

Flexible Pavement Design Spreadsheet: [F806FAA.xls](#)

This spreadsheet was designed to produce flexible 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 10 steps and is designed to prompt the user for design input parameters during each step. It is important 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 10 to see the results of the variable change.

Flexible Pavement Design AC 150/5320-6D

Step 1 Enter Airport Name and Data

Step 2 Enter Subgrade CBR & Frost Code

Step 3 Enter Subbase Information

Step 4 Select Default Aggregate Base

Step 5 (optional) Calculate Frost Penetration Depth

Steps 6, 7 & 8 Enter Aircraft Mix (steps 6-8)

Step 9 Compute for Stabilized layers

Step 10 Go To Design Summary

Typical Pavement Structure

Pavement Surface layer
Base Layer
Subbase #1 Layer
Subbase #2 Layer
Subbase #3 Layer
Subgrade

To Assure Proper Answers, Complete Each Step in Numerical Order

Light Aircraft Design (30,000 lbs or less)

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

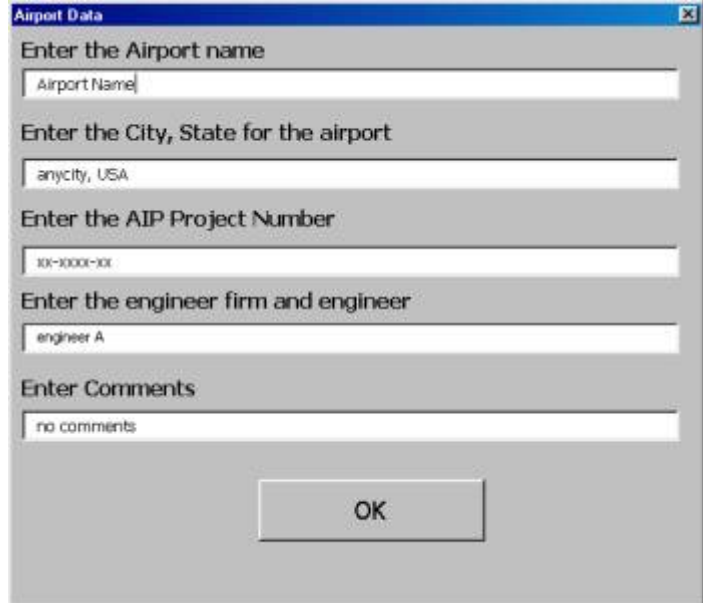
- [STEP 1. General Airport/Project Information](#)
- [STEP 2. Subgrade CBR](#)
- [STEP 3. Number of Subbases](#)
- [STEP 4. Default Aggregate Base Material](#)
- [STEP 5. Frost Penetration](#)
- [STEP 6. Enter Aircraft Data](#)
- [STEP 7. Find Required Thickness for Each Aircraft](#)
- [STEP 8. Accept Critical Aircraft](#)
- [STEP 9. Compute for Stabilized Layers](#)
- [STEP 10. Go to Design Summary](#)

STEP 1. General Information

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

This information is optional and does not affect numerical calculations.

[Return to Top](#)



Airport Data

Enter the Airport name
Airport Name

Enter the City, State for the airport
anycity, USA

Enter the AIP Project Number
101-10001-101

Enter the engineer firm and engineer
engineer A

Enter Comments
no comments

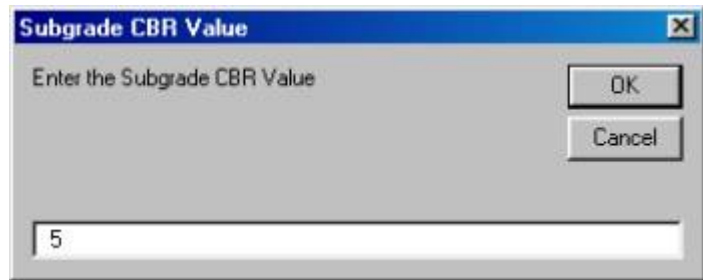
OK

STEP 2. Subgrade CBR

Enter the subgrade CBR value as defined in paragraph 315 of AC 150/5320-6D.

High values of CBR (i.e. >20) may not be appropriate for this design method.

Thickness results from high CBR subgrade layers may appear incorrect as the program will default to minimum thickness requirements as identified in 150/5320-6D. Designs performed with high subgrade CBR values may indicate negative subbase layer thickness.



