Data Entry

Flexible Pavement Design

FAARFIELD 1.305 Hands-On Training

Federal Aviation Administration

Presented to: IX ALACPA Seminar on Airport Pavements
Ciudad de Panamá, Panamá

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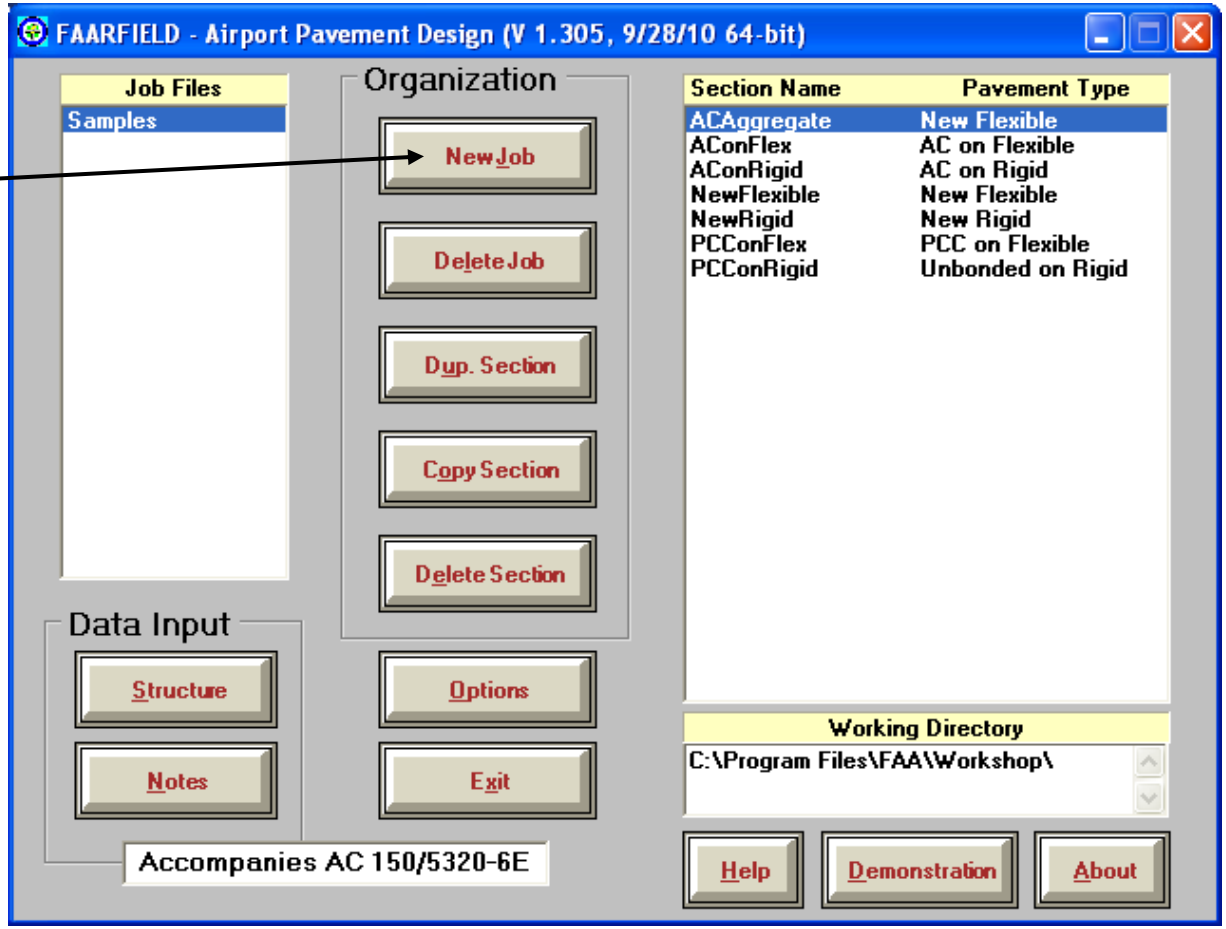
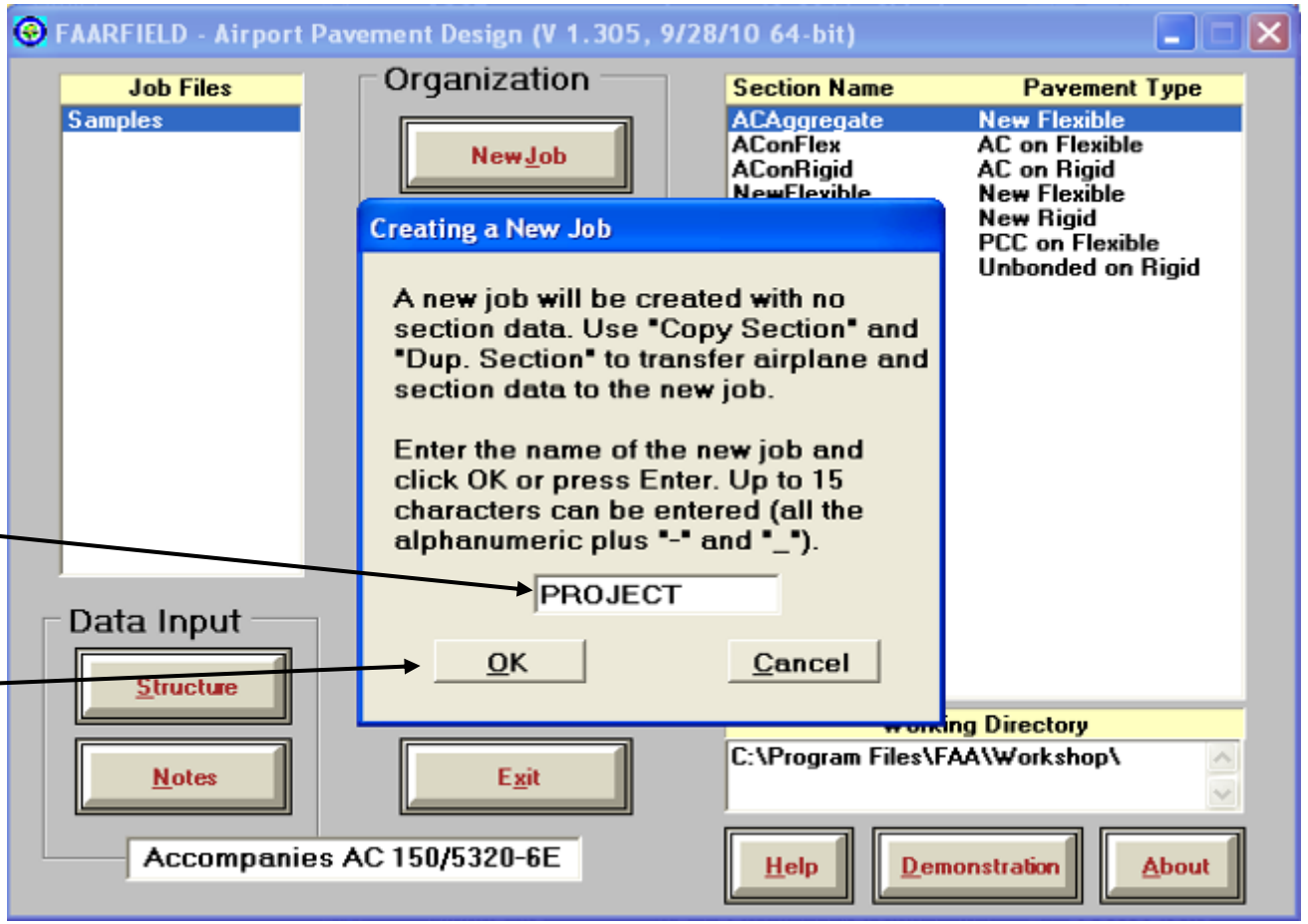
Date: September 13, 2012

Starting Screen – No Job Files Created

Click on "New Job"



Creating/Naming a Job File

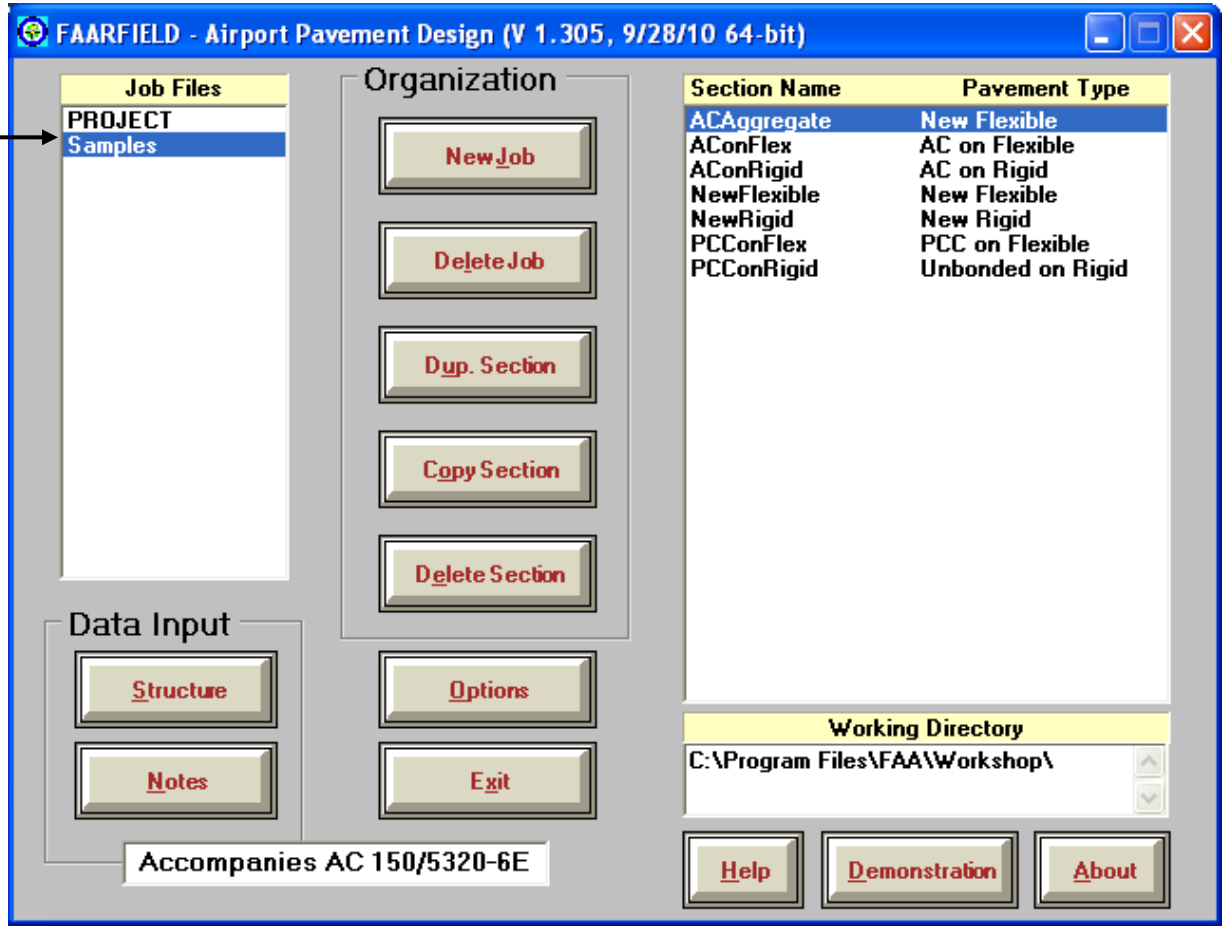


Enter Job Title

Click OK

Copy Basic Section/Pavement Type from Samples

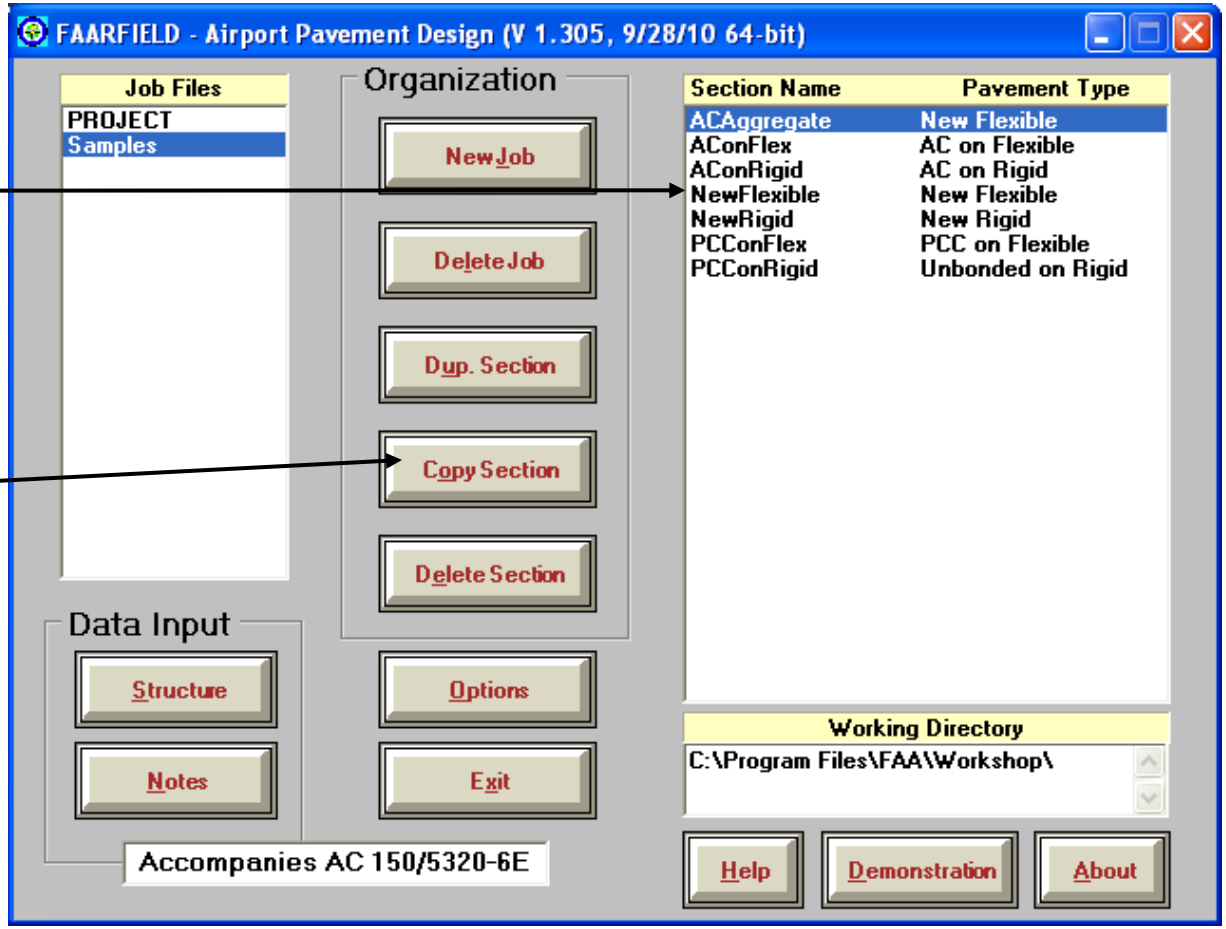
Click on "Samples" →



Copy Basic Section/Pavement Type from Samples

Default Basic Pavement Sections

Click on "Copy Section"



7 Basic Starting Structures in FAARFIELD

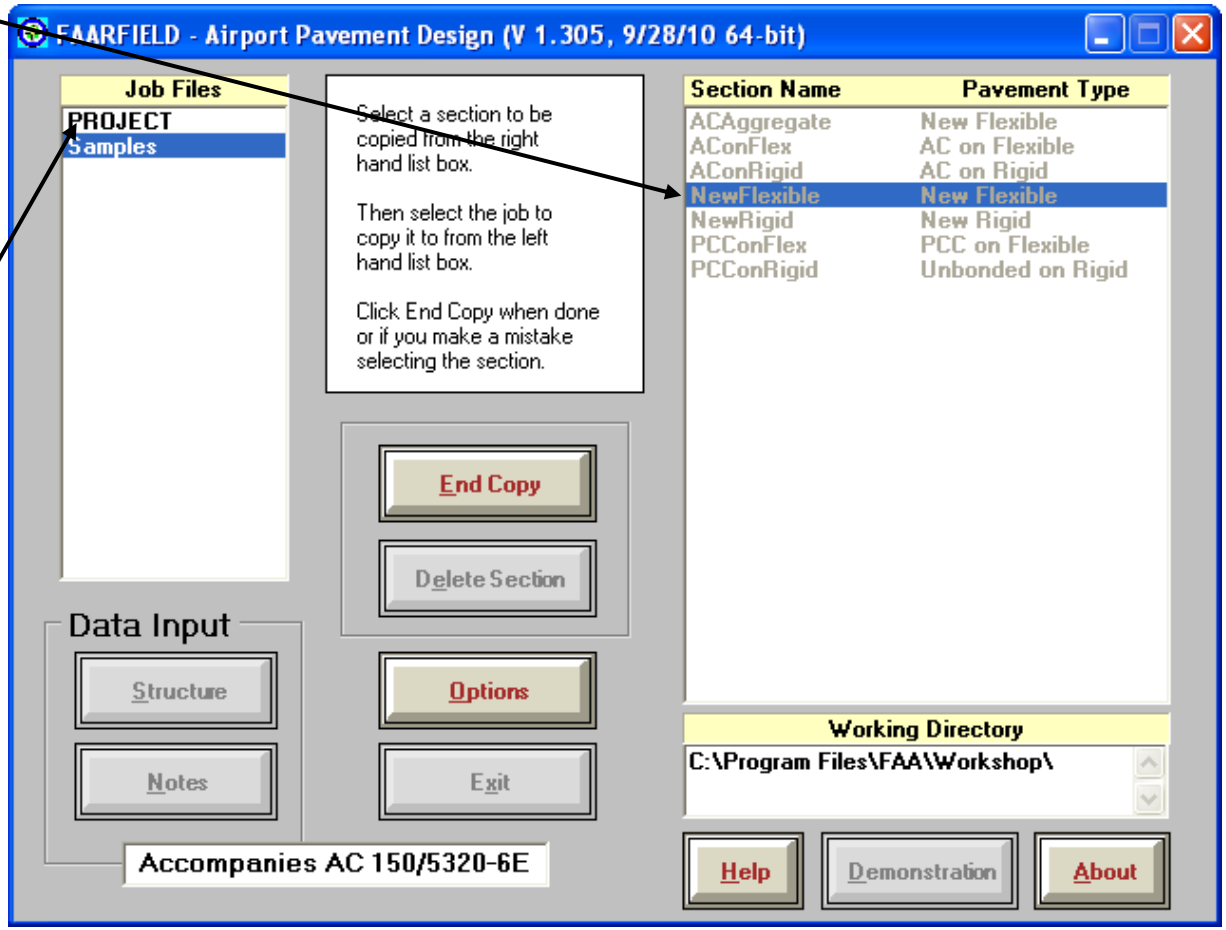
Section Name	Pavement Type
ACAggregate	New flexible on aggregate base
AConFlex	HMA overlay on flexible pavement
AConRigid	HMA overlay on rigid pavement
NewFlexible	New flexible on stabilized base
New Rigid	New rigid on stabilized base
PCConFlex	PCC Overlay on flexible
PCConRigid	Unbonded PCC on rigid

Be sure to select the pavement type that most correctly represents your design requirements.

Copy a Sample Pavement Section

Click on desired pavement section.

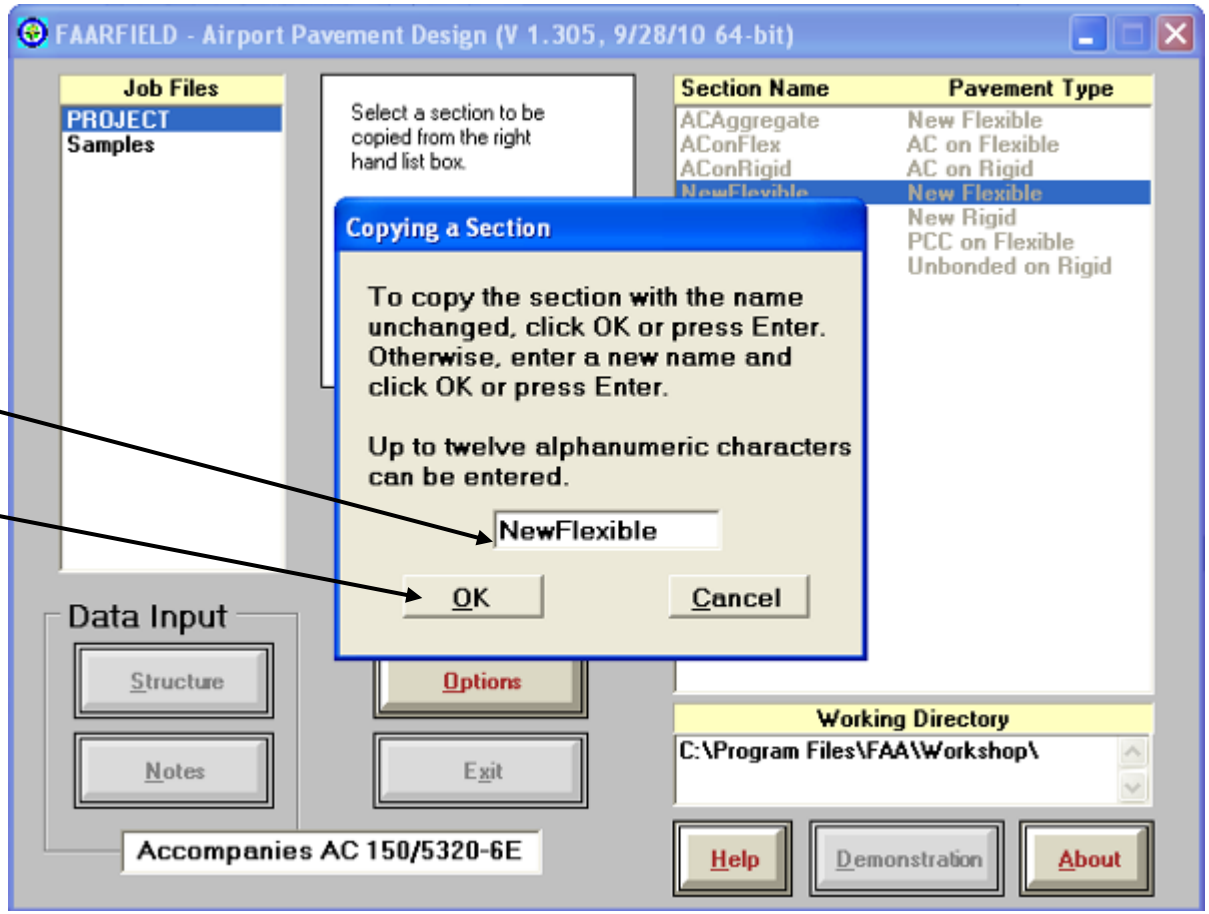
Then click on the project where the section will be saved.



