D Foundation Selection Tables

Tables 10.3, 10.1 and 10.2 from the main text are reproduced here as Tables D.1, D.2 and D.3 respectively for ease of reference in the foundation selection process.

Each of the tables gives details of suitable foundations to suit varying site and sub-soil conditions with guidance notes for factors to be considered during the selection process.

Table D.1 Foundation selection – bearing strata strength and depth

Sub-soil conditions	Suitable foundation
Condition 1 Suitable bearing strata within 1.5 m of ground surface	**Strips** **Pads** **Rafts** When loading on pads is relatively large and pad sizes tend to join up or the foundation needs to be **balanced** or connected then **continuous beam** foundations are appropriate. Strip foundations are usually considered the norm for these conditions but rafts can prove more economical in some cases.
Condition 2 Suitable bearing strata at 1.25 m and greater below ground surface	**Strips** **Pads** **Rafts** } on improved ground using vibro or dynamic consolidation techniques
Condition 3 Suitable bearing strata at 1.5 m and greater below ground surface	As Condition 2 plus the following **Piles** and **ground beams** **Pier** and **ground beams** **Piles** and **raft**
Condition 4 Low bearing pressure for considerable depth	As Condition 2 plus the following **Buoyant rafts**
Condition 5 Low bearing pressure near surface	As Condition 2 plus the following **Rafts** Ground improvement using preloading to support reinforced strips on rafts

Table D.2 Foundation selection – sub-soil type

Sub-soil type	Suitable foundation	Factors to be considered
Group 1 Rock; hard sound chalk; sand and gravel, sand and gravel with little clay content, dense silty sand	Strips/Pads/Rafts	(1) Minimum depth to formation for protection against frost heave 450 mm for frost susceptible soils. (2) Weathered rock must be assessed on inspection. (3) Beware of swallow-holes in chalk. (4) Keep base of strip or trench above groundwater level where possible. (5) Sand slopes may be eroded by surface water – protect foundation by perimeter drainage. (6) Beware of running sand conditions.
Group 2 Uniform firm and stiff clays (a) where existing nearby vegetation is insignificant	Strips/Pads/Rafts	(1) Trench fill likely to be economic in this category. (2) Minimum depth to underside of foundation 900 mm. (3) When strip foundations are cast in desiccated clay in dry weather, they must be loaded with the structure before heavy rains return.
(b) where trees, hedges or shrubs exist close to the foundation position or are to be planted near the building at a later date	Concrete piles supporting reinforced ground beams and precast concrete floor units OR Concrete piles supporting a suspended reinforced in situ concrete slab OR Specially designed trench fill (possibly reinforced) in certain clay soils depending on position of foundation relative to trees OR Rafts	(1) Clay type and shrinkage potential, distance of trees from foundation and spread of roots dictate necessity or otherwise of piling. (2) Type and dimensions of pile depend on economic factors. (3) Where a suspended in situ concrete ground slab is used a void must be formed under it if laid in very dry weather over clay which is desiccated. (4) Where existing mature trees grow very close (e.g. within quarter of mature tree height) to the position in which piles will be installed. It might be prudent to design for sub-soil group 2(c). (5) Where trees have been or will be planted at a distance of at least one to two times the mature tree height from the foundation, a strip foundation may be suitable. (6) In marginal cases, i.e. with clay of low to medium shrinkage potential and in the perimeter zone of the tree root system, reinforced trench fill can be used.
(c) Where trees and hedges are cut down from area of foundations shortly before construction	Reinforced concrete piles (in previous tree root zone) OR Strip foundations as in groups 2(a) and 2(b) (outside previous root zone) OR Rafts	(1) Piles must be tied adequately into ground beams or the suspended reinforced concrete slab. An adequate length of pile must be provided to resist clay heave force, and the top section of the pile possibly sleeved to reduce friction and uplift. (2) Special pile design may be required for clay slopes greater than 1 in 10 where soil creep may occur and it is necessary to design for lateral thrust and cantilever effects. (3) In marginal cases, i.e. with clay of low to medium shrinkage potential and in the perimeter zone of the tree root system, reinforced trench fill can be used.
Group 3 Soft clay, soft silty clay, soft sandy clay, soft silty sand	Wide strip footing if bearing capacity is sufficient and predicted settlement allowable OR Raft OR Piles to firmer strata below – for small projects consider pier and beam foundations to firm strata	(1) Strip footings should be reinforced depending on thickness and projection beyond wall face. (2) Service entries to building should be flexible.
Group 4 Peat	Concrete piles taken to firm strata below. For small projects, consider pad and beam foundations taken to firm strata below. Where no firm strata exist at a reasonable depth below ground level but there is a thick (3–4 m) hard surface crust of suitable bearing capacity, consider raft.	(1) Pile types used are bored cast in place with temporary casing; driven cast in place; and driven precast concrete. (2) Allow for peat consolidation drag on piles. (3) Where peat layer is at surface and shallow over firm strata, dig out and replace with compacted fill. Then use raft or reinforced wide-strip foundations depending on expected settlement. (4) Where raft is used, service entries should be flexible. Special high-grade concrete and protection may be necessary in some aggressive peat soils.
Ground improvements of sub-soil Groups 3 and 4 by vibro treatments can often be achieved and can be an effective and economical solution when used in conjunction with raft or strip foundations		