A dialog box titled "Subgrade CBR Value" with a close button (X) in the top right corner. The main text inside says "Enter the Subgrade CBR Value". There are two buttons: "OK" and "Cancel". Below the text is a text input field containing the number "5".

Remember that the CBR design method requires that each layer be an improvement over the layer directly beneath, i.e. the subbase layer CBR must be higher than the subgrade CBR.

Each time the user activates Step 2, the default value in the pop up box will be a CBR of 5. Simply re-enter the desired CBR value and click OK.



A dialog box titled "Subgrade Soil" with a close button (X) in the top right corner. The main text says "Subgrade Soil Frost Condition". There are five radio button options: "Non Frost Conditions" (which is selected), "F-1 Frost Code", "F-2 Frost Code", "F-3 Frost Code", and "F-4 Frost Code". At the bottom is an "OK" button.

If frost consideration is appropriate, the spreadsheet calculates the pavement thickness necessary for a Reduced Subgrade Strength in accordance with paragraph 308 of AC 150/5320-6D.

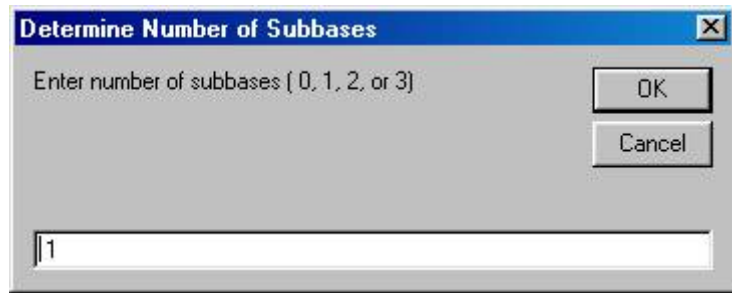
NOTE: The Reduced Subgrade Support method is not permitted for FG-4 soils with the publication of AC 150/5320-6D

If the user wishes to verify designs produce under AC 150/5320-6C, they may do so by manually reducing the subgrade CBR and selecting Non Frost Conditions.

STEP 3. Number of Subbases

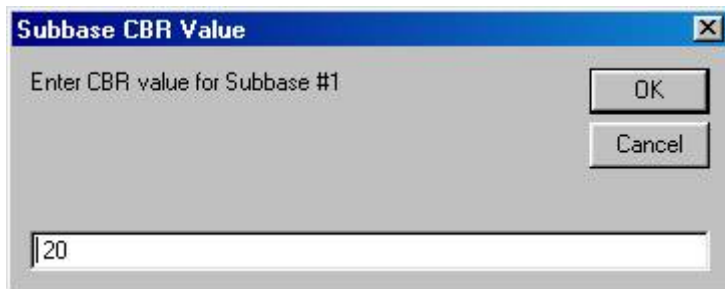
Determine the number of subbase layers to be included in the design.

The spreadsheet can design for a maximum of 3 subbase layers, however, most design requirements do not need the additional layers to provide sufficient pavement strength.



The dialog box titled "Determine Number of Subbases" has a blue header bar with a close button (X). The main area contains the text "Enter number of subbases (0, 1, 2, or 3)". Below this text is a text input field containing the number "1". To the right of the input field are two buttons: "OK" and "Cancel".

A design with multiple subbase layers tends to over-design the lower layers and under-design the upper layers. This is because the methodology is to determine the total thickness required over the subgrade material then subtract the thickness required over the first improved layer. The thickness of subsequent layers is subtracted from the remaining thickness. For example if a total thickness of 35 inches is required over the subgrade and a thickness of 15 inches is required over a subbase of CBR=20, then the subbase layer would be $35-15=20$ inches thick. This only leaves 15 inches to be distributed to any remaining layers.



The dialog box titled "Subbase CBR Value" has a blue header bar with a close button (X). The main area contains the text "Enter CBR value for Subbase #1". Below this text is a text input field containing the number "20". To the right of the input field are two buttons: "OK" and "Cancel".

20 for Item P-154.

Due to construction practicalities and cost feasibility, most typical designs only incorporate one subbase layer.

