U.S. Department
of Transportation

**Federal Aviation
Administration**

Advisory Circular

Subject: CHANGE 1 TO AIRPORT PAVEMENT DESIGN AND EVALUATION

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Change: 1

1. PURPOSE. The purpose of this change is to correct an error in the graph for Figure **2-4,** Effect of Subbase on Modulus of Subgrade Reaction, and to change a typographical error in paragraph 339b, which was incorrect in the initial printing of **AC** 150/5320-6D.

The change number and date of change is shown at the top of each page.

PAGECONTROLCHART

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15 and 16	7/7/95	15	1/30/96
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for
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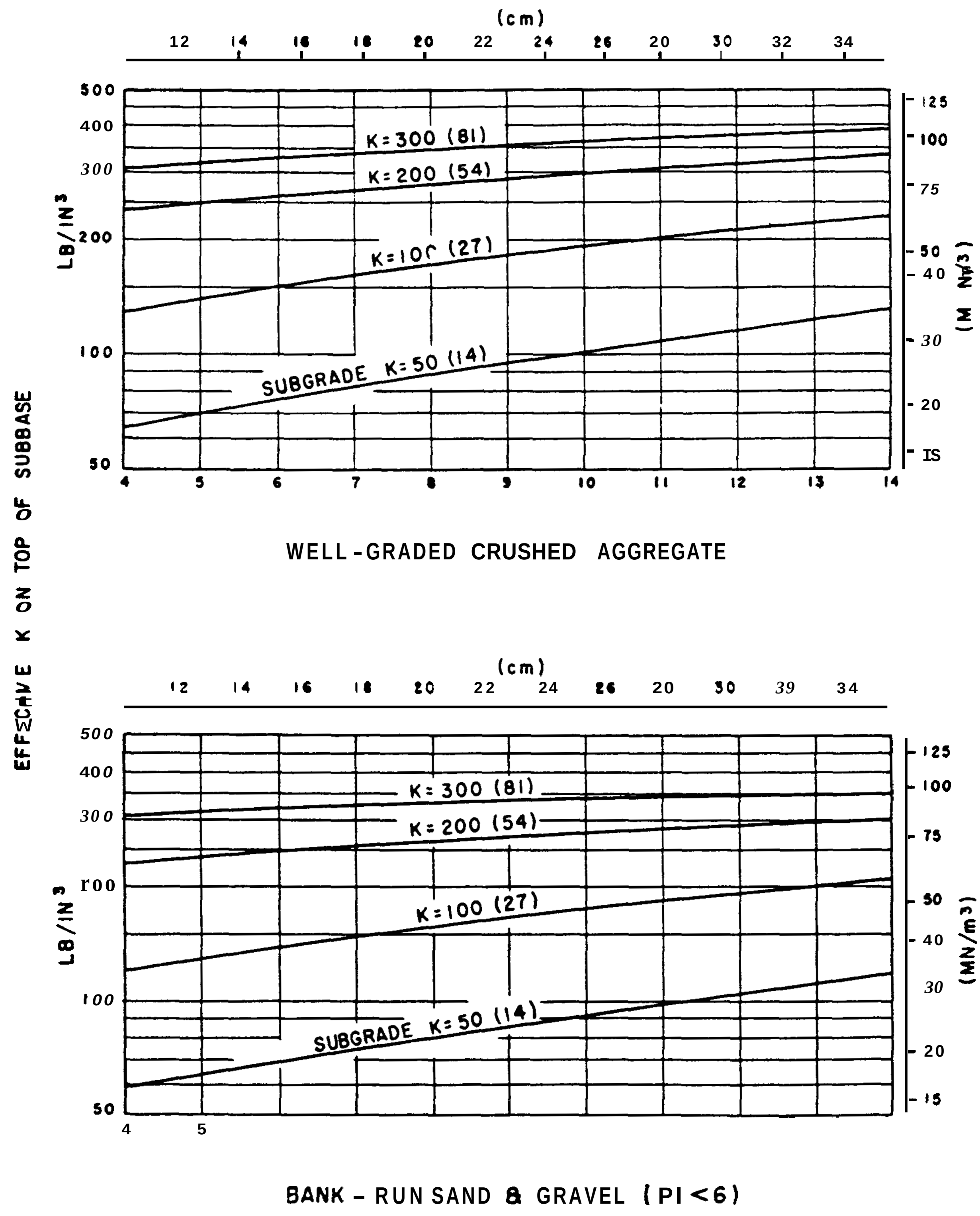

FIGURE 2-4. EFFECT OF SUBBASE ON MODULUS OF SUBGRADE REACTION

207. SUBGRADE STABILIZATION. Subgrade stabilization should be considered if one or more of the following conditions exist: poor drainage, adverse surface drainage, frost, or need for a stable working platform. Subgrade stabilization can be accomplished through the addition of chemical agents or by mechanical methods.

