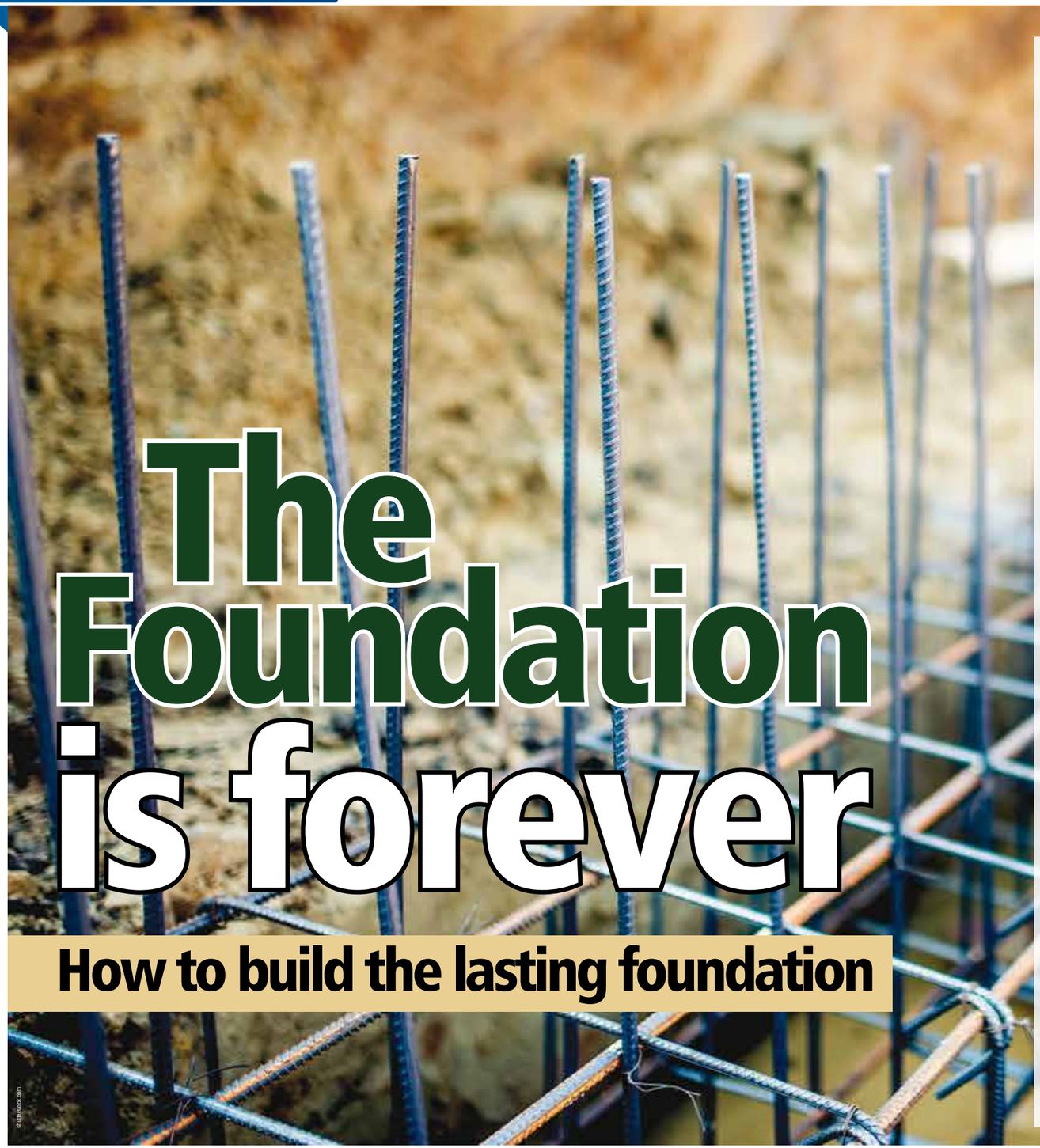
BUILDER EDUCATION

The Foundation is forever

How to build the lasting foundation



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Foundations are the supportive structures on which the whole building is built. They are the most heavily loaded structural element in the building. The data indicate that approximately 20% of building projects are delayed due to problems at the foundation stage.

Foundations should work not only as the support for the building but also as moisture insulation. What is the most important - they should last forever. That is why the proper foundation has to be adequately planned with soil conditions, water tables and quality of the backfill taken into account. It has to be also well built- the base properly compacted, the formwork set up right, the concrete free of voids. Long lasting foundations should be plum, level and free of discolorations (sign of poor quality concrete). The slab foundation should have a sturdy footing with a vapour proofed reinforced concrete pads that sits on the compacted crushed stone.

