

# Chapter 4.4

## Strip and trench fill foundations

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# 4.4 Strip and trench fill foundations

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## SCOPE

This Chapter gives guidance on meeting the Technical Requirements and recommendations for strip and trench fill foundations.

## DESIGN STANDARDS

### 4.4 - D1 Design shall meet the Technical Requirements

Design that follows the guidance below will be acceptable for both strip foundations and trench fill foundations.

## STATUTORY REQUIREMENTS

### 4.4 - D2 Design shall comply with all relevant statutory requirements

Design should be in accordance with relevant Building Regulations and other statutory requirements.

## REQUIREMENT FOR FOUNDATIONS

### 4.4 - D3 All loadbearing elements shall be adequately supported by foundations

Elements requiring foundations include the following:

- external walls
- separating (party) walls
- chimney breasts
- piers
- internal loadbearing walls.

### SLEEPER WALLS

In Scotland, a sleeper wall is also defined as a loadbearing element and must be provided with a suitable foundation.

In England, Wales, Northern Ireland and the Isle of Man, sleeper walls should not be built off oversite concrete:

- on shrinkable clay soils where heave could take place
- where infill below the oversite concrete is greater than 600mm
- which is less than 100mm thick.

In these situations, suitable foundations will be required.

## SAFE TRANSMISSION OF LOADS

### 4.4 - D4 Foundations shall be designed to transmit loads to the ground safely and without excessive settlement

Items to be taken into account include:

#### (a) dead and imposed loads

Dead and imposed loads should be calculated in accordance with BS EN 1991-1-1, BS EN 1991-1-3, BS EN 1991-1-4 and BS 648.

Appendix 4.4-A shows suitable foundation dimensions and gives minimum widths of strip foundations for different sub-soil and wall loadings. Strip foundations should be 150mm to 500mm thick. Trench fill foundations should be greater than 500mm thick.

### (b) stability of the dwelling and any associated constructions

Where appropriate, reference should be made to BS 8103.

Unless there are reasons for doing otherwise, foundations should be symmetrical beneath loadbearing elements.

Strip and trench fill foundations should be continuous throughout the building, including integral garages, porches, conservatories, bay windows, etc. The foundations should be of sufficient width throughout to avoid overstressing the ground, especially where the foundation is required to support piers or columns.

Reference should be made to Chapter 4.2 'Building near trees' where:

- soil is shrinkable
- trees have been, or are being, removed since heave is possible in these situations special precautions are necessary.

The width of the foundation will depend on the loadbearing capacity of the sub-soil and the loads from the building. However, the foundation width should not be less than the wall thickness, plus at least 50mm each side, to ensure that the foundation is not oversailed by any part of the wall.

### (c) stability of any adjoining dwelling or construction

Foundations adjoining those of an existing building may require special design. If taken to a greater depth, such foundations will usually need to be Engineer designed and carefully supervised to check the standard of workmanship. Where necessary, allowance should be made in the design for differential movement.

## DESIGN BY AN ENGINEER

### 4.4 - D5 Foundations on hazardous ground shall be designed by an Engineer

Details of hazardous ground to be taken into consideration are given in Chapters: 4.1 'Land quality - managing ground conditions', and 4.2 'Building near trees'.

Foundations should be designed by an Engineer in accordance with Technical Requirement R5 where:

- buildings exceed 3 storeys in height
- retaining walls are required for habitable rooms below ground.

### 4.4 - D6 Where foundations are on hazardous ground, notice shall be given to NHBC before work starts on site

Where hazardous ground has been identified, NHBC must be notified before

work starts. Hazardous ground is defined in Chapter 4.1 'Land quality - managing ground conditions'.

NHBC Rules state:

"If a Home is to be constructed on a Hazardous Site you must before making an Application for Inspection notify the NHBC in writing of the particular hazards which arise. You must do this at least 8 weeks before work begins on the site."

## SITE CONDITIONS

### 4.4 - D7 Foundation design shall take account of site conditions

Items to be taken into account include:

#### (a) the results of site appraisal

All relevant information about the nature and loadbearing capacity of the ground should be available before the foundations are designed.