a. Chemical Stabilization. Different soil types require different stabilizing agents for best results. The following publications are recommended to determine the appropriate type and amount of chemical stabilization for subgrade soils. US Army, Corps of Engineers, Technical Manual TM 5-818-UAFM 88-6 Chapter 6 ; Technical Manual 5-825.2/AFM 88-6 Chapter 2; Technical Manual 5-824-3/AFM 88-6, Chapter 3; Soil Cement Handbook. Portland Cement Association; and The Asphalt Institute Manual Series MS-19, A Basic Asphalt Emulsion Manual.

b. Mechanical Stabilization. In some instances subgrades cannot be adequately stabilized through the use of chemical additives. The underlying soils may be so soft that stabilized materials cannot be mixed and compacted over the underlying soils without failing the soft soils. Extremely soft soils may require bridging in order to construct the pavement section. Bridging can be accomplished with the use of thick layers of shot rock or cobbles. Thick layers of lean, porous concrete have also been used to bridge extremely soft soils. Geotextiles should be considered as mechanical stabilization over soft, fine-grained soils. Geotextiles can facilitate site access over soft soils and aid in reducing subgrade soil disturbance due to construction traffic. The geotextile will also function as a separation material to limit long-term weakening of pavement aggregate associated with contamination of the aggregate with underlying fine-grained soils. More information regarding construction over soft soils using geotextiles is provided in FHWA-KI-90-001 (see Appendix 4).

208. SEASONAL FROST. The design of pavements in areas subject to seasonal frost action requires special consideration. The detrimental effects of frost action may be manifested by nonuniform heave and in loss of soil strength during frost melting. Other related detrimental effects include: possible loss of compaction, development of pavement roughness, restriction of drainage, and cracking and deterioration of the pavement surface. Detrimental frost action requires three conditions be met simultaneously: first, the soil must be frost susceptible; secondly, freezing temperatures must penetrate into the frost susceptible soil; thirdly, free moisture must be available in sufficient quantities to form ice lenses.

a. Frost Susceptibility. The frost susceptibility of soils is dependent to a large extent on the size and distribution of voids in the soil mass. Voids must be of a certain critical size for the development of ice lenses. Empirical relationships have been developed correlating the degree of frost susceptibility with the soil classification and the amount of material finer than 0.02 mm by weight. Soils are categorized into four groups for frost design purposes, Frost Group 1 (FG-I), FG-2, FG-3, and FG-4. The higher the frost group number the more susceptible the soil, i.e., soils in frost group 4 are more frost susceptible than soils in frost groups 1, 2, or 3. Table 2-4 defines the frost groups.

b. Depth of Frost Penetration. The depth of frost penetration is a function of the thermal properties of the pavement and soil mass, the surface temperature, and the temperature of the pavement and soil mass at the start of the freezing season. Several methods are available to calculate the depth of frost penetration and subsurface temperatures. The method presented here is a simplification of a method based on the modified Berggren equation. This method requires the use of the air freezing index and the dry unit weight of the soil.

(1) Air Freezing Index. The air freezing index is a measure of the combined duration and magnitude of below freezing temperatures occurring during any given freezing season. the average daily temperature is used in the calculation of freezing index. For example, assume the average daily temperature is 10 degrees below freezing for 10 days. The freezing index would be calculated as follows, 10 degrees X 10 days = 100 degree days. Ideally, air freezing indices should be based on actual data obtained from a meteorological station located in close proximity to the construction site. The air freezing index used for design (design air freezing index) should be based on the average of the 3 coldest winters in a 30 year period. if available, or the coldest winter observed in a 10 year period. Figures *2-6* and 2-7 show the approximate design air freezing indices for the lower United States and Alaska, respectively. The values shown in Figures 2-6 and 2-7 do not show local variation which may be substantial, especially in mountainous areas.

SECTION 3. RIGID PAVEMENT DESIGN

324. GENERAL. Rigid pavements for airports are composed of portland cement concrete placed on a granular or treated subbase course that is supported on a compacted subgrade. Under certain conditions, a subbase is not required, see paragraph 326.

325. CONCRETE PAVEMENT. The concrete surface must provide a nonskid surface, prevent the infiltration of surface water, and provide structural support to the Item P-501, Cement Concrete Pavement.

326. SUBBASE. The purpose of a subbase under a rigid pavement is to provide uniform stable support for the pavement slabs. A minimum thickness of 4 inches (100 mm) of subbase is required under all rigid pavements, except as shown in Table 3-10 below:

TABLE 3-10. CONDITIONS WHERE NO SUBBASE IS REQUIRED

Soil Classification	Good Drainage		Poor Drainage	
	No Frost	Frost	No Frost	Frost
GW	X	X	X	X
GP	X	X	X	
GM	X			
GC	X			
SW	X			

Note: X indicates conditions where no subbase is required.

327. SUBBASE QUALITY. The standard FAA subbase for rigid pavements is 4 inches (100 mm) of Item P-154, Subbase Course. In some instances it may be desirable to use higher quality materials or thicknesses of P-154 greater than 4 inches (100 mm). The following materials are acceptable for use as subbase under rigid pavements:

Item P-154 - Subbase Course
Item P-208 - Aggregate Base Course
Item P-209 - Crushed Aggregate Base Course
Item P-211 - Lime Rock Base Course
Item P-304 - Cement Treated Base Course
Item P-306 - Econocrete Subbase Course
Item P-401 - Plant Mix Bituminous Pavements

Materials of higher quality than P-154 and/or greater thicknesses of subbase are considered in the design process through the foundation modulus (k value). The costs of providing the additional thickness or higher quality subbase should be weighed against the savings in concrete thickness.

