Foundation design

In this section, you'll find technical guidance on foundation designs – for both the range of high masts in this brochure and bespoke masts designed by Abacus for specific clients' projects. All foundations meet BS8004 standards and comply with the Institute of Lighting Engineers' Technical Report No.7.

Allowable ground-bearing pressures

A key factor in determining the size of mast foundations is the bearing pressure of the ground in which it will sit.

Over the following pages, each standard foundation reference incorporates the ground-bearing pressure within its code, making it quick and simple to identify the kind of foundation you need.

The table below shows subsoil classifications according to the BS8004 standard, against the approximate allowable bearing pressure. We're also working to the new eurocodes,

If there is any doubt over ground conditions, it is the client's or contractor's responsibility to consult a qualified civil engineer to establish the true bearing pressures.

Typical foundation details are provided for guidance only and should be checked with the client before use. Abacus Lighting Limited will not accept responsibility for any foundations unless they are specifically designed by us at the client's request.

Types of subsoil

Types of subsoil	Condition of subsoil	Field test applicable	Approximate allowance bearing pressure kN/m²
Rock	Not inferior to sandstone, limestone or firm chalk	Requires at least a pneumatic or other mechanically operated pick for excavation	1000
Gravel, sand	Compact	Requires pick for excavation. Wooden peg 50mm² in cross section is hard to drive beyond 150mm	Dense to very dense 150-400 Loose to medium dense 50-250
Clay, sandy clay	Firm	Can be moulded by substantial pressure with the fingers and excavated with graft or spade	50-100
Sand*, silty sand*, clayey sand*	Loose	Can be excavated with a spade. Wooden peg 50mm² in cross section can be easily driven	<75
Silt*, clay*, sandy clay*, silty clay*	Soft	Fairly easily moulded with the fingers and readily excavated	<75
Silt*, clay*, sandy clay*, silty clay*	Very soft	Natural sample in winter conditions exudes between fingers when squeezed in fist	<75

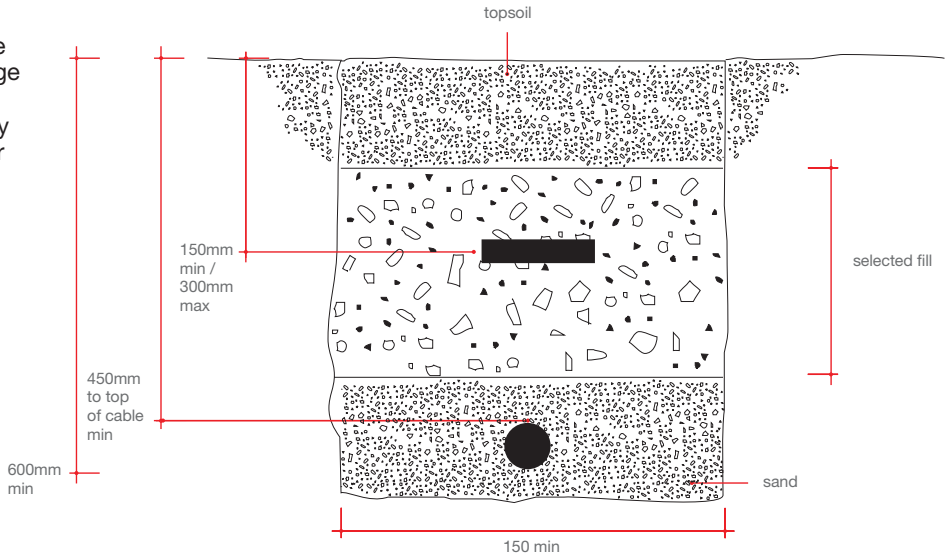
These values are provided for guidance only. If in any doubt, consult a qualified civil engineer.
*Foundations on these soils require assessment and design by a qualified civil engineer.

Planning the site: cable trenches

Cables buried directly in the ground must be marked by cable covers or a suitable marking tape.

Cables, conduits and ducts must be buried deep enough to avoid damage from any reasonably foreseeable ground disturbance. If you are in any doubt, refer to national guidelines or standards.

Typical cable trench



Foundations and flange plates

The principal method for installing a high mast involves a flange plate supported by a prepared foundation*.

