

Rigid Pavement Design Spreadsheet: [R805FAA.xls](#)

This spreadsheet was designed to produce Rigid pavement design thickness' in accordance with FAA Advisory Circular AC 150/5320-6D, Airport Pavement Design and Evaluation.

The spreadsheet breaks the design process into 8 steps and is designed to prompt the user for design input parameters during each step. Users are encouraged to complete the design by following the individual steps in numerical order. Since thickness computations are based upon values gathered during each step, completion of the steps in numerical order assures that the proper values are assigned for the respective variables. Once all steps have been completed, the user may go back and modify the input values of any step, then skip directly to step 8 to see the results of the variable change.

The screenshot displays the 'Design Pavement Section' of the 'FAA Rigid Airport Pavement Design' spreadsheet. On the left, a vertical list of steps is shown in a yellow box:

- Enter Airport & Design Information (step 1)
- Enter Subgrade Frost Information
Subgrade k-value and Subbase Information (step 2)
- Concrete Properties (step 3)
- Enter Aircraft Mix (steps 4-6)
- Overlay Design (step 7)
- Go To Design Summary (step 8)


On the right, a diagram shows a cross-section of an aircraft on a runway. Below the aircraft, the pavement structure is depicted as a stack of four layers: PCC Pavement (white), Stabilized Subbase Layer (light blue), Aggregate Subbase Layer (light green), and Subgrade (orange).

Below the diagram, a yellow box contains the instruction: 'To assure correct answers - complete each step in numerical order. If data is changed in any given step, complete each step below that step.'

At the bottom of the spreadsheet interface, a white box with a black border contains the following disclaimer: 'This software is currently under development and is not officially adopted as a FAA standard. Designs developed using this program should be checked against AC 150/5320-6D to insure accuracy and conformance to existing standards'

- [STEP 1. General Airport/Project Information](#)
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STEP 1. General Airport/Project Information - Displayed with Output



The image shows a dialog box titled "Airport Data" with a close button (X) in the top right corner. The dialog box contains six input fields, each with a label above it:

- Enter the Airport Name**: The input field contains "Airport USA".
- Enter the City Associated with the Airport**: The input field contains "Anywhere USA".
- Enter the Project AIP Number**: The input field contains "X-XX-XXXX-XX".
- Enter the Design Firm**: The input field contains "Engineer's Are Us".
- Enter the Designers Name**: The input field contains "Joe Engineer".
- Enter the Date the design is performed**: The input field contains "10/10/00".

At the bottom center of the dialog box is an "OK" button.

Provides general project data which is displayed with the design summary.

This information is optional and does not affect numerical calculations.

STEP 2. Subgrade Support Information

Frost Design
✕

Subgrade Frost Design

The design of an airport pavement must consider the climatic conditions which will act on the pavement during its construction and service life. The protection of pavements from the adverse effects of seasonal frost and permafrost are considered in the design of airport pavements in one of three ways.

- (1) Complete Frost Protection
- (2) Limited Subgrade Frost Protection
- (3) Reduced Subgrade Strength

[Click here for additional information on Frost Protection methods and Frost Codes](#)

Re-enter Degree Day and Soil Unit Weight to Calculate Depth of Frost Penetration
(This does not change the k-value of the subgrade)

Degree Days (°F)	250
Dry Unit Weight of Soil (lb/cf)	100
Depth of Frost Penetration (in)	22.5

Pavements with subgrade soils of the FG-1, FG-2 & FG-3 frost groups may be designed using the REDUCED SUBGRADE STRENGTH method. FG-4 soils and extreme FG-3 soil should use the COMPLETE FROST PROTECTION design method.

The user must determine what level of frost protection will be provided to the pavement section. The spreadsheet can determine the required thickness for the non-frost condition and the Reduced Subgrade Support conditions. If the user elects to use the RSS method they should click the button labeled "Use the RSS method for this pavement Design". The program will override the input values for subgrade modulus (k-values) with predetermined values in accordance with the following table

Frost Code	Reduced Subgrade k-value
F-1	50
F-2	35
F-3	25
F-4	Not Applicable

These values represent a weakened subgrade during the frost thaw period. Note that the RSS method is no longer applicable when F-4 Frost code soils are encountered. When F-4 soils are involved, the user must protect against frost weakening by improving the subgrade materials within the anticipated frost depth.

