Table 39 Reinforcement percentages, depth/projection ratios and ground pressures for reinforced footings for f_y = 460N/mm^2

q kN/m^2	d/a 0.24	0.32	0.37	0.41	0.43	0.46	0.49	0.60	0.70	≥0.80
50	0.18	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
100		0.20	0.15	0.13	0.13	0.13	0.13	0.13	0.13	0.13
150			0.23	0.19	0.17	0.15	0.13	0.13	0.13	0.13
200				0.25	0.23	0.20	0.17	0.13	0.13	0.13
250					0.28	0.25	0.22	0.15	0.13	0.13
300						0.30	0.26	0.17	0.13	0.13
400							0.35	0.23	0.17	0.13

The stippled areas indicate combinations of q and d/a that should not be used.

The above percentages apply to reinforcement with f_y = 460N/mm^2. For f_y = 250N/mm^2 multiply the above reinforcement percentages by 1.85.

4.10.5.3 Eccentrically loaded footings

The design of eccentrically loaded footings proceeds as follows:

1. determine initial depth of footing from Table 39 using maximum value of **unfactored** ground pressure
2. check punching shear according to clauses 4.2.3.4 and 4.2.5.2
3. check face shear according to stage 2 in clause 4.10.5.2 using V_{eff} from clause 4.2.3.4 in lieu of N
4. increase the depth if necessary to avoid shear reinforcement
5. with the chosen depth (revised according to stage 4, if necessary) enter Table 39 to obtain the reinforcement percentage.

4.10.6 Design of other footings

4.10.6.1 Strip footings

Strip footings should be designed as pad footings in the transverse direction and in the longitudinal direction at free ends or return corners. If reinforcement is required in the transverse direction it should also be provided in the longitudinal direction and should not be less than that obtained from the procedures in clause 4.10.5.2.

4.10.6.2 Combined footings and balanced footings

Combined footings and balanced footings should be designed as reinforced pad footings except as extended or modified by the following requirements:

Punching shear should additionally be checked for critical perimeters encompassing two or more closely spaced columns according to clauses 4.2.3.4 and 4.2.5.2. Bending moments should additionally be checked at the point of zero shear between the two columns. Reinforcement should be provided in top and bottom faces tied together by links and may be curtailed in accordance with the detailing rules in subsection 4.12.

Where a balanced footing consists of two pad footings joined by a beam, the beam may be designed in accordance with subsection 4.4.

Steps in the top or bottom surface may be introduced if necessary provided that they are taken into account in the design.

4.10.7 Reinforcement

Where reinforcement is required it should be provided in two generally orthogonal directions. The areas in each direction should not be less than 0.0013 bh for Grade 460 or 0.0025 bh for Grade 250 reinforcement, where b and h are the breadth and overall depth in mm, respectively. All reinforcement should extend the full length of the footing.

If $l_x > 1.5\ (c_x + 3d)$, at least two-thirds of the reinforcement parallel to l_y should be concentrated in a band width $(c_x + 3d)$ centred at the column, where l_x and c_x are the footing and column dimensions in the x-direction and l_y and c_y are the footing and column dimensions in the y-direction. The same applies in the transverse direction with suffixes x and y transposed.

Reinforcement should be anchored each side of all critical sections for bending. It is usually possible to achieve this with straight bars.

The spacing between centres of reinforcement should not exceed 200mm for Grade 460 nor 300mm for Grade 250. Reinforcement need normally not be provided in the side face nor in the top face, except for balanced or combined foundations.

Starter bars should terminate in a 90° bend tied to the bottom reinforcement, or in the case of an unreinforced footing spaced 75mm off the blinding.

4.10.8 Design of rafts

The design of a raft is analogous to that of an inverted flat slab (or beam-and-slab) system, with the important difference that the column loads are known but the distribution of ground bearing pressure is not. A distribution of ground bearing pressure has to be determined that:

(a) satisfies equilibrium by matching the column loads
(b) satisfies compatibility by matching the relative stiffness of raft and soil
(c) allows for the concentration of loads by slabs or beams continuous over supports, and
(d) stays within the allowable bearing pressure determined from geotechnical considerations of strength and settlement.

Provided that such a distribution can be determined or estimated realistically by simple methods, design as a flat slab or beam-and-slab may be carried out. In some cases, however, a realistic distribution cannot be determined by simple methods, and a more complex analysis is required. Such methods are outside the scope of this *Manual.*

4.10.9 Design of pile caps

The design of pile caps should be carried out in accordance with the following general principles:

(a) The spacing of piles should generally be three times the pile diameter
(b) The piles should be grouped symmetrically under the loads
(c) The load carried by each pile is equal to N/(no. of piles). When a moment is transmitted to the pile cap the loads on the piles should be calculated to satisfy equilibrium
(d) Pile caps should extend at least 150mm beyond the theoretical circumference of the piles
(e) For pile caps supported on one or two piles only, a moment arising from a column eccentricity of 75mm should be resisted either by ground beams or by the piles.