Create a New Job Title

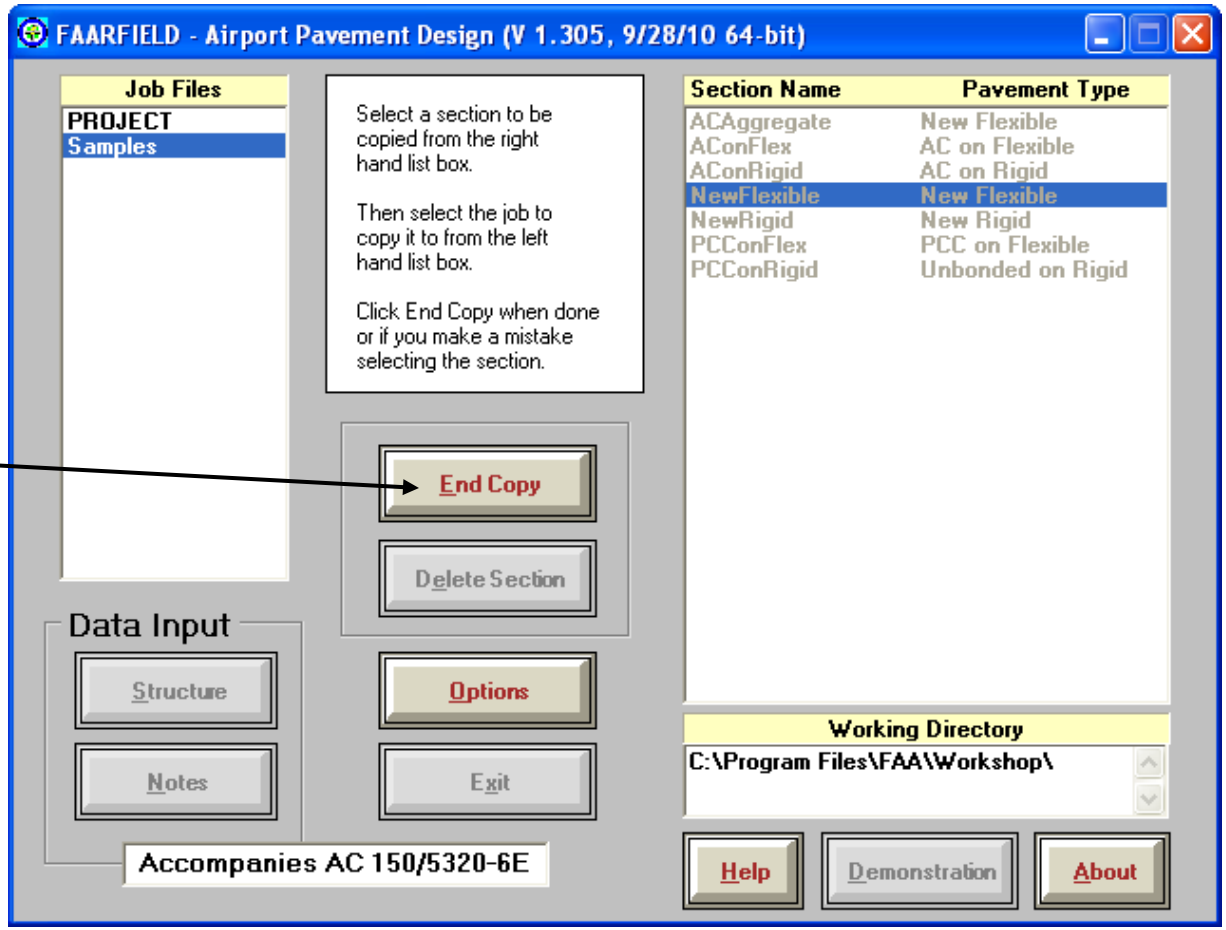
Enter job title

Click OK



Create a New Job Title

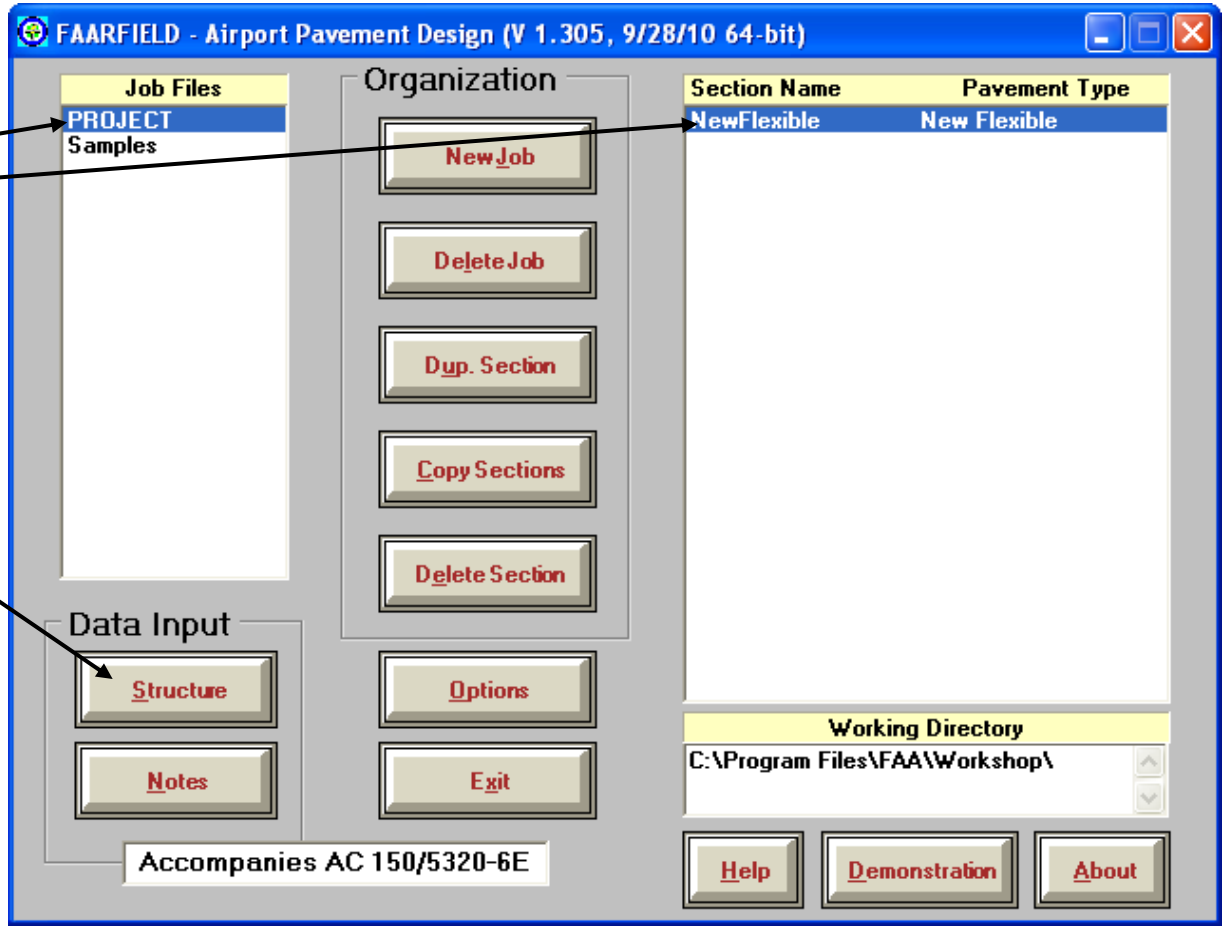
Click “End Copy”



Working With a Pavement Section

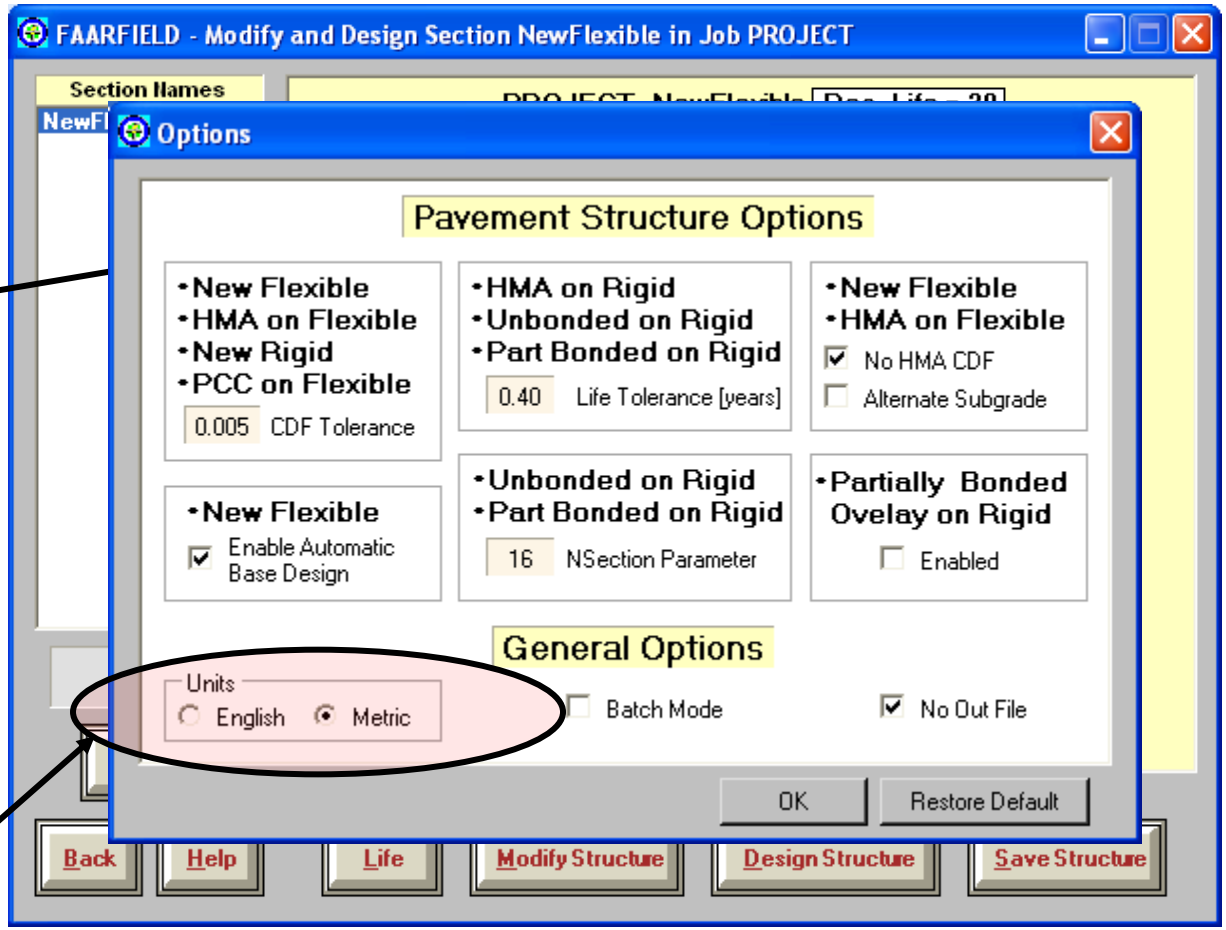
Select the job and then the section you want to analyze.

Click on "Structure" to open the file.



Working With a Pavement Section

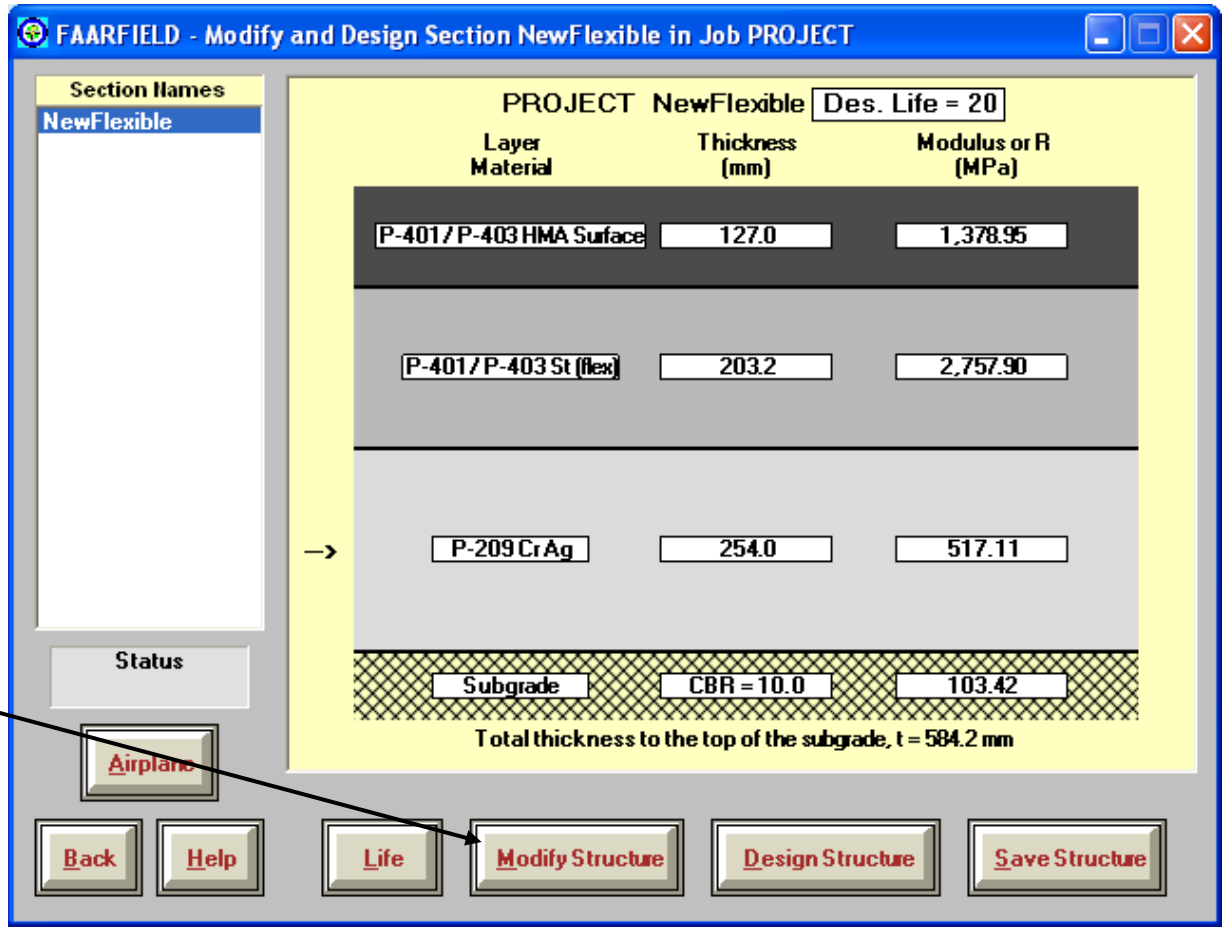
- The selected sample pavement will appear.
- By default, FAARFIELD uses U.S. units.
- To change to metric, hit Alt-O to bring up the Options window.
- Select “Metric” and hit OK.



Working With a Pavement Section

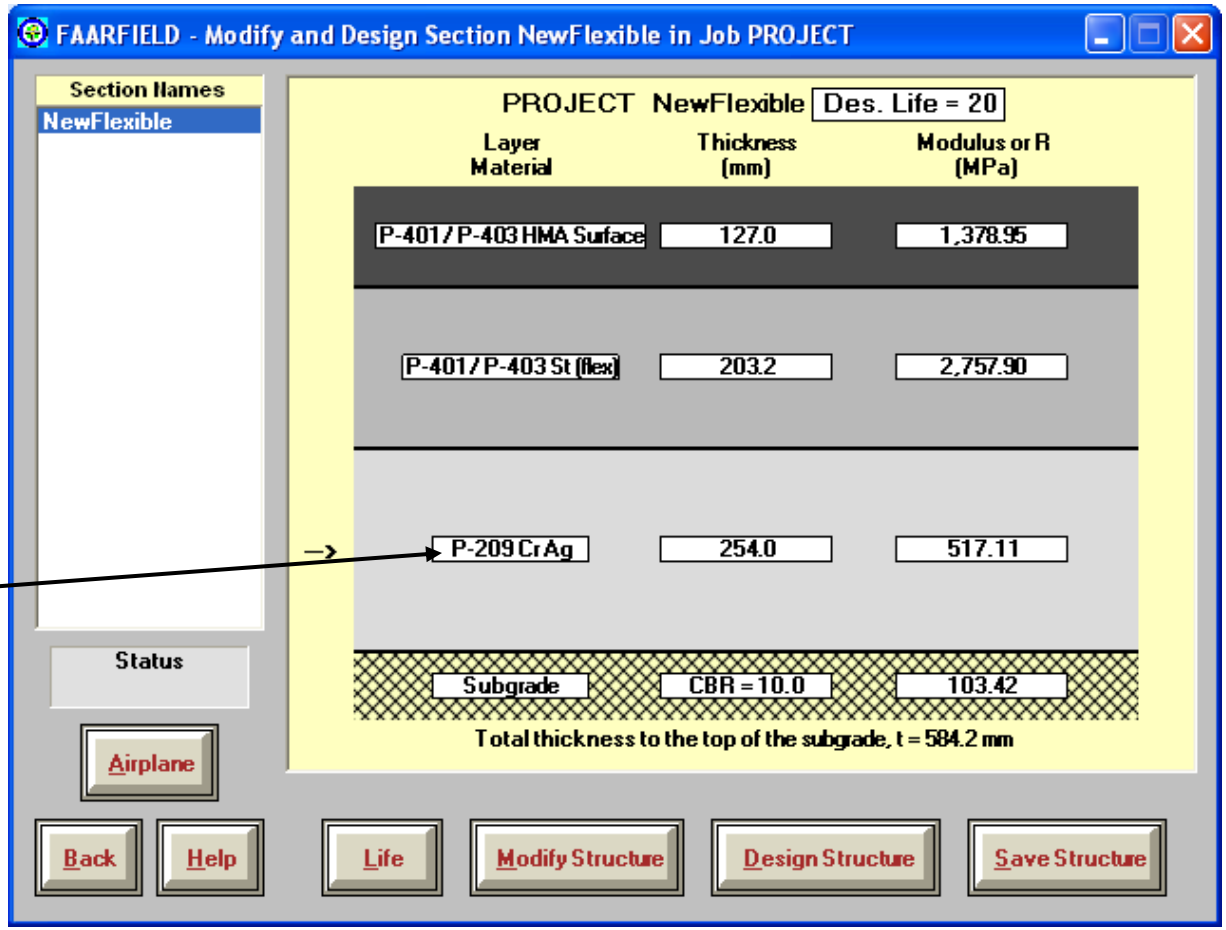
Thickness and modulus are now given in metric units.

Click on "Modify Structure" to modify the structure.



Modifying a Pavement Section

Click on the box for the layer material type you want to modify.