Frost Design

Enter the Air Freezing Index (Degree Days °F)
Value must be between 200 and 4500

550

Enter the Dry Unit Weight of the Soil (lb/cf)
Value must be between 100 and 150

110

OK

Frost depth information is in tabular form as provided by the Corp of Engineers in 1986. Frost depth values are simple interpolations of the tabular data.

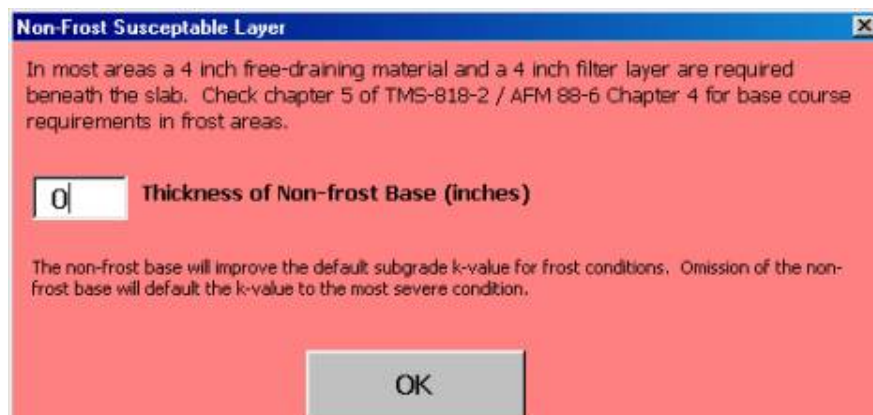
Frost Penetration (Inches)

Degree Days	Soil Unit Weight lb/cf			
	100	115	125	150
200	20.5	21.5	23.8	25.5
400	27.5	30.5	35	38.5
600	34	38	44.5	49
800	40	44.5	54	59
1000	45	51	62	69
2000	69.5	79	102	113
3000	92	105	140	156
4000	115	130	177	205
4500	125	145	197	225

If Complete Subgrade Protection or Limited Subgrade Protection are desired, the user may enter the Degree-Days and Soil Unit Weight to determine the depth of frost penetration. This information does not affect the thickness calculations.

The final pavement section should be checked against the required depth for complete frost protection. If additional thickness is required, it should be constructed of non-frost susceptible material.

When the user elects to design the pavement based upon the Reduced Subgrade Support (RSS) method they will be asked for a thickness of a free draining material beneath the slab. This layer is not discussed in AC 150/5320-6D but is recommended for design in Chapter 5 of TMS-818-2 / AFM 88-6 "Pavement Design for Seasonal Frost Conditions." If the designer elects to include this layer, it will improve the subgrade k-value above the default frost values. If the pavement section requires a stabilized base layer the free draining material should be below the bound layer. The free draining material should never be "sandwiched" between relatively impervious bound layers.



The screenshot shows a dialog box titled "Non-Frost Susceptible Layer". The background is light red. The text inside reads: "In most areas a 4 inch free-draining material and a 4 inch filter layer are required beneath the slab. Check chapter 5 of TMS-818-2 / AFM 88-6 Chapter 4 for base course requirements in frost areas." Below this text is a text input field containing the number "0" and the label "Thickness of Non-frost Base (inches)". At the bottom of the dialog box is an "OK" button. A small note at the bottom of the dialog box states: "The non-frost base will improve the default subgrade k-value for frost conditions. Omission of the non-frost base will default the k-value to the most severe condition."

The user then selects the subgrade soil frost code. The frost code determines the minimum subgrade support value as shown above and as detailed in Table 3-1 of AC 150/5320-6D.



The screenshot shows a dialog box titled "Subgrade Soil". The background is light gray. The text inside reads: "Subgrade Soil Frost Code". Below this text are five radio button options: "Non Frost Conditions", "F-1 Frost Code", "F-2 Frost Code", "F-3 Frost Code", and "F-4 Frost Code". At the bottom of the dialog box is an "OK" button.

Since the use of the Reduced Subgrade Support method is no longer permitted with F-4 soils, the spreadsheet will not allow RSS for F-4 soils. If the user wishes to verify previous designs, then may do so by designing a non-frost section with a manually reduced subgrade support value.