First of all we can distinguish between shallow and deep foundations. It refers to the depth of soil foundations are made. Shallow foundations can be made in depths of as little as 3ft (1m), while deep foundations can be made at depths of 60 - 200ft (20 - 65m). First are built in small buildings and on the hard and level surfaces, while deep ones are for large structures. Shallow foundations can be also called spread footings or open footings, what refers to the fact that they are made by the excavation of soil to the bottom of footing and constructing the footing. Deep foundations are used for more complex projects or when soil conditions are poor or when building a structure on a hill. Deep foundations are more than 3 feet (91.44 cm) deep and can have varying depths throughout. The type of foundation used depends on the building age and the type of ground. We will describe two main types of shallow foundations- trench, strip and raft and one type of deep foundations- pile foundation.

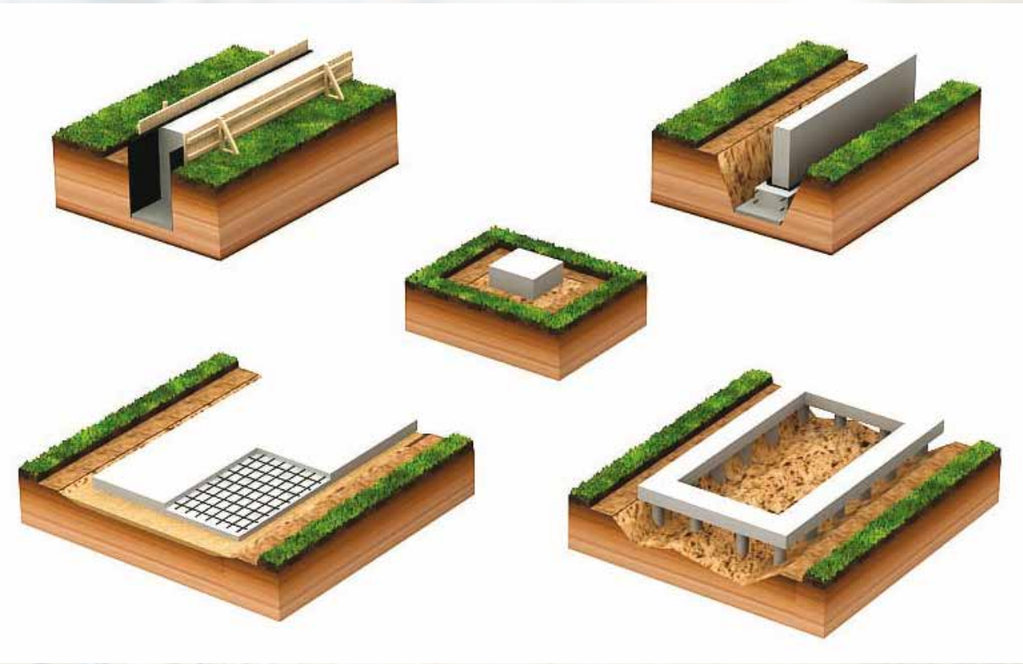
SHALLOW FOUNDATIONS

STRIP and TRENCH

Strip foundations are the most common type due to their simplicity and cost effectiveness. We can distinguish between traditional shallow strip, wide strip for higher-load structures, and deep strip- trench/fill foundations. It is the long strip that supports the weight of the entire wall. Exterior loadbearing walls sit on channels filled with concrete. Any internal loadbearing walls may also be built up from trench foundations. The depth of the foundation will depend on the geology of the underlying ground and the size of the building. Shallow and wide strip foundations are similar to trench but less concrete is poured into the channels with the wall from below the ground level. Walls may be constructed from the bricks or blocks that form the main walls or from different blocks rising to just above the ground level.

Trench foundations avoid bricklaying below the ground with the concrete poured to within 150mm of the surface ground level. Both the sides and bottom of the trench play the supportive role so can be built on the strong soils like clay or chalk soils.

Stip foundations are typically 300mm thick, with the exact thickness determined by the masonry courses of the walls up to the DPM



(damp-proof course) level. As they spread the load of the building on the larger area then the trench foundation they are often build in softer soils like sand.

STEP BY STEP

1. Foundation layout based on specification
2. Digging the foundation openings
3. Building Control inspection
4. Install the shuttering play around the opening to prepare for concrete
5. Fill up with concrete
6. Building Control inspection

Block or brick foundations

These are similar to strip foundations but build up with bricks or blocks. Not very common in the UK.