Enter the CBR value for the subbase material

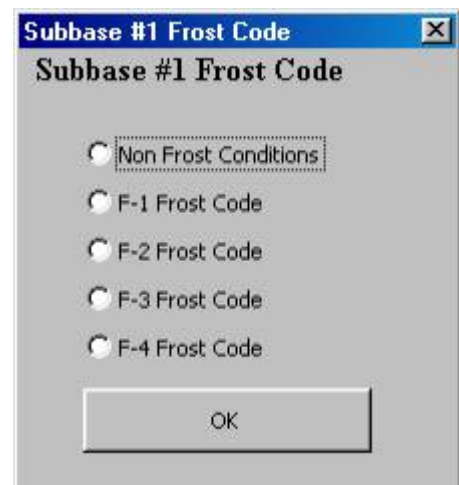
The user is reminded that AC 150/5320-6D assumes a CBR of

Select the Frost Code for the subbase material

Repeat for each subbase layer selected.

See the figure in the program for order of subbases (#1 is the top most layer)

Subbase layers must increase in strength as you move up in the pavement structure.



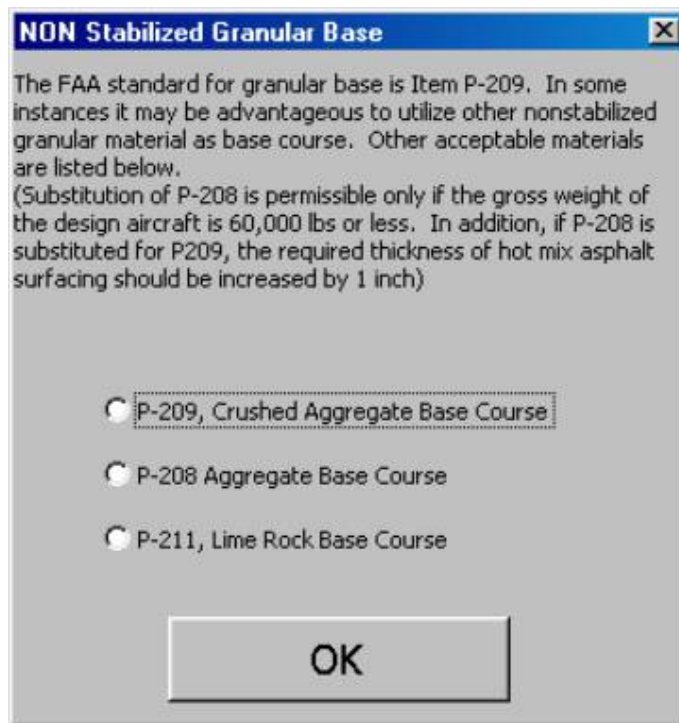
The dialog box titled "Subbase #1 Frost Code" has a blue header bar with a close button (X). The main area contains the text "Subbase #1 Frost Code" in bold. Below this text are five radio button options: "Non Frost Conditions", "F-1 Frost Code", "F-2 Frost Code", "F-3 Frost Code", and "F-4 Frost Code". The "Non Frost Conditions" option is selected. At the bottom of the dialog box is an "OK" button.

STEP 4. Default Aggregate Base Material

Item P209 is the default material for granular base. It is assumed that P-209 material can achieve a minimum CBR value greater than 80. This default value cannot be altered in the spreadsheet.

Others base materials, when permitted, will increase the asphalt surface course minimum thickness. If Item P-209 is not the default base material, the minimum thickness of the surface asphalt layer is automatically increased to 5 inches.

Item P-208 is permitted when aircraft are not expected to exceed a gross weight of 60,000 pounds.



STEP 5. Frost Penetration

Enter the degree days °F/day and subgrade unit weight lb/ft

This is an optional step and does not affect pavement thickness calculations. The user should compare the frost depth to the required protection depth. Computation of the frost depth is not necessary when the pavement design is based upon the Reduced Subgrade support method of frost design.

