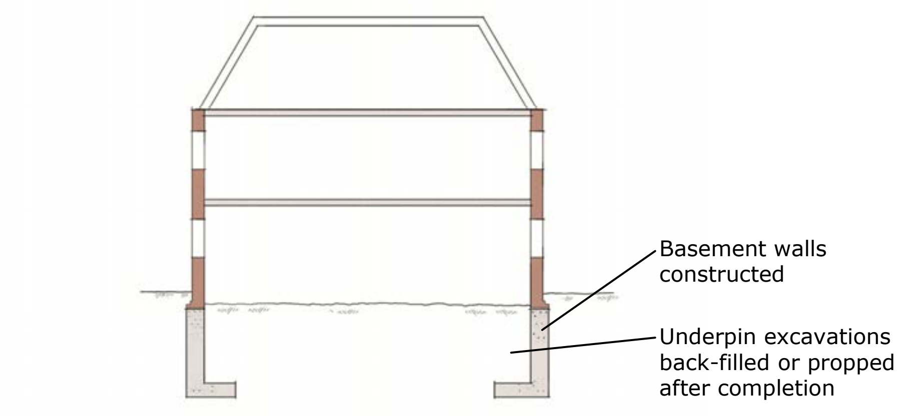
f. Intermediate level slabs are built as the excavation continues. Some horizontal propping may be required depending on the design and detailed sequence.

g. Intermediate / lower level underpins or inner RC walls (if piled) are built as construction continues downwards.

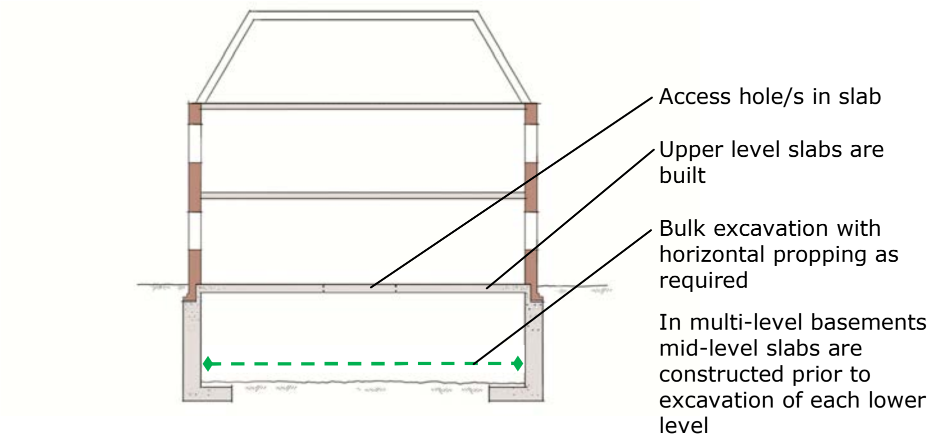
h. Process continues until the full dig depth is reached.

i. Basement ground slab, and any drainage under the basement ground slab, constructed.

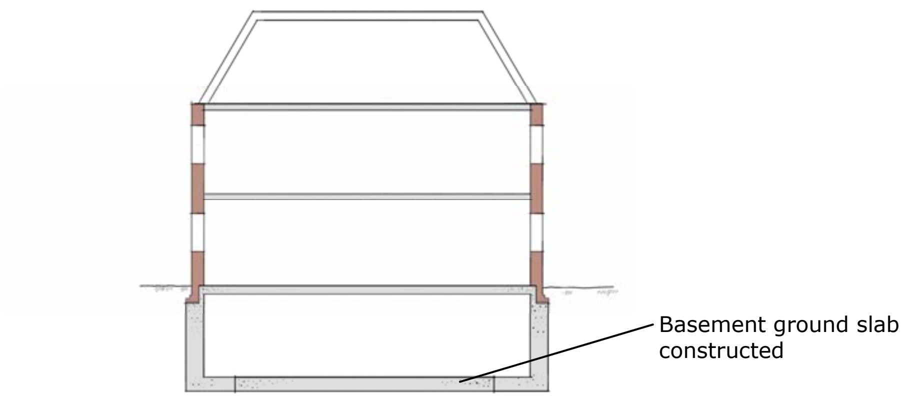
The drawings below outline this general sequence.



Phase 1. Basement walls constructed



Phase 2. Upper level slabs constructed



Phase 3. Basement ground slab constructed

Figure 34. Top down construction sequence

As with bottom up construction correct sequencing of the temporary works is vital and the Structural Engineer, Temporary Works Engineer and the Temporary Works Coordinator must coordinate effectively.

Permanent RC elements of the works need to have gained sufficient strength before they are relied on as structural elements.

Figure 35. Top down construction

6.2.4 Comparison of bottom up and top down construction

The advantages and disadvantages of bottom up and top down construction are summarised below.

	Bottom up	Top down
Advantages:	• The excavation and substructure construction will, all other things being equal, be quicker as larger plant can be used and there will be better access	• Lower risk of movement, all other things being equal, due to stiff permanent works being used to provide restraint and of there usually being fewer number of load transfers • Superstructure construction can proceed at the same time as the substructure, provided the necessary vertical supports, generally piles, are in place • Once installed the permanent upper slab provides access from the street and solid space for welfare or other facilities
Disadvantages:	• More load transfers and usually less stiff horizontal support due to greater use of temporary horizontal temporary propping means increased risk of movement and damage • Sequential construction of the substructure and the superstructure often means a longer overall programme • Horizontal propping impedes the final excavation and construction of the permanent works	• The excavation works and substructure construction are often slower and more expensive due to the restrictions on the size of plant and the limited access • Additional temporary access holes may have to be left in the slabs to provide access for the subsequent excavation and works • Vertical support for the permanent slabs is often required in the temporary condition • Stiffer construction during intermediate construction stages can attract higher loads into the permanent structure

6.3 **Tunnelling**

6.3.1 Outline

Construction by tunnelling is achieved by making access underneath the existing floor then building the new basement perimeter, usually by building RC cantilevered underpins.

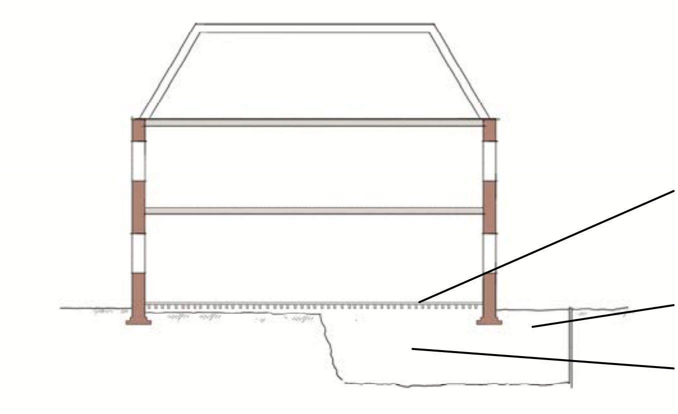


Figure 36. Tunnelling

Loads from the existing structure and floor above must be supported by permanent or temporary works as construction progresses. The permanent supports will often be designed as structural steel beams and columns.

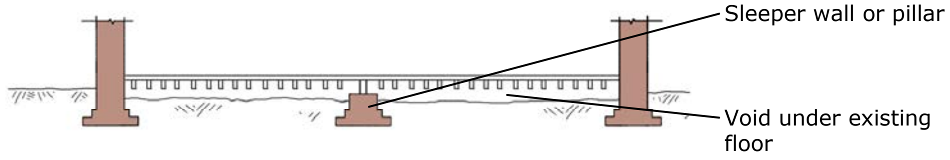
Figure 37. Tunnelling under occupied house

Installation of structural steelwork will often involve temporary works in restricted spaces. There will often also be a desire for the permanent steel beams to be installed as close to the underside of the existing floor as possible necessitating a tight vertical temporary works zone. These factors can make the installation of structural steelwork complex.

6.3.2 Existing floor construction

The existing floor will generally be either:

- A spanning floor - usually timber joisted with sleeper wall or brick column supports or, occasionally, pre-cast concrete beam and block or RC slabs
- Ground bearing, non-spanning floor - usually a mass or lightly reinforced concrete slab



a. Suspended timber floor - spanning

b. Ground bearing concrete floor

Figure 38. Examples of existing floor construction

Tunnelling underneath a spanning floor is achieved by supporting the floor close to or at the currently supported locations. This will support the existing floor adequately provided the supports introduced are sufficiently strong

.

Figure 39. Tunnelling under spanning suspended timber floor

Tunnelling underneath a ground bearing floor is more difficult. The position of temporary and permanent supports for a ground bearing non-spanning floor must be calculated based on assumptions. Often there will be limited information on the strength or composition of the existing floor so conservative assumptions should be made and the floor should be supported at small span distances.

Timber sheets, e.g. 18mm plywood, can be laid on the upper surface of unreinforced concrete floors to spread minor load where the floor above will remain in use during the works in order to reduce the risk of localised damage.

Once underneath the structure it is important that, where possible, the accuracy of the initial assumptions are confirmed.

Figure 40. Temporary works during tunnelling below ground bearing concrete slab

Figure 41. Permanent steelwork to support ground bearing concrete slab

Note: In the picture above the two props on the left are not providing support to the steel beam which is already spanning in the permanent condition. When providing temporary support a simple device such as a G clamp should usually be used to secure each prop at the head.

Tunnelling below ground bearing concrete floors will usually be significantly slower and more costly than building underneath a spanning, self-supporting floor.

6.3.3 Point loads

Existing columns, masonry pillars or other point loads are particularly difficult to deal with from underneath. A specific temporary works design and method will usually be needed to deal with each point load.

In some instances it may be necessary to reduce load on the column or pillar by using temporary works above ground.

6.3.4 Considerations

Tunnelling underneath existing floors requires careful planning and coordination. Particular points to note are:

- The position of the existing supports to the internal structure and floors probably cannot be confirmed prior to the works
- The temporary works plans and sequence may need to be changed during the works once the structure is confirmed. Changes need to be agreed with the Temporary Works Engineer and implemented under the control of the Temporary Works Coordinator.
- Good access into and egress from the working areas is critical both for the health and safety of the operatives and to enable the job to make good progress. Multiple access points should be put in place where possible.
- The working areas need to be well ventilated - forced air handling may be needed
- The working areas need to be well lit
- Care must be taken not to undermine existing foundations when making access tunnels - these foundations for walls and for any columns and pillars inside the footprint of the building

6.3.5 Summary

Basement construction by tunnelling can be the appropriate method for many projects especially in timber joisted houses where the occupants want to remain living in the property during the works. However even apparently modest projects need careful risk assessment and planning in order to be completed safely and efficiently.

6.4 Comparison of ground level down construction and tunnelling

	Ground level down	Tunnelling
Advantages:	• Structural basement works will be quicker and less costly than for tunnelling - access across the full site immediately • Temporary works will be less difficult • Piling rigs and other larger equipment are more likely to be usable	• Property should remain habitable throughout • Existing floor will not need to be replaced • Should be no need for anything other than cosmetic repair or decoration
Disadvantages:	• Lowest level of existing building will always need to be repaired and redecorated • New floor will be needed at lowest existing level • Lowest level cannot be occupied during the works	• Structural basement work will be slower and more expensive • Access is more difficult and will slow the works • Increased health and safety considerations around access, ventilation and lighting • Sequence and temporary works will often need to be confirmed or adjusted during the project requiring additional planning, coordination and control

6.5 Summary

There is no single best construction method for all basements. For many projects the most appropriate construction technique and method will be reasonably obvious however for others careful consideration, initial investigative works and analysis may be needed before the best method can be chosen.

7 IMPACT ON OTHERS

7.1 Introduction

Basement construction can have a significant negative impact on neighbours, local residents, other road users and other members of the public. Minimising negative impact on others needs to be considered at an early stage in the project to avoid high impact methods being locked in by the design.

The main negative impacts on others are:

a. Damage to surrounding buildings and structures.

b. Noise, vibration and dust.

c. Traffic congestion.

Early communication and consultation with local residents will go some way to reduce negative construction impact.

7.2 Damage to surrounding buildings and structures

7.2.1 Introduction

There will always be some risk of damage to surrounding buildings when any construction work takes place, be it basement or above ground work. The risk of damage should always be minimised.

Underpinning and piling combined with appropriate temporary works, when correctly designed and installed, should minimise damage. In the majority of cases there should be no noticeable structural damage. Damage should usually be limited to superficial cosmetic damage. The table for categorisation of damage to buildings is at appendix B.

In nearly all cases where there is greater damage than this the root cause is either poor design or workmanship. Instructing a competent and experienced contractor is probably the most critical factor in avoiding damage to surrounding buildings and structures.

7.2.2 Predicted settlement of the building under which the basement is being constructed

The likely extent of anticipated movement of the building, depending on the scale and complexity of the project, should be calculated by the Structural Engineer during the engineering design. Various modelling techniques can be used based on the permanent design and the construction method. A geotechnical specialist should be commissioned to model ground movement on complex, large or high risk projects.

A load take down is required for each stage of construction. The reaction from the ground at each stage can then be analysed and a prediction of the anticipated movement to the structure can be calculated. The sensitivity of the existing and surrounding buildings should also be considered to assess the degree of ground movement that can be tolerated. Vertical and horizontal movements must be considered.

The movement that occurs during and after construction is dependent on the quality of workmanship. For example underpinning excavations and bases must be adequately propped to minimise relaxation of the ground as well as to provide safety for the site operatives.

The contractor will often have proposed the detailed method. The method must then be followed as this will have been used by the structural or geotechnical engineer to estimate ground movement.

7.2.3 Predicted settlement of the surrounding buildings

The extent of the bulb of influence on the ground around the basement construction will depend on the nature of the soils. The degree of influence will be greater the nearer a property is to the basement construction. In some cases the bulb of influence can extend further than expected, even as far as across a road. All buildings within the bulb of influence must be considered.

7.2.4 Party Wall Act

The Party Wall Act provides a legal framework under which work can be completed on, to or underneath party walls or alongside property boundaries. The Act was not written with retro-fit basement construction in mind and so there are various parts of the Act where the wording is open to interpretation. One of these is the section on special foundations consent that has already been mentioned (para 4.2.3).

The intention is that no damage is caused however the Act allows that damage may occur. In this instance the Building Owner remains fully liable to make good or pay compensation to the Adjoining Owner for any damage. This remains the case even if the damage is non-negligent. Non-negligent damage is classed as damage that occurs despite everything having been done correctly.

Under the Act Building Owners have a responsibility to notify Adjoining Owners of their intention to work under or close to any party wall or, usually, along any boundary line. Work should not usually be started until party wall agreements are in place. Adjoining Owners have the right to appoint a surveyor and a checking engineer to act on their behalf. The reasonable costs for these are paid by the Building Owner.

The Act is not perfect but does give a workable framework that balances the rights of property owners to undertake work while providing a level of security to neighbours.

7.3 **Noise, vibration and dust**

Noise, vibration and dust can be caused by:

- Construction work on site
- Spoil removal
- Materials stored on the road or on the site

The worst noise, vibration and dust on site is generally produced by:

- Breaking out concrete especially reinforced concrete
- Cutting steel reinforcement and structural steel

- Drilling into concrete
- Use of large plant such as piling rigs
- Delivery and collection vehicles
- Above ground demolition works

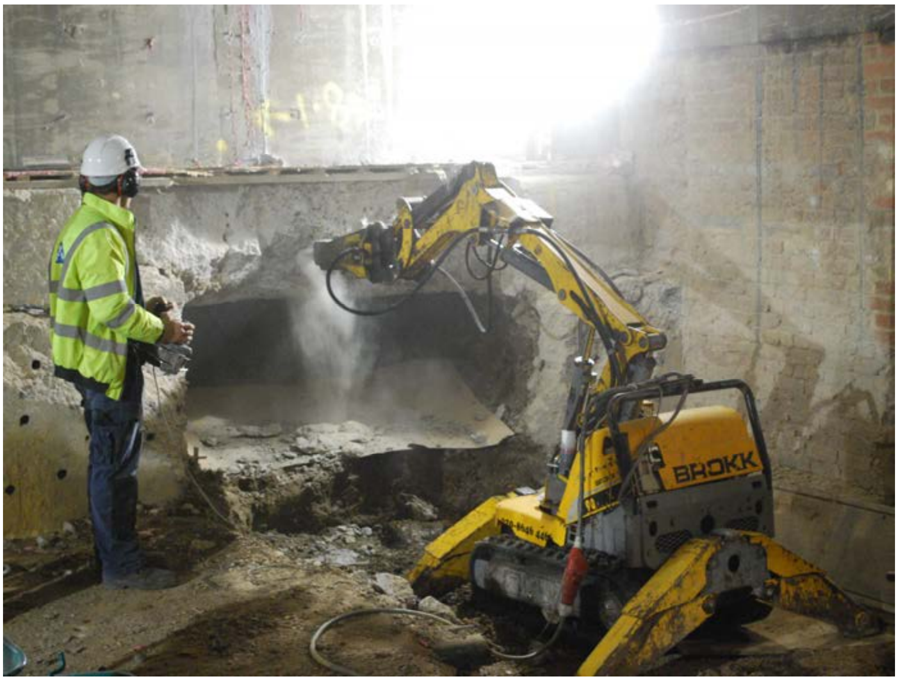


Figure 42. Concrete break out

Use of remote controlled demolition machine avoids health risk (Hand Arm Vibration [HAV]) to operator and allows the operator to stand well away from the machine and falling debris. Water spray is used to suppress dust.

Excavation of ground, building formwork, tying reinforcement and placing concrete do cause noise, vibration and dust but do not generally cause significant problems to others.

The working hours on site are set by the local Council. In residential boroughs they are generally 0800 to 1730 hours Monday to Friday and 0800 hours to 1300 hours on Saturday. Some sites near offices may be subject to periodic noisy working under Section 60 of the Control of Pollution Act 1974. Imposition of this control usually means that noisy working is restricted to two hours with a quiet period of two hours in between.

Actions that can be taken to reduce construction site impact include:

- Keeping doors and windows closed where possible
- Using muffled or silenced compressors and other plant
- Using, where practical, electrically powered tools rather than air powered tools - electrical tools do not need a compressor unit

- Using relatively low power handheld breaking tools for removing existing foundations
- Using, where practical, non-percussive methods for removing concrete, including using diamond saws, diamond drills, concrete bursters and concrete crunchers
- Using sound shielding around noisy work areas
- Using non-percussive piling methods
- Informing and communicating with local residents on the best times to complete very noisy works
- Informing local residents of the times of very noisy works in advance
- Agreeing non-noisy working times
- Stopping site operatives from shouting or raising their voices unnecessarily
- Banning the use of radios, other than communication radios, on site
- Using good quality suppliers with modern delivery vehicles
- Ensuring conveyors are well maintained and lubricated
- Making sure materials are fully enclosed by waterproof and dustproof coverings especially cement and ballast

7.4 Traffic congestion

The main causes of traffic congestion around sites are:

- Delivery and collection vehicles, notably spoil removal vehicles and ready mix concrete delivery lorries
- Hoardings, skips and welfare facilities on the highway

Use of the highway for skips, materials storage and the like should generally be minimised. It is not always possible to store everything on site and in this instance the most efficient use of space should be employed.

Possible actions that could be considered are:

- Implementing a Construction Traffic Management Plan (CTMP)
- Limiting vehicle delivery, collection and spoil removal operations to low traffic volume times, say between 9.30am and 4pm
- One way approach and departure route plan
- Ensuring an adequate system of vehicle call up to avoid having multiple vehicles on site at the same time

- Positioning banksmen and traffic marshals at sensible places to give local traffic the option of using alternate routes before they are committed to the road past the project

- Providing the traffic marshals with communication radios

- Moving the delivery or collection vehicle when local traffic wants to pass

- Using the lowest impact method for spoil collection - possibly vehicles waiting under a conveyor for loading or grabs lorries rather than skips on exchange

- Communicating with local residents to gain feedback on the effectiveness of the measures being taken

- Avoiding deliveries and collections at times when the local refuse collection takes place

- Avoiding routes past local traffic generators such as schools, especially at their expected busy traffic times

- Coordinating deliveries and collection with any other nearby construction sites

- Organising the site efficiently to minimise the need for storage on the highway

7.5 **Summary**

Basement construction projects can cause significant negative impact on others especially if poorly planned and executed. There will always be some negative impact but this should be minimised through early engagement, imaginative planning and considerate execution.

8 FACTORS AFFECTING CHOICE OF CONSTRUCTION TECHNIQUE AND METHOD

8.1 Introduction

Health and safety considerations will override all other considerations. However health and safety excepted the remaining main factors that affect the choice of construction technique and sequence are:

a. Architectural design

b. Occupier's desire to live in the existing building during the works

c. Existing building

d. Party wall matters

e. Soil and geology

f. Hydrogeology

g. Surrounding structures

h. Site access

i. Impact on others

8.2 Architectural design

The architectural design will often have a significant impact on the structural design and on the construction technique and method. There are nearly always trade-offs between the desired architectural design, what can be built, cost and the value of the added space.

The main architectural design factors that affect construction are:

a. Depth - deep multi-level basements will, all other things being equal, tend to favour piling over underpinning especially for open sites. However piling will mean a loss of some space, usually in the order of 700mm to 1,000mm thickness around the perimeter, especially underneath a building. Underpinning will usually follow the line of the existing structural wall above or might need to come in up to approximately 100mm.

b. Size of garden basements - smaller garden basements will tend to favour reinforced concrete retaining walls or underpinning while larger garden basements with long runs of wall will tend to favour piling. Again piling will usually mean a thicker perimeter wall construction but in large gardens this may not be a significant concern.

c. Size of open areas without columns - there is often a desire for basements to have large open areas with no columns or other interruptions. These are possible but can be difficult to achieve in certain circumstances. There is a trade off between the distance between structural elements, the vertical load that must be supported and the vertical thickness of the structural beam required to support the vertical load above. A large span with a high load will need a vertically thick structural beam. There is usually a desire to hide structural beams within the floor build up. However at some point the beam's vertical thickness will become greater than the thickness of the floor and the beam will have to have a down stand in the ceiling.

d. Basement plan being different to plan of existing building - the most straight forward basement designs from a construction perspective have the structural walls at basement level directly underneath the main structural walls at the lowest existing floor level. In this way the main existing vertical loads are transferred straight down to the new basement foundations. Once the basement plan deviates from this principal construction becomes progressively more complex. Basements with plan layouts that do not follow the lines of the existing building above can be constructed using temporary or permanent RC bored piles combined with transfer slabs.

8.3 **Occupier's desire to live in the existing building during the works**

The property owner may wish to live in the building during the works. This will generally mean that either a tunnelling method must be used for works under the existing building or that at least the lowest level of the existing building must be unoccupied.

Where the upper floors only remain in use during the work it may be necessary to provide additional temporary works in the form of an external stairway and secured opening into the building. Internally the original stairway can then be blocked off.

There is a trade off to be considered that balances the costs of renting alternative accommodation, replacing any floors that will be removed and any making good and decorative work against the additional cost of the structural work and construction duration if completed by tunnelling.

8.4 Existing building

The condition and structure of the existing building influence the choice of construction technique and method.

The table below summarises some of the key points:

Factor	Favours / allows
Depth and quality of existing foundations	Generally strong, deep foundations will favour underpinning
Delicate building fabric or structure	Favours ground level down construction over tunnelling
Strong, well documented building structure	Allows tunnelling method to be more fully considered
Multiple, highly loaded column and pillars	Favours ground level down construction
Ground bearing concrete floors, especially if old and suspected of being fragile	Favours ground level down construction; tunnelling appropriate only after careful consideration and possibly comprehensive investigative works
Spanning existing floor construction	Makes tunnelling more viable

8.5 Party wall matters

The critical party wall matter, as mentioned previously, is special foundations consent, which can be given or withheld by the Adjoining Owner. Reinforced concrete underpins cannot be used without special foundations consent.

In the case where special foundations consent is not given then either mass concrete underpins with a lining RC retaining wall or a piled retaining wall solution will probably need to be used.

It is reasonably unusual now for special foundations consent not to be given, most party wall surveyors working for Adjoining Owners tend to recommend that consent is given.

8.6 Soil and geology

The soil and geology in most parts of the United Kingdom where basement construction is undertaken is generally favourable, or at least not wholly unfavourable, to below ground construction.

Generally ground can be divided into two types:

a. Granular, non-cohesive soils - such as sands and gravels. Granular soils tend not to be self supporting even in the short term.

b. Cohesive soils - such as clays. Cohesive soils tend to be self supporting at least in the short term.

General points to consider with soil and geology are:

Cohesive soils are often better for both underpinning and piling as the ground will tend to stand well as opposed to non-cohesive soils where local collapse is more likely.

This has practical implications for basement construction:

a. Underpinning - underpin excavations in non-cohesive soils will need more thorough local shoring than in cohesive soils.

b. Piling:

   i. The bored holes for RC piles in non-cohesive soils will often need to be temporarily cased or use hollow stem augers in order to prevent local collapse during construction.

   ii. The spacing between piles in a contiguous piled wall may be greater in cohesive soils than in granular soils.

In addition the bulking factor of cohesive soils is generally greater than for granular deposits and therefore tends to cost slightly more to remove from site.

A site investigation consisting of an initial desk top study followed by on-site investigative work should usually be completed to ascertain the ground stratigraphy as well as to find out about groundwater, contamination of the ground and the construction of the existing foundations.