STEP BY STEP

1. Foundation layout based on specification
2. Digging the foundation openings
3. Building Control inspection
4. Fill the thin (approx. 10cm) layer of the concrete in the opening
5. Install the reinforcement box
6. Building Control inspection
7. Fill up the box with the concrete
8. Building Control inspection
9. Build up walls from engineering bricks or high dense concrete blocks

RAFT

Raft foundations are the concrete slabs, reinforced with steel which covers the entire area on which the house is based (the whole ground floor area). Well insulated, often used on soft and compressible subsoils eg. clay and peat. Raft foundations are also common when basements are to be built. The entire basement floor slab acts as a foundation with the weight of the building spread evenly over the footprint of the structure.

Beneath a ground-bearing concrete floor slab, the ground must be properly prepared. Firstly, the site should have been stripped clear of topsoil and vegetation before the foundations were dug. Hardcore should be used in a layer, at least 150mm thick, but no greater than 300mm, in selected aggregate. It's then compacted down in layers with a plate compactor. If this task is done badly or with the wrong material, settlement is to be expected, causing the slab to crack.

STEP BY STEP

1. Foundation layout based on specification
2. Digging of the hole on the entire surface
3. Building Control inspection. Check the depth of the hole
4. Fill up the hole with the hardcore
5. Compacting the hardcore
6. Cover compacted hardcore with sand, sharp sand etc.
7. Install DPM
8. Install reinforcement- one or two layers
9. Building Control inspection
10. Fill in with concrete

DEEP FOUNDATIONS

PILE

Pile foundations are capable of bearing higher loads than the spread footings and are used in cases:

- when there is a layer of weak soil and the load of the building has to be based on the stronger soil or rock deep into the ground, below the weak layer
- when building has very heavy, concentrated loads

Pile foundations are mostly pre-engineered. The walls are built on a concrete beam. This rests on the solid and loadbearing reinforced concrete, or steel beams, drilled into the ground - up to 15m below the surface. The piles might be precast and drilled into the soil or cast on site. The depth and frequency of beams depend on the type of ground and building size. Piles might be required for internal loadbearing walls too.

We can distinguish between two types of pile foundations: end bearing pile and friction pile.

In the end bearing pile the bottom of the pile rest on the intersection of the stronger soil or rock with the weaker soil layer. The bearing load of the building is transferred into the strong layer of soil. The friction pile transfers the load of the building to the soil across the full length of the pile. The amount of the load that the friction pile can support is proportionate to its length.

STEP BY STEP

1. Foundation layout based on specification
2. Machinery drills holes for piles. Every few meters there is soil test.
3. Building Control inspection, Soil and concrete test required for approval certificate.
4. Insert the steel reinforcement
5. Building Control inspection
6. Fill with special mixed concrete
7. Install the reinforcement box in the opening for foundation between each pile. Standard reinforcement box is 500x500 mm, made of reinforcement bars
8. Building Control inspection
9. Fill with concrete

The position of the walls on the foundations can be assessed and any relevant issues inspected.

Building control inspections on foundations

There is requirement to notify the building control officer at the certain stages of the groundworks to receive the approval to proceed with works.

First inspection- Commencement (statutory)

The Building Control Officer will come on site for the first time to discuss the specification and requirements for foundations. Trial pits should be ready for the inspection. Trial pits are usually 1 to 4 meters deep hole of excavated ground in order to check the soil condition and existing foundations.

Second inspection- Foundation excavation

This inspection is to ensure that the ground upon which the building is to be founded is satisfactory.

The Building Control Surveyor will consider various aspects during this inspection, including:

- The load bearing capacity of the ground
- The proximity and depth of any drain runs and manholes
- Any indication of filled ground, generally or limited areas
- The depth of existing foundation
- Proximity of trees, or trees already removed

In ground with any clay content a minimum foundation depth of 1000mm is normally required.

Third inspection - Foundation concrete

It is after the foundations openings are filled with concrete to establish how the blockwork will be built up to damp-proof course level. The position of the walls on the foundations can be assessed and any relevant issues inspected.

Why foundations fails?

ATTENTION IMPORTANT

Soil Type. Soils expand with moisture and may cause the up and down movements. Clay or organic matter absors water like a sponge, what increase the risk of foundation cracks. Expansion, shrinking or contraction of soils can disturb the foundation Curing time. Concrete must cure slowly to reach proper strength (full concrete set approx 30days, brick/block laying after 3days). Keep it damp by often watering. Insufficient compacting. If the fill material is poorly compacted, the slab will likely settle or crack.