Information about ground conditions and the past history of the site may be available from a number of sources. These include NHBC, Local Authorities and the area offices of the Gas, Water and Electricity Companies. Aerial photographs, Ordnance Survey maps and geological maps and surveys may often be studied at local Public Libraries and Record Offices.

Site assessment surveys may require supplementary site investigations involving trial pits and borings. Details are given in Chapter 4.1 'Land quality - managing ground conditions'.

#### (b) dwelling design and layout

Foundation design is governed by the shape and size of the dwellings as well as the site conditions. Foundations for terraced dwellings may require special precautions to prevent damage from differential settlement.

#### (c) site levels

Stepped foundations or suspended floors may be needed for sloping sites. Reference should be made to Clause D9 for stepped foundations and to Chapter 5.2 'Suspended ground floors' (Design).

## FOUNDATION DEPTH

### 4.4 - D8 Foundation depth shall be adequate for the site conditions

Items to be taken into account include:

#### (a) soils with volume change potential

In shrinkable soils that are classified as containing more than 35% fine particles (clay and silt), and have a modified Plasticity Index of 10% or greater, the minimum foundation depth should be as in the following table:

# 4.4 Strip and trench fill foundations

Modified Plasticity Index	Volume change potential	Minimum depth (m)
40% and greater	High	1.0
20% to less than 40%	Medium	0.9
10% to less than 20%	Low	0.75

## (b) frost susceptible soils

To avoid damage from frost action, the depth to the underside of the foundation in frost susceptible ground, eg chalk, should be at least 450mm below finished ground level.

This depth should also be used when construction is undertaken during cold weather. Alternatively, precautions should be taken to prevent freezing of the ground.

## (c) suitable bearing strata

The depth of foundations should be such as to give a clean, firm and adequate bearing for the design loads.

Trench fill foundations greater than 2.5m in depth must be designed by an Engineer in accordance with Technical Requirement R5.

## STEPPED FOUNDATIONS

### 4.4 - D9 Foundations shall be taken to a suitable bearing level when building on sloping ground

Sloping ground may require stepped foundations.

Where foundations are stepped, the height of the step should not exceed the thickness of the foundation, unless it forms part of a foundation designed by an Engineer in accordance with Technical Requirement R5.

For details of stepped foundations, reference should be made to Sitework Clause 4.4 - S13(b).

## SERVICES AND DRAINAGE

### 4.4 - D10 Foundation design shall make allowance for drainage and other services

Items to be taken into account include:

#### (a) ground water drainage

Provision should be made for adjusting any existing ground water drains affected by excavation work.

#### (b) existing services

Precautions should be taken to accommodate the effects of settlement, where drains run under or near a building.

#### (c) access for services

Where services are to pass through or under foundations, provision should be made for suitable ducts or lintels to enable them to be installed later.

Reference should be made to Chapters 8.1 'Internal services' (Design and Sitework) and 5.3 'Drainage below ground' (Design and Sitework) for further details.

## MOVEMENT JOINTS

### 4.4 - D11 Movement joints shall be suitable for their intended purpose

Where movement joints are specified in foundations, they should be continuous with those in the superstructure.

## PROVISION OF INFORMATION

### 4.4 - D12 Drawings and specifications shall be produced in a clearly understandable format

It is important that all relevant information needed for the completion of the sitework is stated clearly and unambiguously and is readily available to all concerned.

All necessary dimensions and levels should be indicated and related to:

- at least one benchmark, and
- reference points on site.

All necessary details of junctions, steps, movement joints and, where necessary, any critical sequences of construction should be provided.

### 4.4 - D13 Designs and specifications, together with relevant site information, shall be distributed to appropriate personnel

Both designers and site operatives need to be aware of the ground conditions and, in particular, any features requiring special attention, such as any existing sewers or other services, levels of water table and the presence of any deleterious substances, especially sulfates.

Information on ground conditions, the results of site investigation and the foundation design can be requested by NHBC, even for those sites which are not classified as hazardous.

Where toxic materials (or materials likely to present a health hazard) are found, all available information should be supplied to NHBC, together with proposals for dealing with the hazard.