Further information on site investigation is given at appendix A to this document.

8.7 Hydrogeology

Hydrogeology deals with the distribution and movement of groundwater.

A project specific site investigation including boreholes provides the most reliable information on the extent and movement of any groundwater.

There are two critical points:

a. Basement construction below the ground water level poses significant additional challenges and may make some projects uneconomic. Early knowledge about any groundwater is critical.

b. Any permanent change to the flow of groundwater caused by the basement must be considered and dealt with effectively by the permanent design.

Construction below the ground water level can generally be achieved safely using one of the following methods, covered previously in detail in section 4 - *Techniques used in basement construction*.

- Ground dewatering
- Secant or sheet piling
- Ground stabilisation through techniques such as permeation grouting

However they all add cost, some of which will be hard to quantify fully before the works start on site.

8.8 Surrounding structures

The stability of surrounding structures must be fully considered. The following points should be noted:

- Foundations from nearby buildings may surcharge the load on the walls of the proposed basement. The permanent and temporary works designs need to take account of these loads.
- Support provided to surrounding structures by elements that are to be demolished or altered must be considered and be replaced by support from temporary or permanent works
- Where a party wall is underpinned there will be a point, usually at the front or rear elevation, where the underpinning stops and the adjacent wall remains supported on its existing foundations. The underpinned wall will be founded at depth while the adjacent wall will be founded on the existing, nearly always, shallower foundations. In this instance there is the possibility for differential movement. The degree to which this is of concern should be assessed by the Structural Engineer and relevant designs, such as transitional underpins, may be considered.
- Owners of any surrounding building or structures, known as the Adjoining Owner in the Party Wall Act, should be notified of the works in advance. Adjoining Owners have the right to instruct a party wall surveyor and a structural engineer to check the permanent and temporary works designs and method of work.

8.9 Site access

Site access can make a significant difference to how a project may be undertaken. In particular poor access will usually mean:

- Steel sheet piles are not practical
- Piling will be possible only with smaller or mini-piling rigs which work more slowly than larger rigs, generally have less power to penetrate difficult ground and can have less exact vertical tolerances

- The overall project duration will increase due to the difficulty of moving material onto site and spoil off site - extremely poor access may limit the size of some projects either because of unacceptable project duration or high cost

Figure 43. Example of restricted site access

The scaffold tunnel over the pavement allows pedestrians to pass the site without having to cross the road and protects them from any material falling from the conveyor above.

8.10 **Impact on others**

Some construction methods may cause greater noise, vibration, dust and traffic movement than others.

These include:

- Steel sheet piling using percussive piling - this will generally not be acceptable in urban areas

- Bored piling using large rigs - this will involve delivery and movement of large plant and reinforcement cages for insertion into the piles

8.11 **Summary**

Health and safety is the most important single factor to be considered when choosing the construction technique and method.

All of the factors, together with health and safety, need to be considered for each project.

Groundwater, if present, will have a major impact on the design and method of construction. The other factors will usually have less individual influence but they need to be considered individually and collectively.

9 HEALTH AND SAFETY

9.1 Introduction

Basement construction under or near existing structures has a high level of inherent construction hazard. The foundations of the project building and nearby buildings are always undermined. Deep excavations with their potential to cause local ground movement are part of everyday operations. Structural alterations involving the removal of load bearing walls and other elements are nearly always part of the works. Large amounts of material are moved around and on and off site continuously during work. And all of this takes place in generally restricted sites and in close proximity to the public going about their daily business.

In order that this work can be undertaken safely all members of the construction team, most notably the contractors, must be suitably experienced and qualified as well as being committed to safe working practices. It is critical that Clients only appoint individuals and companies who meet this high benchmark.

All basement construction projects must have in place appropriate health and safety management with arrangements including access to competent health and safety advice on general and construction matters.

9.2 Outline

This section will cover:

- Safety hazards
- Health hazards
- Responsibilities
- Health & safety of others
- Designing to mitigate risk
- Planning for risk management
- Managing and supervising
- Competence, training, and induction
- Welfare arrangements
- Emergency planning and procedures
- Summary

9.3 Safety hazards

There are numerous serious safety hazards involved in basement construction directly below or near to existing buildings.

These hazards include:

- Collapse of excavations
- Collapse of existing buildings and structures
- Access to work areas
- Falls from height
- Scaffolding and ladder safety
- Existing services
- Electrical handheld power tools
- Mobile plant safety
- Confined spaces
- Fire and means of escape
- Dangerous substances
- Lifting operations
- Lighting
- General site order and slips, trips and falls on the same level

Collapse of excavations and of existing buildings and falls from height, including into excavations, are the three hazards most likely to lead to death or serious injury both to site workers and members of the public.

All temporary works associated with excavations and support to existing buildings must be undertaken in line with section 5 of this document, Temporary works.

Mitigating actions for all of these safety hazards are given at appendix C.

9.4 Health hazards

In addition to the safety hazards there are also significant health hazards associated with basement construction projects. The main health hazards are:

- Asbestos
- Hazardous substances and processes
- Respiratory disease especially from dust containing silica
- Carbon monoxide and other noxious gases

- Dermatitis
- Damage to eyes
- Noise
- Hard arm vibration
- Manual handling and musculoskeletal disorders
- Inclement weather

Work related stress and alcohol and drug abuse are also serious health issues affecting the wider construction industry.

Mitigating actions for these health hazards are given at appendix D.

9.5 **Responsibilities**

9.5.1 Outline

Individuals with health and safety responsibilities are called duty holders.

The main duty holders are:

- Clients – the person or organisation instructing the work who is either business or domestic
- Designers - usually architects and structural engineers but designers include anyone contributing to the design of the work including those altering the design or designing temporary works
- Contractors – the people on site physically managing and carrying out the work

The Health and Safety at Work etc Act 1974 (HSW Act 1974) and Construction (Design and Management) Regulations 2015 (CDM 2015) set out the main statutory duties on clients, designers, contractors and others involved in basement construction projects.

Other health and safety regulations cover specific relevant hazards such as work at height, use of plant and equipment, lifting operations, hazardous substances, fire and explosion, confined spaces, and noise and vibration.

9.5.2 Client

Where a basement project is carried out in furtherance of a business the client has direct responsibilities under CDM 2015. Where the project is for a domestic client (not in furtherance of a business) the person procuring the project has duties under CDM 2015 but these are largely transferred to either the contractor, principal contractor or, at client's request, to a principal designer.

Business clients (for example a developer or landlord or commercial premise owner or occupier) have extensive duties including the requirements to take reasonable steps to check contractor competence, appoint a principal designer and principal contractor where there is more than one contractor involved in the project plus making arrangements for managing the health and safety for the project.

Domestic clients have the same duties under CDM 2015 as a business client. However these duties automatically transfer to the contractor. Where more than one contractor is involved the first contractor on site, or the main contractor for the work, is deemed to be the principal contractor and is expected to take over the client's duties. Where there is more than one contractor involved the first or the main designer is deemed to be the principal designer and has duties to coordinate the pre-construction work. By arrangement, the client may choose to appoint the principal designer to be responsible for fulfilling the client's duties instead of the principal contractor.

Domestic clients are those who either live in the premises or will live in it once the work is complete and who do not run a business from the premises. However the need for safety and the potential risk of civil liabilities make it sensible for domestic clients to engage competent designers and contractors to ensure the safety of themselves and third parties who may be affected by the works. A domestic client found not to have instructed competent designers or contractors could find themselves the subject of civil litigation. Domestic clients usually have limited knowledge of construction matters and it is vital that they seek advice from a range of experts before embarking on a basement project.

Domestic clients will have direct duties under CDM Regulations if they control the way in which construction work is carried out: for example by insisting on the use of an unsafe means of access or of unsafe equipment. Once anyone starts to control work they must comply with Part 4 of CDM 2015 which covers physical safeguards that must be provided to prevent danger.

9.5.3 Designers

CDM 2015 duties apply to all projects, including non-notifiable and domestic works.

Designers must seek to avoid, so far as is reasonably practicable, construction risk whilst preparing or modifying the design. This is achieved by eliminating hazards and reducing risk from remaining hazards for example using shorter beam spans or lighter beam components and in-situ assembly to reduce manual handling risks.

Designers must also provide information likely to be needed to identify and manage the remaining construction risks.

On all construction projects involving more than one contractor a principal designer must be appointed to coordinate all the design activities. Even on a relatively small project there is likely to be an architect, a permanent works structural engineer and a temporary works engineer undertaking design. Failure to coordinate design work can result in designs that are difficult to build, overload structures while they are in a temporary condition, and cause unsafe working conditions.

9.5.4 Contractors

Contractors must ensure, so far as is reasonably practicable, the control of hazards to health and safety during the works.

The contractor's duties involve:

- Planning: minimising risk and establishing precautions
- Managing: implementing and maintaining precautions
- Monitoring: checking and reviewing precautions

The Contractor must do all three activities throughout the project.

On all construction projects involving more than one contractor a principal contractor must be appointed. This may be the first contractor involved or, more usually, the main contractor for the work. The principal contractor has duties to coordinate the activities of all the parties working on the site and by monitoring activity to ensure that working conditions, arrangements and systems of work are suitable at all times. Failure to coordinate and control work inevitably results in risk of injury, ill health and collapse of structures.

9.6 **Health and safety of Others**

The health and safety of building occupiers, visitors and the general public is of paramount importance on basement construction projects. Work must not be carried out unless the structural integrity of the building being extended and those nearby has been ensured and until work areas have been secured to prevent access by unauthorised people.

Safe areas and safe means of access and egress must be established and maintained through affected public areas with particular care being provided where elderly people or children may be involved.

The arrangements for carrying out the work must include minimising the opportunity for problems to occur either during or outside of working hours. Where the building remains occupied during the work, additional planning is needed to ensure that fire risks for example are tightly controlled.

Site security and access restrictions	Reasonable steps must be taken to prevent access by unauthorised persons to the project site. Only people who are explicitly authorised must be allowed access. Authorised people must have relevant site rules explained to them, wear the required Personal Protective Equipment (PPE) and undertake any necessary site induction. It must not be possible for members of the public, especially children, to wander onto site at any time. A common fault for basement construction projects occurs where workers are moving materials onto site and the main site door is left open and unattended. This must not be allowed.
Warning signs	Warning signs should be highly visible and be located where they are most likely to be seen by someone entering the site.
Works access	Safe means of access and egress must be established and maintained to all areas of work. Special attention should be taken when work is in a restricted area and all reasonable efforts should be made to ensure multiple exit points. Access points for emergency service vehicles must be clear at all times. On larger sites, where possible, separate pedestrian and vehicle entrances should be designated. Vehicle access to site should avoid hazardous situations, for example being close to overhead power lines or causing obstructions to road users. Steps must be taken to prevent dirt, mud or dust being carried out of the site onto public highways.

9.7 Designing to mitigate risk

9.7.1 Outline

The design team must mitigate risk as far as reasonably practical. It is usually preferable if experienced specialist contractors and engineers are part of the design team at an early stage in order to identify the main risks.

The main areas for consideration are:

- Stability of existing structures
- Temporary works
- Avoiding risks from other hazards

9.7.2 Stability of existing structures

The design must prevent the collapse and minimise the movement of existing or nearby structures.

Loads and their distribution must be calculated with particular attention to ensure that loads are transferred to the new basement structure through elements of the building that have sufficient load bearing capacity. All load paths must be identified and checked.

Elements showing signs of distress or weakness must be strengthened to allow the safe transfer of load with a suitable factor of safety allowed to ensure that unintentional redistribution of the buildings' load in the building fabric does not cause problems.

The strength and condition of any existing structures must be assessed to ensure that any zones of failure or separation can be predicted.

Wind loads should be calculated with full recognition given to any localised effects such as funnelling or that might result in uplift of structures such as temporary roofs.

9.7.3 Stability of the works in the temporary condition

Temporary works must be used to ensure the stability of the ground and existing buildings during the works. All temporary works must be designed, installed, monitored and removed correctly.

A Temporary Works Engineer (TWE) must always be appointed to design the temporary works. In addition on all construction projects a named person must be appointed to coordinate temporary works. This includes identifying where temporary works are needed; arranging for designs to be prepared and checked; arranging for suitable subcontractors to be appointed and/or suitable workers to be briefed; ensuring the correct equipment is sourced and correctly used; and maintaining site records. The site engineer will usually provide detailed advice but will not coordinate the arrangements unless contracted to do so. The person who fulfills this function is known as the Temporary Works Coordinator (TWC)

On larger sites the Temporary Works Coordinator may be a dedicated role for one person. On smaller sites the site manager or another manager may be trained to take on this function.

The temporary works should be designed by an engineer, known as the Temporary Works Engineer (TWE). A Temporary Works Engineer must always be appointed.

Both the TWE and TWC must be suitably qualified and experienced individuals.

Further detail on the correct process and responsibilities for temporary works are given in section 5 of this document.

The Structural Engineer should consider designing structures that allow permanent elements to be installed early in order to reduce the need for temporary works. For example designing to allow top down construction where permanent upper level slabs are installed before the main bulk excavation.

9.7.4 Avoiding risk from other hazards

In addition to designing for structural safety all designers must seek to avoid construction risk whilst preparing or modifying the design.

In particular hazards from working at height, manual handling, confined spaces, fire, generation of noise, vibration, and dust, and the use of hazardous and dangerous substances should be avoided in the building design as far as possible.

An example of designing to reduce risk from manual handling is designing structural steelwork beams with a splice or as composite beams in order to reduce the size and weight of each piece of steel. Examples where designers can reduce fire risk are by designing structural steel to be cut and fabricated off-site to help minimise in-situ hot works, and by specifying materials with low combustibility.

A practical action that helps design that avoids unnecessary construction risk is to involve the basement contractor (who will often instruct or control the TWE and TWC) and the Structural Engineer early in the design process. Property owners frequently desire large open spaces with minimal support. These are generally possible but there are limitations and trade-offs which include health and safety considerations. Health and safety pitfalls can largely be avoided if the basement contractor and Structural Engineer are involved early.

9.8 **Planning for risk management**

9.8.1 Outline

The project must be planned to manage risk effectively. This requires:

- Gathering the required information
- Assessing the significant risks
- Developing methods and safe systems of work

9.8.2 Gathering the required information

All relevant information should be gathered as early as practically possible in order to allow the significant hazards to be identified and assessed. The breadth and amount of information required should be appropriate for the scale and complexity of the project.

Comprehensive information would usually be needed for a single or multiple level basement, while limited information may be needed for the deepening of an existing cellar. As a guide more information rather than less should be acquired. A competent contractor will seek to obtain as much information as possible.

A business client is required to provide designers and contractors with pre-construction information consisting of all information which is relevant to the health and safety of those engaged in or affected by the work, or who will use the structure as a future workplace. This should include local knowledge of the site and the information in any relevant existing building health and safety file.

The relevant information may include:

a. Site investigations.

b. Existing and adjoining building and structures.

c. Adjacent underground structures.

d. Location of services.

e. Asbestos surveys.

f. Site access.

Additional detail on the relevant information that may be needed to enable planning for risk management is given in appendix E.

9.8.3 Assessing the significant risks

The basement project main or principal contractor must ensure that a suitable and sufficient assessment of the risks to the health and safety of employees and others who may be affected by the works is carried out by all employers working on the project.

Risk assessments must be site and work specific. It is not adequate to use generic risk assessments, they must relate to a specific project and the activities to be undertaken on that job.

Risk assessments should be practical and provide actions that will avoid or mitigate risk. Historically risk assessments have often been overly complicated paper exercises that are then not used to implement simple actions. This approach should be avoided and straight forward risk assessment that identify the likely hazards and provide practical actions should be used instead.

In the first instance the assessment helps the main parties select the method of construction, the construction sequence, the system of work and the plant, equipment and workforce that is needed. This selection process may be reworked several times before the right mix becomes clear. Once the main decisions are in place the assessment can be refined to help ensure the work will proceed smoothly with minimal risk to workers and others.

A full structural assessment must always be completed. This should identify any limitations on the proposed works and the need for any temporary or permanent works to stabilise structures prior to the main work commencing and during the works.

9.8.4 Developing methods and safe systems of work

Risk assessments should promote the preparation of site specific method statements detailing, with sketches, diagrams or photographs where possible, how the significant hazards will be managed.

Method statements should set out how the operation or activity will be carried out safely and describe the scope and sequence of works.

Specific temporary works designs will often be included as part of a method statement and will need to be available for use before structural or excavation work commences on site. However not all of the temporary works designs are needed before work starts, they can be added and amended throughout the project as required in consultation with the project temporary works engineer.

9.9 Managing and monitoring

9.9.1 General

Once the project has been designed and planned from a health and safety perspective work on site can start. The work must then be adequately managed and supervised.

Ensuring that the work is managed and monitored correctly starts with senior management and works down.

9.9.2 Director or owner reviews

Directors or company owners must take a keen interest in health and safety during all site visits and conduct a formal review of health and safety arrangements and performance during meetings with project managers and engineers.

The company director responsible for health and safety should arrange for a review of the effectiveness of the company health and safety policy, organisation and arrangements at least every twelve months or following any incident, accident or dangerous occurrence.

9.9.3 Management system

A practical health and safety management system must be in place and be used. There is no point in having a system that is not effective because it is overly complex and difficult to operate.

Typical elements of an effective health and safety management system are:

- Health and safety plan presentation by the project manager to senior site management before the start of all jobs
- Health and safety plan presentation by the person directly responsible for the site, for example the Contracts Manager, to the company director responsible for health and safety
- Regular health and safety site visits by a company director or senior manager to each project
- Health and safety site visits by an external health and safety consultant

- Regular health and safety reports on each job to senior management covering risk assessments and methods for current and future phases of work

- Staff inductions are completed where it is made clear that health and safety is a business critical priority and that staff are never expected to take undue health and safety risks, and must report all concerns and any near misses or incidents to site management

- Site management reports and reviews of all accidents, near-misses and instances of non-compliance with lessons learned being communicated out across the company and workforce

- End of job health and safety report with lessons learned being recorded and disseminated

In this context regular may mean weekly or fortnightly.

9.9.4 Monitoring

Health and safety must be continuously monitored. Project managers and engineers should take a keen interest in health and safety during all site visits and conduct formal health and safety inspections at established intervals with inspection reports provided to the managing director. Project managers should monitor for health and safety compliance on all site visits, which would usually be completed on or near to a daily basis.

Site managers and Foremen are expected to monitor health and safety on a continuous basis.

9.9.5 Supervisor checks

Contractors must have procedures in place to check, throughout the working day, that the required safety precautions are being implemented. As a minimum these should ensure that:

- Temporary works are in place, secure and installed in line with instructions

- Excavations are correctly shored

- Access to the site and for all work areas is fit for purpose

- Ladders are secure and correctly installed

- Edges are protected, including edges to excavations

- PPE is available and being used, especially safety boots, head protection, and eye and hearing protection

- Operators are not being exposed to hand arm vibration (HAV) risk from using power tools for extended periods

- Work platforms are safe and secure

- The correct equipment is available and in good working order

- Guards on piling rigs and other plant and equipment are in place and being used correctly
- Exposed reinforcement ends are protected to prevent impalement incidents
- Exposure to dust is being minimised
- Fuels and oils are stored correctly
- Combustible waste is not allowed to build up – offcuts and packaging are regularly removed to open air and away from buildings
- Banksmen are being used to control deliveries and collections
- Welfare facilities are available and serviceable

Checklists are an effective tool to guide these ongoing checks.

9.9.6 Reporting health and safety risks

All staff should be briefed that reporting health and safety concerns and non-compliance up the management chain is their individual responsibility and that doing so is part of the company health and safety plan.

Reporting health and safety problems allows supervisors and managers to take corrective actions to avoid accidents and injuries.

9.10 **Personnel**

9.10.1 Outline

Everyone involved in basement construction, from site operatives to company directors, must be competent and adequately trained in health and safety. The basement contractor needs to take the lead in this area.

9.10.2 Competency

The competence of site workers and supervisors is crucial for the safe completion of basement works. The lack of competent site management is a main cause of major problems on site according to the Health and Safety Executive.

To this end all managers and site foremen must have received appropriate training in site safety management and supervision.

In addition on-site operatives must be able to receive and clearly understand the written and verbal instructions from their immediate supervisor.

The level of supervision and the number of persons on site, their aptitude, experience and training, must be appropriate.

9.10.3 Training

There are no absolute rules over the training requirements for different roles however there are several widely accepted training courses and schemes aimed at different levels of responsibility.

Course	Target level
Director's Role for Health and Safety	One day course aimed at Company Directors run by the Construction Industry Training Board (CITB)
Directing Safely	One day course for Company Directors run by Institution of Occupational Safety and Health (IOSH)
Managing Safely for Executives	One day course for executives run by IOSH
Site Management Safety Training Scheme (SMSTS)	Five day course aimed at Site Managers run by CITB
Managing Safely in Construction	Four day course for managers run by IOSH
Temporary Works Coordinator	Two day course for construction managers undertaking the Temporary Works Coordinator responsibility, run by CITB
Site Supervisor Safety Training Scheme (SSSTS)	Two day course for Site Supervisors run by CITB
Temporary Works Supervisor	One day course for Site Supervisors who will be managing the installation and use of temporary works, run by CITB
Construction Skill Certification Scheme (CSCS)	A card scheme for health and safety competency covering all levels from site operator to management. Individuals are issued a level specific card with personal photograph after passing the test for each level. Run by CITB
Construction Plant Competence Scheme (CPCS)	A registration card scheme for those involved in machine operations. Run by CITB

Companies should conduct internal training to augment external courses and schemes.

9.10.4 Information and induction

Employees and others under the control of the main contractor must be provided with all information, instruction and training needed for the work to be carried out safely and without risk to health.

This should include:

- A site induction
- Information on risks and precautions required
- Any site rules and procedures to be followed in the event of serious and imminent danger

New starters must be instructed on the specific company arrangements in place to deal with health and safety matters and their personal responsibilities.

Trainees and apprentices should develop their knowledge and skills before being asked to work in deep shafts or confined areas or to install complex excavation support. Some workers new to this type of work may find it difficult to work below ground. If they are not progressing and cannot be switched to other work there may be health and safety grounds for terminating employment.

On a site where several trades are working in close proximity a daily briefing or hazard board can help inform about planned activities or changes.

9.10.5 Site briefings and toolbox talks

Site briefings and tool box talks must be carried out to ensure those at risk are familiar with site procedures and that they are aware of all relevant points in the method statements and risk assessments as well as other construction related health and safety issues.

A health and safety section should be included as part of the daily site brief.

Toolbox talks are short periods of instruction on a specific area of site health and safety, and are often completed on a weekly basis. A record of completion of toolbox talks received by each individual should be kept.

9.10.6 Consultation

Contractors must consult employees on day-to-day health and safety conditions so that lessons can be learnt from those dealing first hand with the hazards arising from the works. Lessons learnt should be communicated to the workforce across all sites.

9.10.7 Sub-contractors and the self-employed

A competence questionnaire should be issued to and completed by all new contractors and consultants prior to their appointment. Appointments should only take place after a reply has been received and assessed by the main contractor.

Sub-contractors must be judged competent to undertake the tasks for which they are appointed and have suitable procedures to manage their risks and cooperate with others.

The health and safety performance of sub-contractors should be reviewed during their work to ensure that they maintain the required standards.

9.11 **Welfare arrangements**

Basement construction work often takes place under harsh working conditions, frequently cold, wet and muddy.

Arrangements for the welfare of those working on site must be determined and available before work starts on site.

The arrangements may change as the project progresses but must include:

- Clean and working toilets
- Washbasins with hot and cold running water
- Soap and a means of drying the hands, arms and face
- Sinks large enough to wash face, hands and forearms
- Somewhere to change, dry and store clothing
- Drinking water and cups
- A rest area to sit
- Facilities for making hot drinks and for heating food

Shower facilities may need to be provided if the work is particularly dirty.

The facilities must be kept warm and well ventilated with lighting as necessary.

9.12 **Emergency planning and procedures**

9.12.1 Serious or imminent danger

Procedures must be in place to be followed in the event of serious and imminent danger. These procedures must be communicated to all staff during site induction. The arrangements should also cover the immediate public, especially if occupied buildings are vulnerable to structural incidents or the spread of fire.

9.12.2 First aid

A first aid risk assessment must be undertaken to ensure adequate and appropriate first aid equipment, facilities and trained personnel are provided so those working on site can be given immediate help if they are injured or taken ill at work.

As a minimum each project work site must be provided with:

- A stocked first-aid box including eye wash and wound dressings
- A first aid trained operative
- Information for those working on site about first aid arrangements
- Contact details and a map showing directions to the nearest accident and emergency department

9.12.3 Accidents and near-misses

Accidents and near misses must be reported to site controllers and management. As a minimum injuries must be reported in line with Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) October 2013.

9.13 Summary

Basement construction projects have significant health and safety considerations which if not effectively planned and managed will cause high health and safety risk to construction site operatives and members of the public. They are among the highest risk construction activity that most clients will undertake and will generally involve major structural work undermining existing structures. The health and safety effort needed to undertake these projects safely is significant and requires training, experience and commitment.

In order that basement construction projects are completed safely it is critical that clients understand that this is the case and that they only appoint responsible, competent and experienced designers and contractors.