Frost Design

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

555

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

111

Calculated Frost Depth

35.38

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

STEP 6. Enter Aircraft Data

Step 6 ENTER AIRCRAFT DATA (below)		Step 7 Find Required Thickness For Each Aircraft	Step 8 Accept Critical Aircraft (Return)
Enter up to 21 aircraft (in any order) also enter Max weight & Annual Departures			
Clear All aircraft Information	User's name for Aircraft (optional) e.g. Citation IV	Aircraft grouping ----- Gear type AC 130/5320-6D Default Weight	Max Takeoff weight MTOW Annual Departures Thickness Required for Each Individual Aircraft
	Small biz-jet aircraft	DUAL50 - 50,000 lbs	50,000 1,350 0.00
	Charter - Boeing 727	DUAL200 - 200,000 lbs	190,500 45 0.00
	Regional Commuter	DUAL50 - 50,000 lbs	55,000 300 0.00
	Cargo - 737 aircraft	DUAL100 - 100,000 lbs	115,000 400 0.00
	Corporate AB2	DUAL100 - 100,000 lbs	105,000 200 0.00
		none	0 0 0.00
		none	0 0 0.00
		none	0 0 0.00
		none	0 0 0.00

Selection of Aircraft is limited to aircraft types identified in the original FORTRAN program.

The Spreadsheet is limited to a mixture of 21 individual aircraft. The user may select any combination of aircraft. Aircraft types may be repeated.

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.

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.

STEP 7. Find Required Thickness For Each Aircraft

Step 6 ENTER AIRCRAFT DATA (below)		Step 7 Find Required Thickness For Each Aircraft		Step 8 Accept Critical Aircraft (Return)		
Enter up to 21 aircraft (in any order) also enter Max weight & Annual Departures						
Clear All aircraft Information	User's name for Aircraft (optional) e.g. Citation IV	Aircraft grouping --- Gear type AC 130/5320-6D	Default Weight	Max Takeoff weight MTOW	Annual Departures	Thickness Required for Each Individual Aircraft
	Small biz-jet aircraft	DUAL50 - 50,000 lbs		50,000	1,350	17.84
	Charter - Boeing 727	DUAL200 - 200,000 lbs		190,500	45	26.38
	Regional Commuter	DUAL50 - 50,000 lbs		55,000	300	16.78
	Cargo - 737 aircraft	DUAL100 - 100,000 lbs		115,000	400	27.01
	Corporate ABZ	DUAL100 - 100,000 lbs		105,000	200	23.94
		none		0	0	0.00
		none		0	0	0.00
	none		0	0	0.00	
						Recommended Critical Aircraft

Step 7 finds 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 8.

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 8. Accept Critical Aircraft

Repeats step 7 and performs final calculations
Returns the user to the main screen

STEP 9. Compute for Stabilized Layers

This step allows the user to specify equivalency factors for stabilized layers. Acceptable equivalency factor ranges are provided.

Conversions are restricted to the base and the first subbase layer. Within the program, conversions are for the entire layer. The user may elect to make partial conversions by hand.

Conversion factors have limited ranges in accordance with AC 150/53320-6D.

Stabilized Base Conversion

Base Course

Select the stabilized material to be substituted for the un-stabilized Base course
(Assuming P209 with CBR = 80+)

- P-304, Cement Treated Base Course 1.2 - 1.6
- P-306, Econocrete subbase course 1.2 - 1.6
- P-401, Plant Mix Bituminous Pavements 1.2 - 1.6
- Stabilization not Desired

Enter the Equivalency Factor

OK

Stabilized Subbase Equivalency Factors

Subbase Course

Select the desired stabilized material to be used to replace the un-stabilized subbase. (assuming P154 with CBR = 20)

- P-301, Soil Cement Base Course 1.0 - 1.5
- P-304, Cement Treated Base Course 1.6 - 2.3
- P-306, Econocrete Subbase Course 1.6 - 2.3
- P-401, Plant Mix Bituminous Pavements 1.7- 2.3
- No Stabilization Desired

High Quality Granular Subbase

In some instances it may be advantageous to utilize non-stabilized granular material of higher quality than P-154 as subbase course. This may not be used as a substitute for the required stabilization when gross weights exceed 100,000 pounds.

- P-208, Aggregate Base Course (1.0 - 1.5)
- P-209, Crushed Agg. Base Course (1.2 - 1.8)
- P-211, Lime Rock Base Course (1.0 - 1.5)

Enter the Equivalency Factor

OK

STEP 10. Go To Design Summary

Repeats design calculations (step 8) and 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.