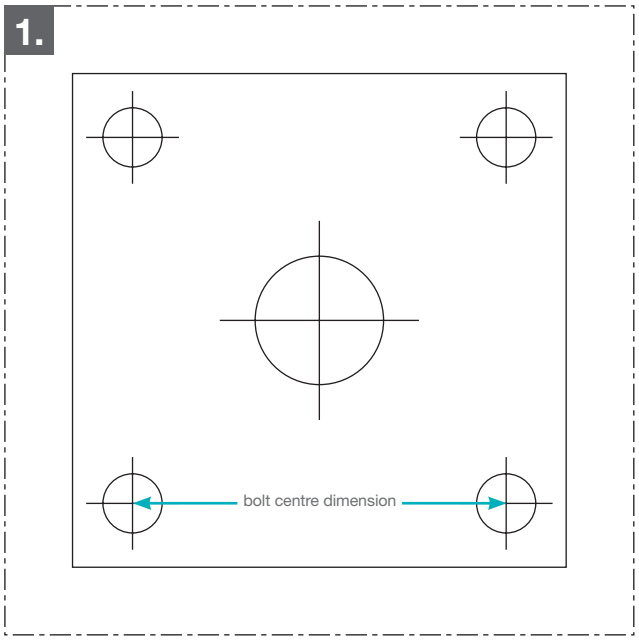
The flange plate, which is welded to the base of the mast, is designed to accommodate the overturning moments (forces) for each specific mast.

Bolt holes in the flange plate are arranged in one of two ways:

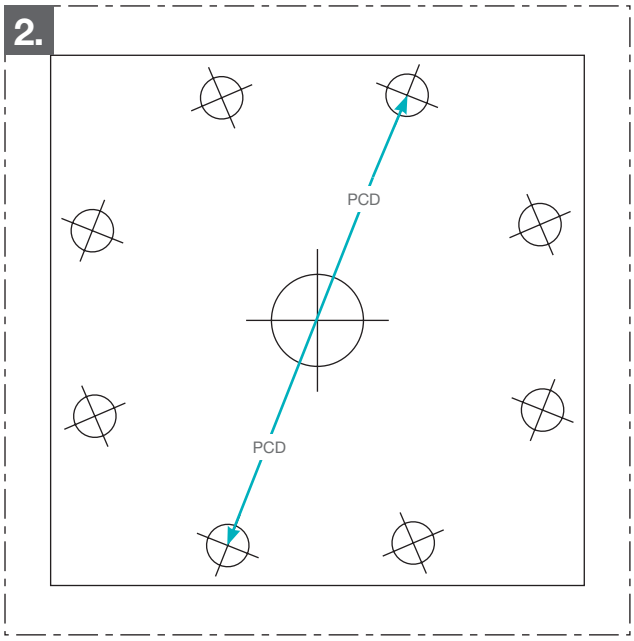
1. In a square, where the stated ‘bolt centre’ dimension is given.
2. In a circle, where the ‘pitch circle diameter’ (PCD), is given.

This diameter is stated for the dimension between bolt-hole centres (see diagram).

*Root-mounting can be an option up to a height of 18m, but we don’t cover this here. If you’d like more information on this method, please contact the Abacus sales office.



Square bolt configuration, with bolt centre dimensions



Circular bolt configuration, with PCD bolt centre dimensions

Assembling foundation bolts into concrete

Foundation bolts

Foundation bolts are supplied with nuts, washers, a spacer plate and a fixing template in either wood (smaller masts) or steel. Make sure the foundation bolt is put together accurately with bolts vertical and fixed rigidly so it won't be displaced or misaligned during concreting. Also, check that bolts project correctly above the foundation.

After the concrete has cured, the mast is erected and levelled on the double nuts.

The bolts should then be tightened in accordance with the final torque value, as shown in the table to the right.

Concrete

Foundations should be constructed in accordance with the following design and dimensional details. Unless otherwise specified, they should use:

- For reinforced foundations: grade C28/35 concrete and high tensile reinforcement with a yield stress of 485N/mm²
- For unreinforced foundations: C20/25 grade concrete.