Subgrade / Stabilized subbase / Aggregate subbase

Enter the subgrade k-value and the thickness of the stabilized and/or aggregate subbase

Concrete Pavement

0	Enter the Thickness of the Stabilized Subbase Layer minimum thickness is 4 inches Enter 0 if no stabilized layer is present	Improved k-value after all layers 195
10	Enter the thickness of subbase aggregate layer minimum aggregate layer is 4 inches Enter 0 if no aggregate layer is present <input checked="" type="radio"/> Crushed Aggregate <input type="radio"/> Uncrushed Aggregate	k-value on top of aggregate layer 195
0	Free Draining Non-Frost susceptible Layer (If present, typically a 4" free draining material with 4" filter layer see chp 5 of TMS-818-2 / AFM 88-6 chp 4)	
100	Enter the Foundation Modulus (k value) for the S (Maximum permissible value is 500 psi)	k-value from Frost design 0

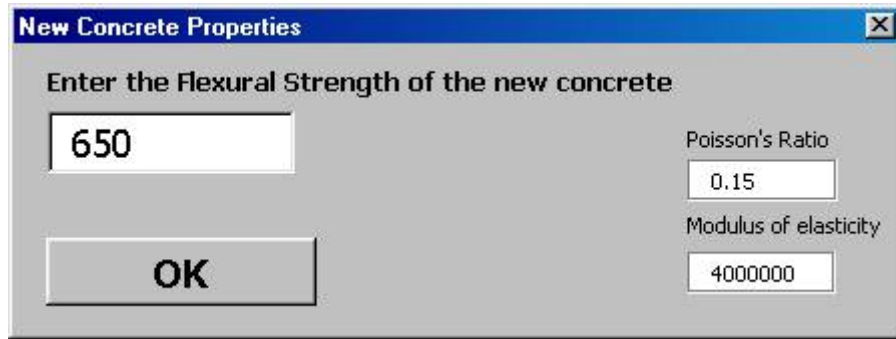
OK

To complete the subgrade data input, the user should enter the subgrade k value and the thickness of all stabilized and non-stabilized layers. The improved k-value will appear at the thickness of each layer is entered. If the design uses the RSS method for frost design, the k-value will default to the k-value determined by the soil frost code.

The user must also input the thickness of any subbase layers. The thickness of un-bound aggregate or stabilized layers must be determined by the user. Minimum thickness requirements are provided in AC 150/5320-6D, paragraphs 326 and 327. Other factors such as constructability may determine the minimum subbase requirements.

STEP 3. Concrete Properties

The user should enter the Flexural Strength of the new concrete. The Poisson's Ratio and Modulus of Elasticity may also be modified in the spreadsheet, however the default values are recommended and represent the values assumed in AC 150/5320-6D. Thickness designs performed with modified values for Poisson's Ration or Modulus of elasticity will not be consistent with the requirements of AC 150/5320-6D.



The image shows a dialog box titled "New Concrete Properties" with a close button (X) in the top right corner. The dialog box contains the following elements:

- A text label: "Enter the Flexural Strength of the new concrete"
- An input field containing the value "650".
- An input field labeled "Poisson's Ratio" containing the value "0.15".
- An input field labeled "Modulus of elasticity" containing the value "4000000".
- An "OK" button.

There is considerable debate regarding the age of the concrete in relationship to the flexural strength. Previous guidance had recommended that a 90 day flexural strength be specified for design purposes. Current guidance recommends that the design flexural strength of the concrete be based upon the age and strength the concrete will be required to have when it is scheduled to be opened to traffic.