FLEXIBLE PAVEMENT DESIGN FOR		program date 3/26/02
Airport Name Any City, USA		AC Method
Engineer - No comments	Engineer Ann Us	AIP No. AIP No. xx-xxxx-xx
28.5" Total Thickness Required (inches) <i>No thickness adjustments required</i>		
Initial Pavement Cross Section		<i>Stabilized Base/Subbase Area Required</i>
4" Pavement Surface Layer (P-401)	4" P-401 Plant Mix Bituminous Pavements	
8" (7.2") Base Layer (P-209)	6.5" P-401, Plant Mix Bituminous Pavements	1.5
16.5" Subbase #1 (P-154) CBR= 20	11" P-209, Crushed Aggregate Base course	1.5
8" Subbase #2 CBR= 0	8" Material as defined by user	
8" Subbase #3 CBR= 0	8" Material as defined by user	
<i>() = Submitted base thickness calculation</i>		
Frost Considerations		
112 lbf Dry Unit Weight of Soil		
455 Degree Days F		
32.82" Frost Penetration Depth		
5 Original CBR value of subgrade Soil		
5 CBR Value used for the Subgrade Soil	Non-Frost Code for Subgrade Soil	
20 CBR Value used for subbase #1	Non-Frost code for Subbase #1	
0 CBR Value used for subbase #2	Non-Frost code for Subbase #2	
0 CBR Value used for subbase #3	No frost selection made for Subbase #3	
Design Aircraft Information		
The Design Aircraft is a DUAL100 - 100,000 lbs -- (Cargo - 737 aircraft)		
110000 lbs Gross Weight	20 Design Life (years)	
852 Equivalent Annual Departures		
Subgrade Compaction Requirements for Design Aircraft		
Non-Cohesive Soils		Cohesive Soils
Compaction	Depth Required	Compaction Depth Required
100%	0 - 17.6"	95% 0 - 6.3"
95%	17.6 - 30.6"	90% 6.3 - 12.6"
90%	30.6 - 43.2"	85% 12.6 - 19.6"
85%	43.2 - 56.5"	80% 19.6 - 25.9"
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		

Print
Summary and
Aircraft
Listing

Print
Summary
Only

Return to
Flexible
Design

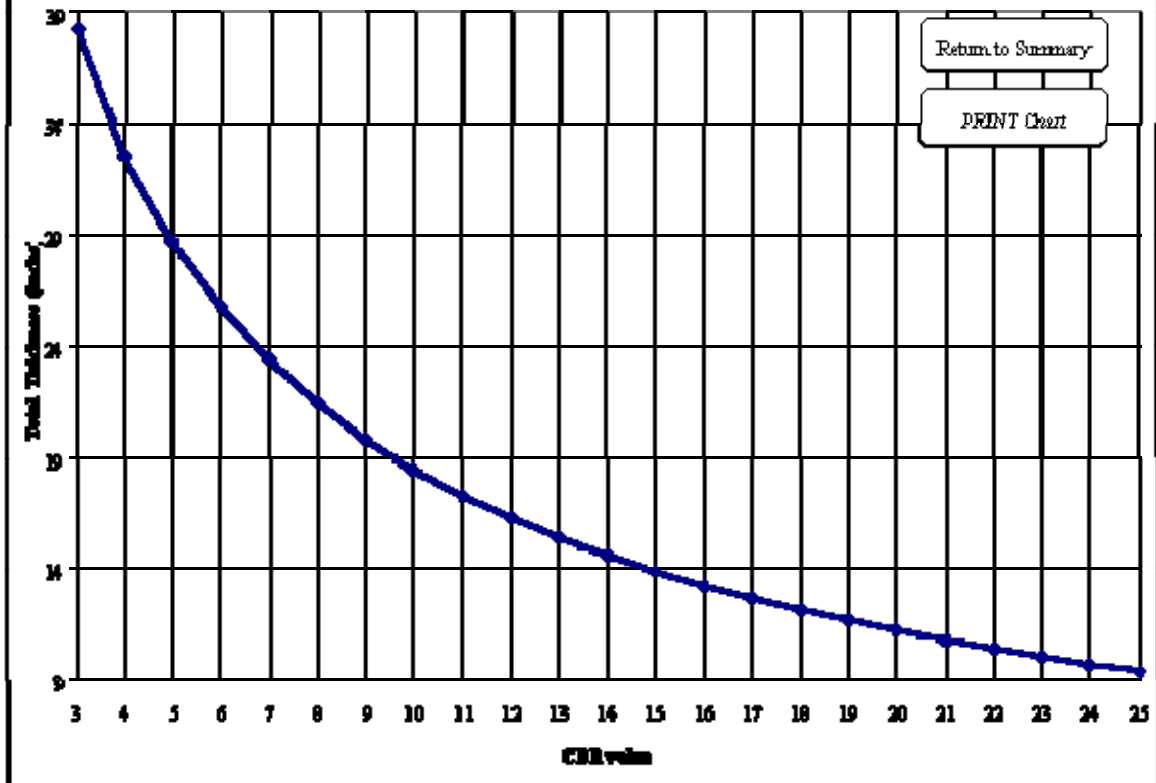
View/Print
Graph of
Departure vs
Total
Thickness