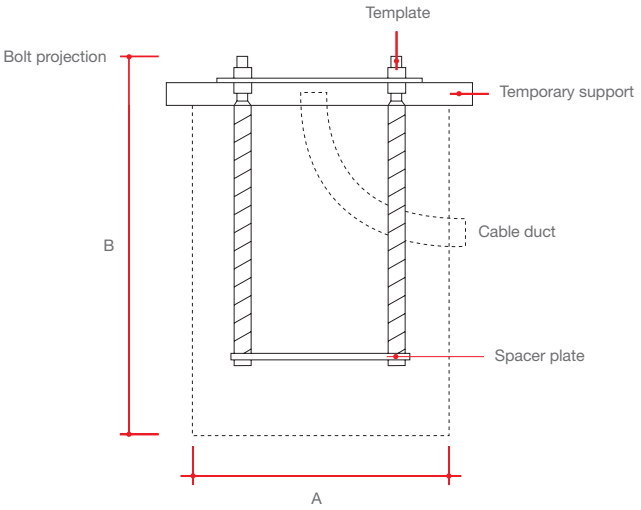
Cable entry ducts should be placed centrally within the concrete to facilitate entry into (and in some cases out of) the mast itself.

Concrete will typically take a minimum of 14 days to cure – enough to erect the mast subject to various factors and in accordance with recommendations.

Holding-down bolt projection and final torque values

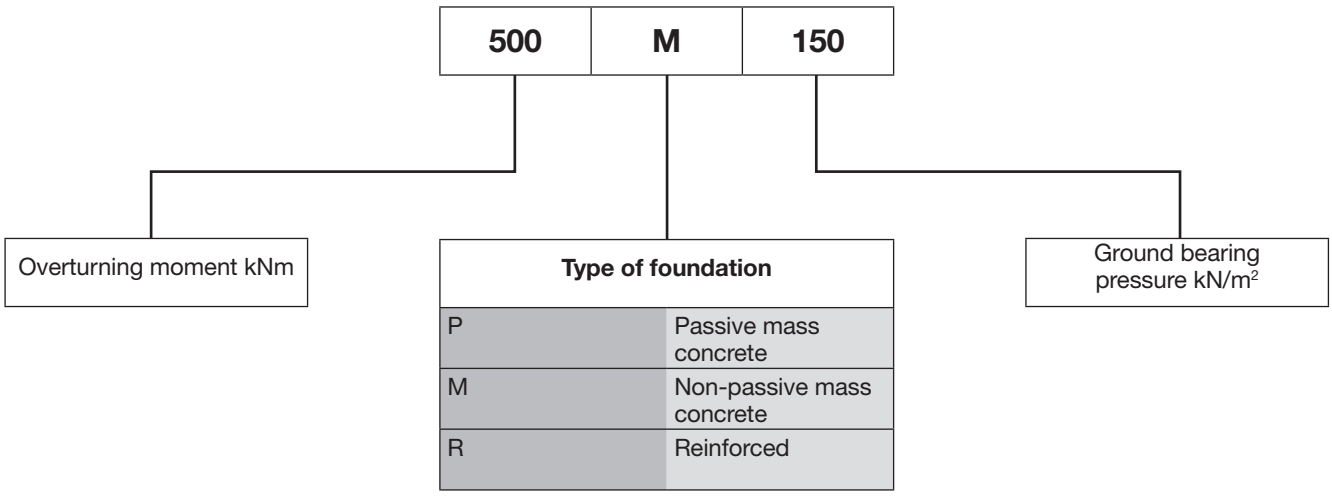
Bolt size and grade	Projection (mm)	Torque (Nm)
M16*500 long grade 4.6	125	25
M20*500 long grade 4.6	125	50
M24*600 long grade 4.6	125	160
M30*800 long grade 4.6	150	310
M24*880 long grade 8.8	150	425
M30*1220 long grade 8.8	150	850
M36*1200 long grade 8.8	175	1450
M36*1350 long grade 8.8	175	1450
M36*1590 long grade 8.8	175	1450
M42*1700 long grade 8.8	210	2350
M48*1870 long grade 8.8	210	3500

Typical section through foundation



Glossary of foundation reference codes

The foundation reference codes on the following pages are put together like this:



Standard-mass concrete: passive and non-passive foundations

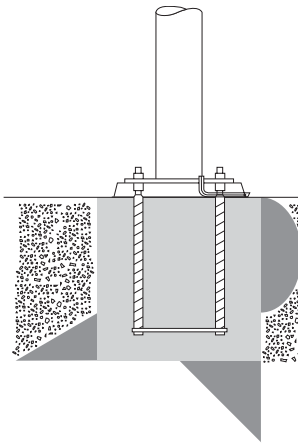
We offer two standard concrete types for non-reinforced-mass foundation designs – passive and non-passive.