STEP 4. Enter Aircraft Data

Step 4 ENTER AIRCRAFT DATA (below) Calculate thickness for each aircraft (step 5) Accept Critical Aircraft (step 6) (Return)

Enter up to 21 aircraft (in any order) See right for Large Aircraft Optional design

Clear All Aircraft	User's name for Aircraft (optional) e.g. Citation IV	Aircraft grouping --- Gear type AC 150/5320-6D	Default Weight	Max Takeoff weight MTOW	Annual Departures	Thickness Required for Each Individual Aircraft
		None		0	0	0.00
		None		0	0	0.00
		SINGLE WH-30		0	0	0.00
		SINGLE WH-45		0	0	0.00
		SINGLE WH-60		0	0	0.00
		SINGLE WH-75		0	0	0.00
		DUAL WH-50		0	0	0.00
		DUAL WH-75		0	0	0.00
		DUAL WH-100		0	0	0.00
		None		0	0	0.00
		None		0	0	0.00

Large Aircraft Design
 Gear Parallel to Joints (standard)
 Gear Skew to Joints (optional)

The user can enter up to 21 aircraft in the traffic mix. The aircraft selection is limited to those aircraft originally listed in the R806faa.exe program. Any combination of aircraft may be selected and aircraft types may be repeated.

The user may also select whether to use the optional design method discussed in AC 150/5320-6D, paragraph 332b, which considers aircraft gear skewed relative to the concrete joints.

Aircraft Input

Select the Desired Main Gear Configuration or Aircraft
 SINGLE WH-45

Accept the default weight or enter a desired aircraft weight
 45000

Annual Aircraft Departures
 0

Lower Limit: 37500 Upper limit: 52500

OK

Gear spacings are only accurate for limited weight ranges. The design aircraft weight must be between the limits below. If a weight outside these limits is desired, select a different main gear configuration

The program will prompt the user for aircraft weight and annual operations. Since each gear type is based upon a reasonable anticipated weight for the gear configuration, the program will limit the permissible weight range. If desired, the user may over-write these values directly in the spreadsheet. The user is cautioned to observe the weight limitations and select gear configurations appropriately. Greater thickness requirements will result from overloading a small gear versus under loading a larger gear. For example, a dual wheel aircraft weighing 125,000 pounds could be input as a DUAL100 or a DUAL150 aircraft.

The user can assign a local name to an aircraft for ease of identification. Local names can be entered directly into the spreadsheet. This is particularly useful when numerous aircraft are from a common gear configuration but vary in weight.

STEP 5. Calculate Thickness for Each Aircraft

The screenshot shows a software interface for calculating pavement thickness. It includes a table with the following data:

Clear All Aircraft	User's name for Aircraft (optional) e.g. Citation IV	Aircraft grouping --- Gear type AC 130/5330-6D	Default Weight	Max Takeoff weight MTOW	Annual Departures	Thickness Required for Each Individual Aircraft
	ABC Corp Jet #1	SINGLE WH-45		45,000	800	7.30
	ABC Corp Jet #2	DUAL WH-50		45,000	800	6.14
	MD-80	DUAL WH-100		100,000	800	10.37
	B-737	DUAL WH-100		120,000	800	11.74
	MD-80 Low Activity	DUAL WH-100		100,000	100	9.70
	B-737 Low Activity	DUAL WH-100		100,000	100	9.70
		None		0	0	0.00
		None		0	0	0.00
		None		0	0	0.00

Additional interface elements include:

- Buttons: Step 4 ENTER AIRCRAFT DATA (below), Calculate thickness for each aircraft (step 5), Accept Critical Aircraft (step 6) (Return)
- Large Aircraft Design options: Gear Parallel to Joints (standard), Gear Skew to Joints (optional)
- Text: Enter up to 21 aircraft (in any order), See right for Large Aircraft Optional design
- Label: Recommended Critical Aircraft (pointing to the B-737 Low Activity row)

Step 5 calculates and displays the required pavement thickness for each aircraft in the mixture and determines the most demanding (critical) aircraft.

This step is provided for the user's information and may be skipped as it is repeated by step 6.

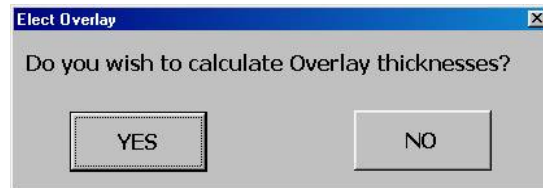
This step is particularly useful when analyzing the impact of one design variable. Suppose the user wants to see the impact of increasing weight while keeping annual departures constant. By entering the same aircraft multiple times and varying the weight, the user can immediately see the change in thickness required for each change in weight. Likewise, any variable can be changed while holding other variables constant.

STEP 6. Accept Critical Aircraft (Return)

This step repeats step 5 and accepts the aircraft data entered. The user is returned to the initial program entry screen.