Table D.3 Foundation selection – varying site conditions

Site condition	Suitable foundation	Factors to be considered
Filled site	Concrete piles taken to firm strata below. For small projects consider beam and pier foundations taken to firm strata below. If specially selected and well compacted fill has been used consider (1) Raft or (2) Reinforced wide-strip footings (3) Strip/pad/raft on ground improved using vibro or dynamic consolidation depending on fill type	(1) Allow for fill consolidation drag on piles, piers or deep trench fill taken down to firm strata below. (2) Proprietary deep vibro and dynamic compaction techniques can with advantage improve poor fill before construction of surface or shallow foundations. (3) If depth of poorly compacted and aggressive fill is small remove and replace with inert compacted fill, then use reinforced strip or raft foundations. (4) Deep trench fill taken down to a firm stratum may be economic if ground will stand with minimum support until concrete is placed. (5) Allow flexible service entries to building. (6) Avoid building a unit partly on fill and partly on natural ground. (7) Take precautionary measures against (a) combustion on exposure to atmosphere, (b) possible toxic wastes, (c) production of methane gas.
Mining and other subsidence areas	Slip-plane raft	(1) Where a subsidence wave is expected, building should be carried on individual small rafts. Avoid long terrace blocks and L-shaped buildings. (2) In older mining areas, locate buildings to avoid old mining shafts and bell-pits. (3) In coal mining areas, consult The Coal Authority in all cases. (4) Avoid piled foundations.
Sloping site	Foundations to suit normal factors and soil conditions, but designed for special effect of slope	(1) Strip foundations act as retaining walls at steps. With clay creep downhill, design and reinforce for horizontal forces on foundations. Provide good drainage behind retaining wall steps. (2) Foundations are deeper than normal, so keep load-bearing walls to a minimum. Keep long direction of building parallel to contours. (3) In addition to local effects of slope on foundations, consider total ground movement of slopes including stability of cohesionless soils, slip and sliding of cohesive soils. (4) Make full examination of all sloping sites inclined more than 1 in 10. (5) The presence of water can increase instability of slope. (6) Special pile design may be required for clay soil slopes greater than 1 in 10 where soil creep may occur and it is necessary to design for lateral thrust and cantilever effects.
Site containing old building foundations	Normal range of foundations. It is possible to use strips, piling, and pads but beware of varying depths of fill in old basements, causing differential settlement, and old walls projecting into fill over which slabs may break their backs.	(1) Notes relating to 'filled site' apply. (2) Where possible, dig out badly placed or chemically aggressive fill and replace with inert compacted material. (3) Remove old walls in filled basements, or use piers or piles carrying ground beams to span such projections. (4) Deep trench fill down to firm strata at original basement level may be economic. (5) Trench fill depths may vary greatly as old basement depth varies. Some formwork may be required in loose fill areas. (6) Remove old timber in demolition material – a source of dry rot infection.
Site with groundwater problems	Normal range of foundation types can be used. Consider piling through very loose saturated sand to denser stratum to provide support for raft or strip foundation at high level above groundwater. Consider use of proprietary vibro-replacement ground techniques to provide support for raft or strip foundation at high level above groundwater.	(1) In sand and gravel soil, keep foundation above groundwater level where possible. (2) Avoid forming steep cuttings in wet sand or silty soil. (3) Consider use of sub-surface *shelter* drains connected to surface water drains, and allow for resulting consolidation or loss of ground support. (4) Take precautions against lowering of groundwater level which may affect stability of existing structures.