Passive concrete foundation Standard sizes

Foundation	O.T.M (kNm)	Bearing pressure (kN/m²)	A Width (mm)	B depth (mm)
3P150	3	150	650	750
4P150	4	150	700	800
5P150	5	150	750	800
6P150	6	150	750	900
8P150	8	150	850	950
10P150	10	150	900	950
15P150	15	150	950	1100
20P150	20	150	1050	1200
30P150	30	150	1200	1250
40P150	40	150	1250	1300
50P150	50	150	1350	1400
75P150	75	150	1450	1600
100P150	100	150	1600	1700
150P150	150	150	1800	1850
200P150	200	150	1950	2000
300P150	300	150	2250	2150
400P150	400	150	2450	2250
500P150	500	150	2700	2300
750P150	750	150	3050	2600

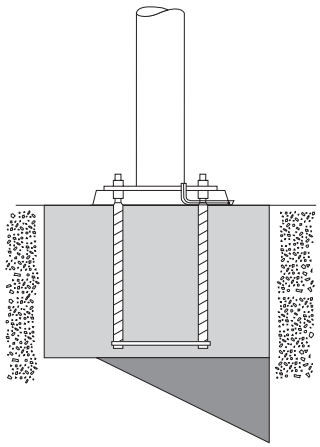
Ground bearing pressures below 150 kN/m² are not applicable.

Passive concrete
Typically used in firm ground with ground-bearing pressure of no less than 150kN/m²



Soil pressure distribution

Non-passive concrete
Typically used with uniform or poor subsoil with ground-bearing pressure of 75-150kN/m²



Soil pressure distribution

Non-passive concrete foundation Standard sizes

Foundation	O.T.M (kNm)	Bearing pressure (kN/m²)	A Width (mm)	B depth (mm)
3M75	3	75	880	590
3M100	3	100	880	590
3M150	3	150	880	590
4M75	4	75	950	625
4M100	4	100	950	625
4M150	4	150	950	625
5M75	5	75	1050	675
5M100	5	100	1050	675
5M150	5	150	1050	675
6M75	6	75	1100	700
6M100	6	100	1100	700
6M150	6	150	1100	700
8M75	8	75	1150	725
8M100	8	100	1150	725
8M150	8	150	1150	725
10M75	10	75	1250	775
10M100	10	100	1250	775
10M150	10	150	1250	775
15M75	15	75	1400	850
15M100	15	100	1350	825
15M150	15	150	1350	825
20M75	20	75	1500	900
20M100	20	100	1500	900
20M150	20	150	1500	900
30M75	30	75	1700	1000
30M100	30	100	1700	1000
30M150	30	150	1700	1000
40M75	40	75	1900	1100
40M100	40	100	1800	1050
40M150	40	150	1800	1050
50M75	50	75	2100	1200
50M100	50	100	1900	1100
50M150	50	150	1900	1100
75M75	75	75	2400	1350
75M100	75	100	2200	1250
75M150	75	150	2200	1250
100M75	100	75	2650	1475
100M100	100	100	2400	1350
100M150	100	150	2300	1300
150M75	150	75	3200	1750
150M100	150	100	2700	1650
150M150	150	150	2500	1400
200M75	200	75	3900	2100
200M100	200	100	3000	1650
200M150	200	150	2700	1500
300M100	300	100	3500	1900
300M150	300	150	3100	1700
400M100	400	100	2100	3900
400M150	400	150	3400	1850
500M100	500	100	4500	2400
500M150	500	150	3600	1950
750M150	750	150	4100	2200