10 WATERPROOFING

10.1 Introduction

Waterproofing ensures the usefulness of a basement and preserves the integrity of the structure. All basements risk water penetration either during the construction process or during their operating life. Water can come either from the ground surrounding the basement, from water-flows at or near the surface or from above in the case of garden basements. Basements must be constructed to resist water ingress from all three sources.

An experienced professional, such as a qualified waterproofing surveyor, should be involved throughout the basement design process to ensure all risk factors are considered and adequately addressed. The nationally recognised industry standard for competency is the Certified Surveyor of Structural Waterproofing (CSSW) qualification.

All basement construction projects must follow the requirements of the British Standard *BS 8102:2009 - Code of practice for the protection of below ground structures against water from the ground*, and building regulations.

BS 8102 provides guidance and recommendations on methods of preventing and dealing with the ingress of water into below ground structures. It also advises on risk assessment for different groundwater conditions.

10.2 Risk levels

BS 8102 classifies the risk of water ingress based on the groundwater level.

a. Low risk - where the water table or perched water table is assessed to be permanently below the underside of the base slab. This only applies to free-draining strata.

b. Variable risk - where the water table fluctuates.

c. High risk - where the water table or perched water table is assessed to be permanently above the underside of the base slab.

10.3 **Levels of protection**

There are three grades of waterproofing set out in BS 8102.

Grade of waterproofing protection	Performance level	Typical use
1	Some seepage and dampness is permitted, depending on the intended use Local drainage might be necessary to deal with seepage	Car parking, plant rooms (excluding electrical equipment), workshops
2	No water penetration acceptable Damp areas tolerable; ventilation might be required	Plant rooms and workshops requiring a drier environment (than Grade 1); storage areas
3	No water acceptable Ventilation, dehumidification or air conditioning necessary, appropriate to the intended use	Ventilated residential and commercial areas including offices and restaurants

Previous editions of BS 8102 had a fourth grade of protection, Grade 4, that was recommended for the storage and exhibition of archival documents. This grade was not retained as the increased performance related to ventilation, dehumidification or air conditioning rather than to the waterproofing system.

Basements that are intended to be used for habitable space must perform to Grade 3, preventing any water penetration.

10.4 **Types of waterproof protection**

10.4.1 Outline

Basement waterproofing can be achieved in three ways.

a. Barrier protection

b. Structurally integral protection

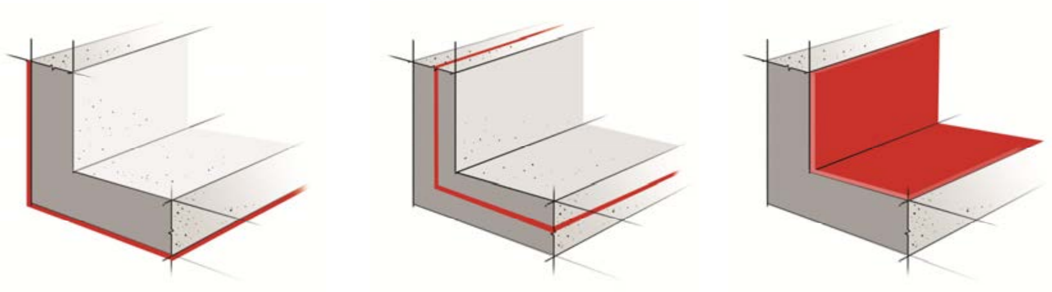
c. Drained cavity protection

In BS 8102 these three methods are designated as Types A, B and C.

Type	Method of protection	Operation
A	Barrier	A membrane is used to keep water physically outside the usable space
B	Structurally integral	The material that forms the basement structure, usually reinforced concrete, is waterproof
C	Drained cavity	The structure minimises water ingress however some penetration is expected An inner cavity membrane (studded high density polyethylene, 'egg carton' appearance) lines the structural wall and floor Water is channelled behind the cavity membrane to a sump chamber where water is removed by a high performance pump

10.4.2 Type A - Barrier protection

Barrier protection is achieved by applying waterproofing materials as a membrane either externally, internally or sandwiched between two elements of the structure. The waterproofing materials can be either hydrophilic (water attracting) or hydrophobic (water repelling).



a. External b. Sandwiched c. Internal

Figure 44. Type A - Barrier protection waterproofing

This type of protection is generally not suitable in areas where the water table is likely to exert hydrostatic pressures and therefore they should not usually be used as the sole method of waterproofing where the water table is either variable or high.

It is also not usually possible to use these systems externally for retrofit basements or those with piled walls because the external face of the basement cannot be accessed to allow construction, maintenance or repair.

There are two main Type A barrier systems.

System	Description and characteristics
Sheet Membranes	Usually made from plastics, rubbers, geocomposite carpets or rubberized asphalts Either bonded directly to the structure or unbonded and placed in sheets with the interfaces lapped, adhered or welded to one another Factory manufactured and so has a constant thickness. As a result it can be more reliable than site applied fluid membranes. Require all surfaces to be well prepared to ensure they are dry and smooth prior to placement - rough or irregular surfaces are very likely to cause defect in the system Installed in sections and interfaces are seamed together Little tolerance for error due to the number of seams - likely that the system will fail if there are any discontinuities
Fluid Membranes	Liquid plastics, vinyls, urethanes, rubbers or asphalts applied as liquids Either sprayed or rolled onto the structure Effectively seamless and can be applied to most shapes or textures of structures Easy to apply Must be applied to absolutely dry surfaces as any water will cause debonding Particularly problematic at edge locations where increased care and consideration is necessary Considerable variation in placed thicknesses can occur as these are applied in fluid form: • Where the membrane is thin weakness can occur leading to defect • Where the membrane is too thick weakness can also occur as material curing may be impeded Can develop defects where they are applied across cracks or penetrations in the structure Can be vulnerable to abrasion and weathering particularly UV light

All Type A membranes are vulnerable to puncture. External membranes are particularly problematic as water may penetrate the membrane through a defect that is remote from the point of ingress to the basement. Water once under the membrane may flow and penetrate the structure in a location remote from the initial puncture. As a result it can be very difficult to locate the initial defect and repairs may therefore be difficult to complete successfully.

10.4.3 Type B – Structurally integral protection

The type B method relies entirely on the structure to prevent water ingress.

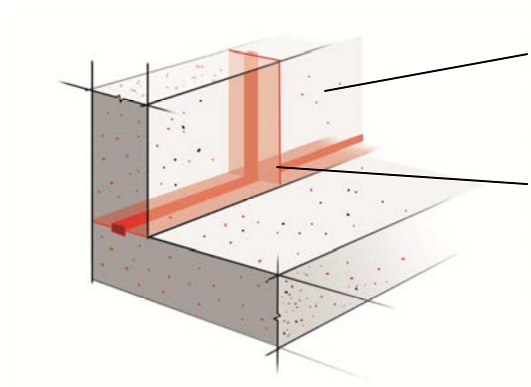


Figure 45. Type B - Structurally integral waterproofing

The structure can be formed using either:

a. Reinforced concrete.

b. Steel sheet piles.

In either case the main risk of water penetration comes from water moving through cracks or discontinuities in the structure or between construction joints. Additional measures are necessary to ensure that water ingress is prevented at these high risk points.

10.4.3.1 Reinforced concrete

All concrete structures form with capillaries and pores. The majority of reinforced concrete structures are designed to BS 8110 - Code of practice for the design and construction of reinforced and prestressed concrete structures. BS 8110 is not intended for the design of structures retaining liquids and allows for cracks of up to 0.3mm in width to develop.

In order to prevent water ingress through a concrete structure, crack width must be controlled and the development of pores and capillaries prevented. There are two principal ways of improving the water resistance of reinforced concrete.

a. Reducing crack width in the concrete through use of additional reinforcement.

b. Using water resistant concrete additives.

10.4.3.1.1 Additional steel reinforcement

BS 8007 - Code of practice for the design of concrete structures for retaining aqueous liquids is an alternative to the standard BS 8110. BS8007 calls for additional steel reinforcement limiting the development of crack widths to between 0.05mm and 0.2mm. This restriction in crack width significantly reduces the likelihood of water ingress.

A reinforced concrete structure designed to BS 8007 is more time consuming and expensive to construct than that designed to BS 8110.

10.4.3.1.2 Water resistant concrete additives

Water resistant concrete additives work by preventing water from moving through pores, capillaries and cracks. They operate within the concrete structure and are applied either by being:

- Mixed into the concrete before placement
- Applied to the concrete surface after concrete placement

The waterproofing additives can be divided into two product types:

- Unreactive (sometimes called hydrophobic)
- Reactive (sometimes called hydrophilic)

Product type	Description and characteristics
Unreactive	Prevents the passage of moisture by blocking pores, capillaries and cracks thereby reducing the permeability of the structure Products are usually only active during the curing process Therefore they do not prevent ingress caused by cracking that occurs after construction, for example cracking caused by settlement or other structural movement
Reactive	Products are predominantly crystalline Additives chemically react with moisture to form new crystalline compounds The new crystalline compounds grow and seal cracks, pores and capillaries in the concrete Products retain this capacity once the structure has cured and will reactivate later during the life of the structure - the product will lie dormant unless another crack develops and water penetrates whereupon the reaction will restart, new crystals will grow and the concrete will effectively self-heal Manufacturers claim sealing of cracks greater than 0.5mm and most issue warranties for the sealing of 0.4mm or 0.5mm width cracks

Reactive products appear to have significant advantages over nonreactive products including:

- Ability to self-heal post construction in the event of subsequent water ingress
- Manufacturers have joint treatment products made with the same additive meaning:
    - Homogeneous treatment with reduced likelihood of defect or debonding at point of change
    - Single product warranty covers the structure and joints
- Suppliers of truly reactive products will offer warranties for suspended structures such as intermediate floors or roofs whereas suppliers of unreactive products usually will not

10.4.3.2 Steel sheet piles

Steel sheet piles are generally impermeable and therefore once installed prevent the passage of water. The joints between steel sections must however be sealed to prevent water passage.

A concrete inner wall will usually also be applied to steel sheet pile structures.

10.4.3.3 Construction joints

All structures are most vulnerable to water penetration at construction joints. In either reinforced concrete or steel sheet pile Type B construction additional measures to ensure the waterproofing system is complete are required at all construction joints.

In the case of steel sheet pile structures the most common sealing technique is welding between the sheets combined with hydrophilic strips which swell upon contact with water to provide a seal.

In concrete structures the measures can either be specific to a water resistant product or generic and can be rendered, painted, injected or fixed either externally, internally or sandwiched within the structure. In some instances all three locations are protected.

Where a proprietary measure is used in conjunction with a specific system both the construction joint and system should be covered by separate certificates or warranties.

10.4.3.4 Good practice

Good practice must be followed for the formation of Type B basements in particular. Only experienced, qualified and competent teams should be used for this type of work.

10.4.4 Type C - Drained cavity protection

Type C drained cavity systems work by trapping any water that penetrates the structure and channelling it by gravity into a collection sump. The water is then removed, usually by being pumped, out of the basement. Occasionally, where the sewer system is sufficiently deep or on sloping sites where a soak away system can be used, the system can be drained under gravity.

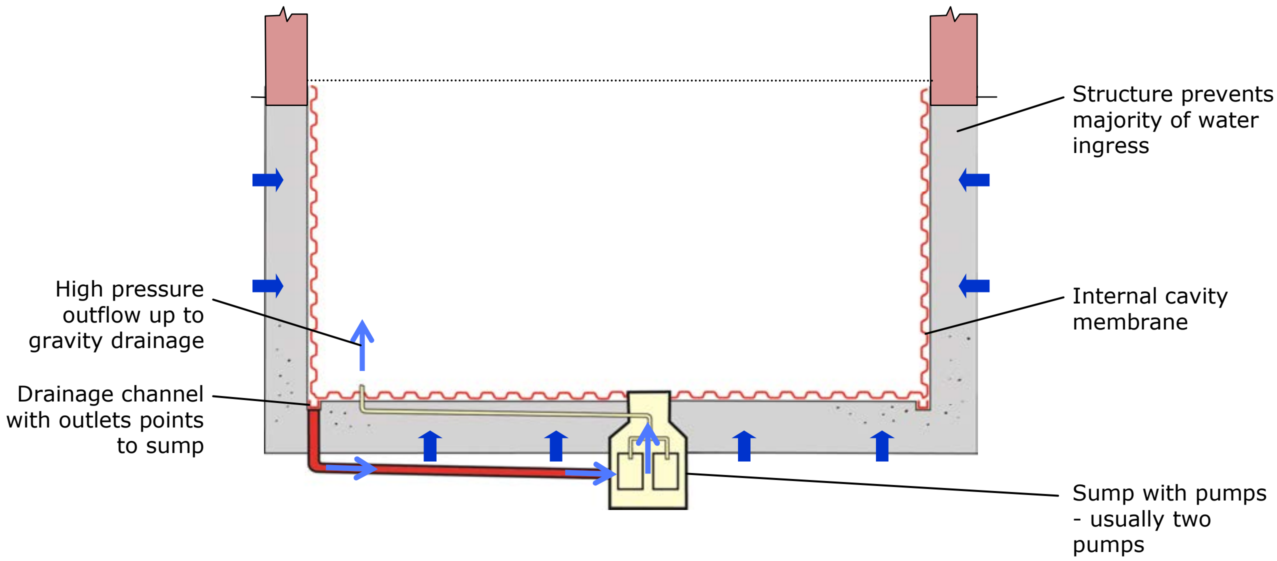


Figure 46. Type C - Drained cavity waterproofing

The membrane in a drained cavity system is plastic, usually polyethylene. The plastic sheets are studded to assist free flow of water and are applied directly to structural walls and to the ground slab. The sheets are impervious to water and can be vapour proof.

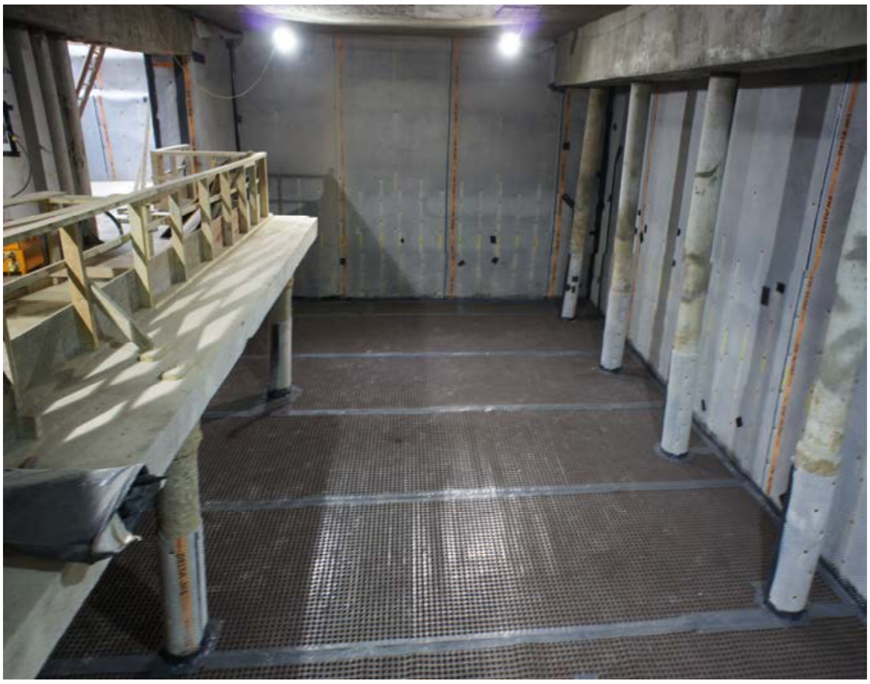


Figure 47. Cavity membrane after installation in a basement

Where a drained cavity is used, the principal means of excluding water from the basement is the structure. The cavity drainage system is intended to cater for the remaining water ingress which may occur through the structure.

Two pumps should usually be installed in the sump so that the system has a back up in the event of a pump failure. The sump should have an alarm to warn of the sump filling, this is usually an audible alarm.

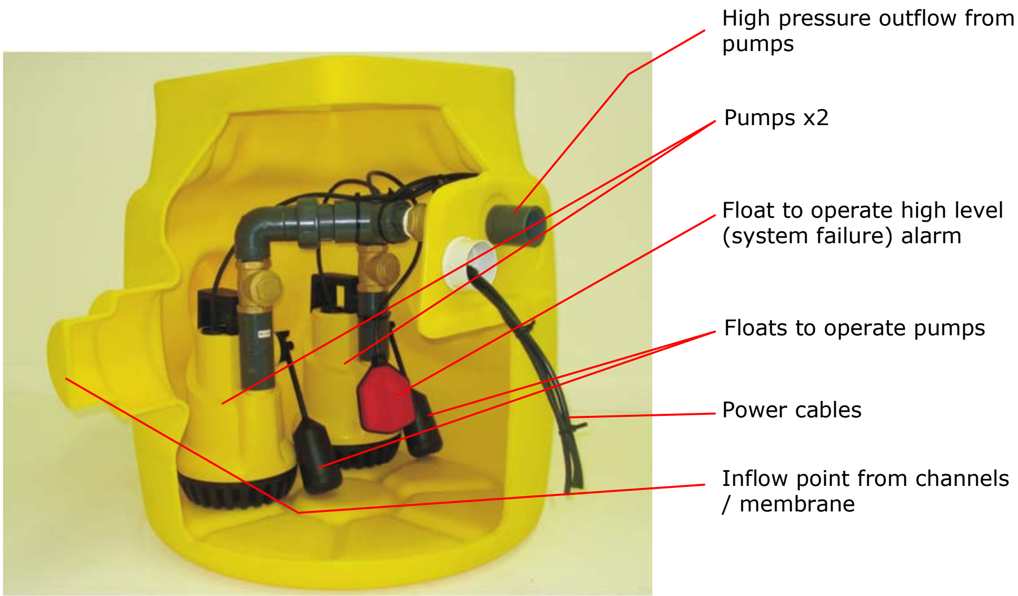


Figure 48. Sump pump and two pumps - cut-away view

The pumps and alarm should each be wired to their own non-switched fused spur electrical supply. This ensures that in the event that one pump is overloaded and fuses the other pump and the alarm will still have a power supply. A common error in wiring the pumps and alarm is having all three devices share one fused supply which means that should one device overload the second pump and the alarm will also lose their power supply and the waterproofing system will fail.

Additional security measures available for the alarm system include:

- Battery packs to provide temporary power in the event of mains electric failure
- Telemetry alarm systems - these can send text messages to multiple telephone numbers to warn of occurrences like pump or alarm failure. They can be particularly appropriate if a property is to be left unoccupied for a long time and could be used to alert a key holding service provider.

Internal finishes including stud walls, insulation, plasterboard and plaster are built inside the waterproof membrane skin. Insulation and plasterboard, or even just plaster, can be applied directly to the face of the cavity drainage membrane but this is not usually preferred.

Cavity membrane systems must be installed by approved competent contractors. The systems, including the pumps, must be commissioned and be serviced once or twice a year.

Cavity drainage systems can also be installed outside the structure if access allows. A geotextile membrane is used to prevent the cavity from becoming blocked by soil. External cavity membranes and drainage can prevent hydrostatic pressures from developing and, in certain circumstances, provide an appropriate solution.

Type C cavity drainage systems are often regarded as the lowest risk and most reliable type of waterproofing for retrofit basements. They are also regarded as the easiest to maintain and repair.

10.5 **Risk level and selection of type of waterproofing**

BS 8102 allows that in low risk situations each of the three methods is acceptable on its own.

In high risk situations or where the consequences of failure are high this is not the case:

- Type A and Type B can be acceptable on their own but only if certain construction parameters are met and / or additional waterproofing products are used

- Type C is acceptable on its own

It should be remembered for Type C waterproofing that the structure should act to minimise water penetration.

In situations of high risk of water ingress combined solutions, using more than one type of waterproofing, should be considered.

10.6 **Design, specification and construction**

10.6.1 Outline

Care and attention should be taken when choosing and appointing professionals to specify and undertake waterproofing work. Waterproofing failure will nearly always cause significant cost and nuisance.

The basement structure and waterproofing system are interdependent and heavily influenced by ability to build. They should be considered together rather than independently.

A qualified professional with experience of basement construction and waterproofing should be appointed early in the design process to ensure that all factors influencing structural design and waterproofing are taken into account. The waterproofing designer should ensure that all materials and products used in the construction of a basement are compatible and are used strictly in accordance with the manufacturer's recommendations.

The intended use of the basement must be specified so that the appropriate level of waterproofing protection can be provided.

10.6.2 Design Considerations

British Standard BS 8102 requires that potential defects in the system, maintenance and repair are considered at the design stage. Steps should be taken to reduce the likelihood of defects occurring.

Recent case law has ruled that designers cannot rely on perfect workmanship in the installation of waterproofing systems. It should be possible to maintain and repair the system. It is also the responsibility of the designer to consider the buildability of the system and of how quality assurance can be carried out during construction and installation. Some systems are not suitable for certain construction situations

In the event that either construction quality control or repair and maintenance of an installed system is impossible, difficult or dangerous, the design should be amended and a system adopted that enables these processes.

10.6.3 Pre-design information

Site investigation information on the following areas is needed to enable design:

- Existing soil conditions - cohesive and impermeable (clay or clay-like) or granular and free draining (sands and gravels)
- Depth of water table
- Existing structure
- Proposed structure
- Intended use of the basement

10.6.4 Groundwater depth

Hydrostatic water pressure will develop when the ground water level rises or water infiltrates the interface of the basement structure and adjacent soil, particularly in cohesive (clay) soils. This must be accounted for in the design as some waterproofing systems will fail under pressure from a head of water.

BS 8102 states that waterproofing systems can be designed:

- Using a risk assessment based on low, variable or high water tables
- With consideration of potential fluctuations in ground water conditions
- To withstand a full hydrostatic head should there be any ambiguity as to the current or future ground water conditions

However water levels can increase locally due to leaking water pipes, sewer back flooding, high rainfall, blocked drains, overflowing rivers and local flooding. It is therefore recommended that waterproofing systems are designed assuming groundwater levels to the full height of the retained ground.

Where possible external drainage measures should be considered to ensure that water build up is prevented and hydrostatic pressure avoided. External drainage measures should include rodding access points to enable clearance of blockages.

10.6.5 Construction joints.

Construction joints, as mentioned previously, are points of particularly high risk of water penetration. Additional measures will often be taken at construction joints.

There are multiple generic and proprietary methods for waterproofing construction joints. These will not be covered in detail further other than to state that the manufacturer's installation instructions should be followed exactly. The greatest cause of failure at construction joints where additional waterproofing measures have been used is poor workmanship.

10.6.6 Interfaces and continuous protection

The waterproofing system of any basement should be continuous and offer complete protection of the structure up to ground level. The basement waterproofing needs to link or work together with the above ground damp proofing and water management.

10.6.7 Service penetrations

Cables and pipes for services will usually need to penetrate the basement walls at below ground level. Almost all waterproofing systems cater for these penetrations however the number of penetrations should be minimised to reduce risk.

The number, location and extent of penetrations should be considered at design stage and allowances be made and detailed accordingly. It is more likely that a defect will occur in a system when penetrations are retrofitted.

All penetrations should have additional waterproofing measures in accordance with the waterproofing manufacturer's guidelines. These additional measures, if provided by a different supplier to the main system, should have their own certificate or warranty.

10.6.8 Environmental controls

Environmental control systems for temperature, ventilation and relative humidity will often be needed so that any moisture within the basement is controlled. The main waterproofing system will prevent water entering the basement from the ground but will not prevent condensation or damp developing from internal sources.

Care should be taken to avoid cold bridging especially around areas of high moisture production such as bathrooms, utility rooms or kitchens. Air tight membranes can be used in combination with external and internal insulation to deal with most cold bridging situations.

10.6.9 Construction stage design information

Design information and specifications should be clear and specific to the project. Drawings need to be sufficiently clear to allow for good quality management at site level and should include details for floor to wall junctions, laps in membrane, changes in the levels of slabs, wall to ceiling junctions, interfaces to the superstructure, at window and door reveals and for services penetrations.

10.6.10 Post installation protection

Waterproofing systems need to be appropriately protected after installation. Protection needs to be from physical damage and from damage caused by sunlight or chemicals.

Written instructions need to be issued to any subsequent contractors on the required protection and ideally the waterproofing should have a final inspection just before it is covered by other works.

10.7 **Waterproofing measures to existing structures**

10.7.1 Outline

Type A barrier and Type C drained cavity can both be used to provide waterproofing protection when an existing cellar or basement is extended. The Type A barrier would need to be applied to the internal face as it will usually not be possible to access the outside or the middle of the existing structural walls.

There are certain additional requirements for both systems that should be considered.

10.7.2 Type A – Barrier

Barrier membranes and tanking need to be applied to clean, dry surfaces. The surfaces of existing structures, particularly masonry in older buildings, are often covered in aggregated salts and are contaminated by hydrocarbons. These must be entirely cleaned off and the brickwork prepared to receive the tanking system. Additional precautions may be required by individual manufacturers.

10.7.3 Type C – Drained cavity

Drained cavity membranes are at risk of being blocked by calcium deposits filling the cavity behind the membrane. This is the case for all drained cavity systems but is of particular concern where existing structures are extended.