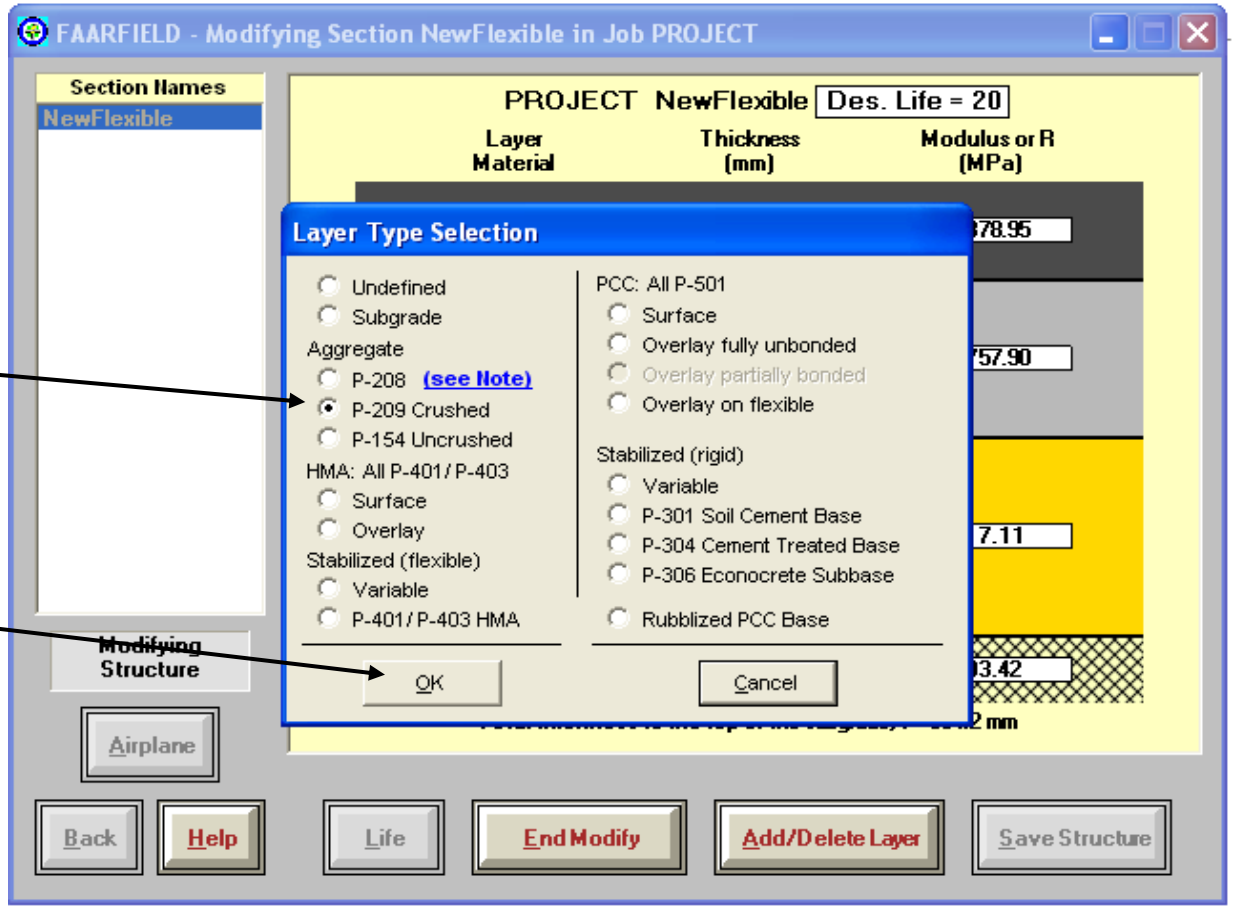
Modifying a Pavement Section

Select the layer type you want to include in the pavement section.

(No modification for this example)

Click OK

(Cancel for this example)



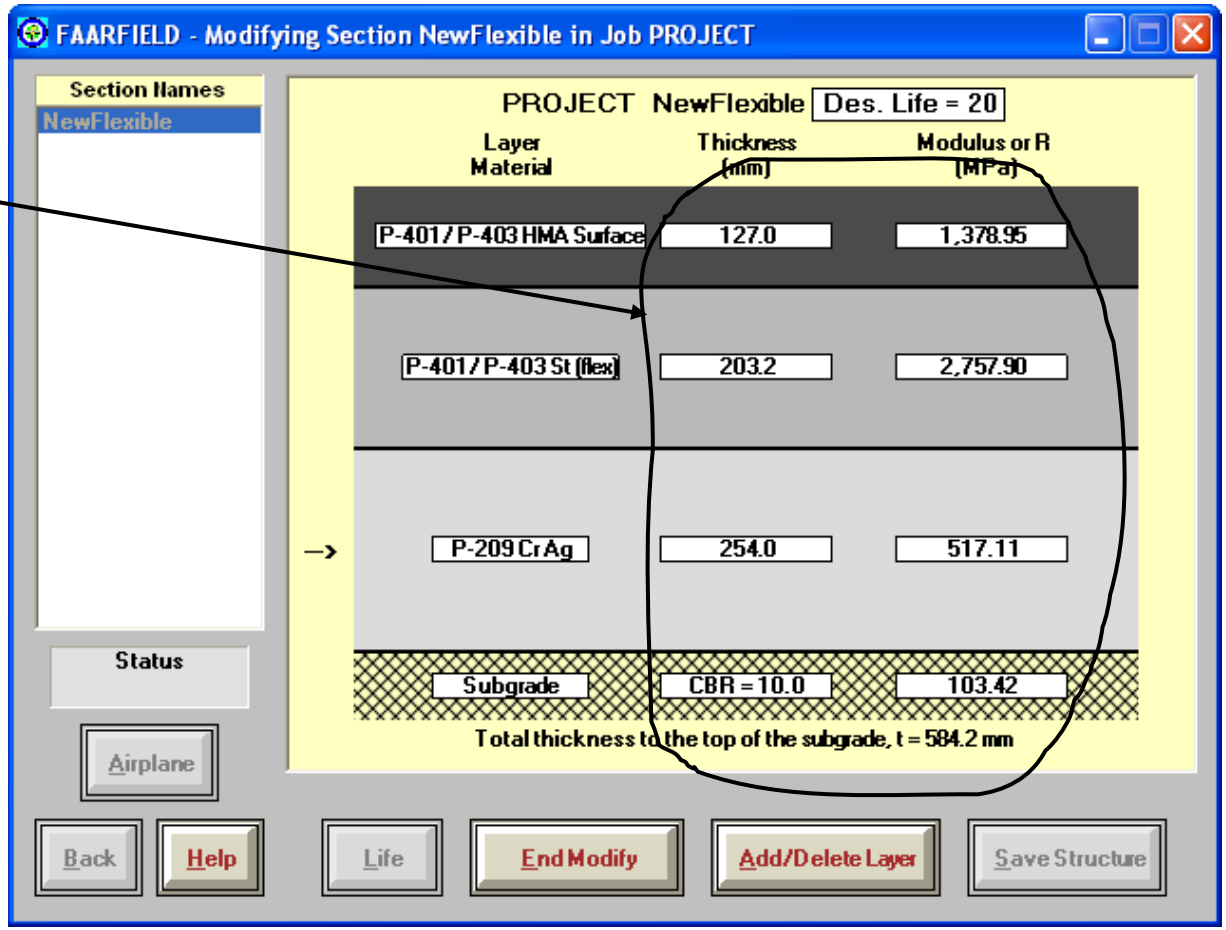
Layer Placement Restrictions

- **There are restrictions on placement of certain pavement layers, e.g.:**
  - Cannot place an overlay below a surface course.
  - Cannot have two aggregate base layers (P-209 on P-209) in the structure.
  - Aggregate layer cannot be the surface layer.
- **Some layer changes cause changes in the pavement type.**
  - Changing the surface HMA layer to PCC will change the pavement type to new rigid.

Modifying a Pavement Section

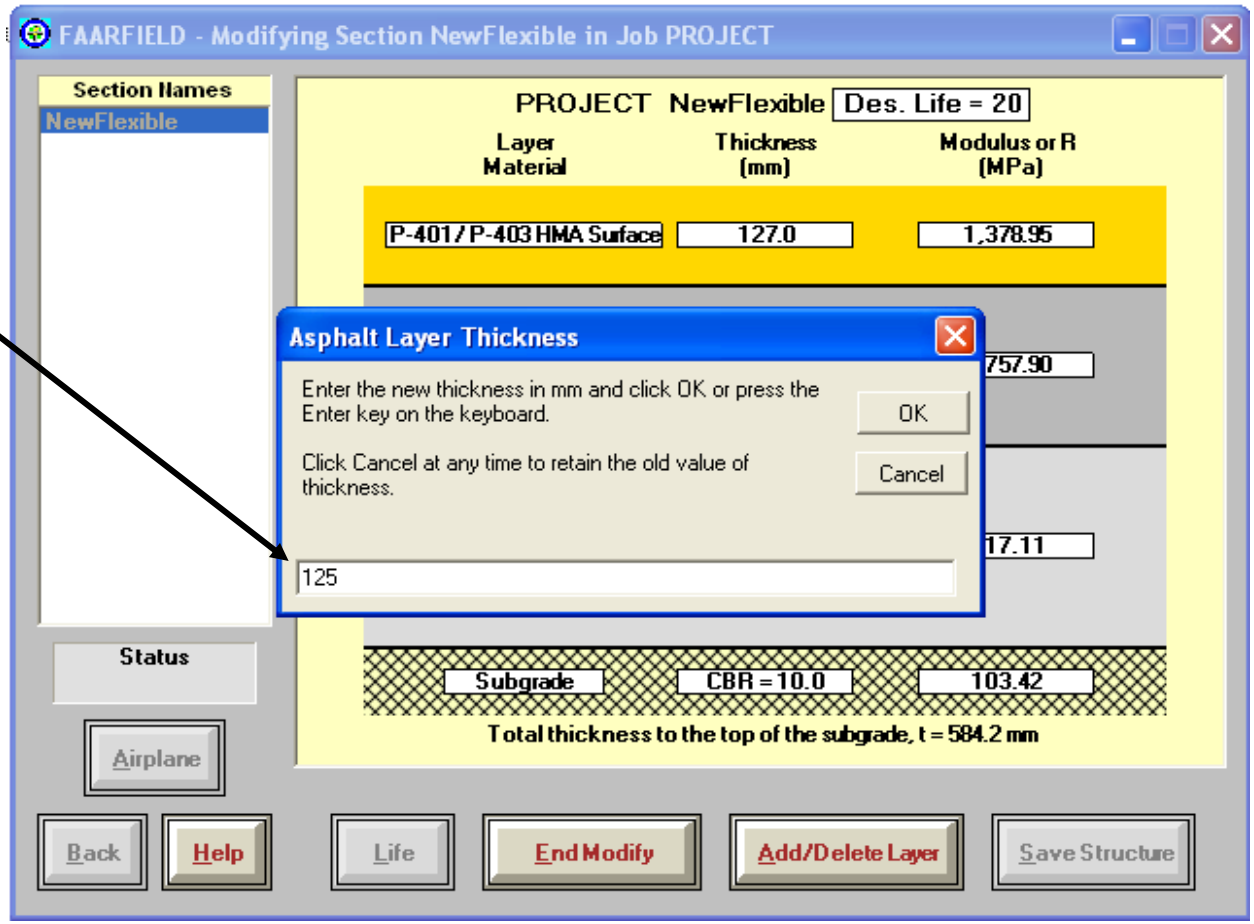
Click on a property in this area to modify it.

Change the layer thicknesses in this example.



Modifying a Pavement Section

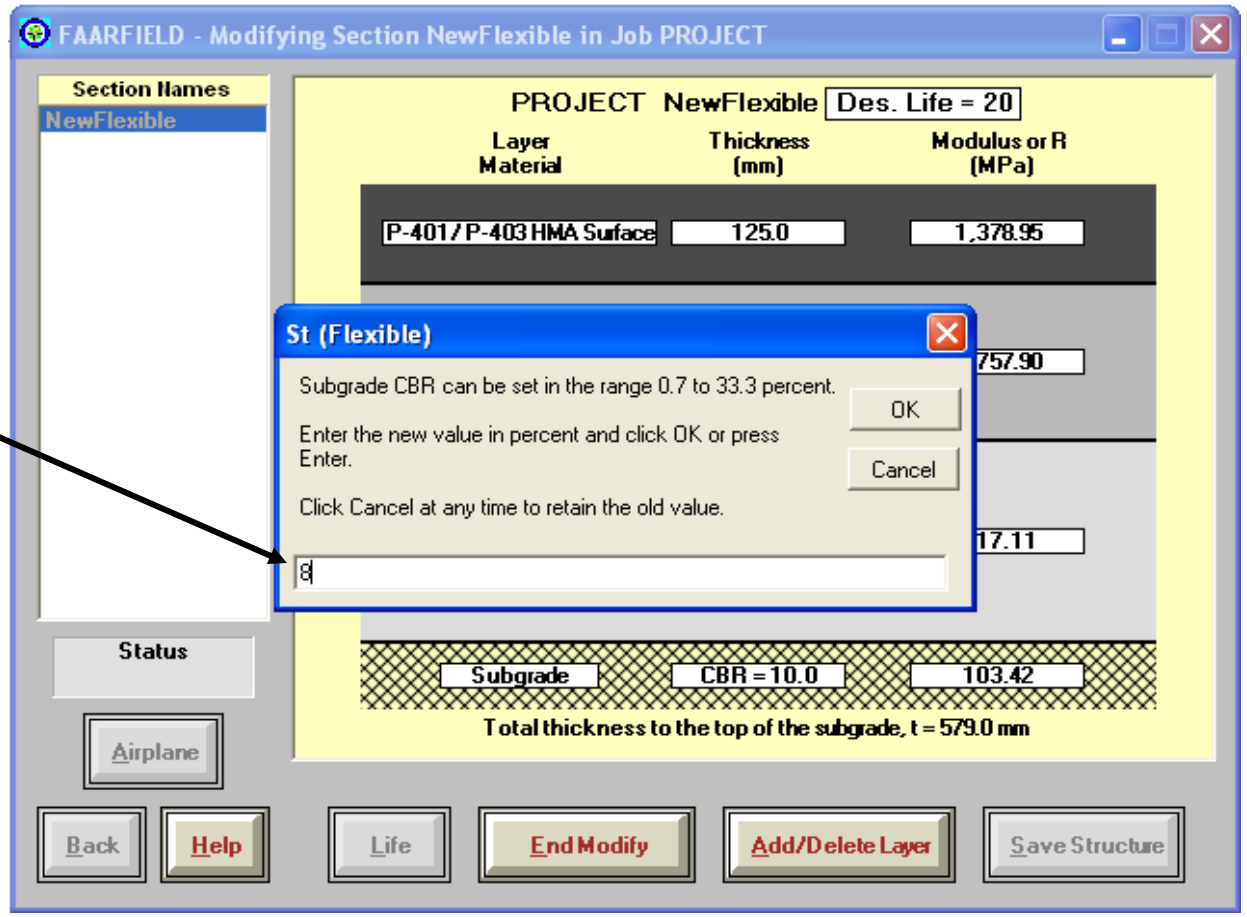
- Click on the P-401 Surface thickness.
- Enter the new value of 125 mm.
- Hit OK.
- Next, change the P-401/P-403 stabilized base layer to 200 mm.



Modifying a Pavement Section

- **Click on the subgrade CBR to change the value.**
- **Enter the new value for the material property.**
- **Click OK.**

Some materials will have limits on allowable values.



Layer Types in FAARFIELD

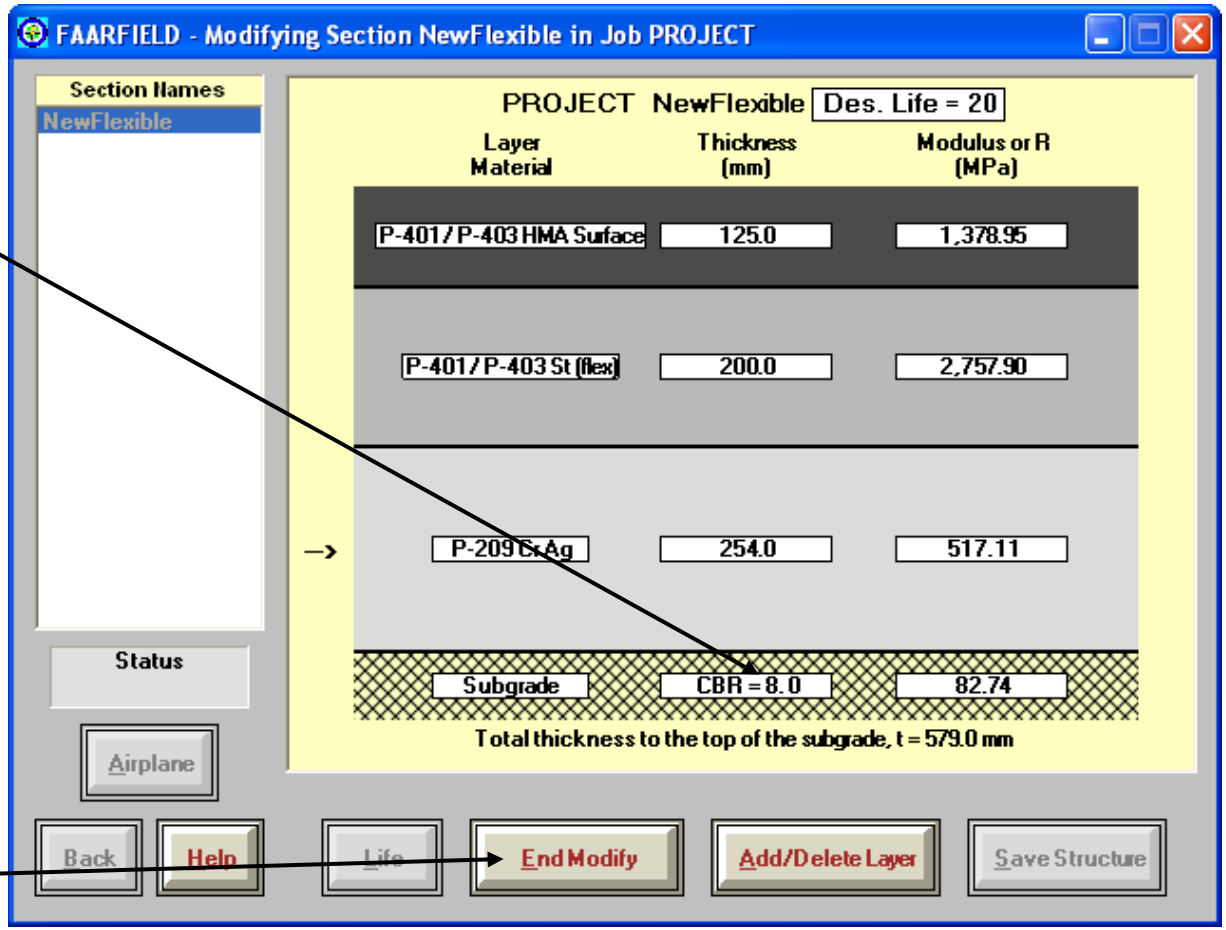
Layer Type	Fixed Modulus
P-401/P-403 HMA Surface	1,379 MPa (200,000 psi)
P-401/P-403 HMA Base	2,760 MPa (400,000 psi)
P-501 PCC Surface	27,600 MPa (4,000,000 psi)
P-306 Econocrete Base	4,830 MPa (700,000 psi)
P-304 Cement Treated Base	3,450 MPa (500,000 psi)
P-301 Soil Cement Base	1,724 MPa (250,000 psi

- Layer moduli for P-209 crushed aggregate and P-154 uncrushed aggregate layers are determined internally in the program.

Modifying a Pavement Section

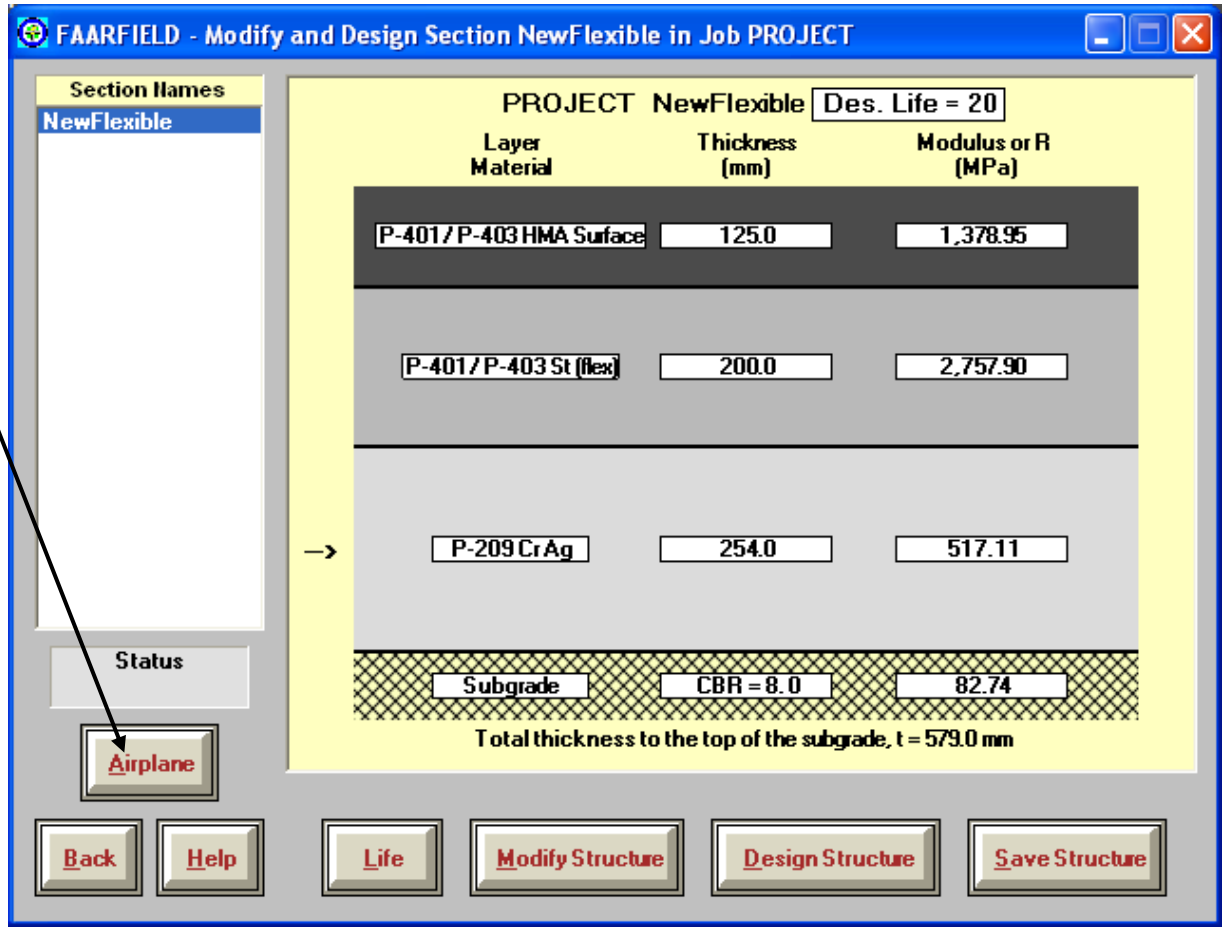
New values appear in the structure window.