328. STABILIZED SUBBASE. Stabilized subbase is required for all new rigid pavements designed to accommodate aircraft weighing 100,000 pounds (45 400 kg) or more. Stabilized subbases are as follows:

Item P-304 - Cement Treated Base Course
Item P-306 - Econocrete Subbase Course'
Item P-401 - Plant Mix Bituminous Pavements

The structural benefit imparted to a pavement section by a stabilized subbase is reflected in the modulus of subgrade reaction assigned to the foundation. Exceptions to the policy of using stabilized subbase are the same as given in paragraph 320.

329. SUBGRADE. The subgrade materials under a rigid pavement should be compacted to provide adequate stability and uniform support as with flexible pavement; however, the compaction requirements for rigid pavements are not as stringent as flexible pavement due to the relatively lower subgrade stress. For cohesive soils used in fill sections, the entire fill shall be compacted to 90 percent maximum density. For cohesive soils in cut sections, the top 6 inches (150 mm) of the subgrade shall be compacted to 90 percent maximum density. For noncohesive soils used in fill sections, the top 6 inches (150 mm) of fill shall be compacted to 100 percent maximum density, and the remainder of the fill shall be compacted to 95 percent maximum density. For cut sections in noncohesive soils, the top 6 inches (150 mm) of subgrade shall be compacted to 100 percent maximum density and the next 18 inches (460 mm) of subgrade shall be compacted to **95** percent maximum density. Swelling soils will require special considerations. Paragraph 314 contains guidance on the identification and treatment of swelling soils.

a Contamination. In rigid pavement systems, repeated loading may cause intermixing of soft subgrade soils and aggregate base or subbase. This mixing may create voids below the pavement in which moisture can accumulate causing a pumping situation to occur. Chemical and mechanical stabilization of the subbase or subgrade can be effectively used to reduce aggregate contamination (refer to Section 207). Geotextiles have been found to be effective at providing separation between fine-grained subgrade soils and pavement aggregates (FHWA-90-001) (see Appendix 4). Geotextiles should be considered for separation between fine-grained soils and overlying pavement aggregates. In this application, the geotextile is not considered to act as a structural element within the pavement. Therefore, the modulus of the base or subbase is not considered to be increased when a geotextile is used for stabilization. For separation applications, the geotextile is designed based on survivability properties. Refer to FHWA-90-001 (see Appendix 4) for additional information regarding design and construction using separation geotextiles.

330. DETERMINATION OF FOUNDATION MODULUS (k VALUE) FOR RIGID PAVEMENT. In addition to the soils survey and analysis and classification of subgrade conditions, the determination of the foundation modulus is required for rigid pavement design. The foundation modulus (k value) should be assigned to the material directly beneath the concrete pavement. However, it is recommended that a **k** value be established for the subgrade and then corrected to account for the effects of subbase.

a. Determination of k Value for Subgrade. The preferred method of determining the subgrade modulus is by testing a limited section of embankment which has been constructed to the required specifications. The plate bearing test procedures are given in AASHTO T 222, Nonrepetitive Static Plate Load Test of Soils and Flexible Pavement Components, for Use in Evaluation and Design of Airport and Highway Pavements. If the construction and testing of a test section of embankment is impractical, the values listed in Table 2-3 may be used. The designer is cautioned that the values in Table 2-3 are approximate and engineeringjudgment should be used in selecting a design value. Fortunately, rigid pavement is not too sensitive to k value and an error in estimating k will not have a large impact on rigid pavement thickness.

b. Determination of k Value for Granular Subbase. The determination of a foundation modulus on top of a subbase by testing is usually not practical, at least in the design phase. Usually, the embankment and subbase will not be in place in time to perform any field tests. The assignment of a **k** value will have to be done without the benefit of testing. The probable increase in **k** value associated with various thicknesses of different subbase materials
* is shown in Figure 2-4. The upper graph in Figure 2-4 is intended for use when the subbase is composed of well graded crushed aggregate such **as** P-209. The lower graph in Figure 2-4 applies to bank-run sand and gravel such as P-154. These curves apply to unstabilized granular materials. Values shown in Figure 2-4 are considered guides and may be tempered by local experience. *

c. Determination of k Value for Stabilized Subbase. As with granular subbase, the effect of stabilized subbase is reflected in the foundation modulus. Figure 3-16 shows the probable increase in **k** value with various thicknesses of stabilized subbase located on subgrades of varying moduli. Figure 3-16 is applicable to cement stabilized (P-304) Econocrete (P-306), and bituminous stabilized (P-401) layers. Figure 3-16 was developed by assuming a stabilized layer is twice as effective as well-graded crushed aggregate in increasing the subgrade modulus. Stabilized layers of lesser quality than P-304, P-306 or P-401 should be assigned somewhat lower k values. After a k value is assigned to the stabilized subbase, the design procedure is the same as described in paragraph 331.

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