Any water penetrating existing mortar, dry pack or existing concrete can dissolve and entrain calcium minerals. This is particularly the case in older buildings where the lime mortar contains and can lose significant amounts of calcium minerals.

In certain circumstances, usually if the water flow through the system is high or if there are areas of sitting calcium-loaded water, chemical precipitation can occur and calcareous deposits will build up. The process is similar to lime scale build up in kettles, pipes and washing machines. Occasionally these deposits can block the cavity behind the membrane leading to a failure of the system.

Steps should be taken to prevent the development of deposits including:

- Reducing the flow of water through the basement structure - it might be necessary to treat at risk masonry with proprietary waterproofing products to reduce ingress

- Applying anti-liming agents to the basement walls and floors in order to prevent the leaching of free lime from the concrete

The system can also be designed with perimeter drainage channels that allow access for rods to clear calcareous deposits or for washing through anti-liming solutions.

10.8 **Guarantee and warranty**

The level of comfort provided by manufacturers' warranties and guarantees is often misplaced. Manufacturers' warranties and guarantees will usually:

- Only cover a fault with the product and not the design or installation
- Limit the cover to repair of the faulty product and not cover any consequential losses, for example the loss due to the damage caused by any water ingress

Poor workmanship is the most common cause of a waterproofing failure, followed by poor design and problems caused by structural movement. It is very rare that the basic waterproofing product fails. It can be even harder to demonstrate that it is the waterproofing product that has failed.

Contractor guarantees have similar risks and need to be checked carefully. Company guarantees are only as strong as the company providing the guarantee. Most insurance backed guarantees only provide cover if the contractor company ceases to trade and if the problem can be demonstrated as having been caused by negligence by the original contractor.

Moreover these guarantees often cover only the cost of repair to the waterproofing system and will not cover the opening up work, repair or replacement of damaged items or building fabric, consequential losses or the cost of temporary accommodation.

In addition care should be taken to ensure that there are no gaps of cover between guarantees and warranties provided by different suppliers.

Comprehensive first party latent defects insurance provides the best form of waterproofing guarantee cover. The best of these:

- Provide cover directly to the property owner and cover the costs of consequential losses, opening up works, damage to property and temporary accommodation if required
- Are transferable upon sale of the property
- Do not require proof of negligence by anyone
- Cover design, workmanship and materials

The ASUC Basement Indemnity Guarantee (BIG) is a comprehensive first party latent defects insurance and provides this level of cover.

10.9 **Summary**

The waterproofing of the basement is vital, any failure will create a major problem. The basement structure, construction and the waterproofing solution are heavily interrelated. They need to be considered and designed hand in hand from as early on as is possible.

There are three main methods of waterproofing and all can be used successfully. In addition the individual systems can be combined to give increased security in high risk situations. Cavity membrane systems are commonly viewed as the most appropriate system for retrofit basements.

Design and installation are critical for all three systems. Good workmanship during installation is particularly crucial. Poor workmanship is the most common cause of waterproofing failure. Only experienced and competent teams should be instructed to complete the design and installation of any basement waterproofing system.

11 THE PROJECT TEAM

11.1 **Introduction**

The foundation of a safe and efficient project is an excellent team with the right knowledge, competency and experience.

There is no set composition for a basement construction project team and not all of those covered in this section will be included in every project probably with the exception of the design or structural engineer who will always be needed. The best results will be achieved by a positive, cooperative approach with each team member being responsible for their own fields and looking to support other team members.

The project team may include some or all of the following:

a. Client

b. Architect

c. Structural or Design Engineer - always needed

d. Temporary Works Engineer (TWE)

e. Temporary Works Coordinator (TWC)

f. Principal Contractor

g. Party Wall Surveyor

h. Quantity Surveyor

i. Others

11.2 **Client**

The client is the person for whom the work is being undertaken. They can be either a business client or a domestic client. It should be remembered that business clients have specific health and safety responsibilities under CDM 2015. Domestic clients' duties usually transfer either automatically to the contractor or, by arrangement, to a principal designer.

Clients will usually want to direct and influence the design of their basement. At the same time there are a lot of technical, practical and health and safety factors that affect what is achievable. It is useful if the client has an understanding of these factors or has a knowledgeable advisor.

The client should set a clear brief on the proposed basement's size and use. This should be developed in discussion with the other members of the project team. The final basement size and design will often be a compromise between the client's ideal requirement and what can be achieved practically given technical, regulatory and budget limitations.

Basement construction projects are most efficient when the design remains the same throughout the project especially once construction has started. This requires the client and the whole team to think through the project in reasonable detail at the beginning. Failure to do this will often be the root cause of costly and frustrating changes and compromises later in the project. In general the later that changes happen during a project the greater the increase in cost and delay.

Clients may assign their own Project Manager or someone to act as their representative, usually called the Client's Representative. This can be effective but requires that the Project Manager or Client's Representative either has decision making authority or can get decisions from the client quickly.

Responsible, practical and imaginative clients can make a significant positive contribution to the safe and effective construction of their basement projects.

11.3 Architect

An architect will usually be involved in the design of a basement. Their responsibilities will often include development of initial plans, obtaining planning permission, detailed architectural design, project management and oversight of the construction work.

Architects will often be:

- The first person appointed by the client on projects that are designed and then put out to tender
- Appointed to help the client put together the rest of the team
- A focal point for the team on projects that are using a traditional procurement method of design followed by tender to contractors

Under CDM 2015, on all projects, whether for a business or a domestic client, if there is more than one contractor involved in the project, the client must appoint one of the designers to act as principal designer. This could be the architect or one of the structural designers.

Especially in basement projects, much of the essential design coordination work involves ensuring that structural stability is maintained at all times as the work progresses. This may make one of the structural designers a better candidate but each team is likely to have a different view. In some situations the project architect has early but short term involvement in the project which makes it less sensible for them to be principal designer. Much of this consideration disappears where the preferred designer or contractor has all the required specialisms within their organisation.

11.4 Structural or Design Engineer

The Engineer is responsible for the permanent structural design of the works. The structural design must:

- Create a structurally sound new building
- Provide adequate support to minimise damage to existing buildings
- Avoid or minimise risk during construction

It is important that the Engineer or someone who has a good knowledge of the likely structural limitations is involved early in the project as practical engineering trade-offs are frequent especially in more demanding basement designs.

The structural design of any piles will often be completed by an engineer working directly for the piling contractor. The structural engineer and the pile design engineer will need to coordinate on matters including pile loadings, lateral strength and allowable horizontal movement.

Some engineers will not be experienced in basement construction under or near to existing buildings. In this instance it may be useful to seek input from an experienced specialist contractor.

11.5 **Temporary Works Engineer (TWE)**

The Temporary Works Engineer (TWE) is responsible for designing the temporary works that will maintain structural stability from the start of the project until the permanent works are completed.

In some instances the Structural Engineer may also be the TWE but the TWE will often be an independent consulting engineer or may work for the basement contractor.

A TWE should be appointed for all but the most straight forward cellar extension.

Further details on the responsibilities of the TWE are given in section 5 Temporary works.

11.6 **Temporary Works Coordinator (TWC)**

The Temporary Works Coordinator (TWC) is responsible for overseeing all aspects of the temporary works on site except for their design. The TWC will often work for the basement contractor.

Further details on the responsibilities of the TWC are also given in section 5 Temporary works.

11.7 **Principal Contractor**

The Principal Contractor is responsible for managing the works on site in a safe and productive manner. The Principal Contractor during the structural and waterproofing basement works could be the basement contractor.

The Principal Contractor's main responsibilities usually include:

- Health and safety
- Risk assessments
- Construction sequence and method statements
- Safe systems of work
- Plan for reduction of impact on others
- Programme
- Site layout
- Traffic management

- Site set-up
- Detailed work plans
- Supervision of labour and subcontractors on site
- Installation and monitoring of temporary works
- Materials ordering and storage
- Excavation and spoil removal
- Construction
- Quality assurance

The contractor's overarching priority should be health and safety and this should be core to all activities.

The number of contractors involved in a project will vary from one contracting firm being responsible for all aspects of the work through to multiple contractors working either for one main contractor or directly for the client. In general a good result will be achieved from having one contractor be responsible for the basement construction and waterproofing work, though this contractor may use subcontractors.

Under CDM 2015, on all projects - whether for a business or a domestic client - if there is more than one contractor involved in the project, then one of the contractors must be appointed as principal contractor and organise and oversee the activity of all other contractors on the site. Usually it is the contractor carrying out the majority of the work who takes on this role. On some projects it is more effective to bring in a managing contractor to fulfil this role.

11.8 **Party Wall Surveyor**

A Party Wall Surveyor (PWS) is usually appointed to deal with putting in place party wall awards with the owners of nearby structures as required by the Party Wall etc. Act 1996 (the Act). Anyone can do this and no qualification or training is legally required however party wall matters for basements are complex and have certain nuances that make it advisable to appoint a building surveyor who has experience with party wall awards for basement works.

It should be remembered that the Adjoining Owner has the right to appoint their own PWS and an independent structural engineer to check the permanent design and the proposed construction method as it affects their building.

11.9 **Quantity Surveyor**

Clients will sometimes appoint a Quantity Surveyor (QS). Quantity Surveyor's main responsibilities are related to costs and contracts.

11.10 **Others**

Various others may also be involved in basement construction projects including:

- Geotechnical engineers
- Hydrologists
- Health and safety consultants - often working directly for the contractor
- Project managers
- General building and interior fit out contractors
- Interior designers
- Mechanical and electrical engineers
- Heating, air conditioning and ventilation designers and contractors
- Pool or spa designers and engineers
- Audio visual and lighting designers and contractors
- Garden designers and contractors

11.11 **Summary**

A good team is fundamental to a safe and efficient project. Choosing the right team will be one of the client's most critical tasks. Involving an experienced and competent contractor as part of this team early in the process will always be beneficial.

12 PROCUREMENT

12.1 Introduction

There are four main recognised procurement methods for construction work.

a. Traditional

b. Design and build

c. Management

d. Integrated

There is no single best method and they each have advantages and disadvantages.

12.2 Traditional

12.2.1 <u>Outline</u>

In the traditional method the design process is separate from the construction work. Full design drawings and documentation are usually prepared by the design team for the client. The design information will be issued and contractors will provide a competitive price on this basis. A contractor will then be selected to complete the work.

There are three broad types of traditional contract.

a. Lump sum

b. Measurement

c. Cost reimbursement

12.2.2 <u>Lump sum</u>

With lump sum contracts the contract sum is determined before the construction work starts. Lump sum contracts are usually priced using the design drawings and supporting documents such as specifications and work schedules. Firm bills of quantities may sometimes be used. Variations in price will occur only if:

- The client instructs a design change, or
- An unexpected condition is encountered, such as a previously unknown obstruction underground. The possible unexpected conditions should usually be raised at some point prior to the start of the works.

Lump sum contracts based on drawings and additional information are common in basement construction projects.

12.2.3 <u>Measurement</u>

The contract sum for measurement contracts is not finalised until completion of the project, where it is assessed on remeasurement to a previously agreed basis. Bills of quantities are a list of work items with a price per unit for each work item. Bills of quantities are often used in measurement contracts.

This type of contract is usually used where the works to be carried out by the contractor cannot be measured accurately before tender.

One form of measurement contract will have an initial set of drawings and a bill of quantities. The drawings are used as a guide to the expected quantities but a measure will be completed at the end of the works and the contract sum confirmed.

Basement construction projects are generally accurately designed before work commences so measurement contracts are not usually the most appropriate contract type.

Sometimes clients or their quantity surveyors look to use a bill of quantities to price variations caused by design changes. This can work but may not always be appropriate because the cost of completing a set amount of a certain type of work can vary markedly at different places and times on one project. For example completing one linear metre of underpinning at five metres below ground level and below the water table will take more effort and be more costly than completing one linear metre of underpinning above the water table and at ground level.

12.2.4 Cost reimbursement

The contract sum for cost reimbursement contracts is not known at the start of the work on site. These contracts are sometimes called 'cost-plus' or 'prime cost' contracts.

In this type of contract the contract sum is determined by calculating the costs of labour, plant and material used and adding an agreed amount to cover overheads and profit. The overhead and profit might be a fixed sum, percentage or be calculated by some other agreed method. Some form of incentive fee may make sense for cost reimbursement contracts.

Cost reimbursement contracts are not common for basement construction projects. They may be appropriate where the complexity, likely design changes and unknowns make other forms of contract impractical.

12.3 **Design and build**

In design and build procurement the contractor is responsible for undertaking both the design and construction work for an agreed contract lump sum price. The client will need to specify their requirements in sufficient detail to allow the design and build contractor to prepare their proposal.

Once the contract is agreed the design passes to the contractor and the client has no direct control over the contractor's detailed design. The contractor will appoint their own consultants or use their own in house team to complete the design.

The client can continue to instruct overall design changes for example an increase in size or basement depth. The contractor should provide a price for the change and obtain an instruction from the client before proceeding with the design change.

The contractor is obliged to complete the project for the agreed contract sum. Variations to the price should apply in the same way as for a traditional lump sum contract.

12.4 **Management**

In the management procurement method a main or principal contractor is appointed to manage the project while the work is completed using a series of separate works or trade contracts. The main contractor is responsible for managing the project through the various works packages.

The client will usually start by appointing design consultants and a contract administrator to prepare drawings, a project specification and a cost plan. The client will have direct control of the design throughout the project through their professional team.

The contractor is appointed by negotiation or tender and interview. The works packages are usually let by competitive tender.

The main contractor is paid for managing the project through the various works packages.

12.5 **Integrated**

Integrated procurement, sometimes known as collaborative procurement or partnering, emerged in the 1990s in response to the often adversarial situations encountered in major construction projects which used the three existing procurement methods.

The intention of the integrated procurement method is to focus all the project participants on the mutual objectives of delivering a project on time, to budget and to quality. It is about working as a team, regardless of organisation or location, to meet a client's needs. A central tenet is that risk and reward are shared by all parties in a way that aligns their actions with a successful project outcome.

The UK government's 1994 Latham Report 'Constructing the Team' started the thinking behind integrated procurement. One of the main recommendations of the report was compulsory inclusion of latent defects insurance on all construction projects in order to overcome the tension that exists in construction work caused by it not being possible to know at the time of completion if there are any problems with the works that are not apparent at that time.

Latent defects insurance is covered in more detail in the Insurance section however it is worth noting at this point that the ASUC Basement Insurance Guarantee (BIG) Scheme is a latent defects insurance in line with the Latham Report and supports collaborative, integrated procurement.

Integrated procurement has been recognised as fundamental in the success of major construction projects like the London 2012 Olympics. There are several forms of contract which support integrated procurement for major works. The most well known is the New Engineering Contract (NEC), or NEC Engineering and Construction Contract.

12.6 **Comparison of procurement methods**

	Advantages	Disadvantages
Traditional	• Allows competitive tender based on the design information • Client has control of design through their design professionals	• Design and construction are sequential processes - usually increasing the overall duration of the project • No certainty over construction cost until initial design work has been completed • Construction cost may be higher than the best achievable due to cost inefficient design - in the order of 30% higher than the most efficient design - the cost advantage from the competitive tender may be illusory • Redesign after the first round of tendering may incur additional professional design fees • Designers may not be incentivised during the project to alter the design in order to achieve cost savings • Can lead towards adversarial relationships between the members of the project team • Contractor is incentivised to complete work as quickly as possible even if this involves increasing health and safety risks
Lump sum:	• Reasonable cost certainty before work starts on site - price change should be limited to variations*	• Requires that the design is largely complete before tendering can start and well before work on site can start • Minor design confirmations, detailing or variations will lead to cost increases

	Advantages	Disadvantages
Measurement:	• Allows contract works to start when it is not possible to complete the design with certainty	• Contract sum is not fixed leaving client with some commercial risk • Bills of quantities can be inappropriate for use in basement construction projects where the difficulty and cost of the same work item on one project can vary significantly depending on location and point of time in the works
Cost reimbursement:	• Allows work to take place where the extent, difficulty, likely design changes and unknowns make other forms of contract impractical	• Contract sum is not fixed leaving client with commercial risk • Can lead to perverse incentives for the contractor if the method of determining the overhead and profit amount is not considered fully
Design and build	• Likely that the design will be cost efficient - cost savings of 30% or more can be achieved over traditional method • Design and construction work can be carried out in parallel allowing reduced overall programme time • Lump sum price gives reasonable certainty of contract sum before design work starts* • Health and safety are more likely to be considered inherently • Contractor can retain a client's initial design team to maintain project continuity	• Clients can perceive that they do not get best value without having a traditional tender process based on completed design drawings • Client needs to have determined the project requirements at the start in sufficient detail to allow the design and build contractor to prepare their proposal • Design and quality risk if the client's requirements are not properly recorded or if the contractor's proposal was not fully understood or articulated • Contractor is incentivised to complete work as quickly as possible even if this involves increasing health and safety risks

	Advantages	Disadvantages
Management	• Client has good control of design and quality • Design can proceed in parallel with construction • Specialist design related to a specific sub package does not need to be completed before appointment of the main contractor and start of work on site • Client appoints the package contractors and so has good control of who is employed and full knowledge of package costs • Design changes are possible during the works provided they do not affect work on packages already instructed • Completion on time is an obligation of the contractor; extensions of time can only be granted by the contract administrator	• No certainty over cost at the start of the project - the cost plan is not generally part of the management contract • Splitting the various work elements of a waterproof structural basement between different contractors would increase the likelihood of defects • Instructing a general main contractor to manage a basement contractor responsible for the full basement package may add an unnecessary level of management cost, depending on the project • Contractor may be incentivised to complete work as quickly as possible even if this involves increasing health and safety risks
Integrated	• Leads to collaborative and productive relationships between project team members • Project team should focus on delivering project on time, to budget and to quality • Formal disputes are significantly reduced	• Some construction professionals may not be familiar with this relatively recent form of procurement • Requirement to agree incentives that align project team members • Needs intelligent, responsible and professional project team

Note: * In construction contracts a fixed or lump sum price will still change based on variations. Variations can be either as a result of client instructed design changes or due to unexpected conditions occurring such as meeting unexpected obstacles in the ground or unexpected ground water.

12.7 **Summary**

Basement construction projects are complex and have an unavoidable element of uncertainty before and during the work on site. In addition they place the client's and the property of others at risk. These factors make it particularly important to choose the most appropriate form of procurement that incentivises safe and efficient construction.

13 INSURANCE

13.1 Introduction

Basement construction projects are major works involving various hazards which can lead to problems ranging from injury to a member of the public through to a structural failure. It is important that the right insurances are in place to protect all parties.

This section outlines the various types of insurance that either should or could be put in place.

a. Professional Indemnity insurance (PI)

b. Employer's Liability insurance (EL)

c. Public Liability insurance (PL)

d. Contractors All Risks (CAR)

e. Non-negligent insurance (JCT 21.2.1 / 6.2.4 / 6.5.1 insurance)

f. Existing building insurance

g. Insurance for client's property for non-negligent damage

All insurance cover depends on the wording of the specific policy. Proper checks should be completed before appointing contractors or designers, and before the start of work.

13.2 Professional Indemnity insurance

Professional indemnity insurance (PI) provides cover for professional error, omissions or negligence. All designers, notably architects and engineers, should have professional indemnity insurance in place at a level appropriate for the value and scope of the works. In particular the person designing the temporary works, who may well not be the main structural engineer, should have PI insurance.

Design and build contractors and any party involved in updating, changing or amending any design element, no matter how small, should have adequate PI cover.

13.3 Employer's Liability insurance

Employer's Liability (EL) insurance provides cover for the employer in the event that an employee or former employee makes a claim against the company. Employers have a legal responsibility for the health and safety of their staff while they are at work. Employees may be injured at work or they may become ill while at work or at some time later as a result of work activities.

Employer's Liability insurance is a legal requirement for companies that employ any staff. The minimum legal level of EL insurance is £5 million. This is a minimum and in practice £10 million cover for basement construction contractors would be a sensible level.

13.4 **Public Liability insurance**

Public Liability insurance (PL) provides cover for a company against claims from third parties. The building owner and family, neighbours and other members of the public would usually count as third parties. Any claims would usually be due to physical injury to the third party or to damage to property owned by the third party.

PL claims require that the claimant demonstrate that the Contractor has acted negligently. For example a PL claim against a contractor by the building owner would require the building owner to demonstrate that the contractor had acted negligently and that this negligence had led to loss, say, damage to the existing building.

It is very important that the contractor's PL insurance provides cover for:

a. The activity which the contractor is undertaking – so excavating and construction down to the depth below ground of the proposed project. It can be quite common that contractors undertaking deep excavations do not have cover for the depth at which they are working. This should be checked.

b. Damage to the existing building above the works. The existing building above the works, often called Existing Buildings/Structure or the Superstructure or similar, is often specifically excluded from the cover provided by a PL policy. In this instance the contractor would not be covered for negligent damage caused to the existing building and so, in the event of a major structural failure to the existing building, the building owner would probably not be able to recover the full amount of the loss from the contractor. Again the existence of superstructure cover should be confirmed before appointing a contractor.

Public liability insurance is not a legal requirement however it would be extremely foolhardy to have works undertaken by a contractor without adequate PL insurance.

13.5 **Contractors All Risks**

Contractors All Risks (CAR) insurance is specific to the construction industry and provides broad cover on site for the contractor. Usually CAR is used to provide cover for:

- Damage to the works themselves including temporary works, or
- Theft of materials or plant from the site.

13.6 **Non-negligent insurance (JCT 21.2.1 / 6.2.4 / 6.5.1 insurance)**

Non-negligent insurance provides cover for damage to adjacent or surrounding property where the contractor has not been negligent. The insurance cover is only to the benefit of the building owner or client and is not to the benefit of the contractor.

This is an unusual type of insurance and is specific to construction works that have a risk of causing damage to other structures, usually works under or close to the foundations of other buildings.

Non-negligent insurance is often referred to as JCT 21.2.1 insurance or sometimes as JCT 6.2.4 or JCT 6.5.1. These names come from the different paragraphs of various forms of standard Joint Contracts Tribunal (JCT) contract which state the requirement for non-negligent insurance.

An example may help to illustrate the cover provided by non-negligent insurance.

In the example the contractor has done everything correctly but there has still been damage to the adjoining property. While rare this can happen. The adjoining property owner will probably make a claim against the building owner who would be liable under the Party Wall Act.

However the building owner would have no claim against the contractor as the contractor has not been negligent and has no liability. In this instance the building owner would have to pay the adjoining owner but would not have a claim against the contractor. The building owner would therefore suffer a loss.

Non-negligent insurance generally covers for the following eventualities where the contractor has not been negligent but there has been damage to an adjacent or surrounding property:

- Subsidence
- Heave
- Landslip
- Collapse
- Vibration
- Lowering of ground water
- Weakening or removal of support

Non-negligent insurance always excludes cover where damage is inevitable.

Non-negligent insurance can be taken out by the building owner, in joint names by the basement contactor on behalf of the building owner or in joint names by a main contractor on behalf of the building owner. In all cases the cover is only for the benefit of the building owner and not the main or basement contractor.

Policies generally have an excess of several thousand pounds so that minor decorative repair to adjoining buildings will not be covered.

13.7 **Existing building insurance**

The existing building's insurer must be notified that works are being undertaken. Not to do so would almost certainly cause the existing cover to be invalid.

It is critical to confirm with the building's existing insurer prior to the works how existing cover is affected by the works and to ensure that adequate cover for the building and its contents is in place.

13.8 **Insurance for client's property for non-negligent damage**

An often overlooked risk that is left uninsured by accident is that of non-negligent damage caused by the contractor to the client's own building.

JCT 21.2.1 non-negligent insurance does not provide cover for the building owner's property. The building owner's existing standard building insurance may suspend cover for the duration of the structural basement works. Even if the building owner's insurance remains in force it may not provide cover for damage caused by the contractor.

This means that the building owner's property will not be insured by anyone for non-negligent damage caused by the contractor. This gap in cover can be significant and is often overlooked.

Building owners must contact their insurer prior to the works and confirm the cover that the existing insurer will provide during the work.

There are several specialist insurance products that the building owners' broker or the contractor should be able to suggest in the event that the existing cover is suspended.

13.9 **Insurances summary table**

Type of insurance	Taken out by	Comments
Professional Indemnity (PI)	All designers including temporary works designers	• Provides cover for negligence in design
Employer's Liability (EL)	Contractor	• Legal requirement for companies employing any staff • Provides cover for claims by employees or former employees against the company
Public Liability (PL)	Contractor	• Provides cover for companies against claims from third parties including the client • Claimant is required to demonstrate negligence

Type of insurance	Taken out by	Comments
Contractor's All Risks (CAR)	Contractor	• Provides broad cover for the contractor • Usually covers for damage to the works or for theft of plant or materials from site
Non-negligent (JCT 21.2.1)	Building Owner (client) Contractor (either Main Contractor or Basement Contractor) on behalf of Building Owner	• Provides cover for the building owner against claims by owners of neighbouring properties where damage has been caused but where no one has been negligent • The benefit of the insurance is for the client/Building Owner and not the contractor
Existing building	Client / Building Owner	• Client must inform their existing buildings insurer about the works • Cover provided by the existing buildings insurance during construction work will be specific to the policy • Cover may be suspended so the cover remaining must be confirmed by the Building Owner with their insurer
Building owner's property for non-negligent damage	Client / Building Owner	• Provides cover for the building owner's property – this is separate to JCT 21.2.1 non-negligent insurance which specifically does not provide cover for the building owner's property • Needs to be arranged by the Client / Building Owner to bridge any gap in cover for the existing building • The benefit of the insurance is for the Client/Building Owner and not the contractor

13.10 Summary

It is vital to have the right insurances in place during any basement construction work. Contractors and designers all need to have appropriate and adequate insurance whilst the building and surrounding buildings should also all be properly covered.