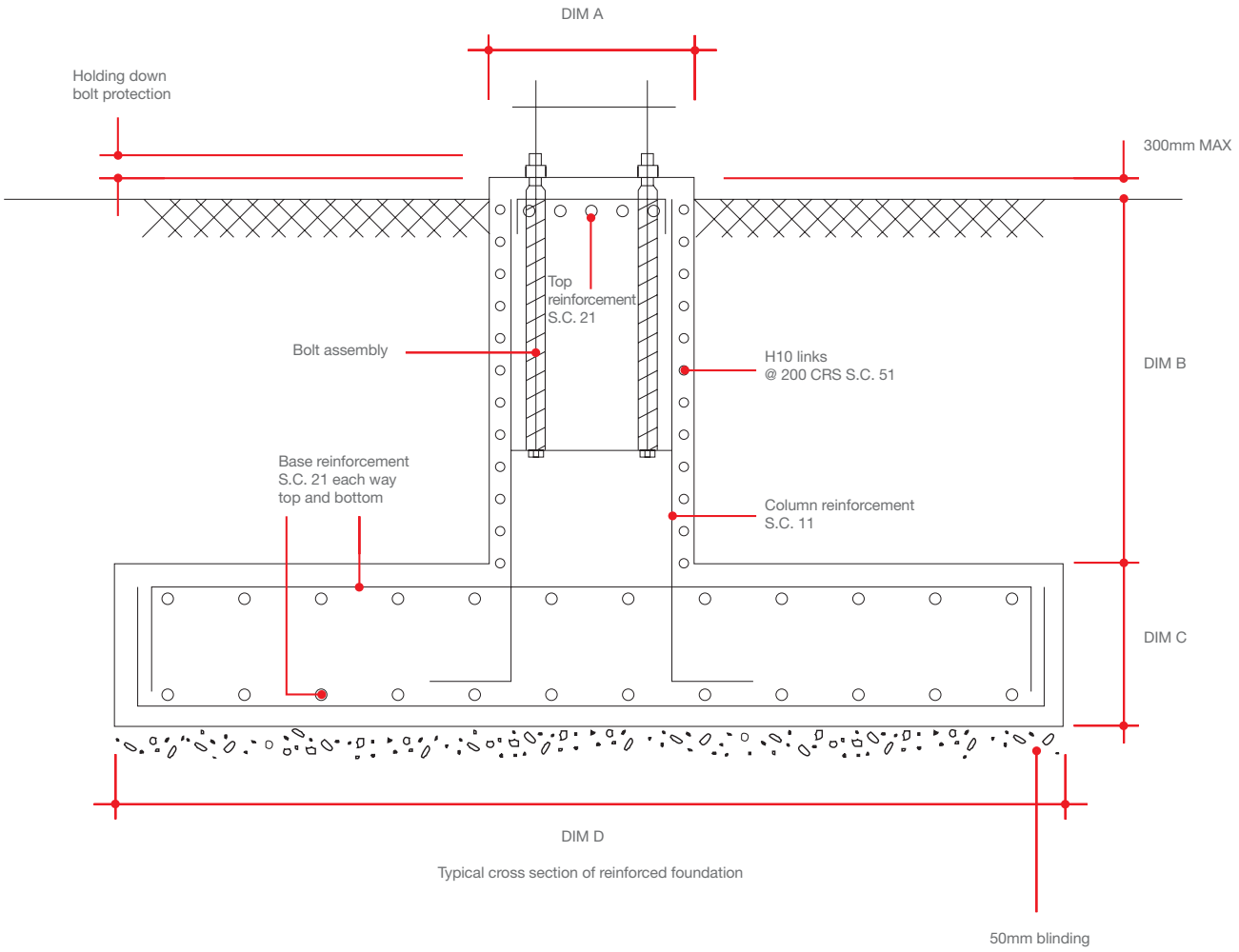
Standard reinforced foundations

Foundation ref	O.T.M. (kNm)	Bearing pressure (kN/m²)	A (mm)	B (mm)	C (mm)	D (mm)	Base reinforcement (Each way S.C. 21)	Column reinforcement (All round S.C. 11)	Top reinforcement (Each way S.C. 21)
75R75	75	75	1100	950	600	2400	H16@250 t and b	H20@225	
75R150	75	150	1100	950	600	2050	H16@250 t and b	H20@225	
100R75	100	75	1100	950	600	2600	H16@250 t and b	H20@225	
100R150	100	150	1100	950	600	2300	H16@250 t and b	H20@225	
150R75	150	75	1100	1350	600	2900	H16@250 t and b	H20@225	
150R150	150	150	1100	1350	600	2500	H16@250 t and b	H20@225	
200R75	200	75	1100	1350	600	3200	H16@250 t and b	H20@225	
200R150	200	150	1100	1350	600	2750	H16@250 t and b	H20@225	
300R75	300	75	1500	1350	750	3700	H16@200 t and b	H20@150	
300R150	300	150	1500	1350	750	3100	H16@200 t and b	H20@150	
400R75	400	75	1500	1500	750	4100	H16@200 t and b	H20@150	H16@175
400R150	400	150	1500	1500	750	3400	H16@200 t and b	H20@150	
500R75	500	75	1500	1500	750	4400	H16@200 t and b	H20@150	
500R150	500	150	1500	1500	750	3700	H16@200 t and b	H20@150	
750R75	750	75	1500	1500	750	5000	H16@200 t and b	H20@125	
750R150	750	150	1500	1500	750	4200	H16@200 t and b	H20@125	
1000R75	1000	75	1500	1850	750	5500	H20@250 t and b	H25@150	
1000R150	1000	150	1500	1850	750	4700	H20@250 t and b	H25@150	
1250R75	1250	75	1500	1850	750	5900	H20@200 t and b	H25@125	
1250R150	1250	150	1500	1850	750	5000	H20@200 t and b	H25@125	
1500R75	1500	75	1500	1850	1000	6800	H20@150 t and b	H32@175	
1500R150	1500	150	1500	1850	1000	5400	H16@150 t and b	H32@175	
2000R75	2000	75	2000	2000	1000	7000	H20@250t and b	H25@150	
2000R100	2000	100	2000	2000	1000	6000	H20@250t and b	H25@150	
2000R150	2000	150	2000	2000	1000	5500	H20@250t and b	H25@150	
3000R75	3000	75	2100	2000	1250	7750	H20@200t and b	H25@150	
3000R100	3000	100	2100	2000	1250	7000	H20@200t and b	H25@150	
