CHAPTER 9

RIGID PAVEMENT DESIGN

9-1. Soil Classification and Tests. All soils should be classified according to the Unified Soil Classification System (USGS) as given in ASTM D 2487. There have been instances in construction specifications where the use of such terms as "loam," "gumbo," "mud," and "muck" have resulted in misunderstandings. These terms are not specific and are subject to different interpretations throughout the United States. Such terms should not be used. Sufficient investigations should be performed at the proposed site to facilitate the description of all soils that will be used or removed during construction in accordance with ASTM D 2487; any additional descriptive information considered pertinent should also be included. If Atterberg limits are a required part of the description, as indicated by the classification tests, the test procedures and limits should be referenced in the construction specifications.

9-2. Compaction.

a. General. Compaction improves the stability of the subgrade soils and provides a more uniform foundation for the pavement. ASTM D 1557 soil compaction test conducted at several moisture contents is used to determine the compaction characteristics of the subgrade soils. The range of maximum densities normally obtained in the compaction test on various soil types is listed in TM 5-825-2. This test method should not be used if the soil contains particles that are easily broken under the blow of the tamper unless the field method of compaction will produce a similar degradation. Certain types of soil may require the use of a laboratory compaction control test other than the above-mentioned compaction test. The unit weight of some types of sands and gravels obtained using the compaction method above may be lower than the unit weight that can be obtained by field compaction; hence, the method may not be applicable. In those cases where a higher laboratory density is desired, compaction tests are usually made under some variation of the ASTM D 1557 method, such as vibration or tamping (alone or in combination) with a type hammer or compaction effort different from that used in the test.

b. Requirements. For all subgrade soil types, the subgrade under the pavement slab or base course must be compacted to a minimum depth of 6 inches. If the densities of the natural subgrade materials are equal to or greater than 90 percent of the maximum density from ASTM D 1557, no rolling is necessary other than that required to pro- vide a smooth surface. Compaction requirements for cohesive soils (LL > 25; PI > 5) will be 90 percent of maximum density for the top 6 inches of cuts and the full depth of fills. Compaction requirements for cohesionless soils (LL < 25: PI <5) will be 95 percent for the top 6 inches of cuts and the full depth of fills. Compaction of the top 6 inches of cuts may require the subgrade to be scarified and dried or moistened as necessary and recompacted to the desired density.

c. Special soils. Although compaction increases the stability and strength of most soils, some soil types show a marked decrease in stability when scarified, worked, and rolled. Also, expansive soils shrink excessively during dry periods and expand excessively when allowed to absorb moisture. When soils of these types are encountered, special treatment will usually be required. For nominally expansive soils, water content, compaction effort, and overburden should be determined to control swell. For highly expansive soils, replacement to depth of moisture equilibrium, raising grade, lime stabilization, prewetting, or other acceptable means of controlling swell should be considered (see TM 5-818-7 for guidance).

9-3. Treatment of Unsuitable Soils. Soils not suitable for subgrade use (as specified in TM 5-825-2/AFM 88-6, Chap 2, and MIL-STD-619) should be removed and replaced or covered with soils which are suitable. The depth to which such adverse soils should be removed or covered depends on the soil type, drainage conditions, and depth of freezing temperature penetration and should be determined by the engineer on the basis of judgment and previous experience, with due consideration of the traffic to be served and the costs involved. Where freezing temperatures penetrate a frost-susceptible subgrade, design procedures outlined in chapter 17 herein, or TM 5-852-3 as applicable, should be followed. In some instances, unsuitable or adverse soils may be improved economically by stabilization with such materials as cement, flyash, lime, or certain chemical additives, whereby the characteristics of the composite material become suitable for subgrade purposes. Criteria for soil stabilization are in TM 5-822-4. However, subgrade stabilization should not be attempted unless the costs reflect corresponding savings in base-course, pavement, or drainage facilities construction.

9-4. Determination of Modulus of Subgrade Reaction. For the design of rigid pavements in those areas where no previous experience regarding pavement performance is available, the modulus of subgrade reaction k to be used for design purposes is determined by the field plate-bearing test. This test procedure and the method for evaluating its results are given in MIL-STD-621A. Where performance data from existing rigid pavements are available, adequate values for k can usually be determined on the basis of consideration of soil type, drainage conditions, and frost conditions that prevail at the proposed site. Table 9-1 presents typical values of k for various soil types and moisture conditions. These values should be considered as a guide only, and their use in lieu of the field plate-bearing test, although not recommended, is left to the discretion of the engineer. Where a base course is used under the pavement, the k value on top of the base is used to determine the pavement thickness. The plate-bearing test may be run on top of the base, or figure 9-1 may be used to determine the modulus of soil reaction on top of the base. It is good practice to confirm adequacy of the k on top of the base from figure 9-1 by running a field plate-load test.