Insurance cover for basement construction projects is complex and advice from experienced parties should be sought. The contractor, the contractor's insurance broker and the building owner's insurance broker are probably the right start points for checking that appropriate cover is in place.

14 GUARANTEES

14.1 Introduction

Guarantees for building work, like many guarantees, often promise much but deliver little. There are multiple types of guarantees available and to some extent each guarantee is different from the next. The detailed wording for each guarantee must be understood in order to know what true level of protection is provided.

This section will give an outline of the various types of guarantees that are often provided.

a. Company guarantees

b. Product guarantees

c. Insurance backed guarantees

d. Latent defects insurance

14.2 Company guarantees

Contractors will usually provide some sort of company guarantee or warranty. The wording of the guarantee should be read carefully and any areas of doubt clarified. There will often be exclusions that will limit significantly the cover provided. The wording will often be ambiguous or unclear in favour of the contractor.

Guarantees should provide security over and above that provided by law. Companies cannot avoid their legal liabilities.

It is worth remembering that a company guarantee is only as sound as the company that stands behind it. If a company no longer exists then the guarantee is worthless.

14.3 Product guarantees

Several specific product guarantees will often be provided from the product manufacturer notably for waterproofing membranes and pumps for ground water and foul water removal. In each case the guarantee wording needs to be read carefully to confirm the cover provided.

Consequential damages – damage to property resulting from a failure in the product – will usually be excluded. This is an important limitation on a guarantee. Also the workmanship involved in the installation of the product will not be covered by a suppliers' product guarantee.

14.4 Insurance backed guarantees

Insurance backed guarantees (IBGs) are usually provided by contractors to clients. They are insurance products which should provide cover to the client in the event that the contractor ceases to trade during the period of either the contractor's:

- Company guarantee, or
- Legal liability

There are two significant points that need to be considered regarding insurance backed guarantees:

a. The insurance backed guarantee will only provide cover to the same extent as if the contractor were still trading. If the building owner would have had to demonstrate negligence by the contractor originally then the same requirement for the building owner to demonstrate negligence will be required by the insurer. The IBG is not a broad, comprehensive cover for any defects with the work.

b. The underwriters providing insurance backed guarantees can be based in offshore jurisdictions. Proceeding with a claim against an unwilling underwriter who is not directly subject to UK law may be difficult. Some underwriters may also have limited balance sheets and will not have funds available to pay claims. It is worth confirming the name and financial strength of any insurer underwriting a guarantee.

It is important to read and understand fully the terms and cover for any insolvency guarantees as they can appear to provide broad cover which sometimes may not be the case.

14.5 **Latent defects insurance**

Latent defects are problems with the work that are not evident when the works are completed but come to light at a later stage.

Latent defects insurance provides cover for loss as a result of a latent defect. They can be thought of as a guarantee for the contract works. They only come into effect once the contract works have been completed, they do not provide cover during the works.

The insurer is the primary party responsible for dealing with any claim rather than the original contractor even if the contractor is still actively trading.

Important advantages of latent defects insurance over other guarantees are:

- The building owner should not need to demonstrate that the contractor has been negligent
- Cover should remain in place even if the contractor is no longer trading

The cover provided can also be indemnity cover which means that the cover is based on economic loss or compensation and is not limited to correction of the problem.

The ASUC Basement Indemnity Guarantee (BIG) is an indemnity latent defects insurance specifically tailored to basement construction projects. All of the basement construction work, so design, workmanship and materials, completed by an ASUC member will be covered under the BIG scheme or the older similar DIG (Defects Insurance Guarantee).

The main points of the cover provided by the BIG and DIG schemes are:

- Defective works cover – there is no need to demonstrate liability; if something is defective then cover should be provided for any of the work completed by the ASUC member

- Cover will remain in place for 10 years (12 years for DIG) irrespective of the ASUC contractor continuing to trade
- Cover is provided up to the gross contract value with cover increasing on an index linked basis
- Up to 25% of the contract sum is insured for consequential losses
- Alternative accommodation is covered for up to 26 weeks
- Can be passed to any subsequent owner of the property
- The schemes' underwriters are major insurers with a minimum of Grade A credit ratings by the major agencies

14.6 **Guarantees summary table**

Type of guarantee	Comments
Company guarantees	• Only as valuable / sound as the company providing the guarantee • Cannot limit the company's legal liability • Need to be read and understood as the cover provided may be limited by the wording of the guarantee
Product guarantees	• Guarantee wording needs to be read carefully to confirm the cover provided • Will usually exclude installation of the replacement produce and any workmanship involved in installation • Damage to property resulting from a failure in the product will usually be excluded – the cover is often limited to supply of a replacement for the failed product only. So for a failed section of waterproof membrane this might cover only for supply and repair of one piece of waterproof membrane.

Type of guarantee	Comments
Insurance backed guarantees (IBGs)	• Usually only comes into effect when the contractor is no longer trading • Will usually be limited to providing the cover that the contractor would have provided if they were still trading • Usually requires that the claimant demonstrates negligence by the contractor • Only as valuable as the underwriter providing the cover - tendency for the underwriter to be an offshore company with low financial strength
Latent defects insurance	• Provides by far the most comprehensive cover / protection • Should provide cover for any problems – design, workmanship or material – with the contract works • The insurer should deal with the claim directly rather than having to involve the contractor • Should not require negligence to be demonstrated • Usually provides indemnity cover – so covers for the economic or consequential loss resulting from any failure e.g. damage to interiors or full cost of repair • Underwriter should be a major insurance company with a strong balance sheet and good credit ratings

14.7 **Summary**

There are multiple types of guarantees that can be associated with basement construction work however the level of cover provided is often confusing and sometimes misleading. Time spent understanding the cover provided by the available guarantees will be time well spent in the hopefully unlikely event that a problem occurs.

A comprehensive indemnity latent defects insurance underwritten by a financially strong insurance company with good credit ratings will provide the best possible level of protection.

It is always sensible to ensure that comprehensive guarantees are in place to provide cover for major building works under or close to existing buildings.

15 DOMESTIC PROPERTY OWNER CONSIDERATIONS

15.1 Introduction

Basement developments are significant construction projects and are generally the most complex structural work that a domestic property owner will undertake. Historically home owners tended to instruct architects to design and manage major construction work however it has become more common for home owners to instruct specialist basement contractors directly on a design and build basis. In parallel home owners have also increased their overall involvement in basement construction projects especially in the initial project feasibility and design stages.

This section will outline the following main areas that a property owner might consider when carrying out the initial assessment of building a basement.

- Property rights and rights of access
- Planning permission
- Trees
- Listed building consent
- Building regulations
- Health and safety
- Impact on neighbours
- Economics of the project
- Living in the building during the project
- Party Wall Agreements
- Legal and liabilities
- Choosing how to proceed

15.2 Property rights and rights of access

Most property owners have the legal right, planning law excepted, to build underneath their own property and have a right of access from the highway to their property. However this is not always the case and a property owner should check that they do have the legal property right to build a basement and have rights of access.

Instances where this may not be the case are where:

- Another party, such as a major estate owner, owns the freehold or has some other right directly over the property. Major estate owners in London include the Crown Estate, the Grosvenor Estate, the Cadogan Estate, the Howard de Walden Estate and the Wellcome Trust.
- A restrictive covenant has been put in place on a property

- Access to the property is only possible across another party's private property

In the event that the property owner does not have the legal right to build and own the basement or the right of access for construction then in order to proceed with the project an agreement must be reached with the party having the rights.

In addition it is important that property owners know the extent of their land and do not accidentally build outside their curtilage. Building on or under another party's property is likely to have negative consequences with the other party being able to demand financial compensation or the removal of the trespassing basement structure. The latter would usually entail a significant cost.

15.3 **Planning permission**

Planning permission is required for most basement projects.

The exception is where the proposed basement is categorised as a Permitted Development. Generally planning permission for Permitted Developments is not needed.

Projects are usually classed as permitted developments where the basement:

- Is restricted to the footprint of the building as first built or as it stood on 1 July 1948, and projects no more than three metres to the rear of the building as first built or as it stood on 1 July 1948
- Is limited to one storey
- Causes no permanent externally visible changes to the front of the property
- Is not under a listed building

There are additional limitations on permitted development in conservation areas, national parks and in areas of outstanding natural beauty.

The Statutory Instrument governing permitted development rights is not simple and it may be worth seeking expert advice, possibly from a planning consultant or planning lawyer, on specific cases.

The local planning authority should usually be asked to confirm, in writing, whether planning permission will be required.

In the more general case where planning permission is required the planning process is controlled by the local planning authority. The planning rules and guidelines for basement development vary by planning authority.

In the first instance the home owner should speak to a basement contractor, architect or other design professional as well as looking at the local planning authority webpage or speaking directly to the local planning authority. Most planning authorities have a duty planning officer who can give informal advice by telephone or at a walk-in desk.

Planning permission usually lasts for three years from the date of approval. It can be quite sensible to obtain planning permission with a view to starting work at a later date.

15.4 **Trees**

Trees are a valuable part of the urban streetscape and are, quite rightly, protected.

Trees often limit the size of basements below gardens. They do not usually limit basement construction underneath existing buildings as tree roots rarely extend below buildings.

Trees are frequently protected either by:

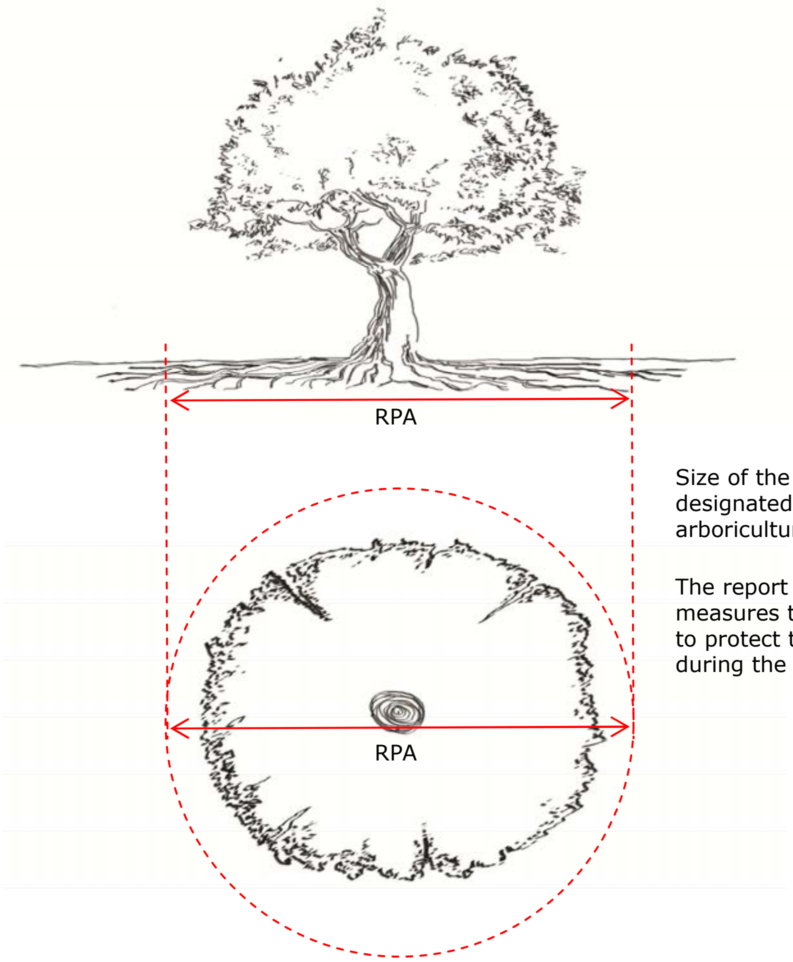
- Tree Protection Orders (TPOs) - these are specific to a particular tree
- Being in a conservation area - any tree with a trunk diameter greater than 75mm diameter measured at 1.5 metres above ground level is automatically protected

The tree and its roots are protected. The roots are protected within an area known as Root Protection Area (RPA). The RPA varies according to tree species and size.

It is an offence to damage any part of a protected tree. The deliberate destruction or damage of a protected tree in a manner likely to destroy it can lead to an unlimited fine. The destroyed or damaged tree would also need to be replaced.

Expert advice from a qualified arboriculturalist should be obtained. The arboriculturalist will survey the site, make an assessment and issue a formal arboricultural report stating RPA sizes and recommended actions to either protect or remove and replace any protected trees.

The RPA will often have a radius from the tree of approximately 10 to 12 times the diameter of the trunk of the tree at 1.5 metres above ground. It will also often be about the same size as the crown of the tree.



Size of the RPA is designated in the arboricultural report

The report also gives measures to be taken to protect the tree during the works

Figure 49. Root Protection Area - indicative

Work should never take place that may damage a protected tree. Expert advice from an arboriculturalist or from the local authority should be obtained if there is any doubt over the status of a tree.

15.5 **Listed building consent**

A listed building is a building, object or structure that has been judged to be of national importance in terms of architectural or historic interest and is included on a special register, called the List of Buildings of Special Architectural or Historic Interest.

Listed building control is a type of planning control which protects buildings of special architectural or historical interest. These controls are in addition to any planning regulations which would normally apply. Listing prevents the unrestricted demolition, alteration or extension of a building without the express consent of the local planning authority or the Secretary of State.

Listed building consent is obtained via the local planning authority following a similar process to that for obtaining a standard planning permission. In addition to the standard planning application information a historic building appraisal by an appropriate specialist is required as part of the application.

It is an offence to carry out work which needs listed building consent without obtaining it beforehand.

15.6 **Building regulations**

Building regulation approval is always required when creating any habitable space. The Building Control department of the local authority oversee building works to ensure compliance with building regulations. Building regulations are particularly pertinent for new basement space where fire safety, light and ventilation must be considered.

All habitable space needs adequate:

- Light
- Ventilation
- Fire safety measures

Natural light is preferable for living space but it is not a requirement under building regulations.

Habitable rooms can be ventilated by natural or mechanical means so this should not be restrictive but it does need to be considered.

Fire safety measures include escape routes to prevent occupants being trapped in the event of fire. This is particularly important in basement design where access can be restricted.

There must usually be at least two routes in and out. Often the second route will be an emergency only route via steps or ladders in a lightwell.

Measures such as internal fire suppression (sprinklers designed for residential use) and emergency fire curtains can be used where only one route in and out is possible.

The fire safety plan must be approved by Building Control. The plan should be thought through early and outline approval gained from Building Control as making changes once construction has started can be difficult and expensive.

15.7 **Health and Safety**

A property owner is not expected to oversee directly or be responsible for health and safety on site. However the employer sets the tone for how the project is undertaken. The most important decision taken by the home owner is to instruct responsible and competent designers and contractors.

Instructing the lowest cost contractor will often mean instructing the contractor with the least care for health and safety including a disregard for correct temporary works and the structural stability of existing buildings.

It is reasonable to expect the contractor to explain how they will approach the various items that have been covered in the health and safety section of this document as well as going to one or two of their current live construction phase sites to assess how health and safety aspects are approached.

15.8 **Impact on neighbours**

Basement construction projects are likely to have a negative impact on neighbours even when well managed. Activities like breaking out concrete or brickwork and cutting steel are noisy. Digging and demolition will create some dust and vibration.

A good neighbour should consider measures to reduce negative construction impact possibly including:

- Giving advance notice of the start date and duration of work
- Communicating with neighbours during the project
- Asking contractors to communicate directly with neighbours
- Notifying in advance periods of particularly noisy work
- Agreeing the timing of the project with neighbours to suite periods when neighbours may be away or delaying a project start to allow children's exam periods to be finished
- Limiting noisy working hours

It should be remembered that anything that causes work to be slowed will increase project duration and cost.

There are unfortunately no perfect answers to this matter and each situation needs to be considered specifically. In general early communication with neighbours will be better received and have a better outcome for all rather than moving forward without any interaction.

15.9 **Economics – will the project add value**

15.9.1 <u>Outline</u>

Basement development under or close to existing buildings is generally the most costly way of building. It will nearly always be more expensive per unit area than extending at ground level or adding upper floors or mansards. Therefore from an economic perspective it will usually only make sense where there is no other way of increasing space and the existing property values are high. Restrictions on above ground building are often due to local planning regulations.

There is significant variation in the likely value added by a basement and in the basement build cost so the economics of each project should be assessed. Owners might consider getting in touch with a design and build basement contractor, an architect with basement construction experience, or a construction design professional with basement experience to get an initial indication of costs.

Among the factors that affect cost are:

a. Ground and groundwater

b. Method of construction

c. Existing buildings

d. Access

e. Contractor

15.9.2 Ground and groundwater

The type of ground in which the new basement will be built can have a significant impact on cost. The single most important factor is whether the basement will be built below the level of the natural groundwater. It is generally possible to build below the permanent groundwater level though it will usually add considerable cost during the construction process and will generally also require increased permanent waterproofing measures. Dry ground, as is the case for most parts of London for at least one basement level below ground, is preferable by far.

Local knowledge and desk top studies can give an indication of the likelihood of hitting groundwater but the best method is to have one or more boreholes drilled usually by a specialist site investigation company. Usually the structural engineer or the basement contractor should advise on the information needed from the borehole.

In addition to the borehole a full site investigation should be considered which could include trial pits to find out about the structure of the existing foundations, tests to check if the ground is environmentally clean or contaminated, and tests during the drilling of the borehole to check the bearing capacity of the ground at the proposed basement foundation level.

For many site investigations there is a trade off between obtaining information and site restrictions such as ease of access and the acceptable level of disruption or damage to the property at this relatively early stage.

Further information on site investigations is at appendix A.

15.9.3 Method of construction

There are two broad methods of construction either:

a. Ground level down - removing the existing floor at ground level and building the basement from the ground level down, or

b. Tunnelling - leaving the existing floor in place and tunnelling underneath. The start point for the tunnelling can either be through an existing entry point, by forming a relatively small access opening in an internal floor, or via an external excavation.

Note – the terms 'Top-down' and 'Bottom-up' construction are used earlier in this document. Slightly confusingly both these terms refer to methods where the existing floor is removed and construction is from the ground level down.

Excavation from ground level down is generally a more straight forward construction proposition than tunnelling. The structural work should take less time and should cost less than for the equivalent tunnelling option. However the finishes, fittings and internal fabric in the existing building at the lowest level will usually be largely destroyed. The cost of refitting a fully finished lower floor can outweigh the cost advantage gained by building structurally top-down. In addition the lowest floor of the property will not be habitable during the work.

Tunnelling will add time to the duration of the structural work and, all other things being equal, the structural work will cost more than if built top-down. Tunnelling typically costs between 15% and 25% more than ground level down construction. However the fabric of the lowest floor should not need to be replaced and the property will usually be habitable during the work. It should be borne in mind that during working hours there will be construction noise.

15.9.4 Existing building

There are three aspects of the existing building that have significant effect on the difficulty and likely cost of construction:

- Construction of the existing floor at ground or lowest level
- Existing foundation depth
- Previous structural building work

Considering each in turn:

15.9.4.1 Construction of the existing floor at ground or lowest level

The existing floor at the lowest level of a property is likely to be either:

- Suspended - meaning it spans between supporting walls. Suspended floors can be made of either:
    - Timber joists and floorboards
    - Pre-cast reinforced concrete beams and concrete blocks - often called beam and block
    - Reinforced concrete (RC) suspended slabs

  or,

- Directly supported by the ground - usually made of mass or lightly reinforced concrete

The floor construction if building from ground level down does not have significant impact on cost however this is not the case if tunnelling.

Tunnelling under a suspended floor is reasonably straight forward. The floor will be supported by the main walls and possibly by sleeper walls or pillars.

The support provided by sleeper walls and pillars can be replaced from below using either structural steel or reinforced concrete.

Tunnelling under a concrete floor that is being directly supported by the ground is generally more complex. The concrete floor is not designed to span and needs closely spaced support from below both while tunnelling underneath during construction and in the permanent condition.

The construction process is similar to mining with numerous props being needed to provide temporary support. Closely spaced structural steelwork, possibly with additional reinforced concrete lintels, is needed to provide permanent structural support to the existing concrete floor.

Building below older concrete floors directly supported by the ground can be particularly challenging because the:

- Floors are often made of fairly weak concrete of variable thickness
- Supporting ground is often brick fill which is unstable and tends to crumble and fall away unlike freshly dug new ground which will stand temporarily while shoring is put in place.

Tunnelling underneath ground bearing concrete needs to be designed and undertaken by particularly competent teams with good supervision to ensure damage to the existing building and floor above is minimised and to make sure that the works are completed safely.

15.9.4.2 Existing foundation depth

All other things being equal deeper foundations in the existing building will usually make construction simpler and therefore have a lower cost than if the foundations are shallow. However this is not an absolute rule and an experienced engineer and / or contractor will need to assess each situation.

15.9.4.3 Previous structural building work

Previous structural alterations to a building will often increase the difficulty of building a basement especially by tunnelling. Concrete foundations or slabs will often have been put in place during recent refurbishment at ground floor level and this concrete will probably need to be replaced or altered.

Tunnelling underneath buildings which have had recent structural changes can have increased challenges. For example structural columns will usually bear onto concrete pad foundations and have high point loading. It is generally difficult to tunnel close to and underneath high point loads.

It is rare that these things cannot be dealt with however they will tend to increase the difficulty and therefore increase the project duration and cost.

15.9.5 Access

Good access to a site makes the job easier and therefore lower cost compared to a job with poor access. The ideal site would allow large delivery vehicles to drive onto site to unload and load however this is rarely the case in built up areas.

15.9.6 Contractor

There will always be some variation in price from different designers and contractors for the same project. The difference in build costs between contractors can be quite large; often it will be larger than might be expected.

No one wants to pay more than they need to for building work however if the price offered by a contractor is lower than that offered by competent firms doing the work correctly then something is probably not right.

It is not possible to build a basement correctly and safely for below a certain cost. In general the main way of lowering cost is by taking unsafe short cuts that aim to reduce the time to complete the work.

Typical short cuts include:

- No temporary works engineer

- Inadequate temporary works throughout the works, specifically:
  - Inadequate horizontal temporary works to support excavations:
    - Ground left un-propped or inadequately propped during underpinning
    - Unrestrained retaining walls left un-propped during the main excavation
    - Horizontal temporary works not correctly designed or installed
    - Temporary works removed before the permanent reinforced concrete (RC) slabs have gained adequate strength
  - Inadequate vertical temporary works to support existing building – propping is put in place under the supervision of the Site Foreman or other unqualified person without an engineered design or correct supervision
- Underpinning excavations are too large - during underpinning the amount of existing wall that is undermined is too great. The general maximum length of a brick wall in reasonable condition to be undermined is 1.2 metres.
- Insufficient time allowed for concrete to strengthen after pouring before the concrete is relied upon to provide structural support. As a guide concrete achieves 50% of its strength after seven days.
- Dry-packing on the top of underpins is not given sufficient time to go off (strengthen and shrink) before adjacent underpins are excavated
- Edge protection around underpins and other excavations is not put in place or is inadequate

All of the actions listed above allow the construction period to be decreased and the contractor to save money. However all of these short cuts increase the risk of damage to the existing property and to adjoining buildings as well as increasing the risk of injury to workers and members of the public.

All ASUC members complete a comprehensive technical audit annually and their projects are inspected at various stages of construction to check that the work is being undertaken correctly and safely. All sites that are part of the ASUC Basements Indemnity Guarantee (BIG) scheme will be inspected at least twice during the works by surveyors working for the insurance underwriters.

Instructing an ASUC member to undertake a project should increase confidence that short cuts are not being taken.

15.10 **Living in the building during the structural work**

When the work is being completed from ground level down it is often impractical to live in the property depending on the layout of the particular property. Alternatively when the construction method is tunnelling it is usually possible to live in the property. Again it should be remembered that the work will be noisy and that there will be dust created in the rest of the property no matter how well working areas and living areas are separated.

Living in the property is generally practical for households where everyone is out during the working day. It can be more problematic for someone working from home or for someone with young children who will be at home for most of the working day. A workable option can be to have a bolt hole close by to escape to at short notice during particularly noisy periods.

15.11 **Party Wall Agreements**

The Party Wall Act 1996 provides a framework for preventing and resolving disputes in relation to building works to or under party walls, boundary walls and for excavations near neighbouring buildings. Anyone intending to carry out work of the kinds described in the Act legally must give Adjoining Owners notice of their intentions.

Basement construction in urban areas will usually involve work invoking the Act and means that notice should be given to Adjoining Owners. Owners can put in place party wall agreements themselves however party wall awards for basement construction have several peculiarities that can cause later problems if not addressed correctly in the early stages. In general it is probably worth the cost of appointing a competent building surveyor with experience of arranging party wall awards for basement projects.