3000R150	3000	150	2100	2000	1250	6250	H20@200t and b	H25@150	
4000R75	4000	75	2100	2000	1500	8500	H20@175t and b	H32@150	
4000R100	4000	100	2100	2000	1500	7750	H20@175t and b	H32@150	
4000R150	4000	150	2100	2000	1500	7000	H20@175t and b	H32@150	
5000R75	5000	75	2100	2000	1500	9000	H20@175t and b	H32@150	
5000R100	5000	100	2100	2000	1500	8250	H20@175t and b	H32@150	
5000R150	5000	150	2100	2000	1500	7500	H20@175t and b	H32@150	H16@175
6000R75	6000	75	2500	2000	1500	9500	H20@250t and b	H32@150	
6000R100	6000	100	2500	2000	1500	8750	H20@250t and b	H32@150	
6000R150	6000	150	2500	2000	1500	8000	H20@250t and b	H32@150	
7000R75	7000	75	2500	2000	1500	10000	H25@225t and b	H32@150	
7000R100	7000	100	2500	2000	1500	9250	H25@225t and b	H32@150	
7000R150	7000	150	2500	2000	1500	8250	H25@225t and b	H32@150	
8000R75	8000	75	2600	2000	1500	10500	H32@200b + H25@250t	H32@150	
8000R100	8000	100	2600	2000	1500	9600	H25@225t and b	H32@150	
8000R150	8000	150	2600	2000	1500	8700	H25@225t and b	H32@150	
9000R75	9000	75	2600	2000	1500	11000	H32@175b H25@225t	H32@125	
9000R100	9000	100	2600	2000	1500	10000	H25@200t and b	H32@125	
9000R150	9000	150	2600	2000	1500	9000	H25@225t and b	H32@125	

Notes:

1. Concrete to have a minimum characteristic strength of 35 N/mm² at 28 days. Minimum cement content to be 300Kg/m³ with a maximum water cement ratio of 0.60. Coarse aggregate size to be 20mm nominal.
2. Reinforcement to be high-yield type 2 to BS4449 – minimum yield strength to be 485N/mm². Cover reinforcement to be 40mm.
3. Links to column section to be H10@200 c/c – shape code 51 to BS8666: 2005-plus H10 internal lacers at 450 max centres horizontal and 250 centres vertical shape code 99.
4. Above table is based on the water table being below the base of the foundation.

Arrangement of reinforced foundations



Typical cross section of reinforced foundation