## MATERIALS STANDARDS

### 4.4 - M1 All materials shall: (a) meet the Technical Requirements (b) take account of the design

Materials that comply with the design and the guidance below will be acceptable for both strip foundations and trench fill foundations.

Materials for strip and trench fill foundations should comply with all relevant standards, including those listed below. Where no standard exists, Technical Requirement R3 applies (see Chapter 1.1 'Introduction to the Standards and Technical Requirements').

References to British Standards and Codes of Practice include those made under the Construction Products Directive (89/106/EEC) and, in particular, appropriate European Technical Specifications approved by a European Committee for Standardisation (CEN).

## CONCRETE

### 4.4 - M2 Concrete shall be of a mix design which is suitable for the intended use

Items to be taken into account include:

- (a) strength to safely transmit loads
- (b) durability against chemical or frost action

For guidance on the specification and use of concrete, particularly in relation to the choice of mix to resist deterioration due to ground aggressivity, reference should be made to Chapter 2.1 'Concrete and its reinforcement' (each section).

## REINFORCEMENT

### 4.4 - M3 Reinforcement shall be sufficient to ensure proper transfer of loads

Where reinforcement may be necessary, for example at construction joints or over small localised soft spots or changes in bearing strata, it should be in accordance with Chapter 2.1 'Concrete and its reinforcement' (each section).

## OTHER MATERIALS

### 4.4 - M4 Compressible materials shall be capable of absorbing potential heave forces, where appropriate

Proprietary materials should have been assessed in accordance with Technical Requirement R3.

## SITWORK STANDARDS

### 4.4 - S1 All sitework shall: (a) meet the Technical Requirements (b) take account of the design (c) follow established good practice and workmanship

Sitework that complies with the design and the guidance below will be acceptable for both strip foundations and trench fill foundations.

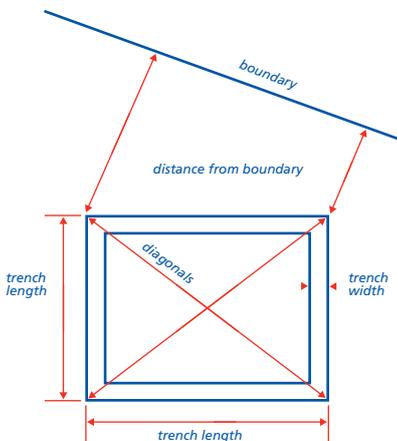
### SETTING OUT FOUNDATIONS

#### 4.4 - S2 The setting out of foundations shall take account of the design details

The accuracy of setting out should be checked by control measurements of trenches, including their location relative to site boundaries and adjacent buildings. Levels should be checked against bench marks, where appropriate.

In particular, for excavations check:

- trench lengths
- trench widths
- length of diagonals between external corners.



Walls should be located centrally on the foundation, unless specifically designed otherwise.

Any discrepancy in dimensions should be reported promptly to the designer. Resulting variations should be distributed to all concerned with sitework, including NHBC, where appropriate.

### EXCAVATIONS

#### 4.4 - S3 Excavations for foundations shall take account of design dimensions

Excess excavation should be avoided. Inaccuracy may prevent walls and piers being located centrally and therefore result in eccentric loading of foundations and possible foundation failure.

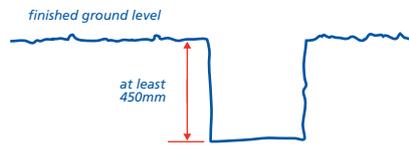
Accurate trench digging is particularly important where the width of the foundation is only slightly wider than the wall to be supported.

Any ground condition that might cause the foundation design to be modified should be reported promptly to the designer.

#### 4.4 - S4 Excavation shall be to a depth that gives adequate bearing and protection from frost damage

To avoid damage from frost action, the depth of foundation in frost susceptible

ground should be at least 450mm below ground level. If finished ground level is to be above existing ground level then, in cold conditions when freezing is expected, the foundation depth should be taken from the existing, not finished, ground level.