When done changing properties, click End Modify



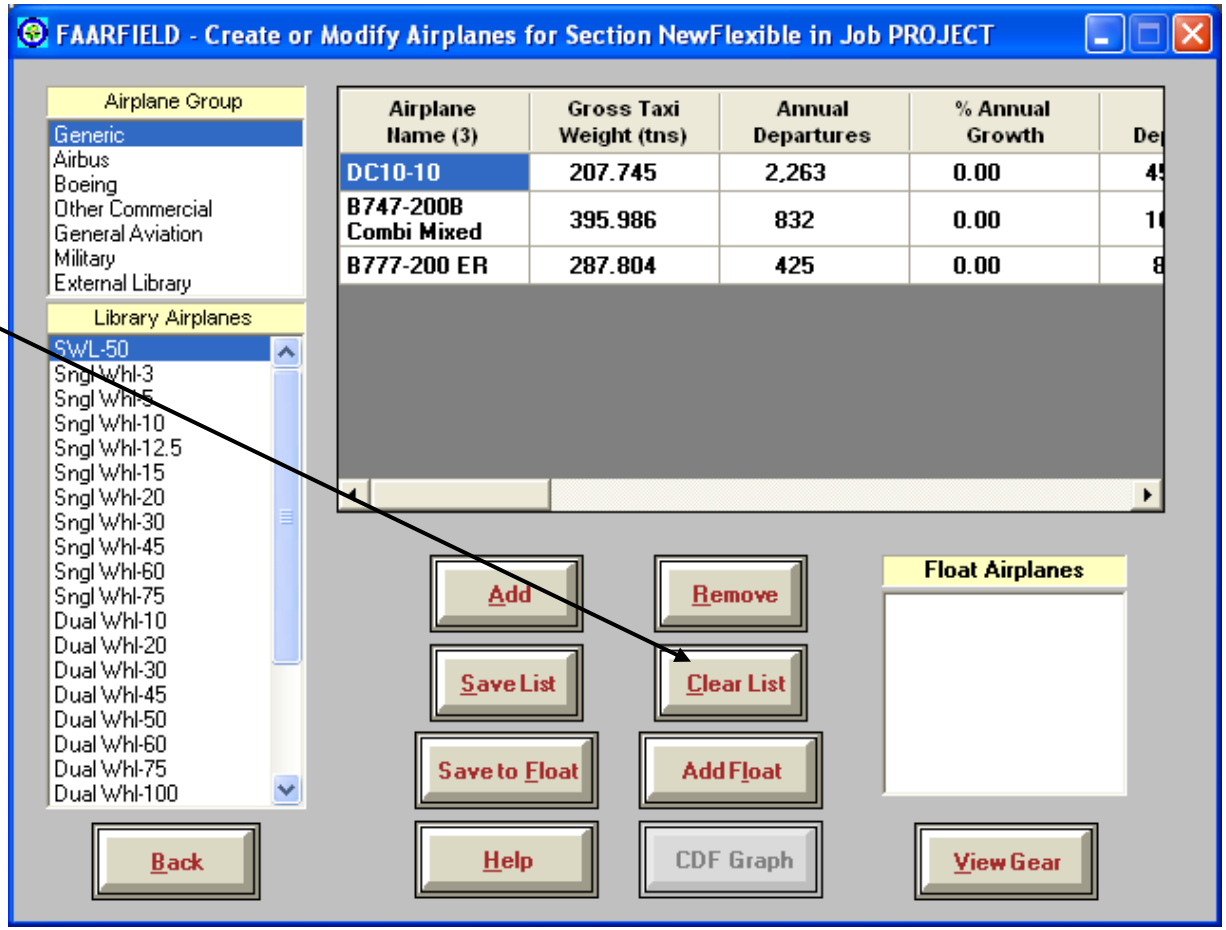
Enter Traffic Mixture

Click on "Airplane" to enter traffic mix



Enter Traffic Mixture

Use “Clear List” to clear the existing airplanes



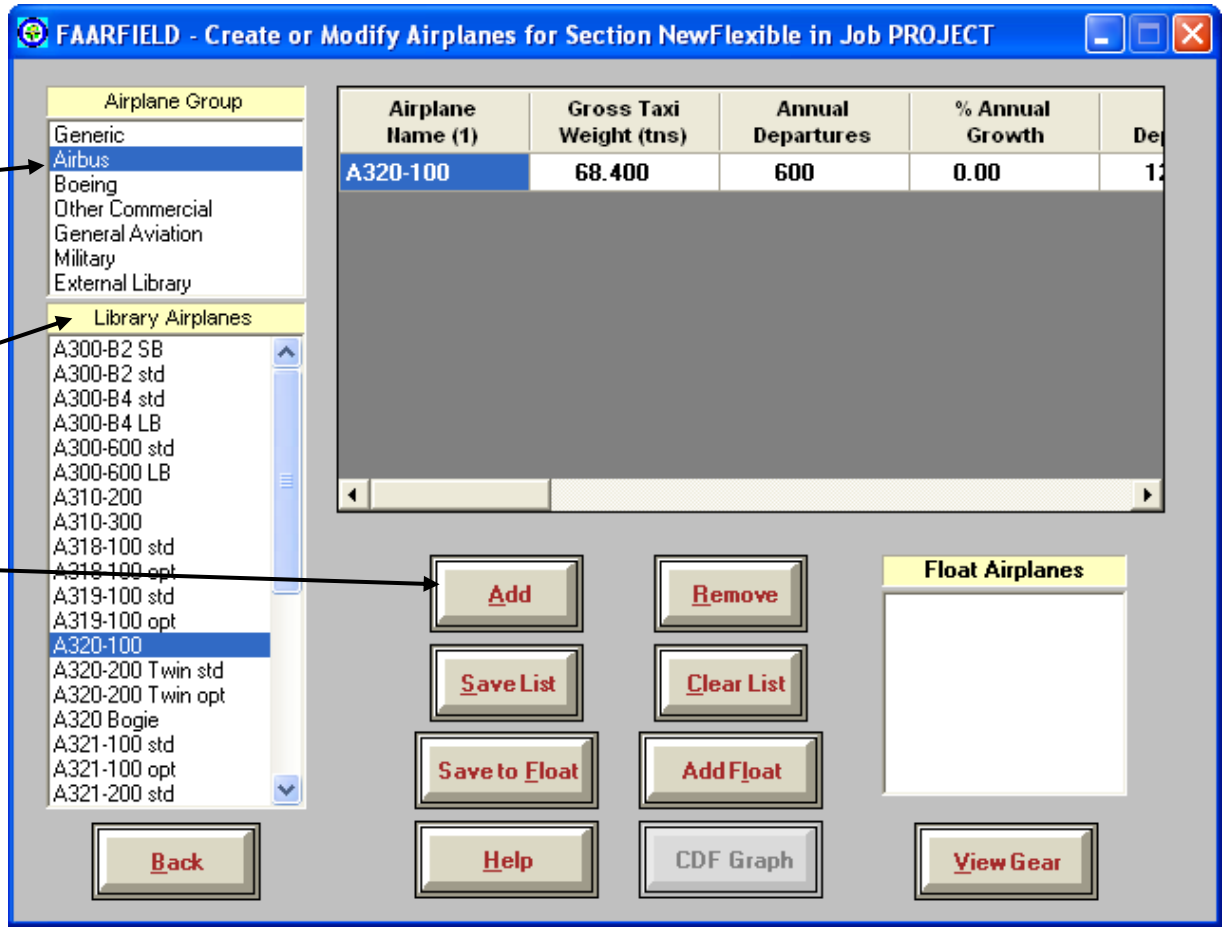
Enter Traffic Mixture

For each airplane:

Click on the desired airplane group.

Then select the desired airplane from the library and click "Add"

Repeat for the complete traffic mixture.



Traffic Mix for This Example

No.	Name	Gross Wt., tns.	Annual Departures	Annual Growth, %
1	A320-100	68.400	600	0.00
2	A340-600 std	365.200	1,000	0.00
3	A340-600 std Belly	365.200	1,000	0.00
4	A380-800	562.001	300	0.00
5	B737-800	79.243	2,000	0.00
6	B747-400B Combi	397.801	400	0.00
7	B747-400 ER Pass.	414.130	300	0.00
8	B757-300	124.058	1,200	0.00
9	B767-400 ER	204.570	800	0.00
10	B777-300 ER	352.441	1,000	0.00
11	B787-8 (Preliminary)	220.446	600	0.00

Enter Traffic Mixture

- **The job file *Workshop.JOB.xml* is included on your thumb drive handouts.**
- **The traffic list stored in this job file is the same as the one in this example.**
- **Hint: To avoid typing the airplane list by hand, try copying the above job file to the working directory and opening it in FAARFIELD.**

Enter Traffic Mixture

Certain airplanes may appear in the list twice. This is to address the presence of wing gears and belly gears.

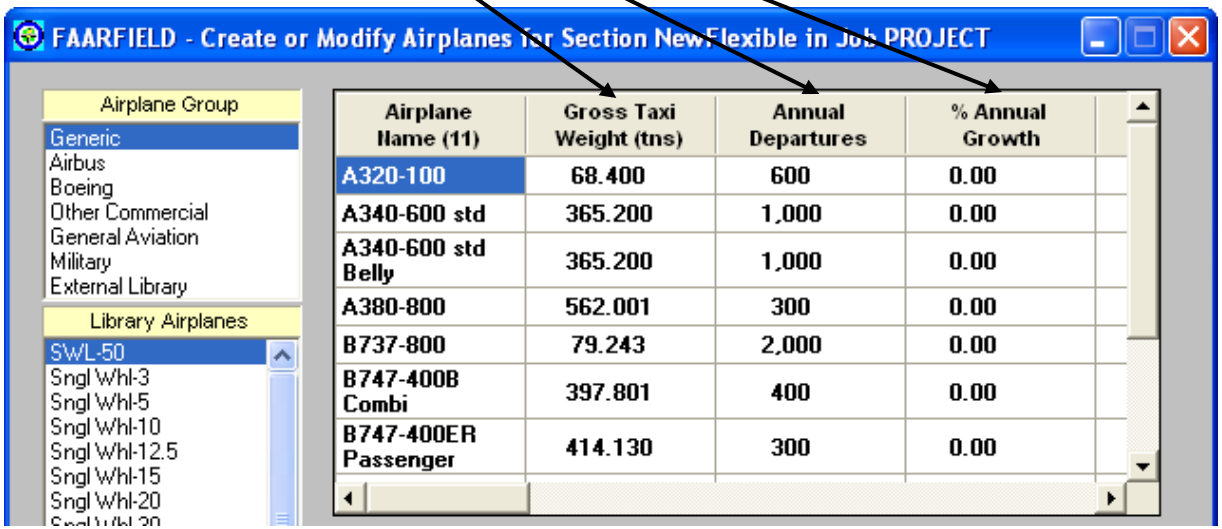
FAARFIELD treats these as two airplanes.

However, the weight and departures are interlocked.

Airplane Name (11)	Gross Taxi Weight (tns)	Annual Departures	% Annual Growth
A320-100	68.400	600	0.00
A340-600 std	365.200	1,000	0.00
A340-600 std Belly	365.200	1,000	0.00
A380-800	562.001	300	0.00
B737-800	79.243	2,000	0.00
B747-400B Combi	397.801	400	0.00
B747-400ER Passenger	414.130	300	0.00

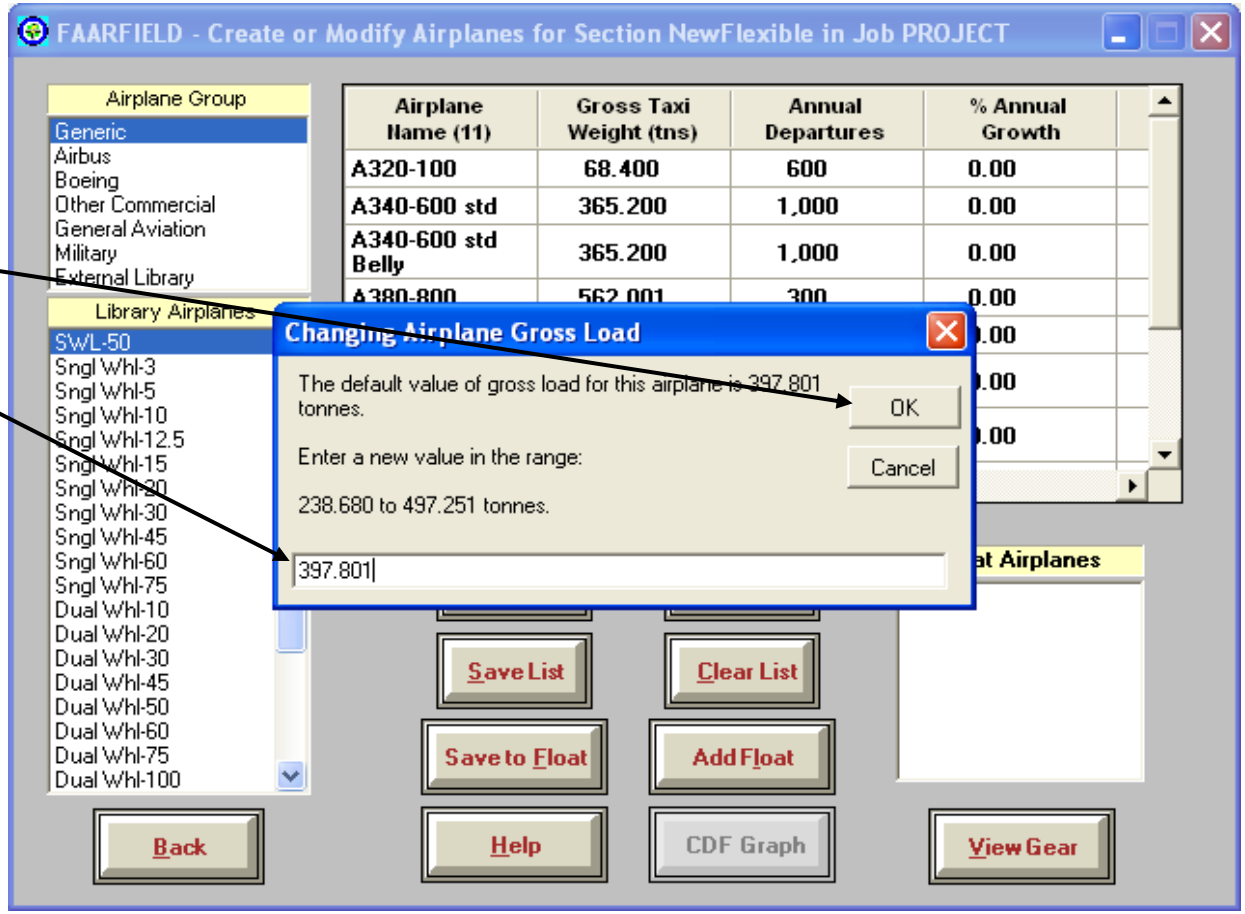
Adjusting Airplane Information

Gross Taxi Weight, Annual Departures and % Annual Growth may be modified.



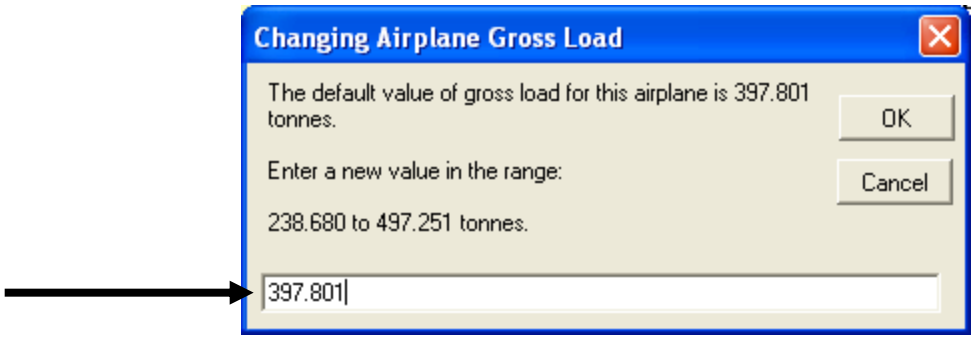
Adjusting Airplane Information
- Gross Weight

Enter the new weight and click OK



Adjusting Airplane Information
- Gross Weight

- **There are limitations on changes to airplane gross weights.**
- **A range is provided for each airplane which represents reasonable weights for the airplane:**
  - Default Weight – 40%
  - Default Weight + 25%



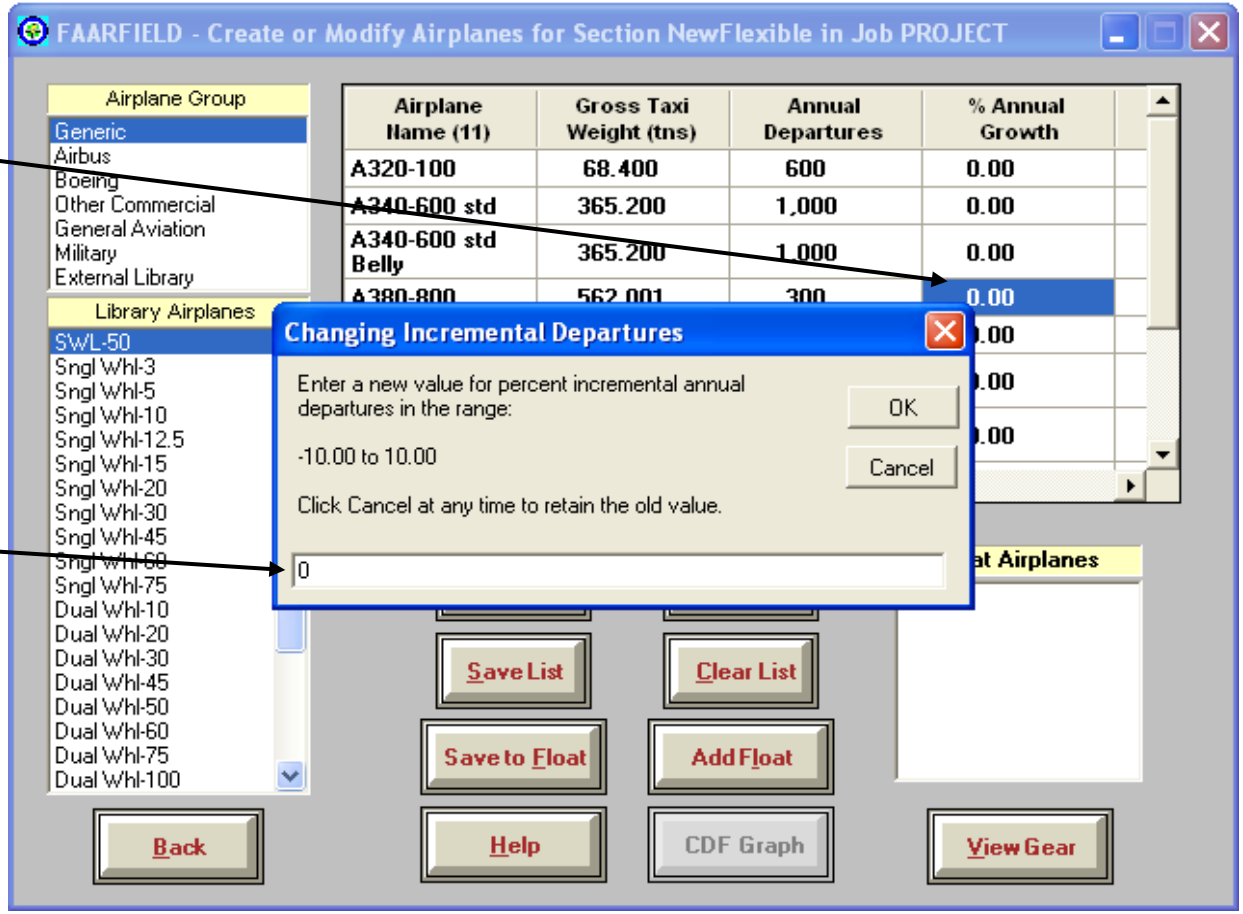
Annual Departures in FAARFIELD

- **Annual departures has the same meaning as in the previous design procedure.**
- **Arrivals are ignored.**
- **For design purposes, FAARFIELD uses the total annual departures, multiplied by the design period in years:**
  - e.g., 1200 annual departures × 20 years = 24,000 departures.