View/Print
Graph of
CBR vs
Total
Thickness

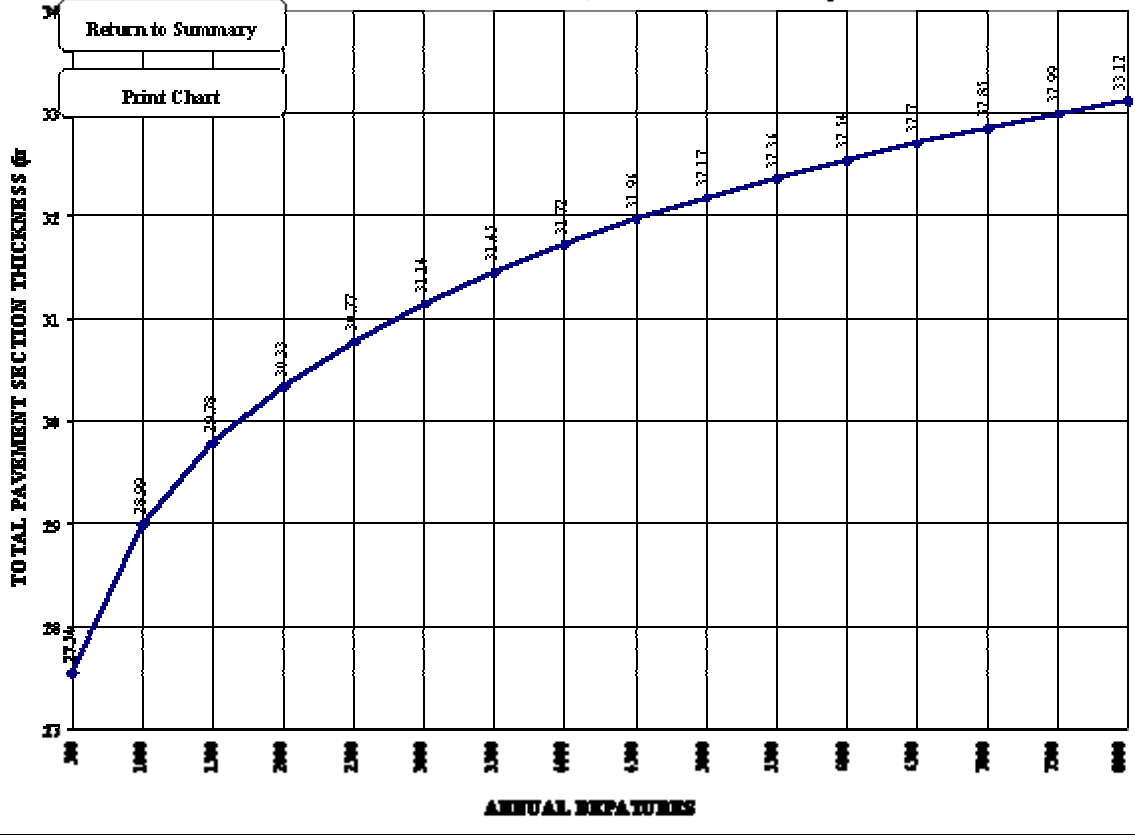
From the summary sheet, the user is permitted to print the summary and/or the aircraft mix.

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

TOTAL THICKNESS FOR DUAL100, 115000 lbs - 862 Departures LIFE = 20 yrs



TOTAL THICKNESS FOR DUAL180, 115000 lb, LIFE - 20 yrs CBR - 5



[Return to Summary](#)

[Print Chart](#)