CHAPTER 9

SELECTION OF FOUNDATION TYPE

9-1. Foundation - selection considerations. Selection of an appropriate foundation depends upon the structure function, soil and groundwater conditions, construction schedules, construction economy, value of basement area, and other factors. On the basis of preliminary information concerning the purpose of the structure, foundation loads, and subsurface soil conditions, evaluate alternative types of foundations for the bearing capacity and total and differential settlements. Some foundation alternatives for different subsoil conditions are summarized in table 9-1.

a. Some foundation alternatives may not be initially obvious. For example, preliminary plans may not provide for a basement, but when cost studies show that a basement permits a floating foundation that reduces consolidation settlements at little or no increase in construction cost, or even at a cost reduction, the value of a basement may be substantial. Benefits of basement areas include needed garage space, office or stor-

Table 9-1. Foundation Possibilities for Different Subsoil Conditions

Subsoil Conditions	Foundation Possibilities: Light, Flexible Structure	Foundation Possibilities: Heavy, Rigid Structure
Deep compact or stiff deposit	Footing foundations	1. Footing foundations 2. Shallow mat
Deep compressible strata	1. Footing foundations on compacted granular zone[a] 2. Shallow mat[a] 3. Friction piles	1. Deep mat with possible rigid construction in basement 2. Long piles or caissions to by-pass 3. Friction piles
Soft or loose strata overlying firm strata	1. Bearing piles or piers 2. Footing foundations on compacted granular zone[a] 3. Shallow mat[2]	1. Bearing piles or piers 2. Deep mat
Compact or stiff layer overlyinga soft deposit	1. Footing foundations[a] 2. Shallow mat[a]	1. Deep mat (floating type) 2 Long piles or caissons to by-pass soft deposit
Alternating soft and stiff layers	1. Footing foundations[a] 2. Shallow mat[a]	1. Deep mat 2. Piles or caissons to underlying firm stratum to provide satisfactory foundation

[a] Consider possible advantages of site preloading, with and without vertical sand drains to accelerate consolidation.

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age space, and space for air conditioning and other equipment. The last item otherwise may require valuable building space or disfigure a roofline.

b. While mat foundations are more expensive to design than individual spread footings, they usually result in considerable cost reduction, provided the total area of spread footings is a large percentage of the basement area. Mat foundations may decrease the required excavation area, compared with spread footings.

c. The most promising foundation types should be designed, in a preliminary manner, for detailed cost comparisons. Carry these designs far enough to determine the approximate size of footings, length and number of piles required, etc. Estimate the magnitude of differential and total foundation movements and the effect on structure. The behavior of similar foundation types in the area should be ascertained.

d. Final foundation design should not be started until alternative types have been evaluated. Also, the effect of subsurface conditions (bearing capacity and settlement) on each alternative should be at least qualitatively evaluated.

e. A checklist of factors that could influence foundation selection for family housing is shown in table 9-2.

9-2. Adverse subsurface conditions. If poor soil conditions are encountered, procedures that may be used to ensure satisfactory foundation performance include the following:

a. Bypass the poor soil by means of deep foundations extending to or into a suitable bearing material (chap. 11).

b. Design the structure foundations to accommodate expected differential settlements. Distinguish between settlements during construction that affect a structure and those that occur during construction before a structure is affected by differential settlements.

c. Remove the poor material, and either treat and replace it or substitute good compacted fill material.

d. Treat the soil in place prior to construction to improve its properties. This procedure generally requires considerable time. The latter two procedures are carried out using various techniques of soil stabilization described in chapter 16.

9-3. Cost estimates and final selection.

a. On the basis of tentative designs, the cost of each promising alternative should be estimated. Estimate sheets should show orderly entries of items, dimensions, quantities, unit material and labor costs, and cost extensions. Use local labor and material costs.

b. The preliminary foundation designs that are compared must be sufficiently completed to include all relevant aspects. For example, the increased cost of piling may be partially offset by pile caps that are smaller and less costly than spread footings. Similarly, mat or pile foundations may require less excavation. Foundation dewatering during construction may be a large item that is significantly different for some foundation alternatives.

c. The most appropriate type of foundation generally represents a compromise between performance, construction cost, design cost, and time. Of these, design cost is generally the least important and should not be permitted to be a controlling factor. If a lower construction cost can be achieved by an alternative that is more expensive to design, construction cost should generally govern.

d. Foundation soils pretreatment by precompression under temporary surcharge fill, regardless of whether vertical sand drains are provided to accelerate consolidation, requires a surcharge loading period of about 6 months to a year. The time required may not be available unless early planning studies recognized the possible foundation cost reduction that may be achieved. Precompression is frequently advantageous for warehouses and one-story structures. Precompression design should be covered as a separate design feature and not considered inherent in structure design.

Table 9-2. Checklist for Influence of Site Charateristics on Foundation Selection for Family Housing

Site Characteristics		Foundations[a]			
Natural Ground	Grading	Post	Spread	Slab-on-Grade (all)	Basement
Level	None	--	--	--	1, 2, 3, 4, 5
Rolling	None	--	--	Requires grading	1, 2, 3, 4, 5
Rolling	Cut and fill	--	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
Hilly	None	--	--	Requires grading	1, 2, 3, 4, 5
Hilly	Cut and fill	--	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
Groundwater					
Surface		--	Requires temporary lowering	--	Do not use
Footing level below footing level		--	--	--	Use perimeter drainage
Soil Type					
GW, GP, GM, GC SW, SP, SM, SC		1, 2	1, 2	1, 2	1, 2
ML, CL, OL MH, CH, OH		3, 4, 5, 6	3, 4, 5, 6	3, 4, 5, 6	3, 4, 5, 6

[a]
1. Compaction control - increase density if required, use compaction control in fills.
2. Check relative density of cohesionless (GW, GP, SW, SP) soils; generally based on standard penetration resistance.
3. Use undrained shear strength, s_u, to estimate bearing capacity and stress ratios for slab design.
4. Check if settlement is a problem.
5. Check liquidity index as indication of normally or preconsolidated clay.
6. Check expansive properties.