#### 4.4 - S5 Excavation in shrinkable soil shall take account of the foundation design

The design should specify the minimum foundation depth. In shrinkable soils, the minimum foundation depth should be as in the following table:

Volume change potential	Minimum depth (m)
High	1.0
Medium	0.9
Low	0.75

These minimum depths may only be used where any existing or proposed trees or shrubs are outside the zone of tree influence (See Chapter 4.2 'Building near trees' (Design)).

#### 4.4 - S6 Excavations shall take account of localised effects

Where localised changes in strata give rise to differences in bearing capacity, special precautions will be necessary and reference should be made to the designer.

At soft spots, excavations should be deepened locally to a sound bottom or, alternatively, the concrete should be reinforced.

Hard spots should be removed.

Where roots are visible on the sides or bottoms of trenches (especially in clay soils), excavations may need to be taken deeper, or special precautions determined by an Engineer in accordance with Technical Requirement R5.

On sites where there are or have been trees, foundations constructed in accordance with the guidance given in Chapter 4.2 'Building near trees' will be acceptable to NHBC.

#### 4.4 - S7 The shape of the trench shall not impair the performance of the foundation

Unless otherwise designed by an Engineer in accordance with Technical Requirement R5, trench bottoms should be horizontal with all loose material removed. Trench sides and steps should be, as near as possible, vertical.



#### 4.4 - S8 Trench bottoms, when prepared for concreting, shall be compact, reasonably dry and even

If any part of a trench bottom is affected by rainwater, ground water or drying, it should be re-bottomed.

Trenches should be kept free of water.

### SERVICES AND DRAINAGE

#### 4.4 - S9 Existing services shall be adequately protected

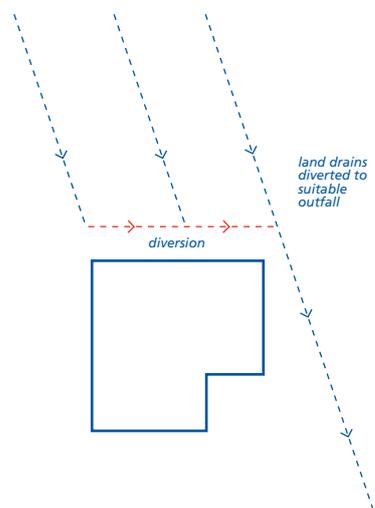
Any existing services, such as cables, water pipes or gas mains, may need to be supported and protected.

Drains which are redundant should be cut open and filled or removed.

Any existing drains should be diverted or adequately protected.

Services should not be rigidly encased in the foundations.

Ground water drains should be diverted.



#### 4.4 - S10 Provision shall be made for service entries or services to safely pass through, or above, foundations

For details of underground drains and services, reference should be made to Chapters 8.1 'Internal services' (Design and Sitework) and 5.3 'Drainage below ground' (Design and Sitework). Reference should also be made to Chapter 5.1 'Substructure and ground bearing floors' (Design and Sitework).

#### STRIP FOUNDATIONS

Services should not pass through strip foundations but through the masonry above. Adequate lintels should be provided

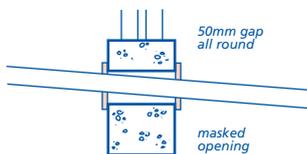
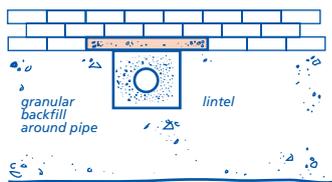
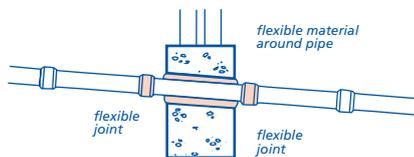
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in the masonry. Reference should be made to Chapter 5.1 'Substructure and ground bearing floors' (Design and Sitework).

## TRENCH FILL FOUNDATIONS

Where services pass through trench fill foundations, they should not affect the ability of the foundations to carry loads. Services should be either sleeved or passed through a suitably strengthened opening in the foundation. This is to ensure that differential movement will not damage services.

In the case of drains, it is important to leave sufficient space for movement to ensure that the drain is capable of maintaining line and gradient.