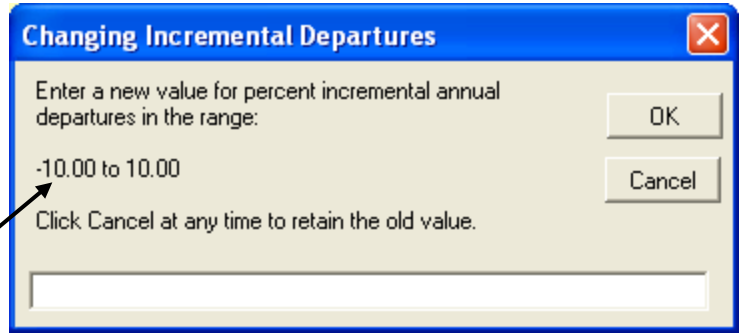
Adjusting Airplane Information
- % Annual Growth of Annual Departures

Click on the annual growth value to bring up the dialog box.

Enter the percent annual growth and click OK.



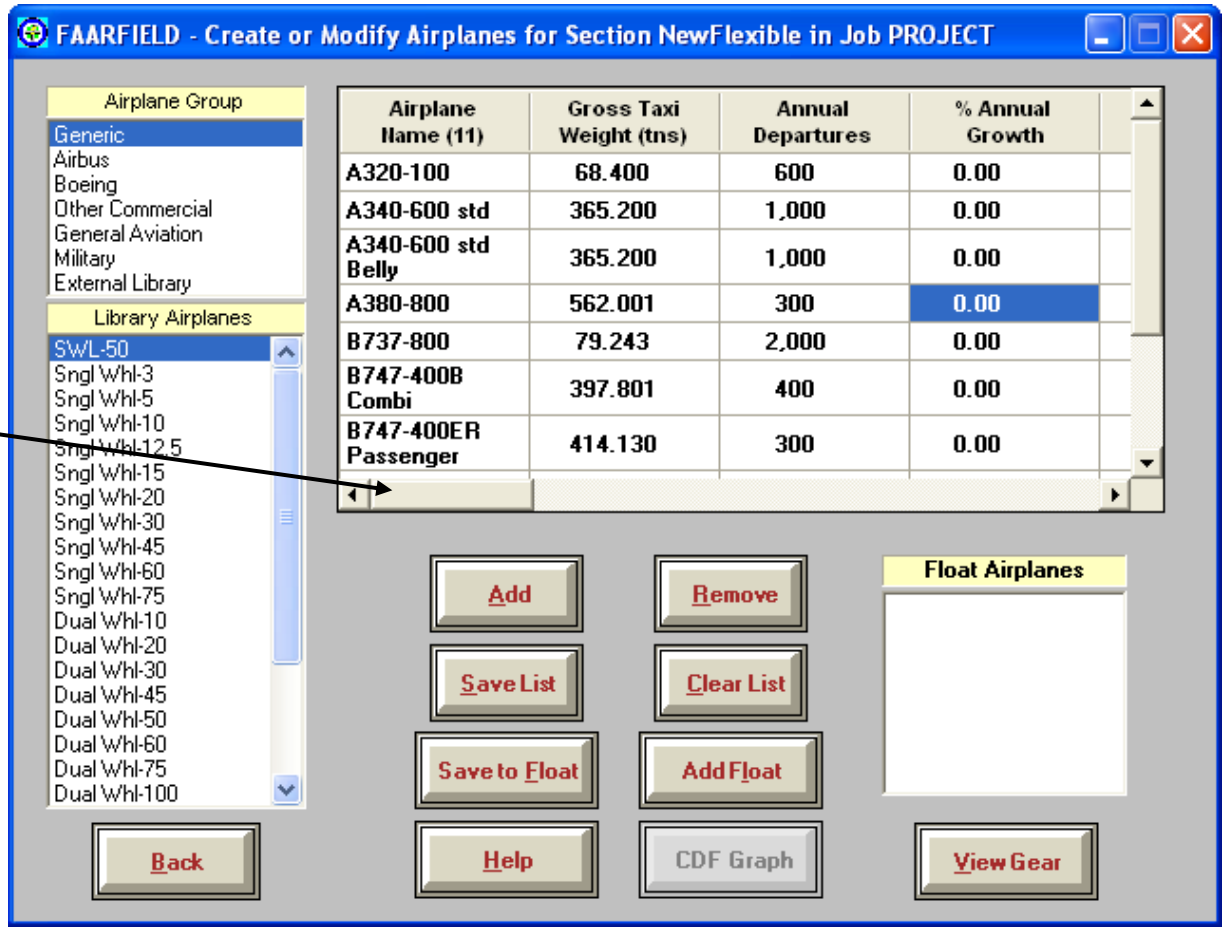
Adjusting Airplane Information
- % Annual Growth of Annual Departures



- **Allowable range of percent annual growth is +/- 10%.**
- **You can create the same effect by modifying the annual departures.**

Viewing Airplane Information

Scroll over to reveal additional columns of information.



Viewing Airplane Information

Available in FAARFIELD Airplane Screen:

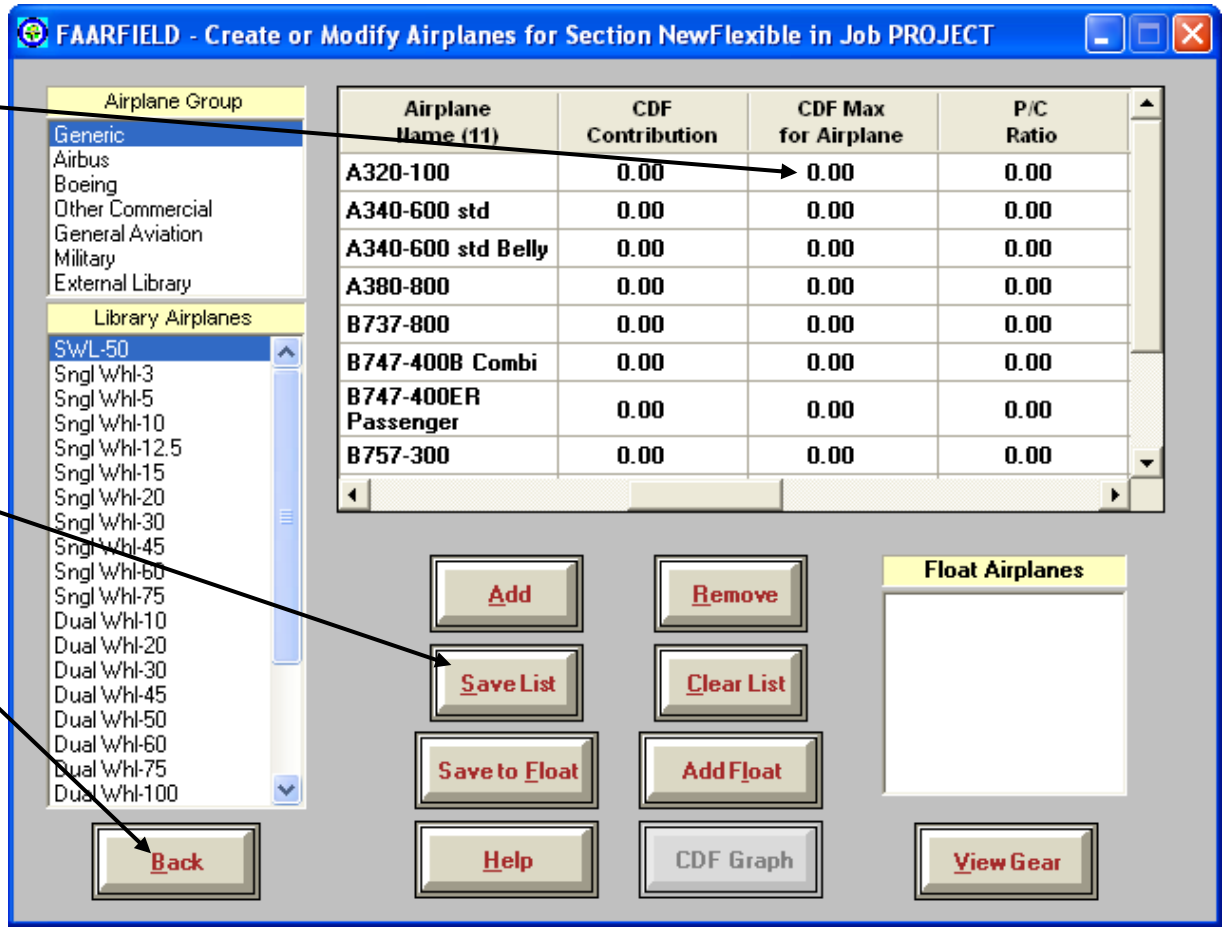
Airplane Name (11)	Gross Taxi Weight (tns)	Annual Departures	% Annual Growth	Total Departures	CDF Contribution	CDF Max for Airplane
A320-100	68.400	600	0.00	12,000	0.00	0.00
A340-600 std	365.200	1,000	0.00	20,000	0.00	0.00
A340-600 std Belly	365.200	1,000	0.00	20,000	0.00	0.00
A380-800	562.001	300	0.00	6,000	0.00	0.00
B737-800	79.243	2,000	0.00	40,000	0.00	0.00
B747-400B Combi	397.801	400	0.00	8,000	0.00	0.00
B747-400ER Passenger	414.130	300	0.00	6,000	0.00	0.00
B757-300	124.058	1,200	0.00	24,000	0.00	0.00

P/C Ratio	Tire Press. (kPa)	Percent GW on Gear	Dual Spacing (mm)	Tandem Spacing (mm)	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm^2)
0.00	1,380	47.5	927.1	0.0	303.1	485.0	115,442.5
0.00	1,606	32.8	1,397.0	1,981.2	381.6	610.6	529,468.5
0.00	1,531	29.3	1,168.4	1,981.2	261.3	418.0	555,703.5
0.00	1,338	95.0	1,348.7	1,699.3	394.6	631.4	195,717.9
0.00	1,407	47.5	863.6	0.0	323.1	517.0	131,218.1
0.00	1,379	95.0	1,117.6	1,473.2	365.6	585.0	167,973.5
0.00	1,572	95.0	1,117.6	1,473.2	349.4	559.0	153,393.5
0.00	1,379	47.5	863.6	1,143.0	288.7	462.0	104,767.9

Viewing Airplane Information

Values in CDF and P/C ratio columns will be zero when airplanes are first entered.

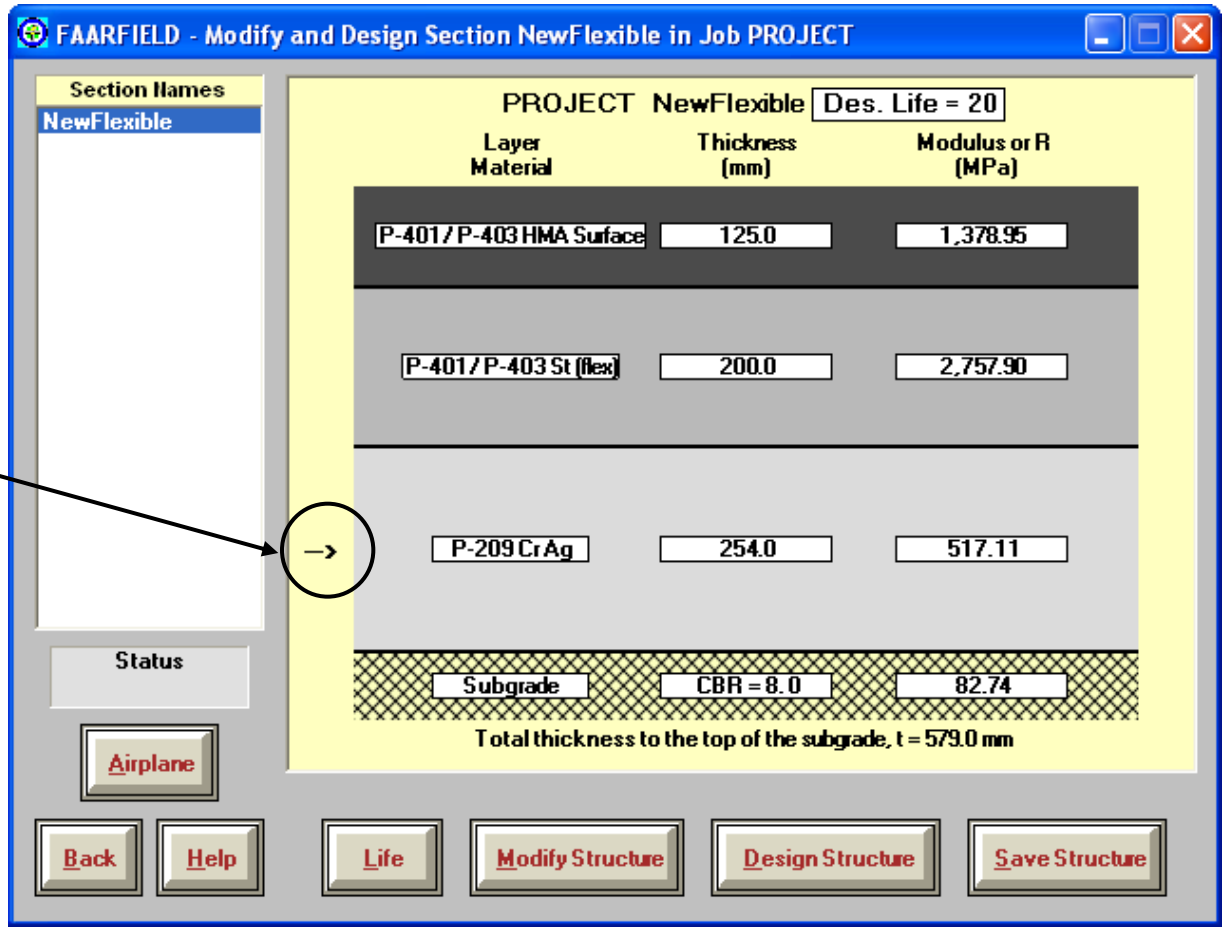
Save the list when finished entering, then click the Back button.



Performing the Pavement Design

The layer with the small arrow is the layer that will be adjusted to provide the structural design.

The location of the arrow is determined by the type of structure.



Layers Adjusted During Design

PAVEMENT TYPE	LAYER ADJUSTED
ACAggregate	P-154 Subbase
AConFlex	P-401 AC Overlay
AConRigid	P-401 AC Overlay
NewFlexible	P-209 Subbase
NewRigid	PCC Surface
PCConFlex	PCC Overlay on Flex
PCConRigid	PCC Overlay Unbond

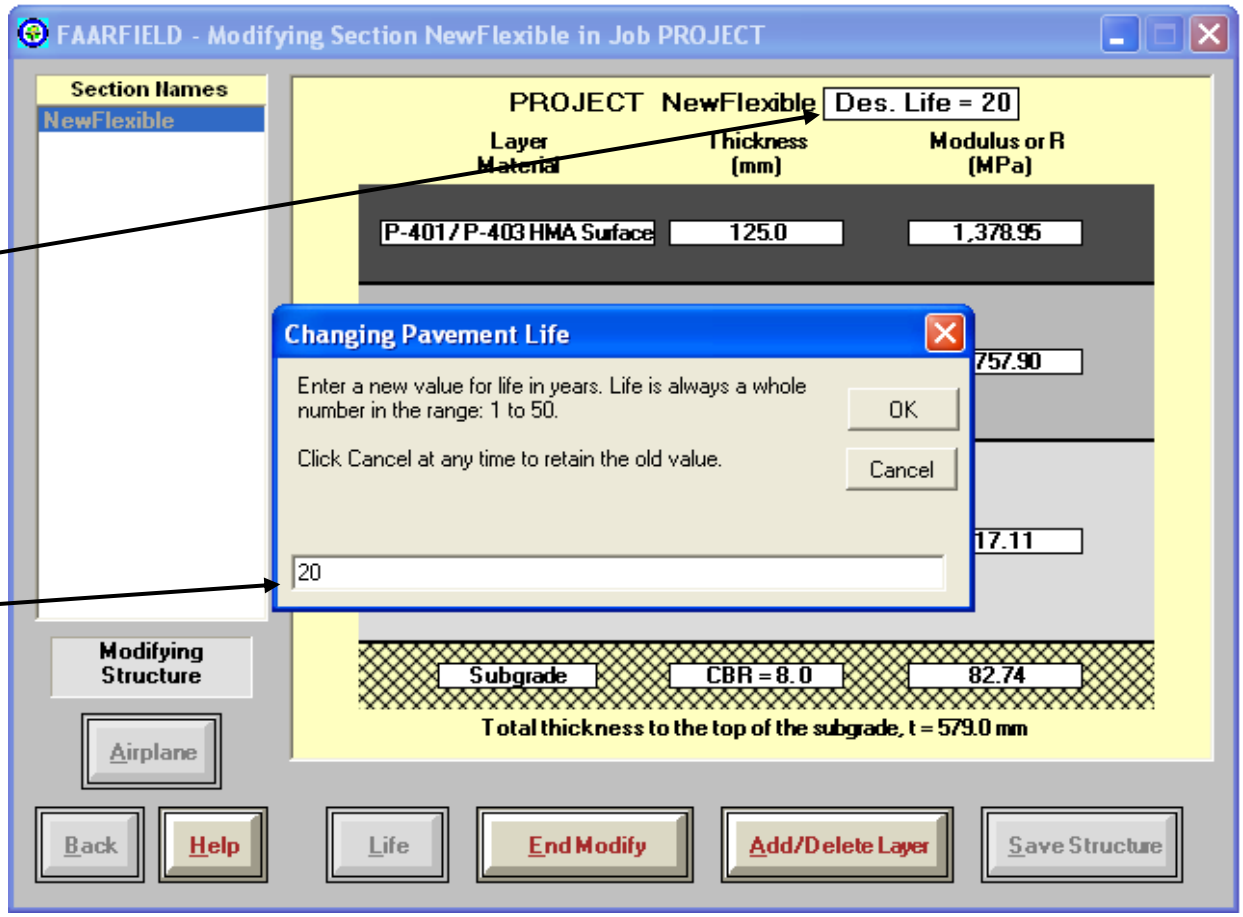
For new flexible sections, the arrow can be moved by double-clicking next to the desired base or subbase layer in “modify structure” mode.

Design Life

Click on "Des. Life" to change the number of years for the design period.

When the dialog box appears, enter the desired number of years (1-50).

NOTE: The standard for FAA design is 20 years.

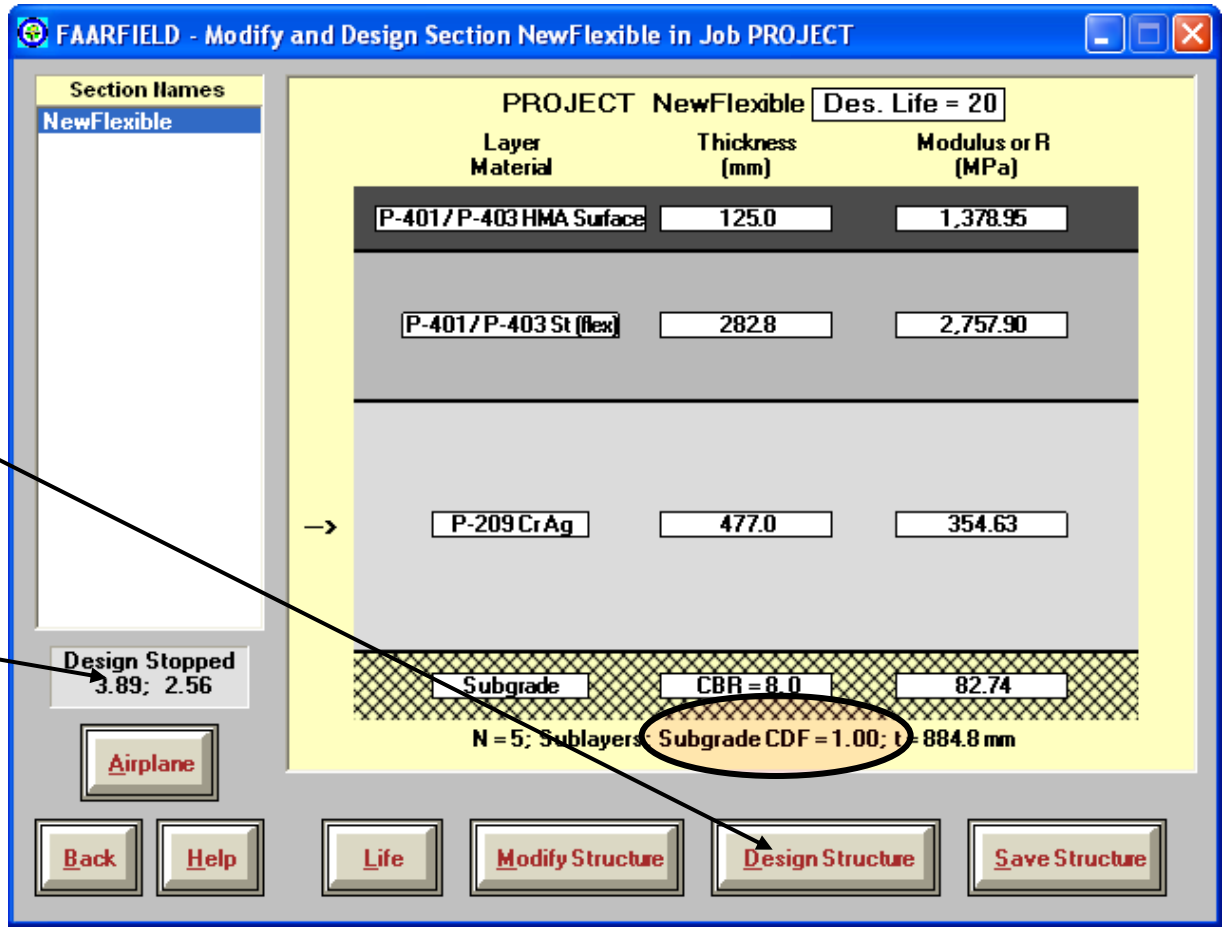


Performing the Pavement Design

You are now ready to design the structure. Simply click on "Design Structure."

