

# Design for Frost Protection of Airport Pavements in FAA Advisory Circular 150/5320-6E



Federal Aviation Administration

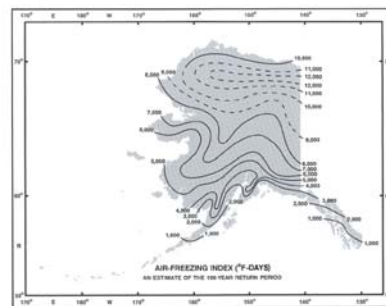
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## Design Air Freezing Index – U.S.

- Air Freezing Index data are no longer referenced in current FAA design guidance (AC 150/5320-6E)
- Useful for illustrating the extent of the United States that is subject to seasonal or permanent frost.



Source: [www.ncdc.noaa.gov](http://www.ncdc.noaa.gov)



## AC 150/5320-6E

### Airport Pavement Design and Evaluation

- **Published 2009.**
- **Superseded AC 15-5320-6D (1995).**
- **Main relevant sections for frost design:**
  - Sections 207, Seasonal Frost, and 208, Permafrost. Characterization of susceptible subgrade soils.
  - Section 307, Frost and Permafrost Design Methods.
  - Section 319, Frost effects, flexible pavements.
  - Section 331, Frost effects, rigid pavements.
  - Section 708, Areas susceptible to frost heave (considerations for shoulders).



## Chapter 2 – Key Elements

- **Engineering issues for airports:**
  - Loss of compaction.
  - Development of roughness (poor ride quality).
  - Surface distresses (cracking, heaving).
  - Disruption of drainage pathways.
- **Three elements to frost susceptibility:**
  - Frost susceptible soil.
  - Depth of frost penetration for local area.
  - Availability of sufficient free water.
- **Identify soil frost group (F1 – F4) for design.**
- **Permafrost involves additional considerations (calculate thawing depth).**



## Soil Frost Groups – Chapter 2

TABLE 2-3. SOIL FROST GROUPS

FROST GROUP	KIND OF SOIL	PERCENTAGE FINER THAN 0.02 mm BY WEIGHT	SOIL CLASSIFICATION
FG-1	Gravelly Soils	3 to 10	GW, GP, GW-GM, GP-GM
FG-2	Gravelly Soils Sands	10 to 20 3 to 5	GM, GW-GM, GP-GM, SW, SP, SM, SW-SM, SP-SM
FG-3	Gravelly Soils Sands, except very fine silty sands Clays, PI above 12	Over 20 Over 15 -	GM, GC SM, SC CL, CH
FG-4	Very fine silty sands All Silts Clays, PI = 12 or less Varved Clays and other fine grained banded sediments	Over 15 - - -	SM ML, MH CL, CL-ML CL, CH, ML, SM

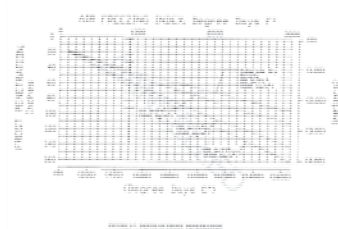
**Note: Classification of soils for frost susceptibility is the same for permafrost areas as for seasonal frost.**



## What was changed from -6D?

**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. In determining the frost penetration depth, primary consideration should be given to local engineering experience. Residential construction practice, including the experience of local building departments, is generally the best guide to frost penetration depth.

- **Primacy now given to local engineering experience (i.e., building departments) to determine frost line.**
- **No longer determine depth of frost penetration from correlation to freezing degree days.**



## Chapter 3 – Design for Seasonal Frost

- **The FAA allows 3 types of frost protection:**
  - Complete frost protection: All material to the frost penetration line must be non-frost-susceptible.
    - Positive results, but most expensive.
    - Usually recommended only for FG-3 and FG-4 (worst).
    - Only to a depth of 72 inches, due to economic considerations.
  - Limited subgrade frost protection: 65% of depth of frost penetration is replaced by NFS material.
    - Idea is to hold frost heave to a “tolerable” level.
    - Use for FG-4, or FG-1 – FG-3 if design conditions allow.
  - Reduced subgrade strength method.
- **3 methods apply to rigid and flexible pavements.**



## Design for Reduced Subgrade Strength

**TABLE 3-3. REDUCED SUBGRADE STRENGTH RATINGS**

Frost Group	Flexible Pavement CBR Value	Rigid Pavement <i>k</i> -value
FG-1	9	50
FG-2	7	40
FG-3	4	25
FG-4	Reduced Subgrade Strength Method Does Not Apply	

- **Designs are determined using FAARFIELD, except use the values above in lieu of “real” values.**
- **Does not consider frost heave risk – only presumed bearing capacity during thaw weakening.**
- **Compensate for lower strength by increasing thickness.**
- **Not allowed for FG-4.**



## Issues for Discussion

- **Current reduced subgrade strength ratings apply to the old design procedures, but may not be correct for FAARFIELD. In particular, the specified  $k$ -values may give the wrong results in the FAARFIELD (3D-FEM) procedure. We need to re-evaluate these.**
- **There are reports of damage to rural airport pavements in permafrost regions due to rising temperatures – what are the options for the FAA?**
- **How to handle pavement strength ratings (PCN) for pavements whose thickness is significantly greater than the structural requirement due to complete or partial frost protection requirements.**



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**Thank You! Takk!**

**<http://www.airporttech.tc.faa.gov/>**



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