## GENERAL CONSTRUCTION

### 4.4 - S11 Concrete shall be correctly mixed, placed and cured

Concreting should be carried out, as far as possible, in one operation, taking account of weather conditions and available daylight. Concrete should be placed as soon as possible after the excavation has been checked.

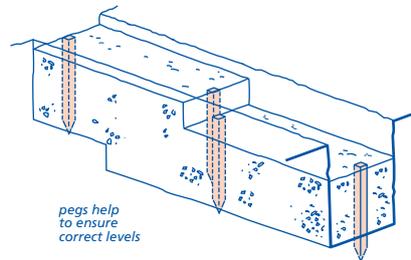
Mixing, placing, testing and curing of concrete should be carried out as indicated in Chapter 2.1 'Concrete and its reinforcement' (each section), and for work carried out in cold weather, Chapter 1.4 'Cold weather working'.

The foundation thickness should be:

- 150mm to 500mm - for strip foundation
- not less than 500mm - for trench fill foundations.

Where trench fill foundations are in excess of 2.5m depth, they must be designed by an Engineer in accordance with Technical Requirement R5.

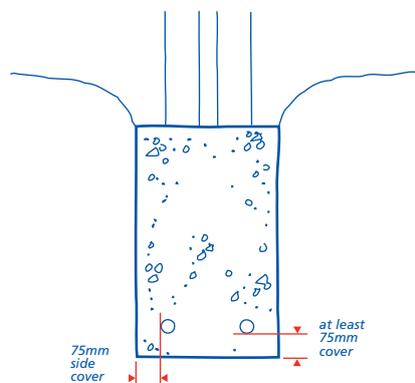
For trench fill, it is particularly important to check that the finished foundation level is correct and horizontal. It will be difficult to adjust for discrepancies in the small number of brick courses (possibly only 6) between foundation and dpc level.



### 4.4 - S12 Strip and trench fill foundations shall be reinforced, where necessary, to suit localised ground conditions

Reinforcement, if needed, should be clean and free from loose rust and should be placed correctly. Bars, of an appropriate size, should be properly supported to ensure that they are 75mm above the base of the foundation or as indicated in the design. They should be secured at laps and crossings.

If in doubt about any soft spots, the designer's advice should be taken before placing the concrete.



## STRIP AND TRENCH FILL FOUNDATIONS

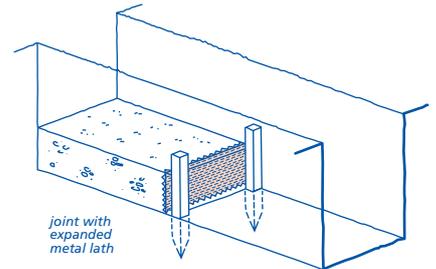
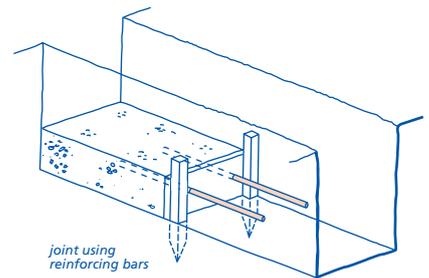
### 4.4 - S13 Strip and trench fill foundations shall be constructed to take account of the foundation design

Items to be taken into account include:

#### (a) construction joints

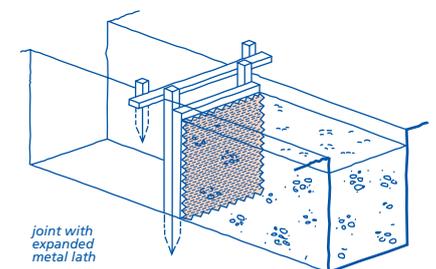
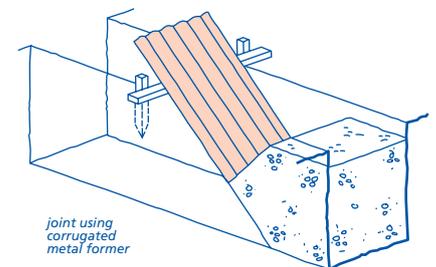
#### STRIP FOUNDATIONS

If construction joints are unavoidable, they should not be positioned near a return in the foundation. All shuttering should be removed before work continues beyond the construction joint. For strip foundations, construction joints may be formed by one of the methods shown below.