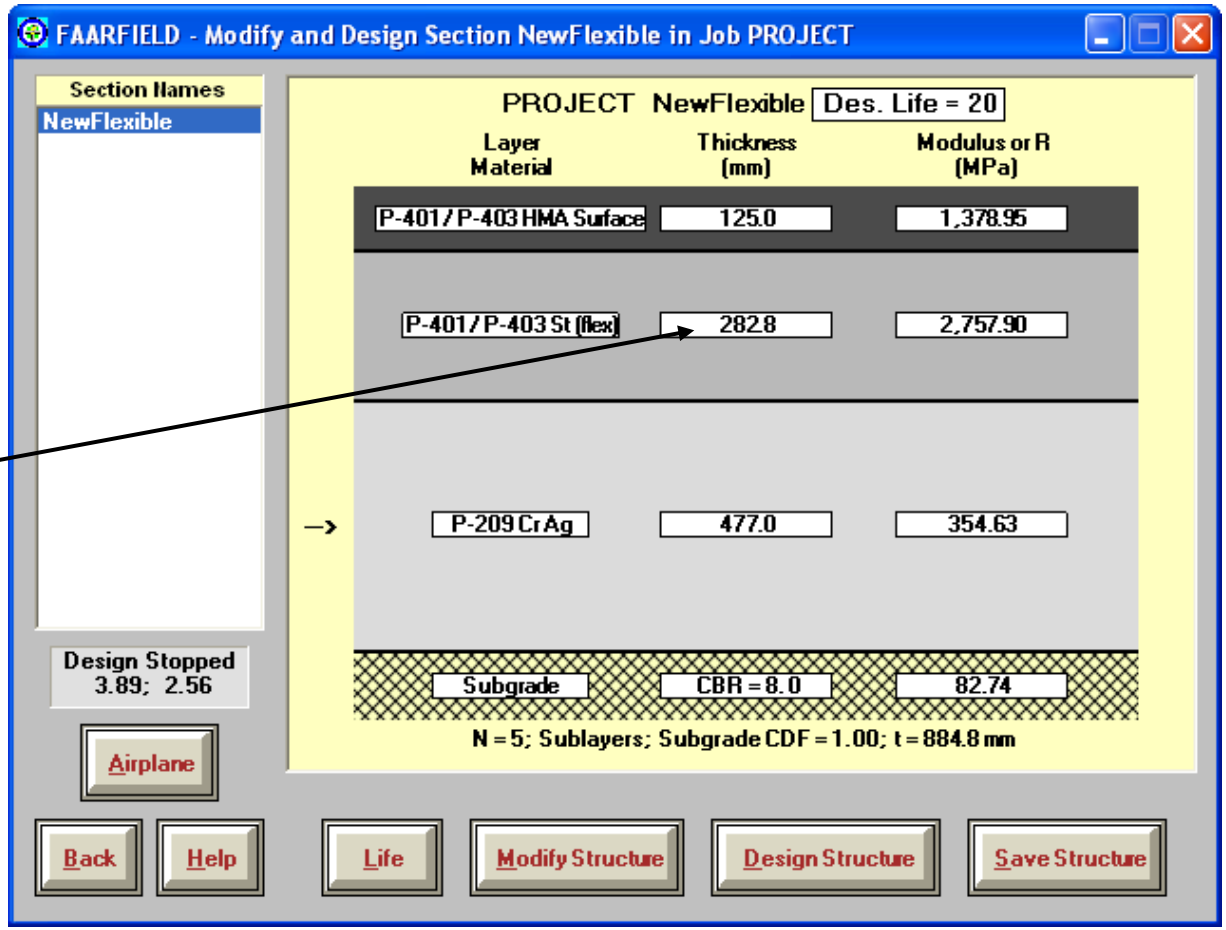
The program will keep you informed about the status of the design.

The program will adjust the design layer until a CDF of 1.0 is achieved.



Result of the Pavement Design

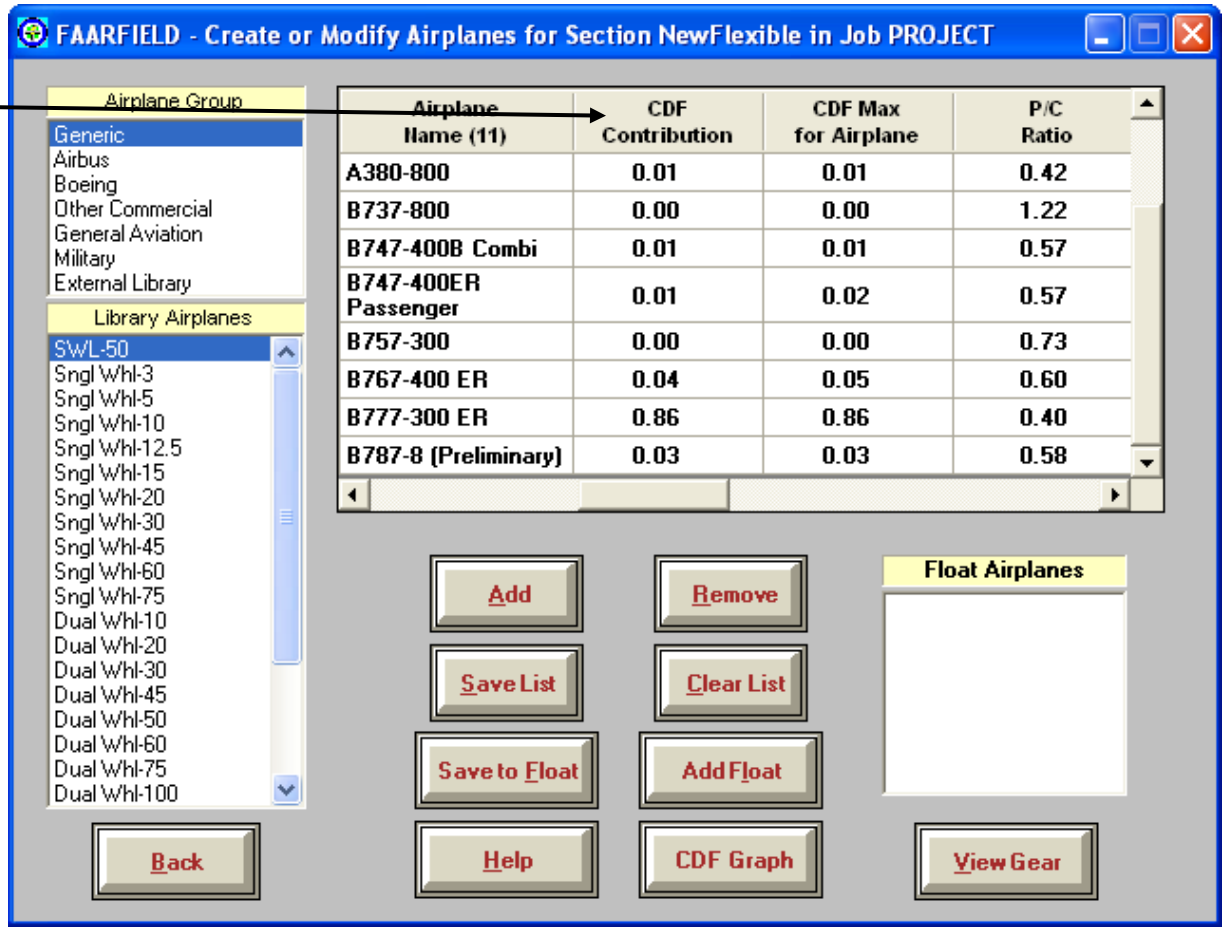
The program has also determined the minimum base layer requirement.



Reviewing Airplane Data After Completing the Design

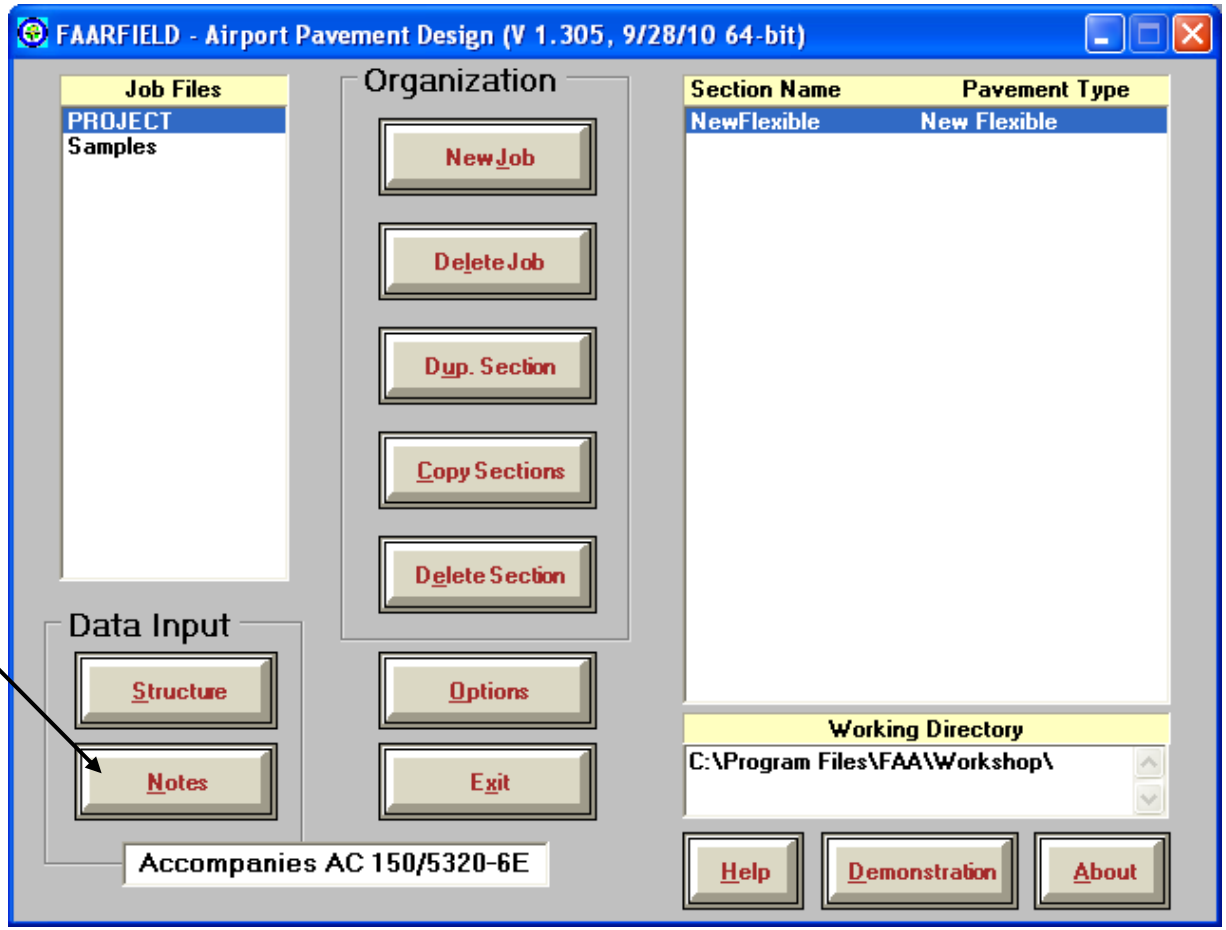
CDF and P/C ratio information is now available.

This information allows you to see which airplanes have the largest impact on the pavement design.



Reviewing Design Information

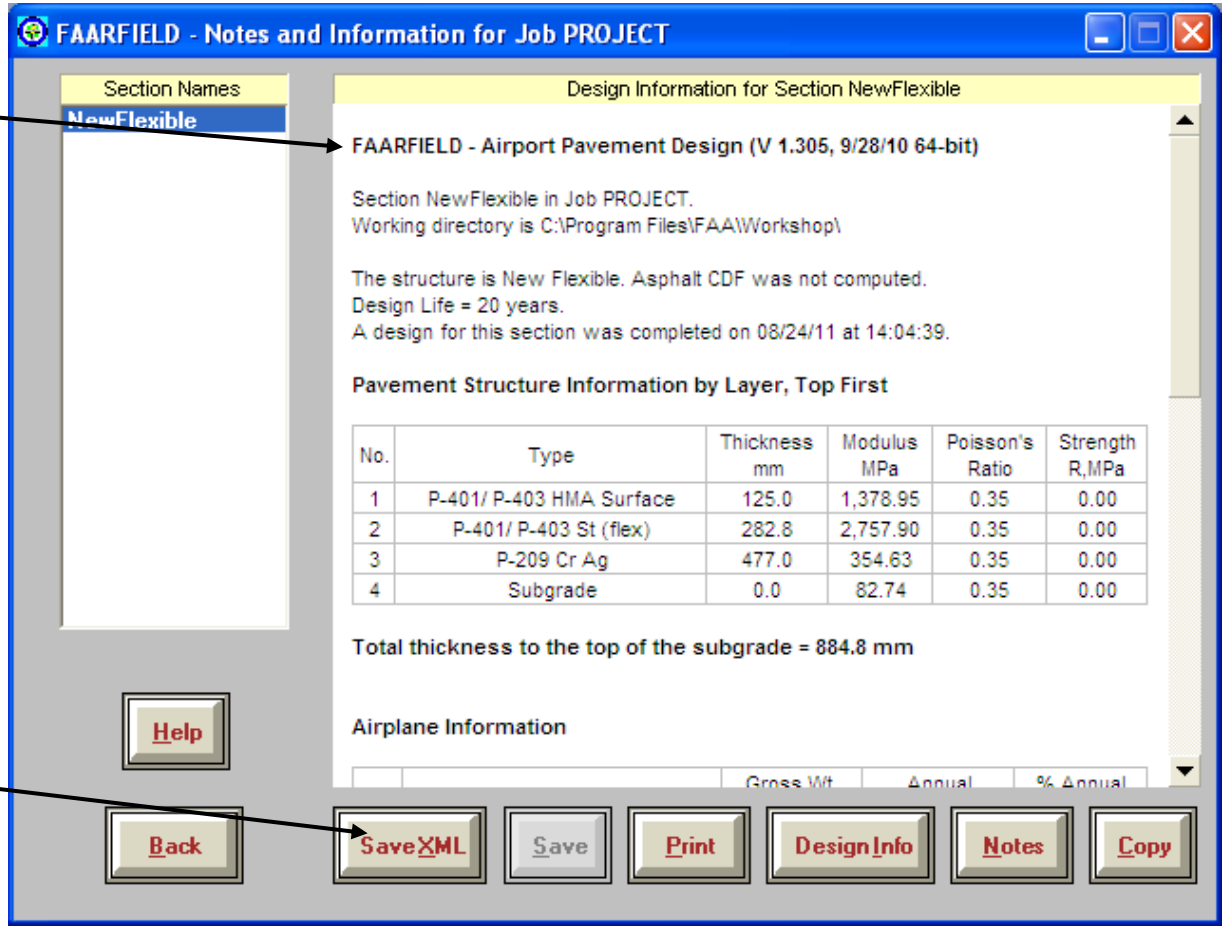
To view a summary of the design information, click the "Notes" button.



Reviewing Design Information

You can view the summary data or copy it to other electronic media.

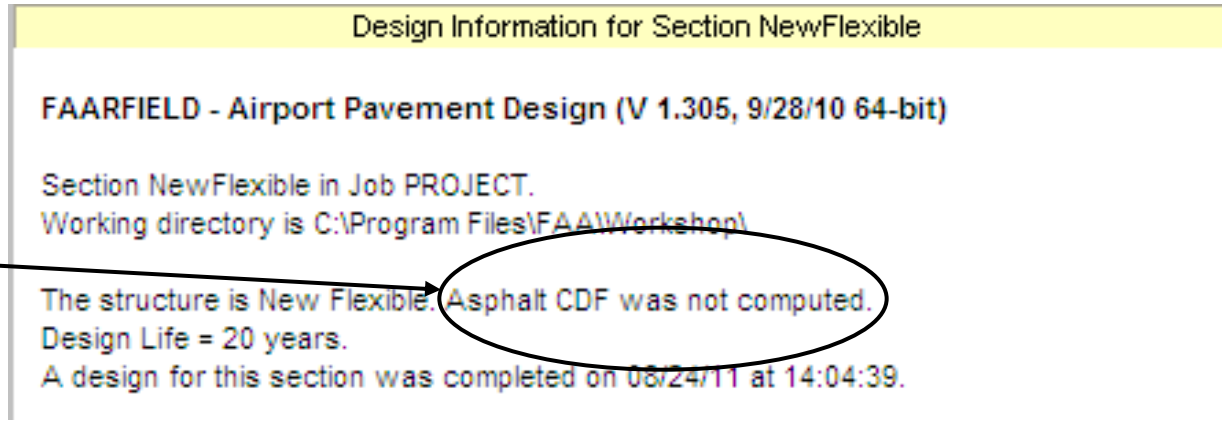
Data can also be exported in XML format to allow automated entry into FAA Form 5100.



Reviewing Design Information

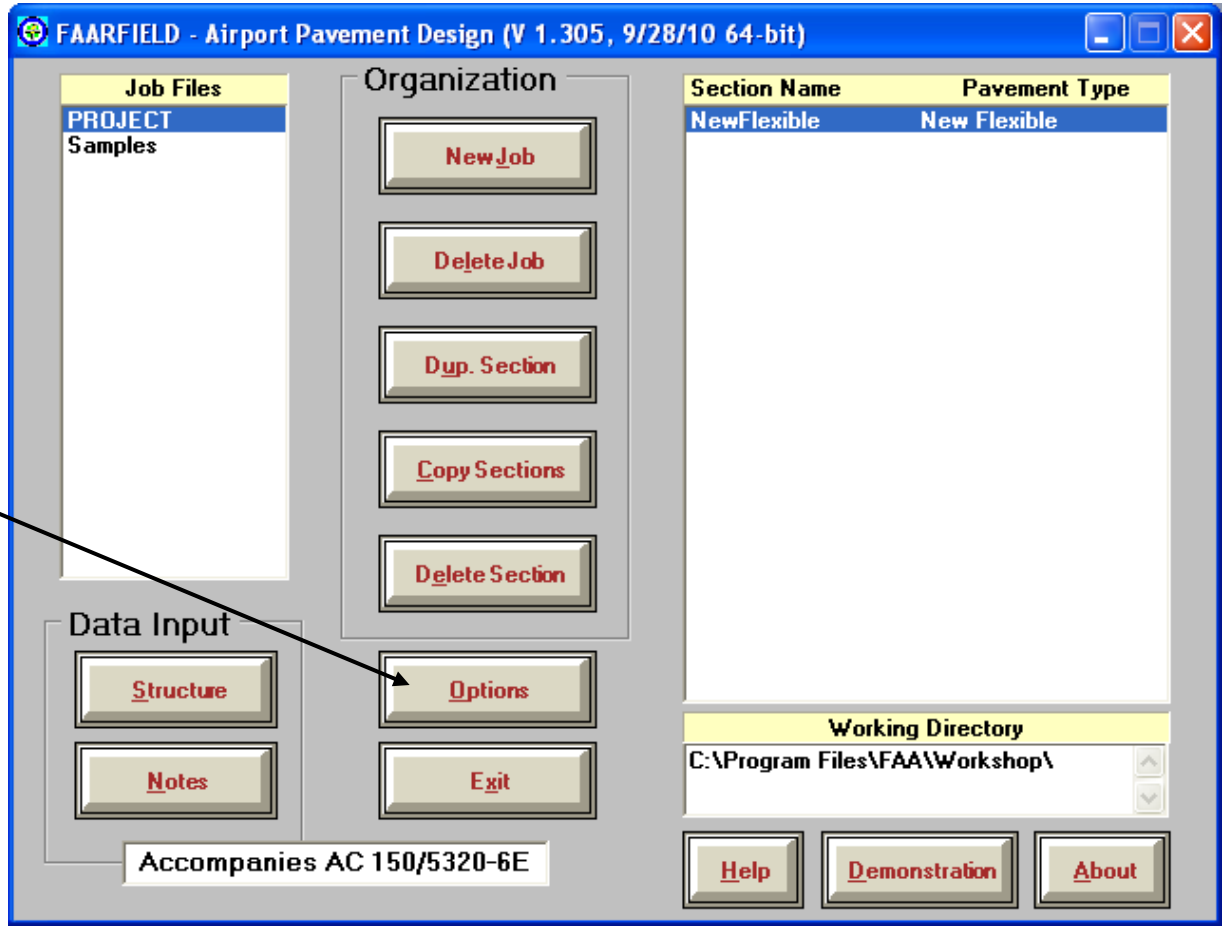
Notice the statement "asphalt CDF was not computed."