In particular for basement projects Owners should note that they are responsible for making good any damage caused by the works to adjoining properties or must make payment in lieu of making good whichever the Adjoining Owner prefers. The liability for repairing damage does not lie with the contractor or design team unless they have been negligent. The Building Owner will have a claim against the relevant party if they have been negligent. Without exception the Building Owner always remains directly responsible to the Adjoining Owner for making good any loss.

Some points to note are:

a. A schedule of conditions of adjoining buildings will be completed as part of the agreement. This protects all parties as it helps identification of changes to the building before and after the works.

b. Adjoining Owners cannot prevent the works being undertaken however they may be able to influence how and at what times the work is done. They have the right to check that the works have been designed correctly and that the works will be undertaken by competent contractors following a safe method.

c. Adjoining Owners have the right to appoint a building surveyor and a structural engineer to act on their behalf. The costs of the Adjoining Owner's surveyor and checking engineer are paid by the Building Owner.

d. Party wall agreements can take some time to put in place. Three to four months should be sufficient though it can take longer than this for complicated projects where there are numerous Adjoining Owners, where there are extensive negotiations or where parties are slow in providing information or responding to communications.

e. Party wall agreements are valid for 12 months so generally they should only be put in place if the intention is to start the works within a year.

Party wall matters can appear complicated however if all is handled correctly the works should proceed without undue fuss. The best way to proceed is to spend time early in the process communicating with Adjoining Owners.

A booklet explaining the party wall act in straight forward language is available at the Government Planning Portal[2].

15.12 **Legal and liabilities**

The main legal responsibilities for a non-business property owner come from the Party Wall Act and from civil litigation.

a. Party Wall – the property owner's responsibilities are given in the previous paragraph of this section. These responsibilities come under civil law however the Act bestows significant power to the party wall surveyors. In the event that the party wall surveyors decided that damage has been caused by the works it will be difficult for the property owner to avoid being fully liable for any loss suffered by an adjoining owner.

b. Civil claims – any person who considers that they have suffered loss, including injury, as a result of the works can undertake a civil action against the instructing property owner. The best practical way of mitigating this risk is to appoint competent designers and contractors and to ensure that they all have the correct insurances in place as outlined in section 13 Insurances.

15.13 **Choosing how to proceed**

Once it has been decided to move forward with a project the right design team should be chosen and the necessary permissions must be obtained.

In general the choice is between instructing an architect or other designer, or moving forward with a design and build contractor. There is no right way of proceeding and either option can lead to successful projects at the correct cost.

A sensible first step might be to gain recommendations and talk to one or two designers and one or two design and build contractors and then choose which way to proceed.

15.14 **Summary**

Basement developments have the potential to add size, improve the quality of existing space and increase property value. However they are complex construction projects, usually the most complicated that a domestic owner will undertake. They lie at the high end of the scale for construction health and safety risk and can have negative impact on other residents during construction.

The feasibility of a basement construction project needs to be assessed on a case by case basis. In all cases it is critical that the work is undertaken only by responsible, experienced and competent designers and contractors.

[2] http://www.planningportal.gov.uk/uploads/br/BR_partywall_explain_booklet.pdf

Instructing an ASUC member to undertake a project should increase confidence that short cuts are not being taken and that the work will be completed correctly and safely.

16 CONCLUSION

Basements built below or near to existing structures can add valuable accommodation to homes and commercial buildings especially where other forms of development are restricted. There has been a significant increase in the number of domestic basement construction of this type however there has also been a rise in health and safety problems and in negative impact on people not involved in the works, particularly local residents.

Basement construction is a complex form of building and will involve elements that many experienced designers and contractors will not have encountered before. Effective health and safety management of basement construction is especially demanding. Temporary works are critical and are often overlooked or addressed superficially.

There are multiple factors that affect the choice of construction technique and method which all need to be considered. Health and safety is the single most important factor. Building below the groundwater level will add significant complexity and cost.

There will nearly always be some negative impact on local residents. This impact should be minimised through early engagement, imaginative planning and considerate execution.

Waterproofing of all basements is critical. The waterproofing design should be considered together with the structural design rather than separately. A comprehensive waterproofing guarantee is particularly important. Most waterproofing problems are caused by poor design or installation. Product manufacturers' guarantees will generally not cover failure due to design or installation and are usually limited only to replacement of the defective element of the installation. Comprehensive first party indemnity latent defects insurance, like the ASUC Basement Indemnity Guarantee (BIG), provide the best form of waterproofing guarantee and provide cover for all aspects of any waterproofing failure.

Selecting the right project team and method of procurement is critical. A structural or design engineer, either an independent consultant or one working for a design and build contractor, will always be needed. There is no best procurement method and any of the four routes can be successful. It is important to choose a form of procurement that incentivises safe and efficient construction.

Correct insurances should be in place to protect all parties. Insurance cover for basement construction projects is complex, domestic clients probably need expert advice.

Guarantees need to be read in detail as cover is often limited despite initial appearances. Comprehensive indemnity latent defects insurance underwritten by a financially strong insurance company provides the best form of cover. The ASUC Basement Indemnity Guarantee (BIG) is provided by this type of indemnity latent defects insurance.

Domestic owners contemplating a basement construction project should consider multiple factors ranging from property ownership and rights to build, through planning and other permissions, to the economics of the project and choosing whether to instruct a design team or a design and build contractor.

In conclusion it can be seen that basement construction is complex but if undertaken after due consideration and by suitably qualified and experienced teams successful outcomes should be achieved. Instructing an ASUC member to undertake a project should increase confidence that the work will be completed safely and efficiently.

17 LIST OF APPENDICES

Appendix A - Site investigations

Appendix B - Building damage classification

Appendix C - Safety hazards and mitigating actions

Appendix D - Health hazards and mitigating actions

Appendix E - Planning for risk management - detail on information required

Appendix F - ASUC*plus* Basement Indemnity Guarantee (BIG) policy

18 APPENDIX A - SITE INVESTIGATIONS

18.1 Introduction

Site investigations provide important information to designers and contractors. The information will be used to ensure an efficient structural design that will minimise settlement or other movement and to mitigate cost risks due to poor ground conditions.

Site investigation information can include:

a. Ground stratigraphy - the type of ground at various depths.

b. Soil characteristics

c. Groundwater presence and depth.

d. Ground bearing capacity at various depths.

e. Construction of existing foundations.

f. Contamination of existing ground especially made ground.

Site investigations will usually consist of a desk study and physical work on site.

The extent of site investigation required will vary by project though having too much information is better than having too little. Intrusive site investigation work can present a practical challenge.

Ideally site investigations will be carried out as early as possible and gather information down to below the proposed foundation level.

18.2 Desk study

The desk study should usually cover:

a. Study of geological maps.

b. British Geological Survey (BGS) information of the area including BGS borehole logs.

c. Review of previous boreholes nearby. Boreholes are required as part of planning applications by some local authorities and this information is then generally available on the council planning websites.

d. Information on existing or adjacent structures. Again planning departments or local authority Building Control departments can be a source of information.

e. Local knowledge from previous work nearby.

f. Any other relevant information.

The results of the desk study will inform the extent of the site work.

18.3 **Site work**

The site work can include:

a. Trial pits.

b. Boreholes.

In addition various tests and studies would usually be carried out on site and subsequently.

Site investigations should usually extend below the deepest element of the new foundations and be completed in accordance with BS 5930 Code of Practice for Site Investigation. The structural engineer and potential specialist contractors should be consulted before the intrusive works are instructed to ensure that all the necessary information is obtained.

18.3.1 Trial pits

Trial pits are generally used to establish the depth, profile and construction of the existing foundations as well as the soil into which it penetrates and the presence of any water. Ideally these should be completed on each wall of the property or on each section of a wall if differing foundation construction is suspected.

Trial pits can be several metres deep and need to be undertaken safely using correctly designed and installed shoring plus edge protection around the excavation if appropriate.

Trial pits that have extended below foundations need to be backfilled and compacted in layers to recreate the ground conditions prior to the excavation. Failure to do this correctly can lead to localised foundation movement as the ground adjusts into the weak backfill.

The ground bearing capacity in trial pits can be ascertained by completing plate bearing tests or Standard Penetration Tests (SPT).

18.3.2 Boreholes

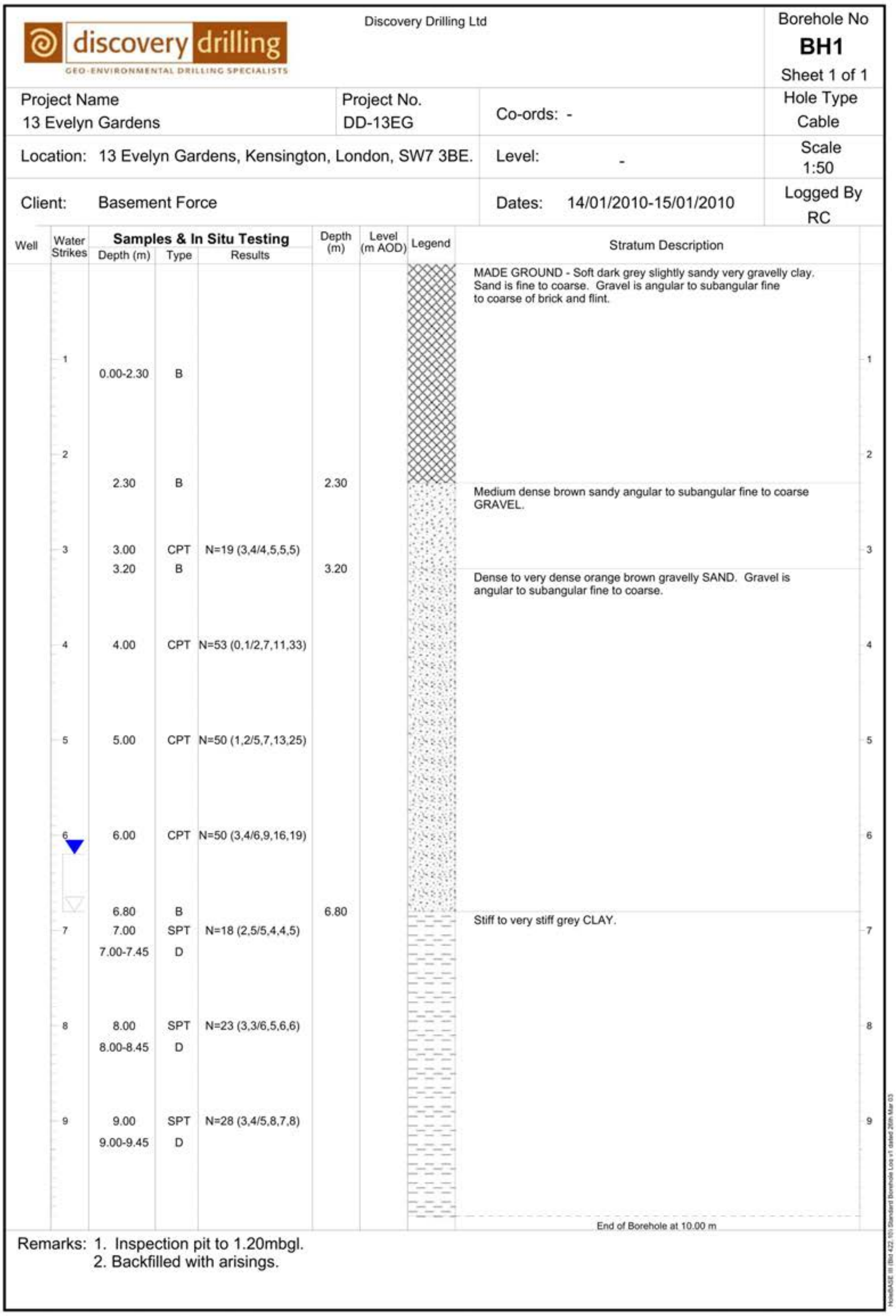
Boreholes should usually be used to establish soil conditions beyond the full depth of the proposed works. Depending upon the size of the site it may be necessary for more than a single borehole to be completed particularly where a hydrogeological assessment is needed.

Boreholes are formed by drilling or driving sampling or measurement instruments into the ground. Soil characteristics are noted and undisturbed soil samples are recovered, each of which are recorded against depth to provide a profile of the ground.

Figure 50. Restricted access modular site investigation rig

Figure 51. Full access site investigation drilling rig

Borehole logs should include engineering descriptions of the soils as set out in BS 5930 and ascertain the presence of water noting the depth of water table and, if possible, the rate of inflow of water. Where water is encountered stand pipes or piezometer tubes should be installed in order to allow future reading of water levels.



Discovery Drilling Ltd

Borehole No: BH1 — Sheet 1 of 1

Project Name: 13 Evelyn Gardens	Project No.: DD-13EG	Co-ords: -	Hole Type: Cable
Location: 13 Evelyn Gardens, Kensington, London, SW7 3BE.		Level: -	Scale: 1:50
Client: Basement Force		Dates: 14/01/2010-15/01/2010	Logged By: RC

Depth (m)	Type	Results	Depth (m)	Stratum Description
				MADE GROUND - Soft dark grey slightly sandy very gravelly clay. Sand is fine to coarse. Gravel is angular to subangular fine to coarse of brick and flint.
0.00-2.30	B			
2.30	B		2.30	Medium dense brown sandy angular to subangular fine to coarse GRAVEL.
3.00	CPT	N=19 (3,4/4,5,5,5)		
3.20	B		3.20	Dense to very dense orange brown gravelly SAND. Gravel is angular to subangular fine to coarse.
4.00	CPT	N=53 (0,1/2,7,11,33)		
5.00	CPT	N=50 (1,2/5,7,13,25)		
6.00	CPT	N=50 (3,4/6,9,16,19)		
6.80	B		6.80	Stiff to very stiff grey CLAY.
7.00	SPT	N=18 (2,5/5,4,4,5)		
7.00-7.45	D			
8.00	SPT	N=23 (3,3/6,5,6,6)		
8.00-8.45	D			
9.00	SPT	N=28 (3,4/5,8,7,8)		
9.00-9.45	D			
				End of Borehole at 10.00 m

Remarks: 1. Inspection pit to 1.20mbgl.
2. Backfilled with arisings.

Figure 52. Example borehole log

Several different techniques are used to gain information on the ground depending on whether the soil is cohesive or non-cohesive. Two of the most common tests are:

a. In situ shear vane test (cohesive soils - clays and clayey silts) - this measures the shear strength properties of the soil, i.e. how resistant the soil is to slipping when under lateral loads.

b. Standard penetration test (SPT) (non-cohesive soils - sands and gravels) - this test gives an indication of the density of the ground and is used in many empirical geotechnical engineering calculations.

Samples should usually be taken for further laboratory testing.

18.4 **Further analysis and reports**

Further work can include:

a. Laboratory testing.

b. Factual reports

c. Interpretive reports

18.4.1 Laboratory testing

Common laboratory tests completed for site investigations for basement projects are:

a. Waste Acceptance Criteria (WAC) tests - these tests establish whether the soil should be treated as inert, non-hazardous or hazardous. They should, depending on the site size and stratigraphy, be carried out at several locations especially in any made ground. They should include a clear statement of the tests results, the classification of the soil and, where the results indicate non-hazardous or hazardous waste, any precautions that site operatives should take when handling the material.

b. Particle size distribution (PSD) curves - these tests determine the proportion of the soil at different particle sizes. This information is commonly used in relation to ground stabilisation requirements and to prove the soil characteristics.

c. Consolidation tests - these tests indicate the likely long term ground settlement. Broadly speaking consolidation is caused by the release of air and water from soil under pressure over time so determining the existing air and water content of a soil and the behaviour under controlled conditions gives an indication of the tested soils likely future behaviour.

d. Triaxial testing - this is a is a common method to measure the mechanical properties of soil. The results are generally used in structural foundation design.

e. Atterberg limit tests - these tests provide information on the limits of plasticity, shrinkage and plastic to liquid behaviour of fine-grained soils. Plasticity indices are related to the moisture content of the soil and are used to determine the likely behaviour of the soil in terms of swelling and shrinking.

Laboratory testing should be completed by a UKAS accredited establishment in accordance with BS 1377-2 1990 Methods of test for soils for civil engineering purposes.

The findings of any site investigation are only truly representative for that specific location and on that specific date. Changes in weather and ground water will affect in situ site conditions.

18.4.2 Factual reports

Factual reports summarise the information that has been gathered but do not add any opinion to the findings.

18.4.3 Interpretive reports

Interpretive reports add layers of additional conclusions and recommendations based on the factual information.

Ground movement reports by a geotechnical consultant should be considered for some projects with difficult ground conditions. The structural engineer or specialist contractors should be well placed to advise on the necessity of a full ground movement report. The Association of Geotechnical and Geoenvironmental Specialists is a good source for a suitable geotechnical consultant.

19 APPENDIX B - BUILDING DAMAGE CLASSIFICATION

Risk category	**Description of degree of damage**	**Description of typical damage and likely form of repair for typical masonry buildings**	**Approximate crack width** (mm)
0	Negligible	Hairline cracks.	
1	Very slight	Fine cracks easily treated during normal redecorations. Perhaps isolated slight fracture in building. Cracks in exterior brickwork visible upon close inspection.	0.1 to 1
2	Slight	Cracks easily filled. Redecoration probably required. Several slight fractures inside building. Exterior cracks visible; some repointing may be required for weather-tightness. Doors and windows may stick slightly.	1 to 5
3	Moderate	Cracks may require cutting out and patching. Recurrent cracks can be masked by suitable linings. Repointing and possibly replacement of a small amount of exterior brickwork may be required. Doors and windows sticking. Utility services may be interrupted. Weather tightness often impaired.	5 to 15 or a number of cracks greater than 3
4	Severe	Extensive repair involving removal and replacement of sections of walls, especially over doors and windows required. Windows and door frames distorted. Floor slopes noticeably. Walls lean or bulge noticeably, some loss of bearing in beams. Utility services disrupted.	15 to 25 but also depends on number of cracks
5	Very severe	Major repair required involving partial or complete reconstruction. Beams lose bearing, walls lean badly and require shoring. Windows broken by distortion. Danger of instability.	Usually greater than 25 but depends on number of cracks

Notes:

Table is based on the work of Burland et al (1977).

Crack width is only one aspect of damage and should not be used on its own as a direct measure of it.

20 APPENDIX C - SAFETY HAZARDS AND MITIGATING ACTIONS

<table>
<tr><th>Hazard</th><th>Actions</th></tr>
<tr><td><u>Collapse of excavations</u></td><td>
All excavations are a collapse hazard if not fully supported and can lead to serious injury or death for anyone in or near to the excavation. There is also the additional hazard of causing instability to any surrounding structures.
Collapse of excavations are, according to the HSE, one of the major causes of problems in basement construction.
Excavations in basements are generally either:

Individual underpin excavations
The main site excavation

All excavations should have a:

Risk assessment considering the ground conditions, depth of excavation, loads on nearby structures
Safe system of work including a temporary works design and supervision of installation
Management system for overseeing and control

As with all temporary works there should be a:

Temporary Works Engineer
Temporary Works Coordinator

Additional information on temporary works is given in the Temporary Works section of these guidelines.
Common root causes of collapse of excavations are:

Lack of initial risk assessment
No temporary works design both in underpin excavation and during the main bulk excavation
Lack of adherence to the temporary works design
Temporary works being removed before the permanent works have gained adequate strength
Lack of management control and supervision of the works

</td></tr>
</table>

<table>
<tr><th>Hazard</th><th>Actions</th></tr>
<tr><td><u>Collapse of existing buildings</u></td><td>There is always the hazard of complete or partial building collapse in basement construction near to existing structures. The hazard is often heavily related to the collapse of excavations.

The main hazards are from:

• Vertical loads in existing structures acting down new load paths after partial demolition or being undermined by excavations or

• Horizontal loads in existing structures not being fully supported especially where there has been some demolition of the existing structure

As for excavations in each case the following must be completed:

• Risk assessment

• Safe system of work including a temporary works design

• Management system

The risk assessment must consider the existing load paths in the building, how these will be affected by the temporary works and the temporary condition, and whether any parts of the existing building will be required to support additional load.

As with all temporary works there should be a:

• Temporary Works Engineer

• Temporary Works Coordinator</td></tr>
<tr><td><u>Access to work areas</u></td><td>Access points often pose a falls from height hazard. In addition in basement construction they are nearly always the emergency escape route.

There must always be safe access and exit for personnel, plant and excavated material.

Personnel access should, where possible, be by temporary stairs rather than by ladders.

Multiple points of access and exit should be established where possible.

Safe access to all active working areas must be maintained at all times. The safe access must be sufficient to allow the movement of a casualty.</td></tr>
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<table>
<tr><th>Hazard</th><th>Actions</th></tr>
<tr><td><u>Falls from height</u></td><td>
Falls from height are a major cause of serious injury and death in construction. The HSE report that, at site visits, insufficient attention to preventing falls from height is a frequent reason for halting operations on basement construction projects.
Falls from upper levels and falls into excavations must be prevented. This applies to access routes and work areas. Falls from open edges and falls through weak materials or openings must be considered. As excavation progresses the situation changes continually and must be checked and the protection adjusted. This often needs to be carried out several times each day.
Areas where fall protection will be needed include the open edges of:

Vertical excavations
Stepped or battered excavations - unless it is possible to walk down the sides of the excavation
Floor slabs with open edges or holes
Stair wells with stairs removed or incomplete
Lightwells
Scaffold or other access platforms

Access to plant and to lorries to assist with unloading should also be considered.
Falls through weak or fragile material also needs to be prevented including:

Rotten timber floors
Partially supported existing or new incomplete structures
Old unreinforced concrete floors
Arched or vaulted floors in delicate condition

There is no legal height limit above which fall protection must be provided. But there is a duty to prevent fall injuries. This means in essence that if a worker can step down onto flat ground from a platform, should they lose their balance, then protection is not required. However if any stumble or slip while at height would result in a fall, then protection must be in place. If the ground below is not flat, or has protruding reinforcing bars or contains standing water, is poorly lit or similar then fall protection may be required whatever the height.
</td></tr>
</table>

Hazard	Actions
	Many contractors have set a limit of one metre potential unobstructed fall height. Above this their procedures require fall protection. Note that for public areas fall protection standards should be limited to a much lower height equivalent to a road kerb or stair riser height before barriers or other edge protection is required. ASUC regards this approach as sensible. Standard methods of protection for open edges include: • Access restriction - access to the area is prevented by secure fencing, signs, briefing and supervision • Edge protection – sturdy guard rails and toe boards - this is the preferred and most common method where access to the edge is needed. It may be fixed to the structure or be part of an independent scaffold, scaffold tower or the enclosed cage of plant, for example a mobile elevating work platform. • Crash matting – usually air safety mats or bean bags that provide a soft landing system for low falls - often used for short duration work, for example at the leading edge where precast concrete floor planks are laid and around delivery flatbed lorries during access onto the vehicle for unloading. • Fall arrest nets fitted just below the work area. These are not common in basement works but on other jobs are often used following steel erection to protect following trades installing items such as permanent steel formwork or timber joists and floors. The net needs to be lashed to or hung from secure anchors. It will sag if fallen on so the area below must be clear of obstructions. • Fall protection harness systems used in restraint mode (to prevent access to the open edge) and fall arrest systems (which stop a person after they start to fall) may also need to be used at times. These rely on sturdy anchor point/s being designed and provided. However harness systems need each individual user to be trained and to understand the limitations of the equipment. They should only be used if other methods are not suitable. And the area will still need to be fenced off so that only authorised workers using the harness system can enter. Typical use includes work at suspended slab level during falsework and formwork installation. Standard methods of preventing falls through weak materials include: • Preventing access to suspect areas by fencing or other

Hazard	Actions
	secure barriers • Reducing loads on floors by, for example, removing stored materials • Propping to prevent overload collapse - this can be very tricky where arched or vaulted existing structures are involved • Boarding over rotten floorboards, provided the joists below are adequate or securely propped • Preventing access onto adjacent flat roofs and never allowing access onto fragile roofs such as corrugated asbestos cement or roofs containing roof lights or glazed panels Access by stairs or temporary stair tower is preferred. Where the area available does not permit this then ladder access may be needed. An inclined ladder (1:4) is easier to climb than a vertical ladder but in some shafts there may only be room for a vertical ladder. Most tower scaffold systems have a built-in vertical ladder that is adequate so long as it has been correctly assembled. An inclined ladder must be secured to the top platform and project above the landing - three or four rungs or an alternative secure handhold is needed. Ladders are very vulnerable to damage and need to be regularly checked and replaced if damaged. They also need to be kept clean in muddy conditions. For some vertical ladder shaft work it can help to use a fall arrest harness and an inertia reel attached to a secure anchor point near the top of the ladder. This can often be combined with the confined spaces procedure. Ladders and step ladders are not ideal as work platforms and are involved in numerous construction accidents each year. Tower scaffolds and access platforms provide a much more secure work area and allow faster progress. Ladders should only be used for carrying out work where other means of access are not possible or where the ladder needs to be moved every couple of minutes. If the ladder cannot be tied at the top to prevent it slipping, a second person will be needed to ‘foot’ it - which is inefficient. As a general rule - if both hands are needed for the work, then a ladder is not suitable. And if the work involves pushing horizontally, for example non pneumatic drilling, or resisting sudden forces, for example core drilling, then a ladder is not suitable. All temporary works and especially those that affect the structure will need input from the project structural engineer and temporary works engineer/designer. The person

Hazard	Actions
	responsible for coordinating temporary works on site should lead this process and advise on the sequence of carrying out the work as there may be ways of reducing the risk of a structural incident as well as simplifying the number of areas where fall protection is needed. More information on preventing falls from height in construction can be found in the HSE publication *Health & Safety in Roofwork* which contains information that is relevant to areas such as garden basement structures with a suspended slab roof and explains the different types of fall protection that are available and the main benefits and issues. http://www.hse.gov.uk/pubns/books/hsg33.htm The Work at Height Regulations 2005 can be viewed at: http://www.legislation.gov.uk/uksi/2005/735/contents/made
Scaffolding and ladder safety	Scaffolding and ladders have an inherent hazard of falls from height. Ladders should be avoided where possible as they cause the greatest risk compared to other options including scaffold towers. Key ladder safety issues include: • Condition • Positioning • Use • Stability Where ladders are used they should be: • Secured or be held in position by another person • Extend an appropriate distance above the top level usually at least four rungs above the uppermost access level or have an alternative secure handhold above the upper platform level • Be protected at the access point to prevent a fall from height ideally with a sprung gate Ladders can be used to work from if more suitable work equipment is not justified because of the low risk and short duration of the work. Short duration is normally seen as being between 15 and 30 minutes.

