CHAPTER 4
SITE INVESTIGATION

4-1. General

Once the floor slab load capacity requirements have been established, an investigation of the existing conditions at the site must be made. Conditions to be considered include an investigation of the subgrade, climatic conditions, the need for and availability of base course materials, and the concrete strength properties likely to be encountered in the locale.

4-2. Subgrade conditions.

a. Importance of subgrade conditions. The subgrade provides a foundation for supporting the floor slab and base courses. As a result, the required floor slab thickness and the performance obtained form the floor slab during its design life will depend in a large part, on the uniformity and bearing capacity of the subgrade. It is desirable, if economically feasible, to thoroughly investigate the subgrade to assess the maximum support potential for the particular subgrade. In unheated structures, the possibility of frost heave emphasizes the importance of uniformity of soil conditions under the floor slab.

b. Initial investigation. Preliminary investigations of subgrade conditions at the site of proposed construction should be performed to determine the engineering characteristics of the subgrade soils and the extent of any peculiarities of the proposed site. The general suitability of the subgrade soils is to be based on classification of the soil, moisture density relationships, expansive characteristics, susceptibility to pumping, and susceptibility to detrimental frost action. A careful study of the service history of existing floor slabs on similar subgrade materials in the locality of the proposed site should be made. Factors such as ground water, surface infiltration, soil capillarity, topography, rainfall, drainage conditions, and the seasonal change of such factors also may affect the support rendered by the subgrade.

c. Exploration and classification. If field reconnaissance and analysis of existing subsurface information are insufficient to provide the necessary data for floor-slab design, an exploration program should be initiated according to provisions of TM 5-81 8-1/ AFM 88-3, Chap. 7. All soils should be classified in accordance with MIL-STD-619. Sufficient investigations should be performed at the proposed site to facilitate the classification of all soils that will be used or removed during construction; other pertinent descriptive information should also be included.

d. Performance data. For the design of rigid floor slabs in areas where no previous experience regarding floor slab performance is available, the modulus of subgrade reaction k to be used for design purposes is determined by the field plate-bearing test. A description of the procedure to be followed for this test and the method for evaluating test results are given in MIL-STD-621. Where performance data from existing floor slabs on grade are available, adequate values for k usually can be estimated on the basis of soil type, drainage conditions, and frost conditions that prevail at the proposed site. Table 4-1 lists typical values of modulus subgrade reaction for various soil types and moisture contents. Values shown may be increased slightly if the density is greater than 95 percent maximum CE 55 density, except that a maximum of 500 pounds per cubic inch will be used for design. These values should be considered as a guide only, and their use in lieu of the field plate-bearing test is left to the discretion of the engineer. The fact that the materials are shown in the table does not indicate suitability for use. Suitability must be determined for the particular job conditions.

Table 4-1. Typical values of modulus of subgrade reaction

Types of Materials	Modulus of Subgrade Reaction, k, in lb/in^3 for Moisture Contents of							
	1 to 4%	5 to 8%	9 to 12%	13 to 16%	17 to 20%	21 to 24%	25 to 28%	Over 29%
Silts and clays Liquid limit > 50 (OH, CH, MH)	--	175	150	125	100	75	50	*25*
Silts and clays Liquid limit < 50 (OL, CL, ML)	--	200	175	150	125	100	75	50
Silty and clayey sands (SM & SC)	300	250	225	200	150	—	—	--
Gravelly sands (SW & SP)	300+	300	250	—	—	—	—	--
Silty and clayey gravels (GM & GC)	300+	300+	300	250	—	—	—	--
Gravel and sandy gravels (GW & GP)	300+	300+	—	—	—	—	—	--

NOTE: k values shown are typical for materials having dry densities equal to 90 to 95 percent of the maximum CE 55 density. For materials having dry densities less than 90 percent of maximum CE 55 density, values should be reduced by 50 lb/in^3, except that a k of 25 lb/in^3 will be the minimum used for design.

4-3. Environmental conditions.

a. Freezing and thawing. Special additional design considerations and measures are necessary where freezing and thawing may occur in underlying soils. The effects of such occurrences, which are termed “frost action,” include surface heaving during freezing and loss of bearing capacity upon thawing. Detrimental frost action is the result of the development and/or thawing of segregated ice in underlying soils. Potential difficulties from frost action exist whenever a source of water is available to a frost-susceptible soil which is subject to subfreezing temperatures during a portion of the year. Conditions necessary for the development of ice segregation in soils together with a description of the ice segregation process and the detrimental effects of frost action are given in TM 5-818-2/AFM 88-6, Chap. 4.

b. Cold storage facilities. A somewhat different problem is encountered in cold storage facilities where a structure in contact with the ground is maintained at subfreezing temperature. Thus, frost action under such structures is a long-term rather than a seasonal phenomenon, and deep frost penetration will eventually result, even in areas where subfreezing ground temperatures are not naturally experienced, unless insulation or provisions for circulation of warm air beneath the slab are provided in design. Recommended as a reference is American Society of Heating, Refrigerating, and Air-Conditioning Engineering ASHRAE Handbook and Product Directory, Equipment, and Applications, (see Biblio). It should be kept in mind that insulation may merely slow frost penetration. It does not prevent heat flow.

c. Permafrost. Since construction alters the existing thermal regime in the ground, an additional problem is encountered in regions where heat flow from the facility may result in the progressive thawing of perennially frozen ground (permafrost). Thermal degradation of permafrost which contains masses of ice will result in subsidence as well as reduction in bearing capacity. Both may be severe. The most widely employed, effective, and economical means of maintaining a stable thermal regime in permafrost under slabs-on-grade is by means of a ventilated foundation. Provision is made for ducted circulation of cold winter air between the insulated floor and underlying ground. The air circulation serves to carry away the heat both from the foundation and the overlying building, freezing back the upper layers of soil which were thawed the preceding summer. The characteristics of permafrost and engineering pinciples in permafrost regions are described in TM 5-852-1/AFM 88-19, Chap. 1, and TM 5-852-4.

d. Applicable technical manuals. Where freezing and/or thawing may occur in underlying soils, slab design will be in accordance, as applicable, with TM 5-818-2/AFM 88-6, Chap. 4 and TM 5-852-4. Thermal computatio procedures are detailed in TM 5-852-6/ AFM 88-19, Chap. 6.

4-4. Concrete strength.

a. General. For a given water-cement ratio, the concrete strength likely to be obtained in a given locale depends primarily on the aggregate sources available. Maximum particle size and quality of the coarse aggregate will have a pronounced effect on concrete strength as will the gradation of the blended coarse and fine aggregate. In general, aggregates of the bankrun variety, as opposed to crushed aggregates, will produce a lower-strength concrete due to particle shape. Specified concrete strength should be sufficient to provide high wear resistance properties, constructability, and a reasonably high flexural stress to attain the greatest economy in the design. A study should be made of the strengths likely to be encountered, since specifying an unusually high-strength concrete mix may result in a higher material cost for the project.

b. Traffic types. The minimum concrete compressive strength for floors subjected to pneumatic tired traffic will be 4,000 pounds per square inch; for floors subjected to abrasive traffic such as steel wheels, the minimum concrete compressive strength will be 5,000 pounds per square inch.