This means the design assumed the failure was in the subgrade and did not calculate the fatigue in the bottom of the HMA layer.



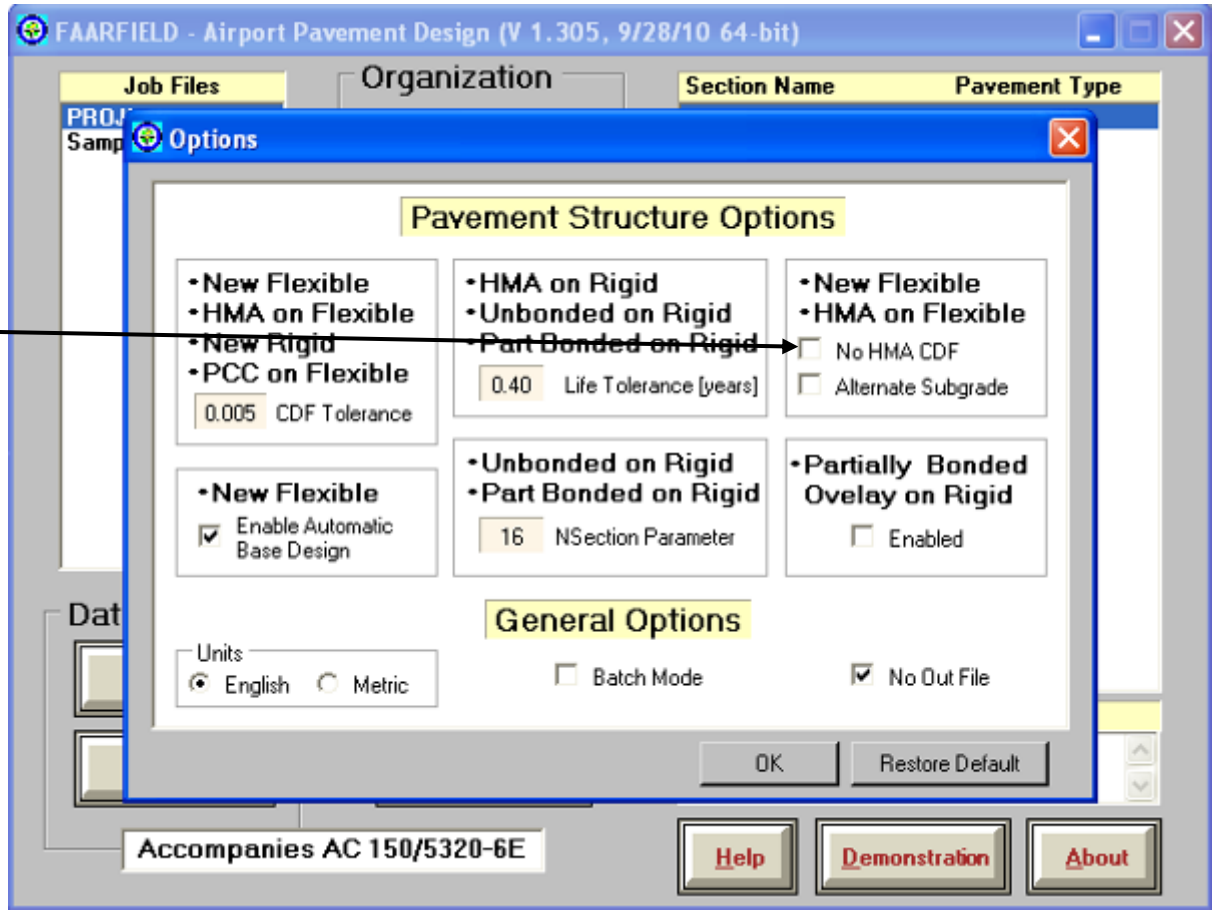
Computing Fatigue in the HMA Layer

The user can access the optional program features including the HMA layer CDF by clicking on the Options button from the starting screen, or by pressing ALT-O from anywhere in the program.



Computing Fatigue in the HMA Layer

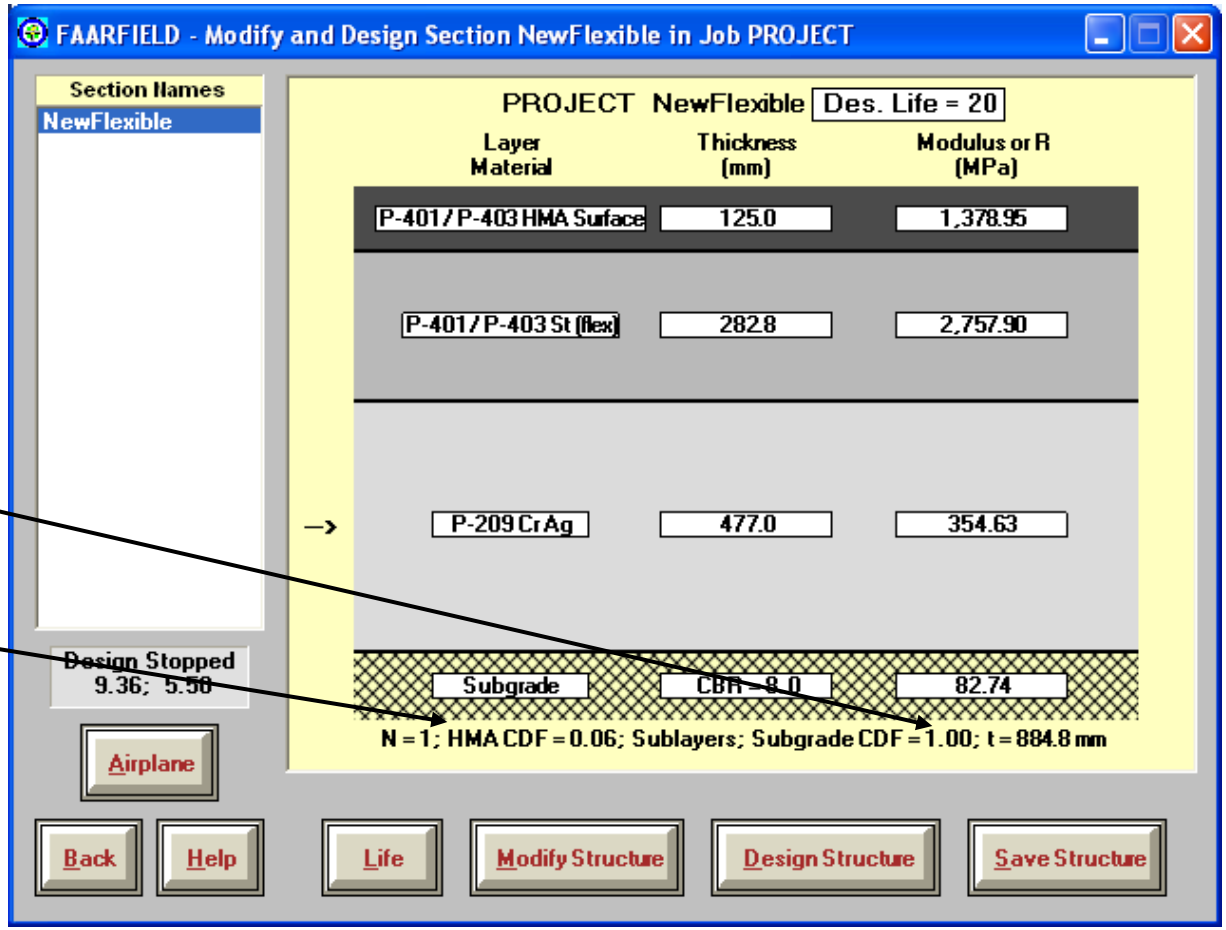
To compute the HMA fatigue, uncheck the "No HMA CDF" box and re-run the design.



Computing Fatigue in the HMA Layer

As this example demonstrates, the controlling feature is almost always the subgrade.

(i.e., the subgrade CDF has reached 1.0 (failure) while the HMA CDF is still 0.06.)

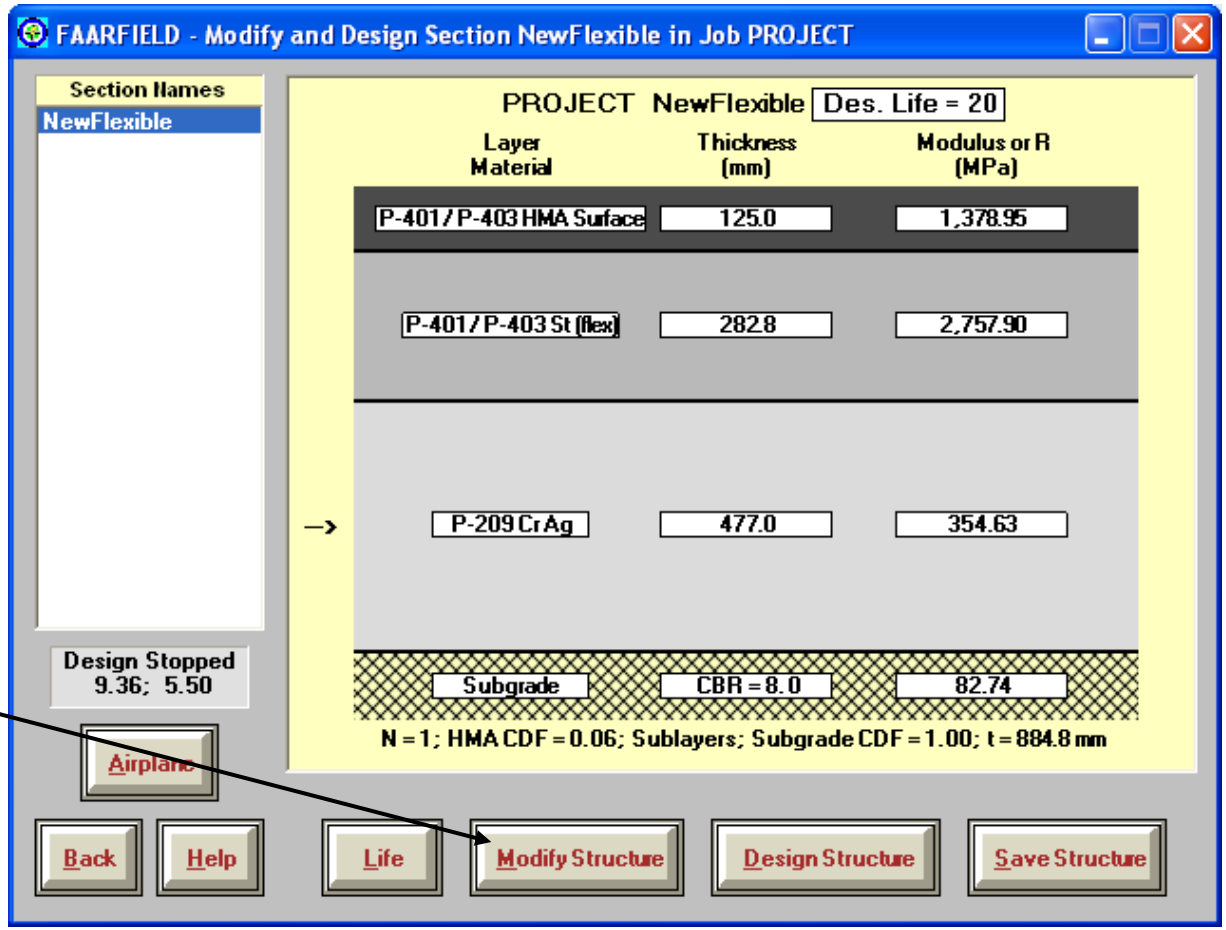


Minimum Base Course Requirements

- **FAARFIELD will automatically determine the minimum base layer requirements.**
- **Users can do this step manually if desired by deselecting this option.**
  - Remove subbase layer and increase subgrade CBR to 20.
  - Re-run the design to obtain the minimum base thickness.

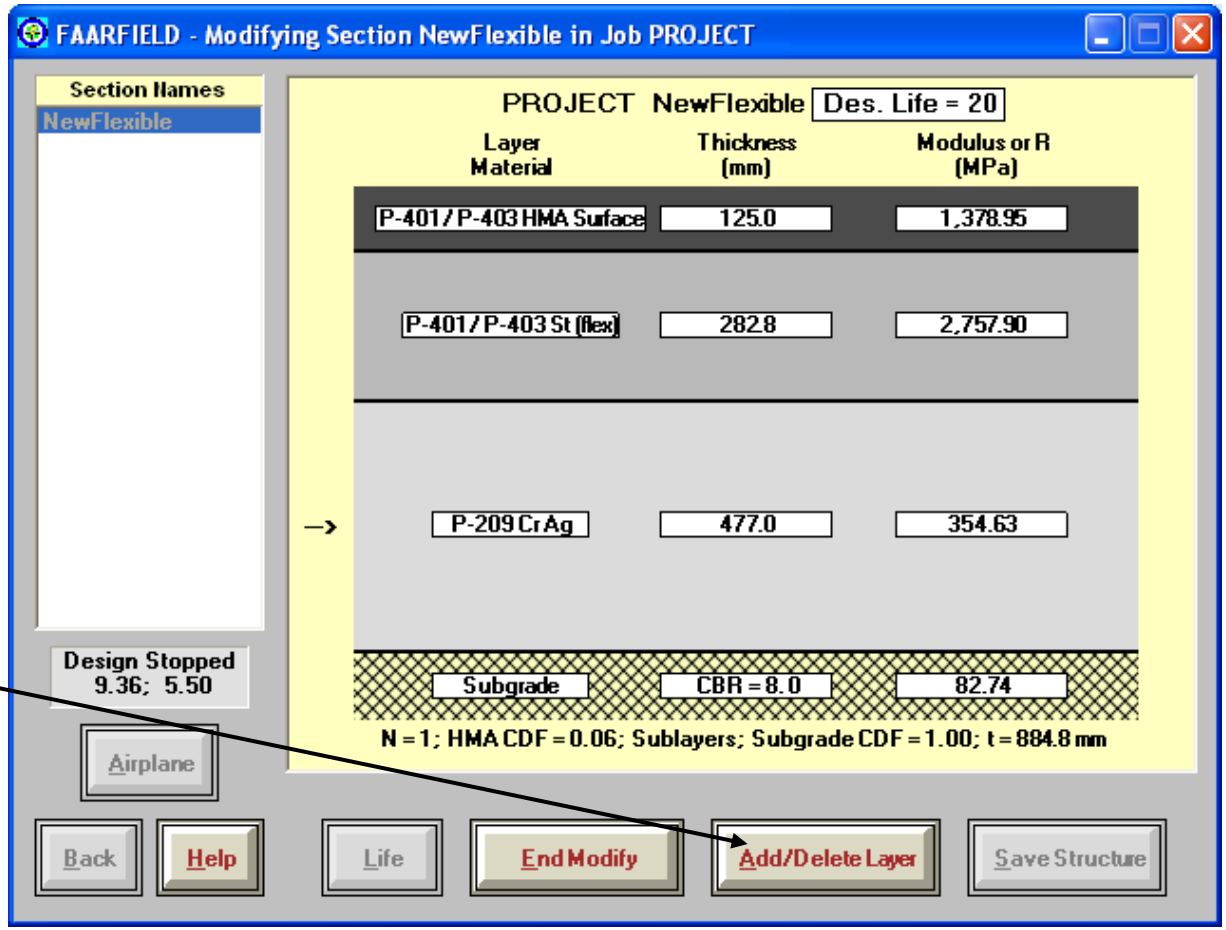
Determine Minimum Base Thickness

Click on "Modify Structure"



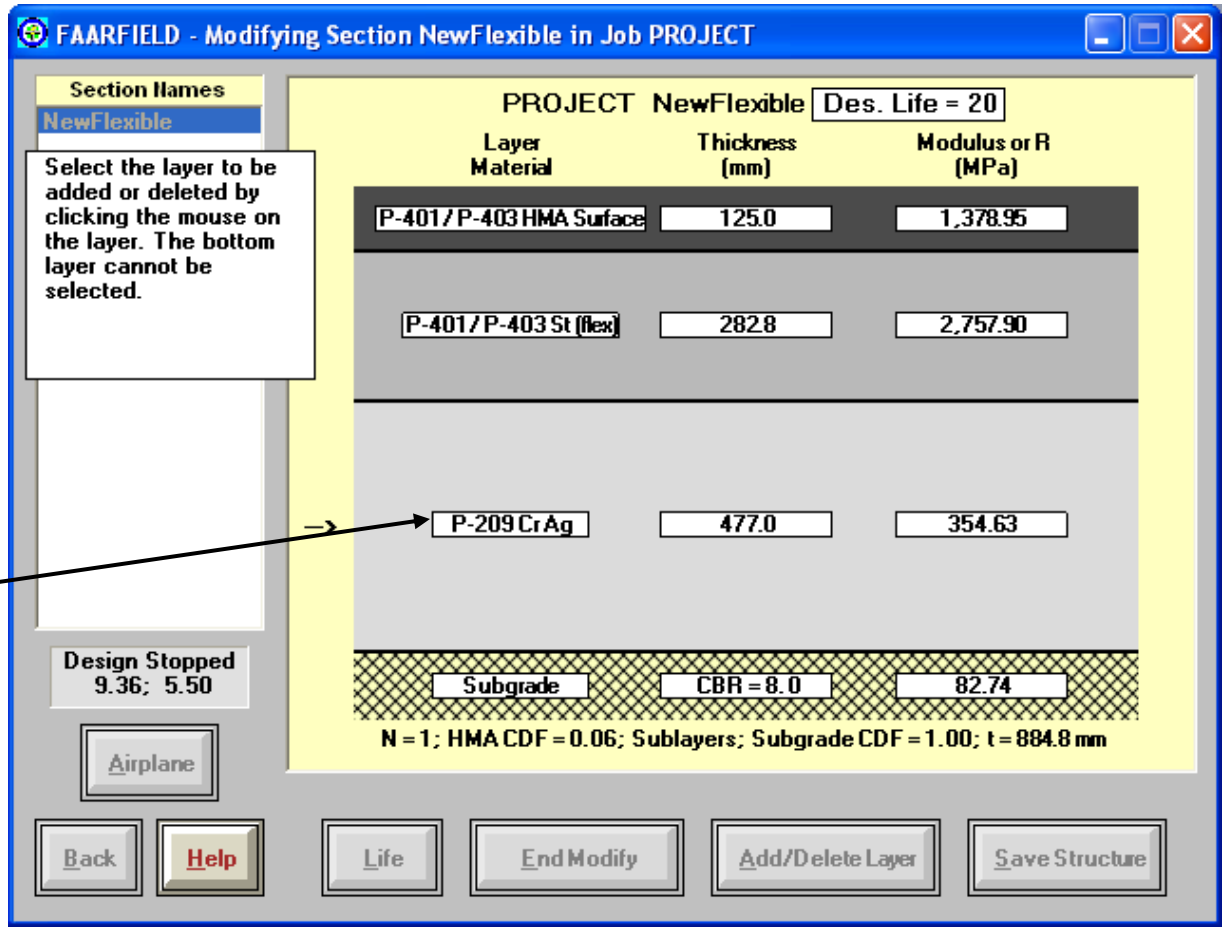
Determine Minimum Base Thickness

Click on "Add/Delete Layer"



Determine Minimum Base Thickness

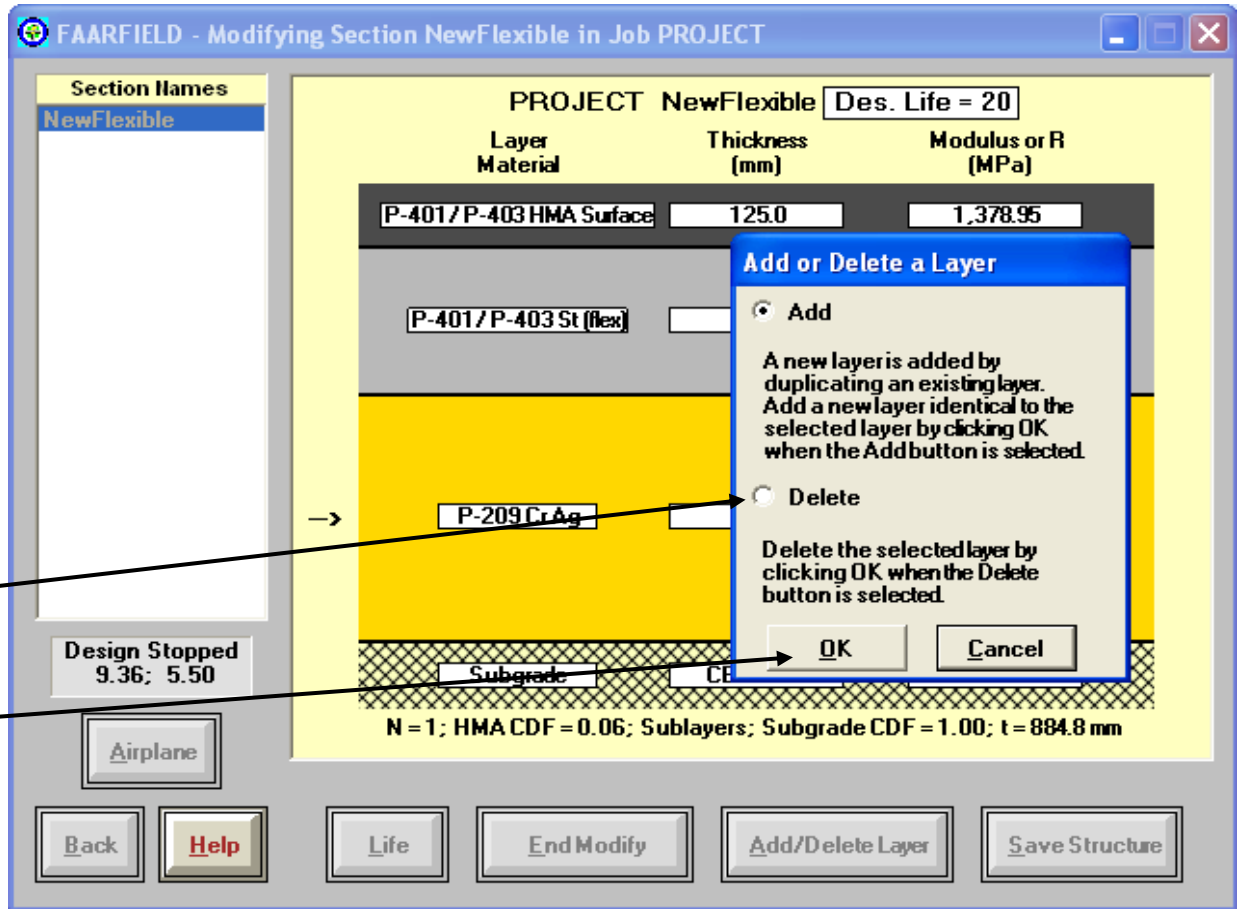
Click on the subbase layer.