#### TRENCH FILL FOUNDATIONS

It is important that concrete mix, workability and placement are maintained throughout a trench fill foundation. However, where a joint is unavoidable, it should not be positioned near a return in the foundation. Before work continues beyond the construction joint, all shuttering should be removed. Construction joints may be formed by one of the methods shown below.



#### (b) stepping of foundations

Sloping ground may require stepped foundations.

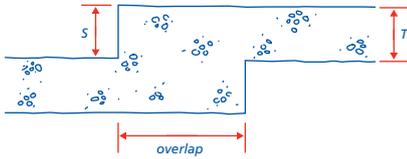
Where foundations are stepped, the height of the step should not exceed the thickness of the foundation, unless it forms part of a foundation designed by an Engineer in accordance with Technical Requirement R5.

Foundation bottoms should be horizontal and steps, as near as possible, vertical.

## STRIP FOUNDATIONS

The overlap should be not less than:

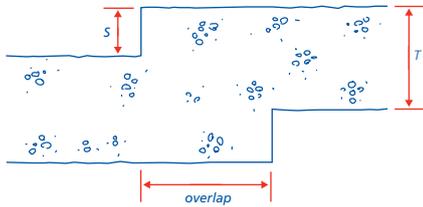
- $2 \times S$ , or
  - $T$  (maximum 500mm), or
  - 300mm,
- whichever is the largest.



## TRENCH FILL FOUNDATIONS

The overlap should be not less than:

- $2 \times S$ , or
  - one metre,
- whichever is the larger.



# 4.4 Strip and trench fill foundations

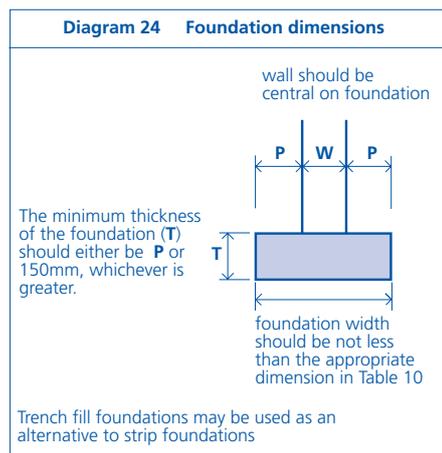
## Appendix 4.4-A

Approved Document A1/2, Section 2E, specifies the size of strip foundations using Diagram 24 and Table 10.

Also see Technical booklet D of Building Regulations (N Ireland) 1990.

Strip foundations should be:

- Located centrally under the wall
- of thickness  $P$  or 150mm (whichever is greater)
- of the width shown in Table 10.



**Table 10 Minimum width of strip footings**

Type of ground (including engineered fill)	Condition of ground	Field test applicable	Total load of load-bearing walling not more than (kN/linear metre)					
			20	30	40	50	60	70
			Minimum width of strip foundation (mm)					
I Rock	Not inferior to sandstone, limestone or firm chalk	Requires at least a pneumatic or other mechanically operated pick for excavation	In each case equal to the width of the wall					
II Gravel or Sand	Medium Dense	Requires pick for excavation. Wooden peg 50mm square in cross section hard to drive beyond 150mm	250	300	400	500	600	650
III Clay Sandy clay	Stiff Stiff	Can be indented slightly by thumb	250	300	400	500	600	650
IV Clay Sandy clay	Firm Firm	Thumb makes impression easily	300	350	450	600	750	850
V Sand Silty sand Clayey sand	Loose Loose Loose	Can be excavated with a spade. Wooden peg 50mm square in cross section can be easily driven	400	600	Note Foundations on soil types V and VI do not fall within the provisions of this section if the total load exceeds 30 kN/m.			
VI Silt Clay Sandy clay Clay or silt	Soft Soft Soft Soft	Finger pushed in up to 10mm	450	650				
VII Silt Clay Sandy clay Clay or silt	Very soft Very soft Very soft Very soft	Finger easily pushed in up to 25mm	Refer to specialist advice					

This table is applicable only within the strict terms of the criteria described within it.

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