Hazard	Actions
	Key tower scaffold safety issues are: • Erection and dismantling • Stability • Precautions and inspection • Using and moving Tower use requires: • That the tower be suitable for the work • Be erected and dismantled by people who have been trained and are competent to do so • Users to know the potential dangers • Users to know the appropriate safety precautions required • Proper management and rigorous scaffold inspection Tube and fitting scaffold should be installed by a reputable scaffolding company who use trained operatives. Once installed the scaffold should be inspected and maintained regularly.
Existing services	Existing services present a major hazard and can cause explosions, fire, flash fires, and burns. Each year damage to services during construction work is responsible for severe injuries and fatalities. Existing services (gas, electricity, water, sewer, telecom, other) must be located and precautions established to prevent damage and avoid danger. Plans of the main services should be obtained from the relevant utility companies. On site: • Use of locating devices prior to excavation: Hum detectors, radio frequency detectors, transmitter-receiver instruments, metal detectors and ground probing radar should be considered • Services should be assumed as live unless confirmed otherwise • Careful hand excavation (not using hand power tools and not using pointed tools) should be used to prove the location of existing services in line with HSE HGS 47

Hazard	Actions
	• Other tools and plant should not be used within 500mm of service locations • Services encased in concrete will need to be disconnected or at least isolated whilst being exposed • Safe methods of excavation around services, including water jetting or high-velocity air jets, should be considered • Unknown services should be treated as follows: ➢ Black - electrical ➢ Yellow - gas ➢ Iron and steel pipes - gas • Operatives should know the modern national colour coding system for buried services ➢ Black - electricity ➢ Red - electricity; some high voltage cables ➢ Orange - street lighting in England and Wales ➢ Yellow - gas ➢ Blue - water ➢ Grey or white - telecommunications ➢ Green - cable television and some telecommunications Overhead power lines should also be identified and the risk assessed. Collection and delivery vehicle sizes should be noted as well as the likely range of movement of the grab arms of muck away lorries.
<u>Electrical handheld power tools</u>	Electrical power creates hazard from burns and shocks. 230 / 240 volt mains power should be discouraged and should not be used directly for tools on site. Where 230 volt power is used, for example in welfare facilities and site offices, residual current or 'trip' devices (RCDs) must be installed. Cordless or 110 volt tools should be used where possible as they are unlikely to cause a fatal shock. The 110 volt transformer should connect to a dry 230 volt supply well away from the work area. High power tool batteries must be kept in dry conditions. Immersion can lead to sudden discharge, overheating and explosion.

<table>
<tr><th>Hazard</th><th>Actions</th></tr>
<tr><td><u>Mobile plant safety</u></td><td>Mobile plant can cause serious injury or death by collision, crushing and overturning. The hazard is to site operatives and to members of the public.

Plant most often used are:
Excavators / diggers
Piling rigs
Dump trucks and barrows
Telescopic handlers
Common general control measures are:
Segregation of vehicles and pedestrians; movement routes and exclusion zones
Maintenance of clear 360° visibility
Use limited to trained and competent staff
Use of signallers and banksmen
Use of well maintained machines that are regularly inspected, serviced and maintained
Speed limits
Levelling of ground to reduce risk of overturning
Use of stop blocks at edges
Use of load spreading pads or a designed platform for high centre of gravity plant</td></tr>
<tr><td><u>Confined spaces</u></td><td>A confined space is any area of an enclosed nature where there is a risk of death or serious injury from hazardous substances or dangerous conditions.

Dangers in confined spaces can arise from:
Lack of oxygen
Poisonous gas, fume or vapour
Liquids and solids which can suddenly fill the space or release gases into it when disturbed
Fire and explosions</td></tr>
</table>

Hazard	Actions
	• Dust present in high concentrations • Hot conditions leading to a dangerous increase in body temperature The hazard is high in below ground areas with poor natural ventilation such as tunnels, excavations as well as in any enclosed space. Air quality may be reduced by a slight reduction in proportion of oxygen or by the presence of a harmful gas. This can affect people without warning – i.e. no smell, taste or unwell feeling. There is a history of multiple deaths where one person goes into a confined space to rescue someone who has collapsed. The rescuer is also overcome and others attempt to assist. Assessment, planning and strict procedures are needed to ensure this scenario cannot happen. Work in confined spaces should be designed out where possible. A ground survey, a check for contamination, and knowledge of the site history and local area may help identify sites at risk. The best control measure is to have good natural ventilation. This may need to be supplemented by forced ventilation. In some cases fresh air may need to be ducted into remote areas. In the extreme – e.g. below ground live sewer connections - it may be necessary to use confined space trained workers equipped with breathing apparatus and rescue equipment. In these cases the working person will be attached to a lifeline with means to pull/lift a person to fresh air and with an outside team always present. Tunnel working may require air monitoring equipment in the tunnel that will alarm if a specified gas is detected or the oxygen level drops. Underground workers on tunnelling projects should also carry a rescue set that provides enough oxygen to allow them to escape if the air monitoring alarm goes off. All work areas must be assessed to decide if the area is to be regarded as a 'confined space'. For all confined spaces a system of work for entry, exit and work in the space must be established. Fume extractors, clean air, and multiple access and egress points should be considered. An emergency rescue plan must be developed, communicated to all relevant persons and practiced on site including a safe system of recovery. Only trained and competent operatives should work in confined spaces.

Hazard	Actions
<u>Fire and means of escape</u>	Fire on a basement construction site has a high hazard of serious injury or death with the likely causes being asphyxiation, choking or burns. Fire will not occur unless there is combustible material, oxygen and an ignition source present. The causes of fire must be managed including: • Minimising the amount of flammable material on site including any solvent based paints and thinners, petrol, LPG, oxyacetylene sets, etc. These are all particularly high fire hazards. • Minimising the amount of combustible material on site at any one time - especially combustible foam, cardboard, thin timber sheet materials etc. • Fuels to be stored outside • Control of hot works and other ignition sources such as grinding steel • Removal of combustible waste from vulnerable areas – eg packaging materials, wood shavings and off-cuts etc on a regular basis – eg twice daily • Either no smoking on site or smoking restricted to designated open areas that are away from confined spaces and critical access routes and combustible materials • Poor condition of electrical circuits and appliances is a major cause of fire on construction sites. Existing circuits in and adjacent the work area are particularly vulnerable, especially if old and deteriorated. Consider making dead and replacing with new, temporary circuits. Inspect and maintain all permanent and temporary circuits, appliances and tools on a regular basis. Where possible isolate circuits outside working hours. All sites must have a fire plan and arrangements covering: • Fire alarms • Fire fighting equipment, generally fire extinguishers, at each level or in each working area • Safe means of escape • Completed regular fire plan drills Flammable materials should be stored outside where possible in a ventilated cabinet or cage. The risk of fuel fumes that are heavier than air collecting in

Hazard	Actions
	excavations should be remembered Householders may wish to remain in occupation of the whole or upper parts of the property during the works. In this instance a plan needs to be developed and communicated to / agreed with the householders which could cover the four main bullet points above (fire alarms, fire fighting equipment being provided, safe means of escape and fire drills). It should be noted that fire extinguishers are provided to enable escape from a burning building as well as to directly fight a small fire. Householders in occupation may also cause a fire. The likely causes of fire within the occupied parts of the building should be considered. The highest risk areas being kitchens, open fires and any areas with heavily loaded, especially old, electrical circuits and appliances. Appropriate mitigating actions for any high risk areas should be considered. Detailed advice on fire prevention and mitigation is contained in HSE publication *Fire safety in construction* at reference 10 in the references at the end of this document
<u>Dangerous substances</u>	Dangerous substances cause a hazard of explosion, burns, asphyxiation, choking and poisoning. All dangerous substances such as fuels, paints, solvents, foam filler with flammable propellant, gas welding sets, LPG heaters and bottles etc. must be risk assessed and appropriate precautions be taken to protect people and the environment. Safe methods must be established and enforced covering: • Storage - solvents should be kept separately from combustibles. LPG and acetylene should be kept completely separately. Flammables should not be stored in excavations or below ground - store them outside in open air - preferably in ventilated cabinets or cages. Minimise the quantities kept on site. • Refuelling of petrol equipment including hand held tools must be carried out outside in open air • The risk from the collection or movement of heavier than air gases and fumes should be remembered
<u>Lifting operations</u>	Mobile crane operations have a hazard of overturning and dropping of loads. The hazard is to operatives and to members of the public especially during deliveries and collections. All mobile crane operations, including lorry loader crane

Hazard	Actions
	deliveries, must be properly planned and have a lifting plan in place before the work starts. The work must be supervised to ensure proper implementation of the lifting plan. For larger lifting operations a temporary works engineer will need to advise on ground conditions to ensure that any crane is not vulnerable to overturn.
Lighting	Poor site lighting increases the likelihood of injury across multiple other areas. All work areas, access and egress walkways and passageways must be adequately and safely lit at all times. Provision of torches or automatic back up lighting should be made to cover for a failure in the main works lighting. Where the site requires temporary lighting this should include battery backup emergency lighting particularly on emergency exit routes.
General site order and slips, trips and falls on the same level	Sites in a poor general condition create an increased hazard for general injuries such as cuts, bruises and impalement. Mitigating actions include: • Use of protective caps on exposed reinforcement ends to prevent impalement • Use of continuity reinforcement strips to reduce the amount of open-ended reinforcement exposed to reduce impalement hazard • Removal of nails and screws from timber including from dismantled formwork • Marking the ends of steelwork, temporary works, props or similar protruding elements with high visibility material or paint • Removing the sharp edges of scaffold, steel, temporary works, edge protection and scaffold gates to reduce the likelihood of cuts and abrasions Slips, trips and falls on the same level may appear minor hazards but can lead to serious injury or in some circumstances to fatalities. Common occurrences on construction sites which cause slips, trips and falls include: • Poorly stacked or located equipment and waste materials

Hazard	Actions
	• Uneven surfaces • Obstacles created during the construction or demolition process • Trailing cables • Wet or slippery surfaces • Changes in level Anyone in control of a construction site must manage work so that people can move safely around the site. The site must be kept in a clean and orderly condition in order to reduce the chance of injury through slips, trips and falls. Clear walkways are essential in order to maintain safe movement.

21 APPENDIX D - HEALTH HAZARDS AND MITIGATING ACTIONS

Hazard	Actions
Asbestos	Exposure to asbestos is the single largest cause of death in the construction industry. Exposure to asbestos is a serious health hazard with exposure to tiny amounts of asbestos being able to cause death or serious injury. An intrusive asbestos survey should be carried out prior to the main works, including any soft strip, on buildings built before about 1990. Practically this cannot be completed to areas that are to be excavated but where possible checks should be made under suspended ground or lowest floors which should consider whether there are any subfloor ducts etc or whether concrete floors have been cast onto asbestos containing formwork. The survey should identify and locate any asbestos containing materials (ACMs). In the event that ACMs are identified then all work must be undertaken in line with asbestos work regulations. Asbestos containing materials that are bound in a matrix, for example asbestos cement such as corrugated roof sheeting and plasterboard coated in textured coatings such as Artex can, legally, be removed by general contractors. Anyone who is asked to remove these items must know the correct methods of removing and handling the product, which is mainly based on damping down and removing whole with minimal breakage. Many asbestos containing materials can only be removed by a contractor licensed to work with asbestos. In the event that a licensed contractor is required to remove asbestos then an asbestos clearance certificate and the original survey must be obtained from the specialist asbestos contractor before general construction work starts and the clearance certificate and original survey must be made available to all parties. All staff who might come across asbestos in the course of their work are required to complete asbestos awareness training. It is a legal requirement that workers know about the health risks from asbestos, how to identify asbestos and what to do if they uncover or damage asbestos. Once construction work is finished, information may need to be communicated about the location and condition of any asbestos that is still within the premises. This is so that the client can comply with their duty to manage asbestos in non-domestic premises.

Hazard	Actions
Hazardous substances and processes	Hazardous substances and processes both present a hazard to health and must be managed. All substances with the potential to be hazardous to health or those that can have significant environmental impacts must be assessed and appropriate precautions established. This includes hazardous substances already present on site, those generated on site and those brought to site as part of the work and include: • Powder cement • Lime • Wet concrete • Paints • Solvents • Plant exhaust fumes And substances that are already on site: • Asbestos • Dust containing silica • Chemical contaminants • Sewage • Pigeon droppings • Rat urine and droppings The assessment should cover the storage and use of the chemical and identify any issues that may occur when more than one chemical are combined. Again the priority should be: • Avoidance – lower risk alternatives should be used if possible • Action – taken to reduce risk • Information – those involved must be provided with all relevant information on the substances, the associated risks and the appropriate mitigating actions Use of PPE, while often necessary, alone should only be used when all other practical alternatives have been considered.

<table>
<tr><th>Hazard</th><th>Actions</th></tr>
<tr><td><u>Respiratory disease especially from dust containing silica and from diesel fume</u></td><td>Respiratory diseases are a significant hazard in the construction sector with the most common being:
Silicosis - silicosis is second only to asbestos in the number of deaths caused in the construction industry. The health risk is from lung damage leading to cancer.
Chronic obstructive pulmonary disease
Occupational asthma
Concrete dust is generally caused by disc cutters and angle grinders. All concrete cutting that produces dust should be completed wet. Suitable respiratory protection will probably still need to be worn during and after the work.

The problem is made worse in an enclosed area.

Exposure to substances that can cause respiratory disease or breathing difficulty if inhaled must, by law, be minimised.

The means of control in priority are:
Elimination of the hazard
Suppression or extraction of the dust
Use of PPE - PPE use on its own is a last resort
All workers who might be exposed should receive clear information, instruction and appropriate training.

Note that diesel fume has recently been reclassified as a carcinogen that causes lung related cancers. This means that older diesel plant may no longer be suitable for use in enclosed basement excavation. Consider use of latest clean technology and also consider ducting the exhaust to open air and increasing general or forced ventilation to dilute any residual exhaust fume.</td></tr>
<tr><td><u>Carbon monoxide and other noxious gases</u></td><td>Site equipment using internal combustion engines as well as inadequately ventilated liquefied petroleum gas (LPG) equipment can produce carbon monoxide gas leading to low oxygen levels or to the presence of flammable gases. Other common asphyxiant gases are ethane, helium, hydrogen, methane and nitrogen. In addition inert gases such as argon, helium, nitrogen or carbon dioxide are sometimes deliberately used on site for activities such as welding purposes or in fire suppression equipment.

Underpin excavations are particularly prone to becoming oxygen</td></tr>
</table>

<table>
<tr><th>Hazard</th><th>Actions</th></tr>
<tr><td></td><td>depleted.

There is also a hazard from leaking underground gas mains. A mains gas leak can quickly lead to a dangerous atmosphere.

The main mitigations are:

• Awareness
• Good ventilation
• Plant and equipment in good condition and properly maintained
• Gas bottles stored outside and valves closed at end of shift
• Gas detectors and alarms used
• Generators must only be run outdoors and completely in open air</td></tr>
<tr><td><u>Dermatitis</u></td><td>Contact dermatitis is inflammation of the skin that can arise from contact with a range of materials commonly used in basement construction. The main signs and symptoms are dryness, redness, itching, swelling, flaking, cracking and blistering. Dermatitis can be painful and can require medical treatment

Dermatitis usually affects the hands and forearms, though the face, neck, chest, and legs can also be affected.

The main products that cause dermatitis are:

• Wet cement
• Epoxy resins and hardeners
• Acrylic sealants
• Bitumen or asphalt
• Solvents in paints, glues or other surface coatings
• Petrol
• Diesel, oils and greases

The use of products known to cause dermatitis must be strictly controlled on site with adequate washing and if necessary decontamination facilities available at all times.

Correct Personal Protective Equipment (PPE) should always be</td></tr>
</table>

Hazard	Actions
	used.
<u>Damage to eyes</u>	Activities on site including breaking of concrete, grinding and cutting timber all have significant hazard of damage to eyes. While the likelihood of injury from one work action is low the damage caused to an eye from even a single minor impact can cause permanent blindness. Correct eye protection should be worn at all times for any work activity that has a possibility of material being moved at speed into the eye.
<u>Noise</u>	High noise levels are a hazard to hearing. Prolonged exposure to high noise levels will cause reduction in hearing levels and eventually permanent deafness. As a guide a noise level which requires the voice to be raised in order to be heard is sufficiently loud to cause damage to hearing. Site operatives generally do not fully appreciate the hazard and must be instructed to use correct ear protection. Noise hazard must be assessed and any required mitigating actions identified and implemented. Where possible this should be by reducing the level and duration of noisy operations. Noise sources should, where possible, be located away from populated work areas and in particular be conducted away from welfare facilities. Ear protection must be used by everyone in an area where there is noise at a level that might cause damage to hearing. Noise is also an environmental issue which can have a serious impact on neighbours and the local community. High levels of noise from the work can be a Statutory Nuisance (as defined in the Environmental Protection Act 1990) to the surrounding community, and in this case the local authority can limit or stop work. Under section 60 of the Control of Pollution Act (COPA) 1974, authorities have powers to control noise (and vibration) from building sites. Control is implemented by serving a notice on the person responsible for the construction operations. The notice can specify types of plant and machinery, permitted hours of operation, boundary noise levels and the use of 'best practicable means' to keep all noise to a minimum. For example plant and machinery used on the site shall be properly silenced and radios or other amplified music shall not be played.

<table>
<tr><th>Hazard</th><th>Actions</th></tr>
<tr><td><u>Hand arm vibration</u></td><td>Hand-arm vibration (HAV) is the health hazard associated with using handheld power tools. HAV causes serious long term health problems and disability in the hands and arms.

Hand held power tools are the main culprit - especially jack hammers, scabblers, and similar tools. Pokers, disc cutters and masonry drills can also cause HAV.

Methods of work that avoid the use of powered hand tools should be used wherever practical. For example concrete could be removed by diamond sawing or drilling and bursting to reduce the use of hand held breakers.

The system of work selected can reduce exposure to HAV. Precise formwork can reduce the need for trimming or tidying of new concrete work.

All tools used on a project should be the lowest vibration rating alternative possible with companies encouraged to adopt a low vibration purchasing policy when hiring or replacing equipment.

All operatives must be educated on the risks and symptoms of HAV and know the method and rules used to reduce HAV damage. HAV exposure should be recorded and monitored as a means of control.

All operatives should complete a pre-employment medical history questionnaire and, before working with vibrating hand tools, complete a HAV’s initial screening questionnaire.

Further screening of operatives may be required should they be identified as being susceptible to HAV or if their specific job has a high potential HAV exposure.</td></tr>
<tr><td><u>Manual handling and musculoskeletal disorders</u></td><td>Construction activities that involve manual handling present a significant hazard of musculoskeletal disorders (MSDs) and must be considered fully with action taken on three fronts:

• Avoidance - manual lifting must be avoided by good design and by use of alternate systems of work such as mechanical lifting means

• Action – where avoidance is not possible a system of work that minimises risk must be employed

• Information – those people who carry out any manual handling must be provided with adequate information on the weight of each load, including if necessary the heaviest side of any load whose centre of gravity is not central

Staff must undertake regular appropriate training including</td></tr>
</table>

Hazard	Actions
	instruction on safe handling to minimise the risk of strains and sprains.
<u>Inclement weather</u>	Basement construction work often involves working in exposed conditions. Suitable and sufficient measures should be taken to protect the works and the workers from both: • Inclement weather - rain, low temperatures and high wind • Strong sunlight and high temperatures In general open sites should have temporary roofs built to provide adequate protection and to avoid the ground becoming waterlogged and increasing the risk of collapse during excavation and construction. It is important that operatives have the ability to: • Dry themselves and their clothes whilst on site • Heat food • Make hot drinks • Have a supply of clean, drinking water • Sit down in a sheltered, warm environment during breaks
<u>Work related stress</u>	Work related stress can be a major cause of illness and unhappiness leading to absence from work and further complications. The HSE has identified six major aspects of work that can be causes of stress across all jobs: 1. Work demands. 2. Control over work. 3. Lack of support from others. 4. Relationships at work.

<table>
<tr><th>Hazard</th><th>Actions</th></tr>
<tr><td></td><td>5. Role of the individual.

6. The effect of change.

The top five most stressful aspects of construction work are:

• Having a dangerous job.
• Excessive travelling or commuting
• Being responsible for the safety of others at work
• Working long hours
• Having too much work to do in the time available

Factors such as personal relationships, financial concerns, domestic issues and bereavement can also affect peoples' ability to cope with pressure at work.

It is important that work related stress is discussed openly on site and is effectively managed if it is identified in an individual.</td></tr>
<tr><td><u>Alcohol and drug abuse</u></td><td>Historically alcohol and drug abuse have been problems in the construction sector.

All companies should have a policy relating to alcohol and drug abuse. As a minimum people found or believed to be suffering from the effects of drugs or alcohol should be excluded from the site.

In some circumstances, if a problem persists, it may be necessary to carry out random drugs or alcohol tests. This should be done by specialists using the appropriate testing equipment and only after prior formal notification to all at risk of being tested.</td></tr>
</table>

22 APPENDIX E - PLANNING FOR RISK MANAGEMENT - DETAIL ON INFORMATION REQUIRED

Area	Detail
Site investigation	Site investigation work is intended to provide information to enable safe and effective design and construction planning. It will usually involve: • Desk top work • Site work Desk top surveys can also identify hazards such as areas of high risk of unexploded ordnance, contaminated ground from previous use or of underground rivers or water. Site investigation work usually includes boreholes, trial pits, and laboratory tests on soil samples to confirm particle size, cohesion and contamination. Further information on site investigations is give at appendix A.
Existing and adjoining building and structures	As much information on the existing and adjoining structures as is reasonably available should be sought. This will usually come from others and from site visits or investigations. Information on the existing and adjoining building and structures can be obtained from various sources including: • Property owners • Local authority planning departments • Local authority building control departments • Architects, engineers and contractors who have previously worked on the properties involved A site visit should be completed to identify and investigate to an appropriate level. Intrusive works may be required though a balance will often need to be struck if a property is occupied between the level of damage caused and the importance of knowing specifics at that stage.

Area	Detail
Adjacent underground structures	Nearby underground structures need to be identified. These can include neighbouring basements, railways, canals or road tunnels - either in use or abandoned, shallow mine workings, air raid shelters, retaining walls, wells, water storage or treatment tanks and sewers. A combination of checking large scale maps, old maps, local authority records and local knowledge may be needed to find out if there are features that may affect a project. Transport for London and London Underground will provide information to confirm that proposed developments will not conflict with their assets. There is a fee for this service. The contact e mail for the service is - railwaysearches@tfl.gov.uk
Services	Existing underground services include gas, electric, water, waste water and communications pipes and cables. The main utility companies can be contacted directly to obtain information on their assets. This information will usually only include the main pipes and cables and will not include the locations of individual supplies to properties. Local investigations with underground detection devices or careful excavation may be needed to identify services within the footprint of the property Occasionally a basement scheme may need to be limited due to the presence of existing services. Waste water pipes that serve properties up stream can be particularly difficult to relocate given their reliance on gravity to operate and the essentially fixed positions of inflow and outflow points of the pipes.
Asbestos	Asbestos, if present, is a major health risk. Exposure to airborne asbestos fibres is the main cause of occupational death in construction workers. Prior to the late 1990s asbestos was commonly used. Checks must always be carried out for asbestos in areas that could be disturbed by the works. In the event that the presence of asbestos is suspected all further investigative work should stop and a specialist licensed contractor should be contacted. All asbestos that could be disturbed by the works needs to be removed under controlled conditions by a licensed contractor. There are very few types of asbestos containing material that a general contractor is allowed to remove using their own asbestos trained workers.

Area	Detail
Site access	Any physical or regulatory limitations on site access must be identified usually using scale maps and a site visit. Access restrictions may limit the size and weight of delivery vehicles or mobile plant. Restrictions may be caused by weight limits imposed to protect old roads, narrow roads, tight road corners, hospitals, pedestrian road crossings, parking restrictions, schools and children's play areas. Several local authorities now require traffic management or construction plans to be approved prior to the start of works. Site hoardings or temporary structures that will cross or be located on the road or footpath will usually require a licence from the council.