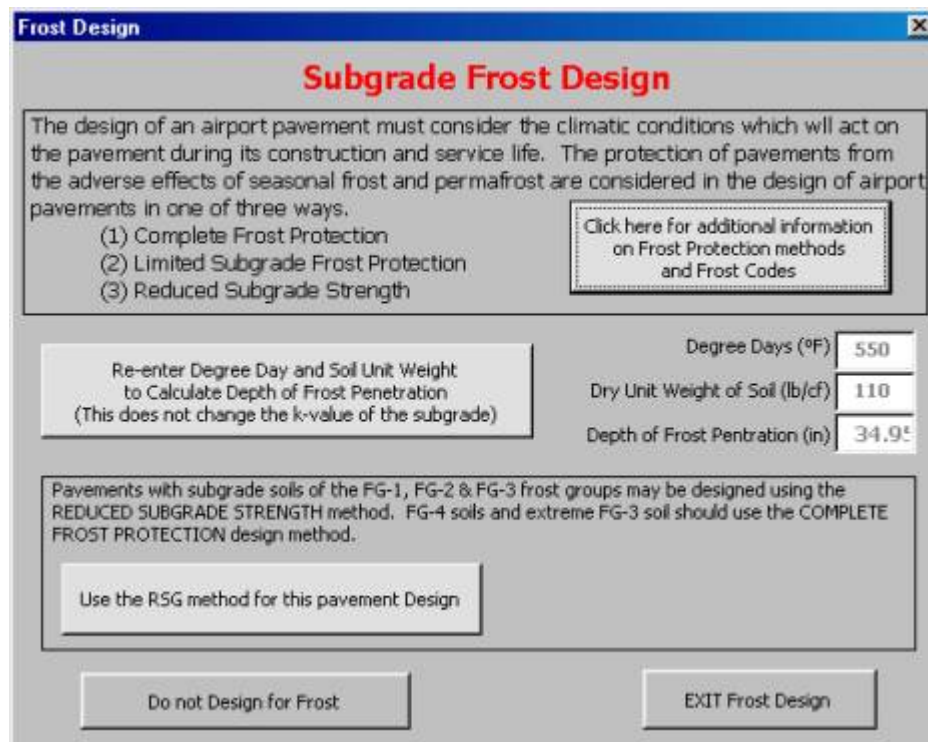
STEP 7. Overlay Design

The user is asked if they wish to calculate overlay thickness. If the user answers no, the data in the overlay section of the summary page will be eliminated. The program defaults to this conditions to avoid erroneous overlay design. If the user answers yes, the program will prompt the user for subgrade information.



A dialog box titled "Elect Overlay" with a close button (X) in the top right corner. The text inside asks "Do you wish to calculate Overlay thicknesses?". Below the text are two buttons: "YES" and "NO".

The subgrade Frost design will re-appear and should be answered as appropriate.



A dialog box titled "Frost Design" with a close button (X) in the top right corner. The main heading is "Subgrade Frost Design" in red. Below the heading is a text box explaining that airport pavement design must consider climatic conditions and lists three methods: (1) Complete Frost Protection, (2) Limited Subgrade Frost Protection, and (3) Reduced Subgrade Strength. A button labeled "Click here for additional information on Frost Protection methods and Frost Codes" is to the right. Below this is a section for re-entering data: "Re-enter Degree Day and Soil Unit Weight to Calculate Depth of Frost Penetration (This does not change the k-value of the subgrade)". To the right of this section are three input fields: "Degree Days (°F)" with value 550, "Dry Unit Weight of Soil (lb/cf)" with value 110, and "Depth of Frost Penetration (in)" with value 34.9. Below these fields is a text box stating: "Pavements with subgrade soils of the FG-1, FG-2 & FG-3 frost groups may be designed using the REDUCED SUBGRADE STRENGTH method. FG-4 soils and extreme FG-3 soil should use the COMPLETE FROST PROTECTION design method." Below this text box is a button labeled "Use the RSG method for this pavement Design". At the bottom of the dialog are two buttons: "Do not Design for Frost" and "EXIT Frost Design".