*Table 9-1. Modulus of Soil Reaction**

Type of material	Moisture content percentage							
	1 to 4	5 to 8	9 to 12	13 to 16	17 to 20	21 to 24	25 to 28	Over 28
Silts and clays, LL greater than 50 (OH, CH, MH)		175	150	125	100	75	50	25
Silts and clays LL less than 50 (OL, CL, ML)		200	175	150	125	100	75	50
Silty and clayey sands (SM and SC)	300	250	225	200	150			
Sand and gravelly sands (SW and SP)	350	300	250					
Silty and clayey gravels (GM and GC)	400	350	300	250				
Gravel and sandy gravels (GW and GP)	500	450						

Notes:

1. Values of k shown are typical for materials having dry densities equal to 90 to 95 percent of the maximum. For materials having dry densities less than 90 percent of the maximum, values should be reduced by 50 pounds per cubic inch (pci), except that a k of 25 pci will be the minimum used for design.

2. Values shown may be increased slightly if density is greater than 95 percent of the maximum, excpet that a k of 500 pci will be the maximum used for design.

3. Frost area k values are given in chapter 10 of this manual.

*Typical values of k in pci for rigid pavement design.

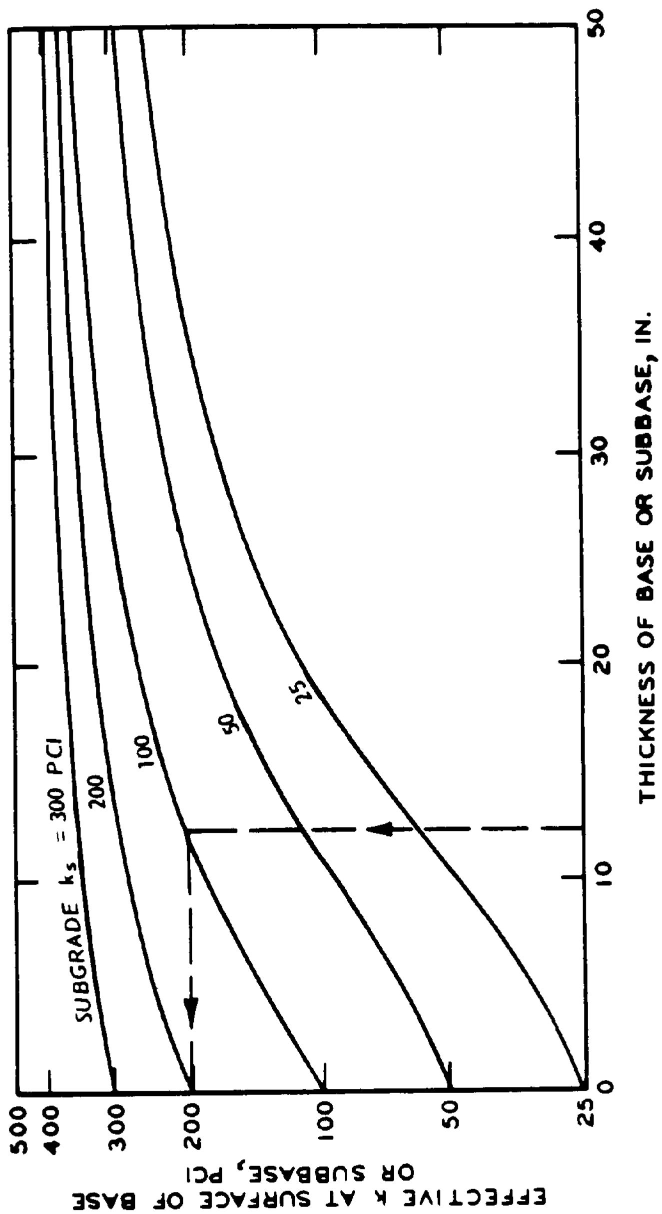

Figure 9-1. Effect of Base-Course Thickness on Modulus of Soil Reaction.