23 APPENDIX F - AN EXAMPLE OF AN INSURANCE BACKED LATENT DEFECTS GUARANTEE TAILORED SPECIFICALLY FOR BASEMENT CONTRACTORS THAT DEALS WITH ALL THE ISSUES RAISED IN CHAPTER 14

Other insurers may offer similar packages to construction contractors.


ASUC

Underpinning and Subsidence Repairs, Engineered Foundation Solutions and Retrofit Basements.

Basement indemnity guarantee

POLICY DOCUMENT

Version2

www.asuc.org.uk

Basement indemnity guarantee

1. INFORMATION

The **Policyholder** is requested to read the Policy and Certificates. These are important documents. If any information is not clear please contact the **Scheme Administrator.**

This Policy consists of:

1) **INFORMATION** on the **Basement Insurance Guarantee;**

2) **DEFINITIONS** detailing all definitions applicable to the Policy;

3) **INSURING AGREEMENT** giving precise details of the cover subject to variation by endorsement;

4) **ADDITIONAL EXTENSIONS detailing additional extensions the Underwriter with its consent will pay in the event of a valid claim**

5) **WARRANTIES** detailing warranties that apply to the whole Policy;

6) **EXCLUSIONS** detailing exclusions that apply to the whole Policy;

7) **CONDITIONS** defining the terms that apply to the whole Policy;

8) **CLAIMS NOTIFICATION PROCEDURES** detailing the procedures that should be followed when notifying a claim under the Policy.

This Policy sets out the insurance cover provided by the **Basement Insurance Guarantee.**

This insurance cover is subject to a number of definitions, conditions, exclusions and financial limits as detailed in the Policy.

The **Basement Insurance Guarantee** is only available to members of ASUC Plus. The ASUC Plus member who has carried out the work at the **Premises** has applied for insurance on your behalf. The **Certificate of Insurance** enclosed with this policy details the extent of the works insured.

It is a Policy of indemnity and does not provide any cover for any legal liabilities that the **Policyholder** may have to third parties arising out of the use or ownership of the **Premises.**

The policy insures the **Basement Works** identified in the **Certificate of Insurance** as specified in this policy document, for a period of 10 years from completion.

The **Limit of Indemnity** for the **Basement Insurance Guarantee** is the value of the **Basement Works** as detailed on the **Certificate of Insurance.** The **Policyholder** may increase the **Limit of Indemnity** on application to the **Scheme Administrator.** An additional premium will be charged. The maximum **Limit of Indemnity** available under the Basement **Insurance Guarantee** is £2,000,000.

LAW APPLICABLE TO ThIS POLICY

The parties to a contract covering a risk in the United Kingdom are free to choose the law applicable to that contract. In the absence of any written agreement to the contrary the law applicable to this contract shall be law of England and Wales.

INTERPRETATION

Where any word or expression is given a specific meaning then such word or expression shall, unless the context otherwise requires, have the same meaning wherever it appears.

NOTES

1) For this Policy to be binding there should be a signed **Certificate of Insurance.** Please look carefully at the Certificate issued to ensure that the details have been correctly entered. This should be filed with the Policy.

2) Extensions in cover at the time of issue of the Policy and subsequent alterations will be confirmed by separate Endorsements, which should be filed with the Policy. The **Policyholder** should refer to these Endorsements and the Policy to ascertain the precise cover in force at any time.

3) This Policy is transferable to future owners of the **Premises** provided that such owners contact the **Scheme Administrator** to notify their details.

NOTICE TO ThE POLICYhOLDER

As a **Policyholder** you have a number of options for making complaints about your **Basement Insurance Guarantee** policy. These are listed below. Before making any enquiry or complaint please consider carefully the most suitable option to address your concern.

In all cases the Policy/Certificate number appearing in the **Certificate of Insurance** should be quoted.

BIG Policy Document 31-001-2.00-050315 Page **1** of **9**

Basement indemnity guarantee

1) MD Insurance Services Ltd also acts as the **Scheme Administrator** for the **Basement Insurance Guarantee.** If you have any complaint about the way in which MD Insurance Services Ltd has performed the duties as the **Scheme Administrator** please contact:

The Complaints Officer
MD Insurance Services Ltd.
2 Shore Lines Building
Shore Road
Birkenhead
WirralCH41
1AU

Email: complaints@mdinsurance.co.uk
Telephone: 0151 650 4300

A copy of the MD Insurance Services Ltd Complaints Procedure will be provided on request.

2) If you have any enquiry or complaint about the insurance provided by the **Basement Insurance Guarantee** this should in the first instance be addressed to:

The Complaints Officer
MD Insurance Services Ltd.
2 Shore Lines Building
Shore Road
Birkenhead
WirralCH41
1AU

Email: complaints@mdinsurance.co.uk
Telephone: 0151 650 4300

or

Amtrust
The Complaints Department
AmTrust Europe Limited
Market Square House
St James's Street
Nottingham
NG1 6FG

NOTE:

A. If after following the procedures set out in this Policy, your complaint has not been resolved to your satisfaction, and you are an eligible complainant you have the right to refer the matter to the Financial Ombudsman, at the following address:-

Financial Ombudsman Service
South Quay Plaza
183 Marsh Wall
London E14
9SR

Email: enquiries@financial-ombudsman.org.uk

The Financial Conduct Authority definition of an eligible complainant is:

- A consumer;
- A micro-enterprise which has a group turnover of less than £1 million;
- A charity with an annual income of less than £1 million;
- A trustee of a trust with a net asset value of less than £1 million.

B. The **Underwriter** and the **Scheme Administrator** are covered by the Financial Services Compensation Scheme. As a **Policyholder** you may be entitled to compensation from the Financial Services Compensation Scheme if the **Underwriter** and/or **Scheme Administrator** are unable to meet their obligations.

Further information about compensation scheme arrangements is available from the Financial Services Compensation Scheme. Their address is:

Financial Services Compensation Scheme
7th Floor Lloyds Chambers
Portsoken Street
London E1 8BN

Basement indemnity guarantee

DATA PROTECTION

The data supplied by you in connection with this Policy may be used for the purposes of insurance administration and handling any claim.

It may be disclosed to regulatory bodies for the purpose of monitoring and/or enforcing compliance with any regulatory rules/codes. Your information may also be used for crime p-prevention. For any of these purposes, your information may be transferred to countries that do not have stringent data protection laws. If this is necessary, the Data Controller will seek assurance from that party as to the security surrounding the handling of your information before it proceeds.

On payment of the appropriate fee, you have the right to access and if necessary rectify information held about you (this is a Subject Access Request).

If you wish to make a Subject Access Request, you should contact:

MD Insurance Services Ltd
2 Shore Lines Building
Shore Road
Birkenhead
WirralCH41
1AU

Telephone: 0151 650 4300
Fax: 0151 650 4344

In assessing any claims made we or our associated companies or agents may undertake checks against publicly available information (such as electoral roll, county court judgements, bankruptcy or repossessions). Information may also be shared with other insurers either directly or via those acting for us (such as loss adjusters or claims investigators).

When your insurance ends all information held about you (including information held on systems) will be destroyed or erased after a period of 7 years. The Data Controller's associated companies and agents will be advised to do the same.

Personal Data held on customers may be used for research and statistical purposes but only with the explicit consent of the customer would this take place.

YOUR RIGhT TO CANCEL

You have the right to cancel cover under the **Basement Insurance Guarantee**. If you wish to cancel the cover you must do so within 14 days starting on the day after you receive the **Basement Insurance Guarantee** policy documents. Your cancellation must reach the **Scheme Administrator** by letter or email along with the Certificate of Insurance, which must be returned. Contact details are:

Scheme Administrator
MD Insurance Services Ltd.
2 Shore Lines Building
Shore Road
Birkenhead
WirralCH41
1AU

Email: info@mdinsurance.co.uk

Please quote your **Basement Insurance Guarantee** policy number when cancelling. If you choose to cancel the premium will be returned. Any return of premium will only be made to the party that has paid the premium.

The **Scheme Administrator** reserves the right to charge an administration fee.

All **Basement Insurance Guarantee** policy documents should be returned to the **Scheme Administrator** with the cancellation request.

Basement indemnity guarantee

2. DEFINITIONS

1. BASEMENT WORKS

The works carried out at the **Premises** under a contract or agreement between the **Contractor** and the **Policyholder** or any other party who has entered into an agreement or contract for the **Basement Works** and who is named in the **Certificate of Insurance.**

2. BASEMENT INSURANCE GUARANTEE

The policy containing the insurance cover provided by the **Underwriter.**

3. CERTIFICATE OF INSURANCE

The Certificate issued by the **Scheme Administrator** on behalf of the **Underwriter** to signify acceptance of the **Basement Works** for insurance hereunder.

4. CONTRACTOR

Any member of ASUC Plus with whom the **Policyholder** or any other party has entered into an agreement or contract for the **Basement Works** and who is named in the **Certificate of Insurance.**

5. DAMAGE

Any defect in the design, specification, workmanship, materials or components of the **Basement Works** affecting or causing physical loss, destruction or damage and/or affecting or causing imminent instability to a **Premises** which is first discovered during the **Period of Insurance.**

6. EXTERNAL ENVELOPE

External Envelope shall mean the reasonable costs incurred in repairing, replacing or rectifying any part of the **Premises** below ground floor slab level as a result of ingress of water caused by a defect in the design, specification, workmanship, materials or components of the waterproofing elements of the **Basement Works**.

7. LIMIT OF INDEMNITY

The liability of the **Underwriter** shall not exceed during the **Period of Insurance** the amount shown as the **Limit of Indemnity** on the **Certificate of Insurance**. The **Limit of Indemnity** is index linked in accordance with Condition 5 of the Policy.

8. MINIMUM CLAIM VALUE

The amount relating to each and every loss in respect of the **Premises** below which the **Underwriter** has no liability under this Policy. If the loss is greater than the **Minimum Claim Value** the **Underwriter** will be responsible for the full amount of the **Policyholder's** claim covered by this Policy.

A separate **Minimum Claim Value** shall apply to each separately identifiable cause of loss or damage for which a claim is made under the Policy.

9. PERIOD OF INSURANCE

The period as detailed in the **Certificate of Insurance.**

10. POLICYhOLDER

The owner or any other party having a financial interest in the **Premises** which is the subject of this insurance or their successor in title and whose interest has been noted under the Policy.

11. PREMISES

The property described in the **Certificate of Insurance** including the structure, all non-load bearing elements and fixtures and fittings for which the **Policyholder** is responsible. **Premises** shall be deemed to include the **Basement Works** which are the subject of this Policy.

12. SChEME ADMINISTRATOR

MD Insurance Services Ltd
2 Shore Lines Building
Shore Road
Birkenhead
WirralCH41
1AU

13. UNDERWRITER

AmTrust Europe Limited
Market Square House
St James's Street
Nottingham
NG1 6FG

BIG Policy Document 31-001-2.00-050315 **Page 4 of 9**

Basement indemnity guarantee

3. INSURING AGREEMENT

The **Underwriter** will indemnify the **Policyholder** against all claims discovered and notified to the **Underwriter** during the **Period of Insurance** in respect of:

3.1 the cost of complete or partial rebuilding or rectifying work to the **Basement Works** which has been affected by **Damage**.

3.2 The reasonable costs incurred in repairing, replacing or rectifying any part of the External **Envelope** within the Premises as a result of ingress of water caused by a defect in the design, specification, workmanship, materials or components of the waterproofing elements of the Basement Works of the **Premises.**

A Time Deductible of 12 months commencing from the date specified in the **Certificate of Insurance** as the commencement of the **Period of Insurance** shall apply in respect of all claims made under Section 3.2 above.

Provided always that the liability of the **Underwriter** does not exceed the reasonable cost of rebuilding the **Basement Works** to its original specification.

The **Minimum Claim Value** shall be as specified in the **Certificate of Insurance.**

In the event of a claim under this Policy the **Underwriter** has the option either of paying the cost of putting right any **Damage** or itself arranging to have such **Damage** corrected.

4. ADDITIONAL EXTENSIONS

In addition, in the event of a claim, the **Underwriter** will with its consent pay within the **Limit of Indemnity:**

A. ADDITIONAL COSTS

Such additional costs and expenses as are necessarily incurred by the **Policyholder** in repairing, replacing or rectifying any part of the **Premises** other than the **Basement Works** which has been affected by **Damage** provided always that the liability of the **Underwriter** does not exceed 25% of the **Limit of Indemnity** for the **Basement Works** as stated in the **Certificate of Insurance.**

B. ALTERNATIVE ACCOMMODATION COSTS

All reasonable additional costs and expenses that are necessarily incurred by the **Policyholder** for a period not exceeding 26 weeks in respect of removal, storage and alternative accommodation whilst the **Premises** are uninhabitable.

C. FEES

Such Architects', Surveyors', Legal, Consulting Engineers' and other fees as are necessarily and reasonably incurred in relation to the complete or partial rebuilding or rectifying work to the **Premises** which has been subject to **Damage**, but shall not include costs or fees incurred by the **Policyholder** in preparing a claim.

D. REMOVAL OF DEBRIS

For each **Premises** the costs and expenses necessarily incurred by the **Policyholder** in respect of:

a) removal of debris
b) dismantling or demolishing
c) shoring up

the **Premises.**

The liability of the **Underwriter** during the **Period of Insurance** for any one claim in respect of Extensions **B, C** and **D** shall not exceed £10,000 indexed as per the provisions of Condition 5 herein.

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Basement indemnity guarantee

WARRANTY

It is hereby warranted that the **Policyholder** shall comply with all recommendations stipulated by the Structural Engineer appointed in respect of the **Basement Works**, in so far as such recommendations are applicable to the maintenance and or removal of trees at the **Premises** or adjoining properties.

The compliance by the **Policyholder** of such recommendations shall be deemed to be a Condition Precedent to this Policy.

5. EXCLUSIONS

The Underwriter shall not be liable to the Policyholder for any:

1. ALTERATIONS

Loss or damage to the **Basement Works** due to or arising from any alteration, modification or addition to the **Premises** after the issue of the **Certificate of Insurance** unless the **Underwriter** has been informed, the **Certificate of Insurance** endorsed, and any applicable additional premium paid to the **Underwriter**.

2. ChANGE IN COLOUR

Any change in colour, texture, opacity or staining or other ageing process to any element of the **Basement Works.**

3 DEFECT IN EXISTING WORKS

Loss or damage due to or arising out of any defect in the design, workmanship, materials or components of the **Premises** which do not form part of the **Basement Works**.

4 hUMIDITY

Loss or damage caused by or consequent upon humidity in the **Premises** that is not the direct result of the ingress of water caused by a defect in the design, workmanship, materials or components of the waterproofing elements of the **Basement Works.**

5. INDIRECT COSTS

We will not pay for any losses that are indirectly caused by the incident that caused you to claim, unless expressly stated in this policy

6. MAINTENANCE AND USE

Inadequate maintenance of **Basement Works** or the imposition of any load greater than that for which the **Basement Works** were designed or the use of the **Premises** for any purpose other than that for which it was designed.

7. PERSONAL INJURY

Any costs, losses, expenses or damages for death, bodily injury, disease, illness or injury to mental health.

Basement indemnity guarantee

8. PRIOR KNOWLEDGE

Anything which would constitute a valid claim under the Policy and about which the **Policyholder** was aware prior to purchasing the **Premises** and as a consequence agreed a reduction in the purchase price for the **Premises** or other contractual remedy.

9. PROPERTY NOT INSURED

Loss or damage to temporary structures, free-standing household appliances, floors, tiles, carpets or other floor coverings and all other contents other than as provided for within Extension A of the Insuring Agreement.

10. RADIOACTIVE CONTAMINATION, ChEMICAL, BIOLOGICAL, BIO-ChEMICAL AND ELECTROMAGNETIC WEAPONS

In no case shall this insurance cover loss damage liability or expense directly or indirectly caused by or contributed to by or arising from

i) ionising radiations from or contamination by radioactivity from any nuclear fuel or from any nuclear waste or from the combustion of nuclear fuel.

ii) the radioactive, toxic, explosive or other hazardous or contaminating properties of any nuclear installation, reactor or other nuclear assembly or nuclear component thereof.

iii) any weapon or device employing atomic or nuclear fission and/or fusion or other like reaction or radioactive force or matter.

iv) the radioactive, toxic, explosive or other hazardous or contaminating properties of any radioactive matter. The exclusion in this sub-clause does not extend to radioactive isotopes, other than nuclear fuel, when such isotopes are being prepared, carried, stored, or used for commercial, agricultural, medical, scientific or other similar peaceful purposes.

v) any chemical, biological, bio-chemical, or electromagnetic weapon.

11. REASONABLENESS

In the event of a valid claim under the Policy the **Underwriter** shall only be responsible for costs and expenses that a reasonable person would incur if spending their own money. Whenever possible if items can be found to match existing items at a reasonable cost the **Underwriter** will endeavour to facilitate this. However the **Underwriter** will have no liability and will not be responsible for any additional costs if a similar match is not possible at a reasonable cost.

12. SEEPAGE

Loss or damage caused by seepage of water into the **Premises** below ground floor slab level.

This exclusion only applies in the event Section 3.2 is not taken out. If Section 3.2 is applicable, this exclusion does not apply

13. SETTLEMENT

Loss or damage caused by or consequent upon normal settlement or bedding down of the **Basement Works.**

14. SONIC BANGS

Loss or damage directly occasioned by pressure waves caused by aircraft or other aerial devices travelling at sonic or supersonic speeds.

15. SPECIAL PERILS

Loss or damage caused by or consequent upon fire, lightning, explosion, typhoon, hurricane, cyclone, volcanic eruption, earthquake, storm, tempest, flood, subterranean fire or other convulsion of nature, aircraft or other aerial devices or articles therefrom, escapes of water from tanks, apparatus or pipes, malicious persons, theft, attempted theft, impact or any accidental cause.

16. SUBSIDENCE

Loss or damage caused by or consequent upon subsidence, heave or landslip unless such loss or damage is as a result of a defect in the design, workmanship, materials or components of the **Basement Works**.

Basement indemnity guarantee

17. TOXIC MOULD

Loss, damage or bodily injury arising out of any pathogenic organisms regardless of any other cause or event that contributed concurrently or in any sequence to that liability.

Pathogenic organisms means any bacteria, yeasts, mildew, viruses, fungi, mould or their spores, mycotoxins or other metabolic products.

18. TREES

Loss or damage due to or arising from trees planted after the completion of the **Basement Works** that cause damage to the **Premises** during the **Period of Insurance**.

19. VERMIN

Loss or damage caused by or consequent upon the actions of rodents, vermin or insect infestation.

20. WAR RISKS

Notwithstanding anything to the contrary contained herein this Policy does not cover Loss or Damage directly or indirectly occasioned by, happening through or in consequence of war, invasion, acts of foreign enemies, hostilities (whether war be declared or not), civil war, rebellion, revolution, insurrection, military or usurped power or confiscation or nationalisation or requisition or destruction of or damage to property by or under the order of any government or public or local authority.

21. WATER TABLE

Loss or damage resulting solely from a change in the water table level. This exclusion shall not however apply to any seasonal change in the water table level.

This exclusion only applies in the event Section 3.2 is not taken out. If Section 3.2 is applicable, this exclusion does not apply

22. WEAR AND TEAR

a) wear and tear;
b) normal dampness, condensation or shrinkage;
c) normal deterioration whether caused by neglect or otherwise.

23. WILFUL ACTS

Any wilful neglect or criminal act of the **Policyholder** or any other party.

6. CONDITIONS

1. ARBITRATION

If any difference shall arise as to the amount to be paid under this Policy (liability being otherwise admitted) such difference shall be referred to an arbitrator to be appointed by the parties in accordance with the statutory provisions then in force. Any making of an award shall be a condition precedent to any right of action against the **Underwriter**.

2. AUTOMATIC REINSTATEMENT OF ThE LIMIT OF INDEMNITY

In consideration of the **Limit of Indemnity** not being reduced by the amount of any loss, the **Policyholder** agrees to pay if required by the **Underwriter** the pro-rata additional premium on the amount of such loss from the date of notification of claim to the date of expiry of the **Period of Insurance.**

3. CONTRIBUTION

If at any time of any occurrence giving rise to a claim under this Policy:

i) there is, or would but for the existence of this insurance, be any other insurance applicable, or;

ii) the **Policyholder** has entitlement to any statutory damages or compensation;

this Policy shall be limited to any amount in excess of such insurance, damages or compensation and shall not be called into contribution.

4. FRAUD

If any claim under this Policy shall be in any respect fraudulent, or if any fraudulent means or devices are used by the **Policyholder**, or anyone acting on its behalf, to obtain benefit under this insurance, all benefit hereunder shall be forfeited.

5. INDEXATION

The **Limit of Indemnity** and **Minimum Claim Value** referred to within the **Certificate of Insurance** will be increased by 5% per annum compound on each anniversary of the commencement of the **Period of Insurance.** For the purpose of settlement of any claim hereunder the **Limit of Indemnity**, as adjusted in accordance with the foregoing provisions, shall be regarded as the **Limit of Indemnity** at the time of discovery by the **Policyholder** of such claim.

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6. UNDERWRITER'S RIGhTS

In the event of any occurrence which may give rise to a claim under this Policy, the **Underwriter** and its agentsshall, with the permission of the **Policyholder,** be entitled toenter the **Premises** in order to carry out rectification worksor the complete or partial rebuilding of the property. If such permission is unreasonably withheld the **Policyholder** shall be responsible for any additional costs caused by the delay in carrying out such works.

7. MISREPRESENTATION

This Policy will be voidable from inception in the event of misrepresentation, misdescription, error, omission or non-disclosure by the **Policyholder** with intention to defraud.

8. RECOVERIES FROM ThIRD PARTIES

The **Underwriter** is entitled to and the **Policyholder** gives consent to the **Underwriter** to control and settle any claim and to take proceedings at its own expense in the name of the **Policyholder** to secure compensation from any third party in respect of any loss or damage covered by this Policy.

9. ThIRD PARTY RIGhTS

A person who is not a party to this Policy has no right under the Contracts (Rights of Third Parties) Act 1999 to enforce any term of this Policy but this does not affect any right or remedy of a third party which exists or is available apart from the Act.

For the purpose of this Condition any third party shall not be deemed to include the **Contractor** who is named in the **Certificate of Insurance.**

7. CLAIMS NOTIFICATION PROCEDURES

NOTIFICATION OF A CLAIM

On discovery of any occurrence or circumstance that is likely to give rise to a claim under the Policy the **Policyholder** shall as soon as reasonably possible:

i) give written notice to the **Scheme Administrator;**

ii) take all responsible steps to prevent further loss or damage;

iii) submit in writing full details of the claim and supply all correspondence, reports, plans, certificates, specifications, quantities, information and assistance as may be required MD Insurance Services Limited

24 GLOSSARY OF TERMS

Banksman	A trained operative who oversees the loading, unloading and movement of materials, plant and construction items safely on and around site.
Bearing capacity	The measure of the capability of a soil to support a foundation load.
Bulb of influence	The theoretical shape and size of the ground pressure bulb exerted by the foundations of a building or structure
Chemical grouting	A process of injecting the ground with a non-cementitious product such as polyurethane resin, acrylic resin or sodium silicate solution.
Clay heave	The increase in the volume of a clay soil as a result of the increase in moisture content and or reduction in confining pressure.
Clay shrinkage	The reduction in volume of a clay soil as a result of the lowering its moisture content.
Cohesive soils	Soils with an inherent unconfined strength and the ability to remain self-supporting in the short term when excavated or bored into eg. clays.
Cold bridging	This is the potential effect created by an object or product which can conduct cold external temperatures through to internal space
Contiguous piling	Bored piles constructed in-line, with the pile spacing slightly greater than the pile diameter.
Drained cavity protection	An inner cavity lining for an underground structure which prevents moisture from the surrounding ground reaching the internal space, collecting it and pumping it away.
Dry pack	A strong sharp sand and cement mixture with low water content used for connecting the original footing of a wall with the underpinning concrete below.
Façade retention	The process of temporarily supporting the façade of a building whilst the remainder of the structure is renewed.
Ground relaxation	This is the effect on the soil of the reduction in confining pressure as a result of excavation.
Hand Arm Vibration (HAV)	This is the potentially harmful effect on fingers, hands and arms of using vibrating tools such as percussive drills and breakers.
Hydrophilic	A substance which has an affinity for water, will absorb it, or dissolve in it.
Hydrophobic	A substance which repels and tends not to absorb or dissolve in water.

Hydrostatic Pressure	The pressure exerted on a structure by groundwater
Mansard	A type of near-vertical walled roof structure on a building which forms the top storey.
Non cohesive soil	Soils with no inherent unconfined strength eg. sands and gravels.
Retro fit	In this case a basement constructed beneath an existing building.
Risk Assessment (RA)	A methodical process of defining the risk associated with carrying out a task.
Secant piling	A process which installs bored piles in a continuous line, where the pile spacing is slightly less than the diameter.
Soil stabilisation	The process of introducing a suitable product into the soil to increase the strength or load carrying capacity of the ground.
Superstructure	The part of a building or structure above the foundations.
Surcharge	An external load exerted on an underground structure from outside the footprint of the building.
Underpinning	The construction process used to increase the depth of footing beneath an existing structure.

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All HSE publications can be downloaded from www.hse.gov.uk

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