Existing Pavement Information

Future Concrete Pavement Overlay Or Asphalt Cement Concrete Overlay

Thickness of existing Concrete Pavement (inches) Enter Flexural Strength of Existing Slab (psi)

Enter the Cr Factor (0.35 - 1.0) Enter the Cb factor (0.75 - 1.0)

<input type="text" value="6"/>	Thickness of Existing Stabilized Subbase Layer minimum thickness is 4 inches Enter 0 if no stabilized layer is present	Improved k-value after all layers <input type="text" value="280"/>	<p>This Information is the same as entered in Step #2</p> <p>Both the new section and the overlay section will be based upon this information</p>
<input type="text" value="6"/>	Thickness of Existing subbase aggregate layer minimum aggregate layer is 4 inches Enter 0 if no aggregate layer is present: <input checked="" type="radio"/> Crushed Aggregate <input type="radio"/> Uncrushed Aggregate	k-value on top of aggregate layer <input type="text" value="157"/>	
<input type="text" value="0"/>	Free Draining Non-Frost susceptible Layer (If present, typically a 4" free draining material with 4" filter layer see chp 5 of TMS-818-2 / AFM 88-6 chp 4)		
<input type="text" value="100"/>	Enter the Foundation Modulus (k value) for the Subgrade (Maximum permissible value is 500 psi)	k-value from Frost design <input type="text" value="0"/>	

Much of the information presented in Step #2 is repeated for the users to view and/or modify as appropriate. In addition to the subgrade information, the user is prompted for information regarding the properties and condition of the existing pavement.

STEP 8. Go To Design Summary

Step 8 takes the user to the summary sheet

All information regarding the design is displayed on the summary sheet. The summary display is dynamic and will change depending upon design features. e.g. if a stabilized base is required, a note will appear on the summary sheet to indicate the requirement.

From the summary sheet, the user is permitted to print the summary and/or the aircraft mix.

The user may also elect to view a plot of annual departures versus required total thickness or a plot of flexural strength versus required total thickness for the design aircraft. These plots provide an indication of how sensitive the design is to changes in concrete flexural strength or annual departures.

Rigid Pavement Design For		Program Date 2/15/02	Print Summary and Aircraft Conversion
Airport Name: Any Airport		AC Method	
Associated City: Anywhere, USA		Date: today's date	
Design Firm: Engineer's Am Us		Designer: Joe Engineer	
AID Number: 3-XX-XXX-XX			
New Pavement Section Required		Stabilized Subbase Is Required	Print Summary Only
12.8	PCC Thickness	650 psi New Concrete Flexural Strength	
6.0	Stabilized Base		
6.0	Subbase		
0.0	Non-Frost Layer (free draining material)		
		Large Aircraft Parallel to Joints Standard design	Return to Rigid Design
Overlay Sections			
11.98"	Asphalt Overlay Thickness	10" Existing Slab Thickness	
6.62"	Unbonded PCC without leveling course	12.79" PCC needed for existing section	
9.87"	Unbonded PCC with leveling course	6" Existing Stabilized Subbase	
3"	Bonded PCC	6" Existing Aggregate Subbase	
		650 psi Existing Slab Flexural Strength	
		1 F-Factor used in design	
		0.85 Cr Factor	
		0.8 Cb Factor	
Frost Considerations (for new pavement section)			
Dry Unit Weight of Soil (lb/cf)	110		
Degree Days °F	500		
Soil Frost Code	Non-Frost		Subgrade k-value was not modified for frost
Frost Depth Penetration (in)	33.21		
k value on top of stabilized layer	280		
k value on top of subbase layer	157		
Original subgrade k value	100		
Design Aircraft Information			View/Print thickness chart for design aircraft
DUAL WE-100	20	Design Life (years)	
125000 lb		Gross Aircraft Weight	
2,016		Equivalent Annual Departures	
<p>is software is currently under development and is not officially adopted as a FAA standard. Designs developed using this program should be checked against AC 150/5320-6D to insure accuracy and conformance to existing standards</p>			
			View/Print Thickness versus Flexural Strength

To prepare the thickness chart for the design aircraft the program will prompt the user for the minimum and maximum number of annual departures. These values will determine the limits of the thickness chart.