Interrupting the concrete pour. A concrete form should be filled in one go. If you interrupt the joint may occur which is likely to crack and leak.

Errosion. If the poor drainage was done and there is the uncontrolled water flow which will take away a soil around foundation. It can cause additional underpinng works.

Trees Adjacent. Before construction of foundation, there is need for careful check if there are no obstacles like tree roots. The closer the tree is to the building the deeper foundation must be done. The minimum depth is 900mm.

New foundation technologies

Technopor foundations- are the latest innovation in foundation green building technologies. The foundation is built on the glass, with no concrete required. It can be installed on almost all ground conditions, for structures up to three storeys high. It offers thermal insulation, load bearing, capillary breaking and provides drainage. After the soil is excavated the entire hole is laid and overlapped with the geo-textile. On the top of the geo-textile, granulate is evenly distributed than compacted. Such surface is ready for the construction of the floor slab.

Underpinning

Underpinning is a method of improvements on the existing foundation. It allows repairing or checking and increasing the depth of the foundations. The soil beneath the existing foundation is excavated and is replaced with foundation material, usually concrete. Underpinning works requires proper risk assessments and professional approach as if carry out negligently may cause damage or collapse of the existing building.

Underpinning is undertaken in situations where for instance:

- The existing foundations of the building have moved – this is caused by poor soil or changes to the soil conditions
- There has been a decision to add another storey to the building and the depth of the existing foundations is inadequate to support the modified structure.

Species	Distance from Building												
	1m	2m	4m	6m	8m	10m	12m	14m	16m	18m	20m	22m	24m
English Oak	*	*	*	2.30	2.15	1.95	1.70	1.60	1.40	1.20	1.10	0.90	
Black Poplar	*	*	*	*	2.30	2.20	2.10	1.90	1.80	1.70	1.60	1.50	1.40
Weeping Willow	*	*	*	2.20	2.00	1.80	1.60	1.30	1.10	0.90			
Hawthorn	*	*	2.10	1.80	1.50	1.20	0.90						
Cypress Leylandii	*	*	2.10	1.80	1.40	1.20	0.90						
Cedar	1.80	1.70	1.50	1.30	1.20	1.10	0.90						
Douglas Fir	1.70	1.50	1.20	0.90									
Pine	1.70	1.50	1.20	0.90									
Spruce	1.60	1.40	1.10	0.90									
Horse Chestnut	1.80	1.70	1.50	1.40	1.30	1.10	0.90						
Ash	1.80	1.70	1.60	1.40	1.30	1.20	1.00	0.90					
Lime	1.80	1.70	1.50	1.40	1.30	1.10	1.00	0.90					
Sycamore	1.80	1.70	1.50	1.40	1.30	1.10	1.00	0.90					
Pear	1.70	1.50	1.30	1.10	0.90								
Orchard Cherry	1.70	1.50	1.30	1.10	0.90								
Alder	1.70	1.60	1.50	1.30	1.20	1.00	0.90						
Maple	1.70	1.60	1.50	1.30	1.20	1.00	0.90						
Beech	1.70	1.60	1.50	1.40	1.20	1.10	0.90						
Plum	1.60	1.50	1.20	0.90									
Laurel	1.60	1.50	1.20	0.90									
Apple	1.60	1.50	1.20	0.90									
Silver Birch	1.20	1.10	0.90										

Foundation Depth in Metres

* Foundations greater than 2.5m deep to be engineer designed.

source: Darlington Borough Council, Building Regulations Guidance, August 2014

TIPS

1. Do not excess the foundation's excavations.
2. Try to level the foundation bottom.
3. Use the good quality concrete as soon as possible after excavations. Remember if there is not enough water the concrete will not dry properly.
4. Control the boarding – that will have an impact on the amount of used concrete.
5. Isolate horizontally the foundation.
6. Compact backfill material approx at every 20cm; in the case of poor ground conditions make drains.
7. Allow for all services- gas, water, electricity cables, lighting, phone etc.
8. Before laying the concrete ensure the sewage levels and secure all pipes.
9. Densify the sand around all pipes.
10. Pour concrete at once or in sections. If you do by sections, never start from the foundation's corners.
11. Smooth over the concrete with float to even the surface.
12. Avoid the foundation to dry to quickly by watering.