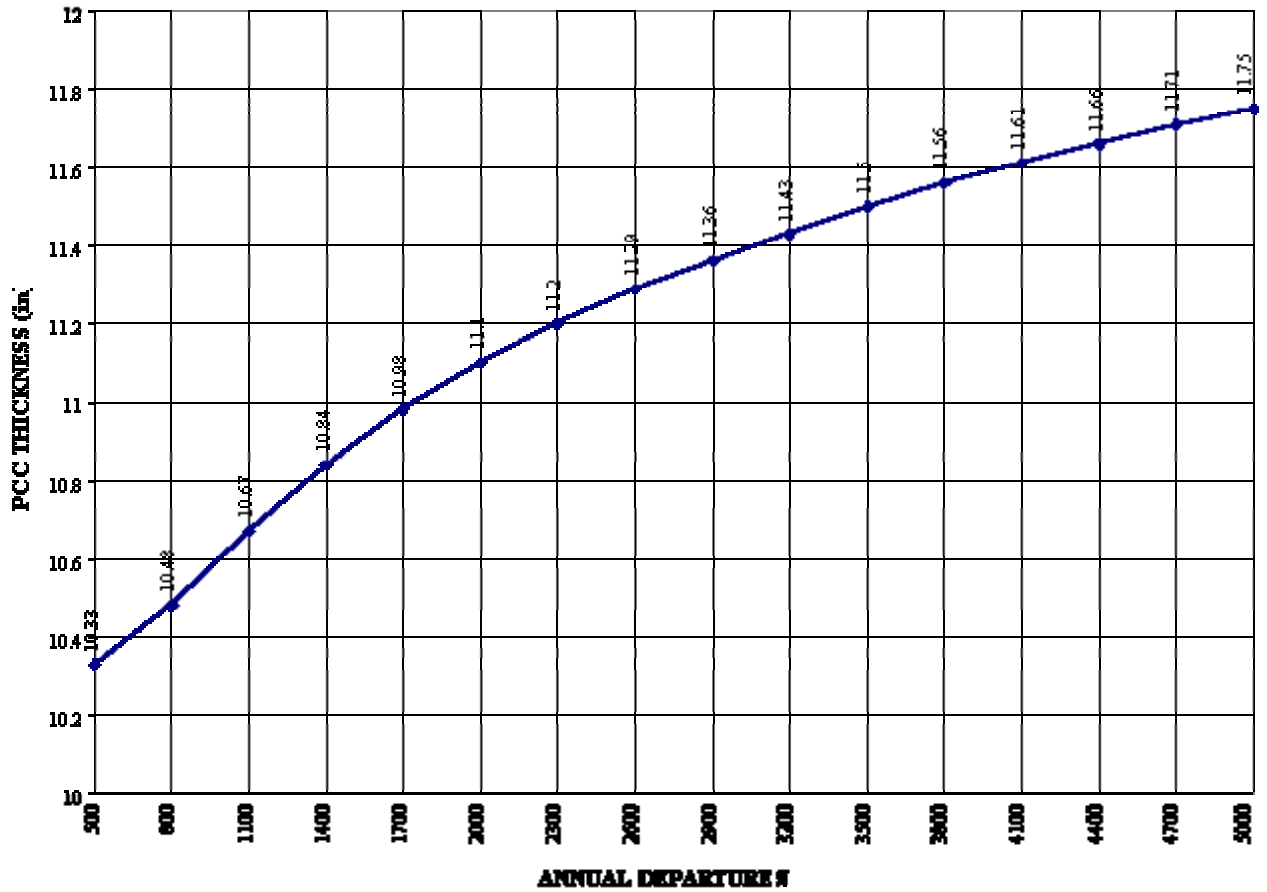
Range of annual departures [X]

Enter the range for the desired annual departures
These number will establish the limits of the thickness chart

Minimum annual departures

Maximum annual departures

Required thickness for DUAL WH-100 at 125000 lbs k on top of all subbase = 280 psi



To prepare the thickness versus flexural strength chart the program will prompt the user for the range of flexural strength. These values will determine the limits of the chart.

Enter the Flexural Strength Range ✕

500

Enter the Minimum Flexural Strength

800

Enter the Maximum Flexural Strength

OK

**Required thickness for DUAL, WE-100 at 125000 lbs k on top of all subbase = 280 pd
2016 departures – sub grade k = 100**