Determine Minimum Base Thickness

Check the Delete option.

Then click OK.

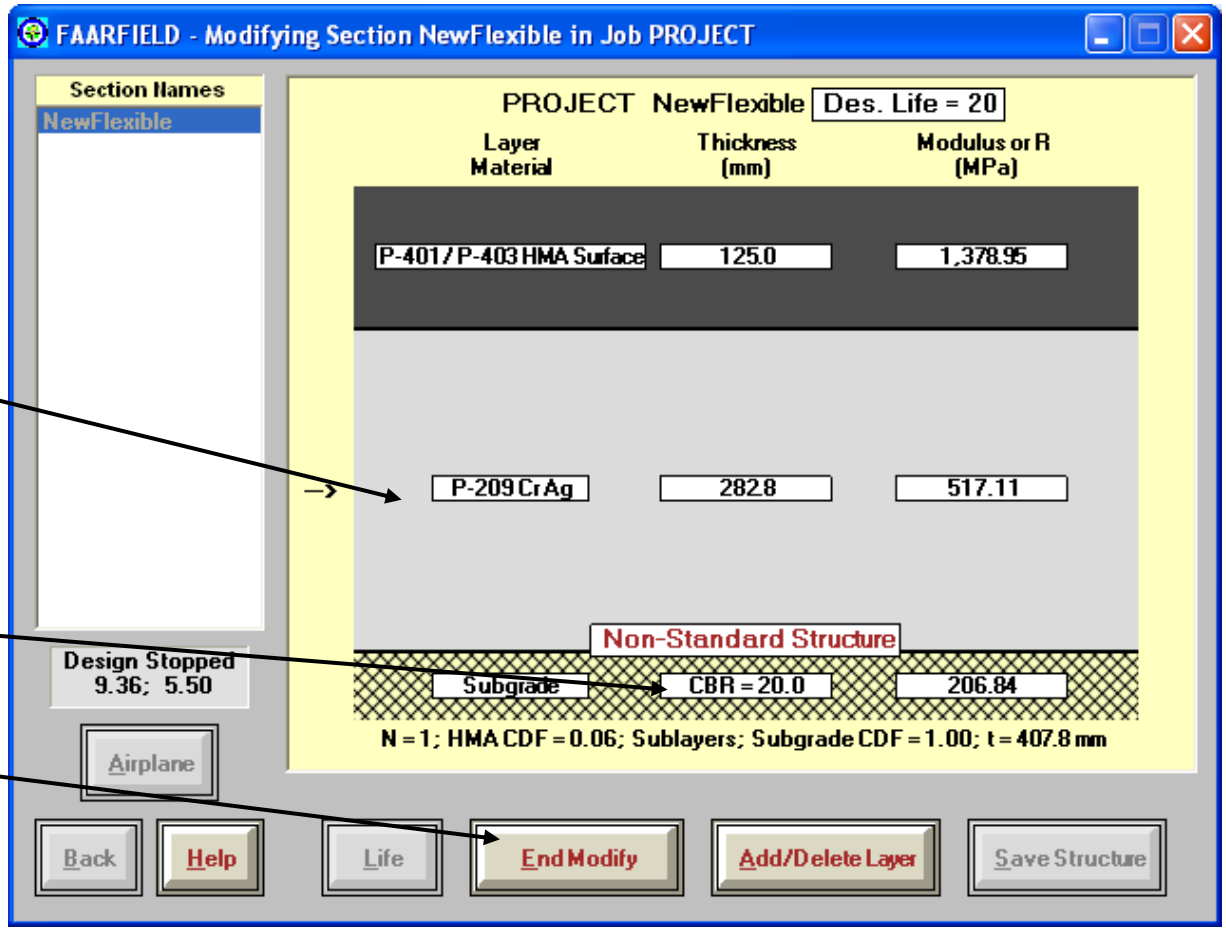


Determine Minimum Base Thickness

Change the P-401 base layer to P-209

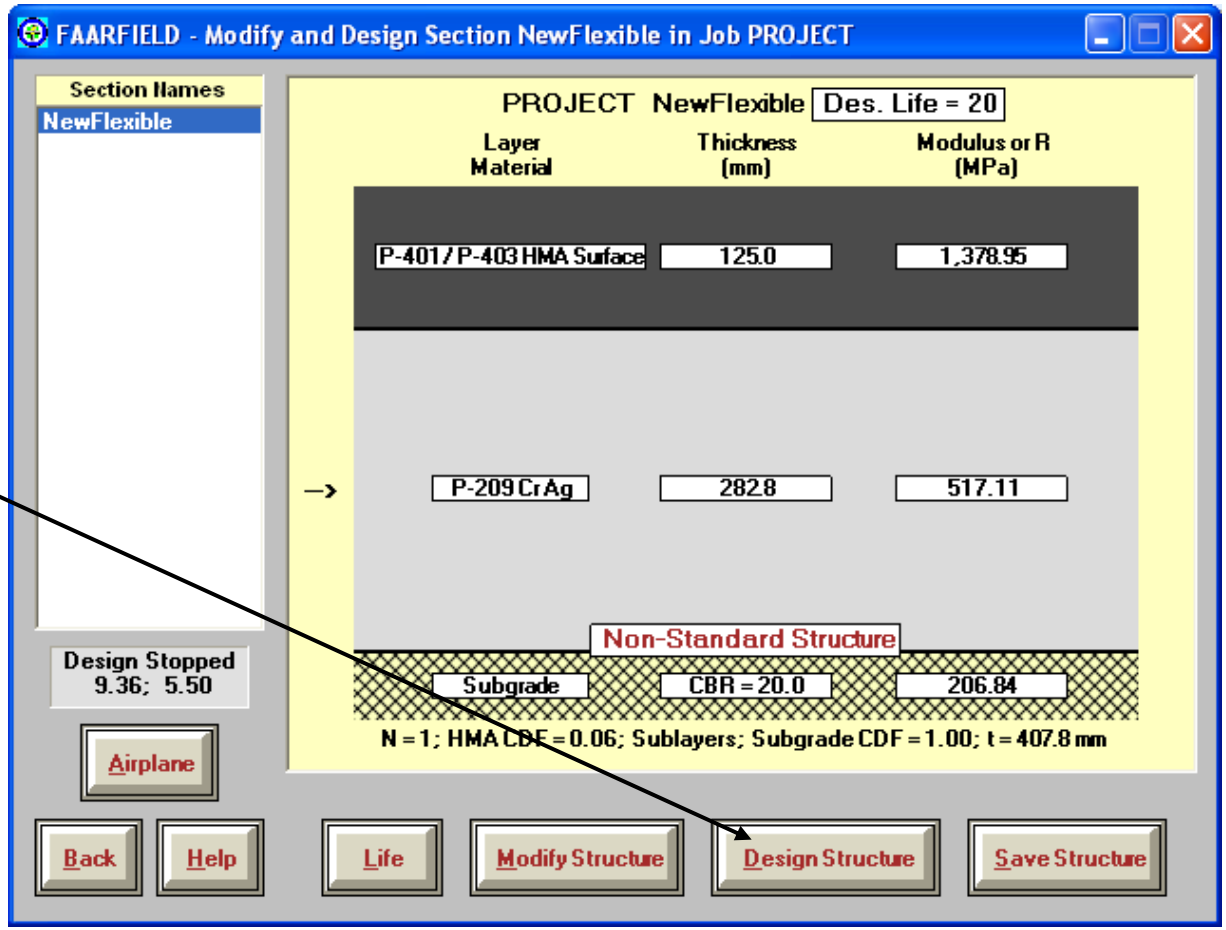
Increase the subgrade CBR to 20

Then click "End Modify"



Determine Minimum Base Thickness

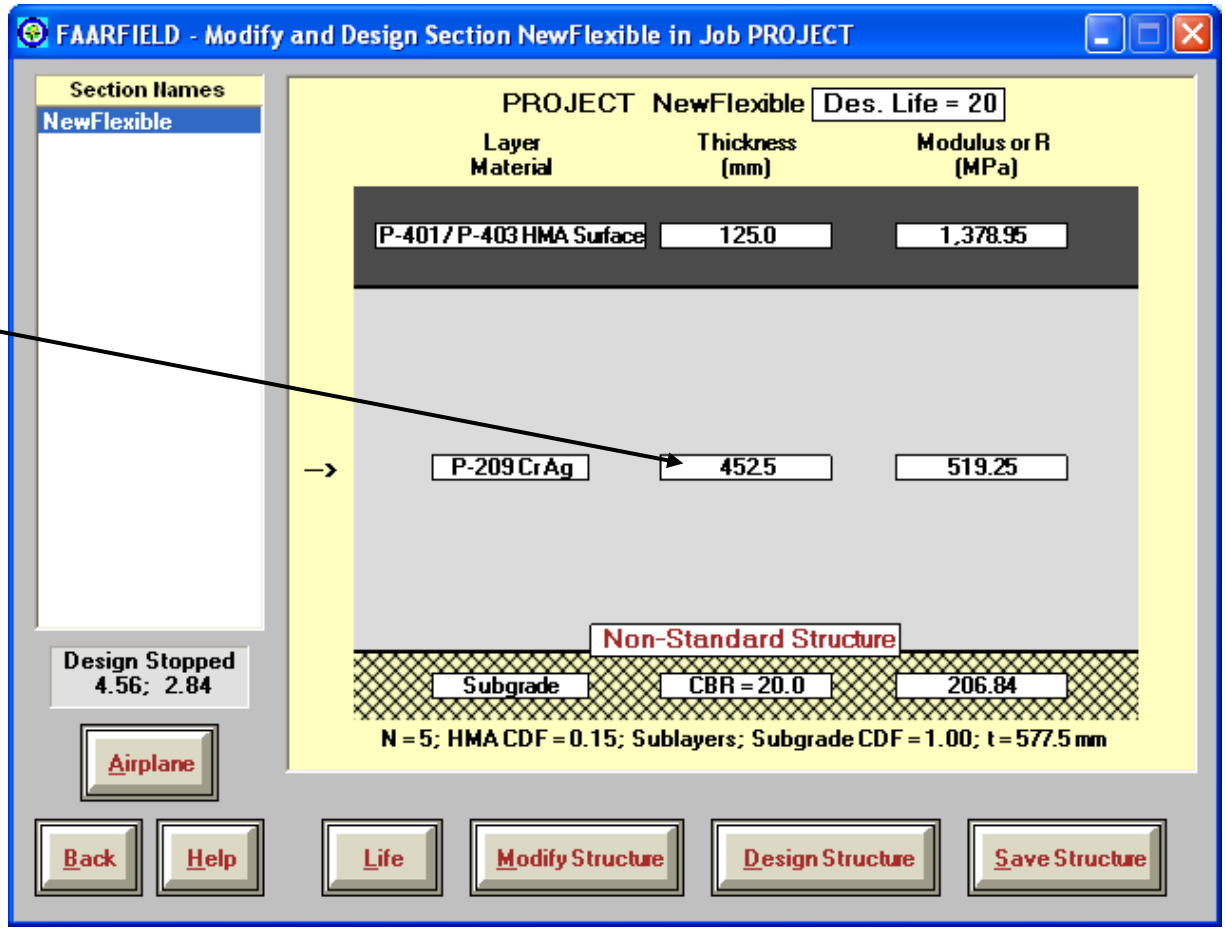
Click "Design Structure"



Determine Minimum Base Thickness

The minimum P-209 base thickness is that necessary to protect the CBR 20 subbase material.

Now, convert P-209 to stabilized material.



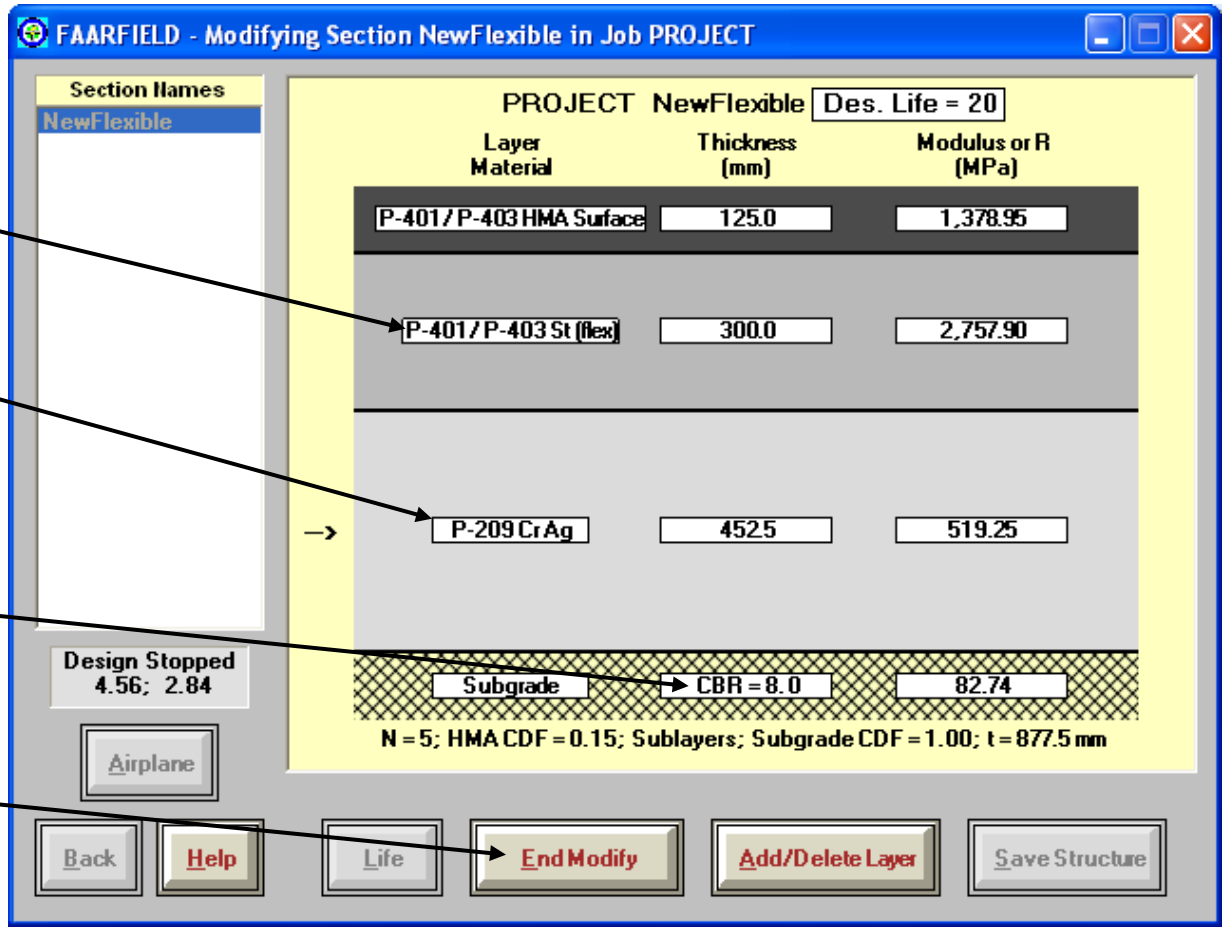
Determine Minimum Base Thickness

- **Convert 452.5 mm of P-209 to stabilized base.**
- **For this example, use P-401 as stabilized material. Convert to P-401 by dividing the layer thickness by 1.6 as provided in AC 150/5320-6E, 314(d).**
  - $T_{P401Base} = T_{P209} / 1.6$
  - $T_{P401Base}$ = 452.5 mm / 1.6 = 282.8 mm (say 300 mm)
- **Program performs this calculation automatically when automatic base design is enabled.**

Final Thickness Design

- **Reconstruct the original pavement section.**
- **Stabilized P-401 base at 300 mm**
- **P-209 as the improved subbase material (design layer).**
- **CBR returned to design value.**

Click "End Modify"

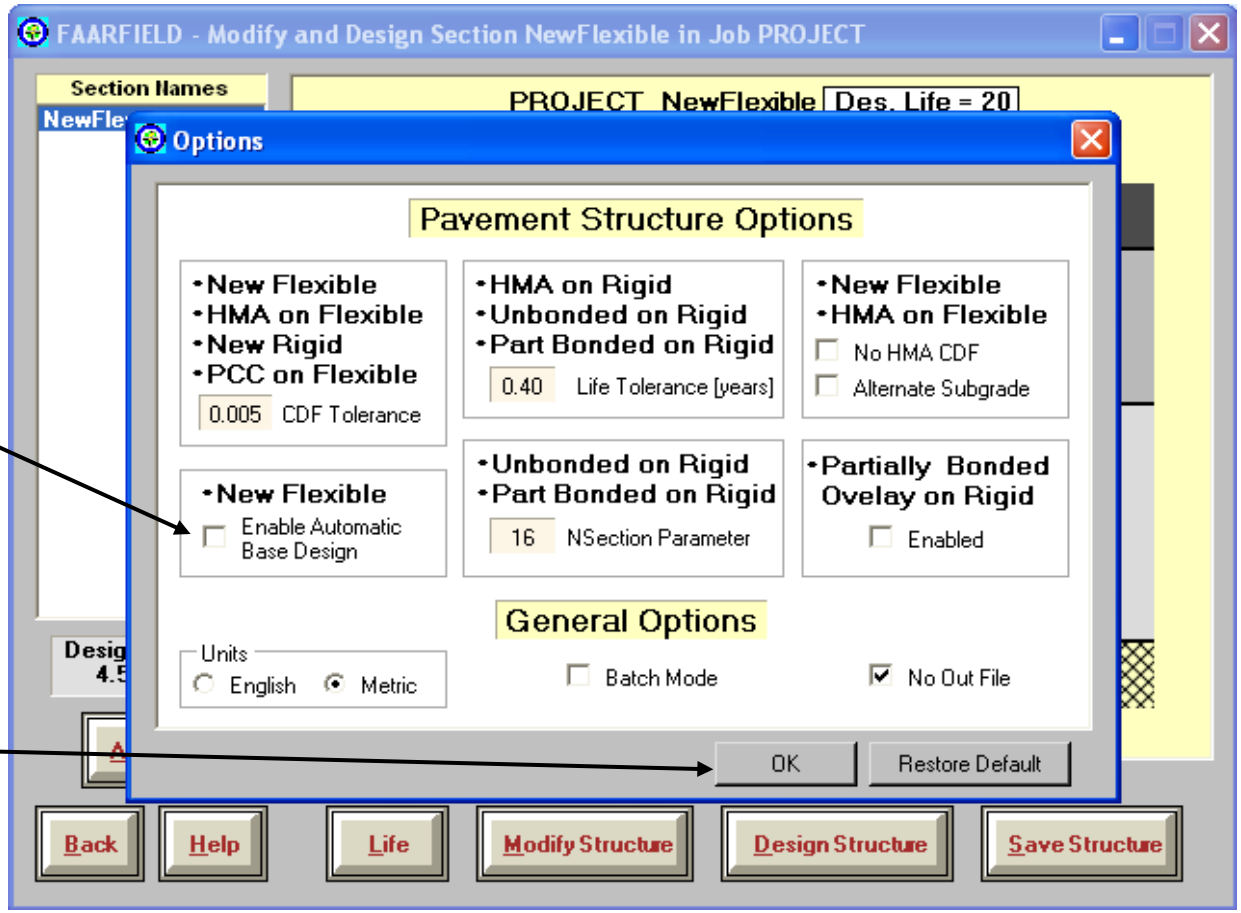


Final Thickness Design

Press ALT-O to bring up the Options window.

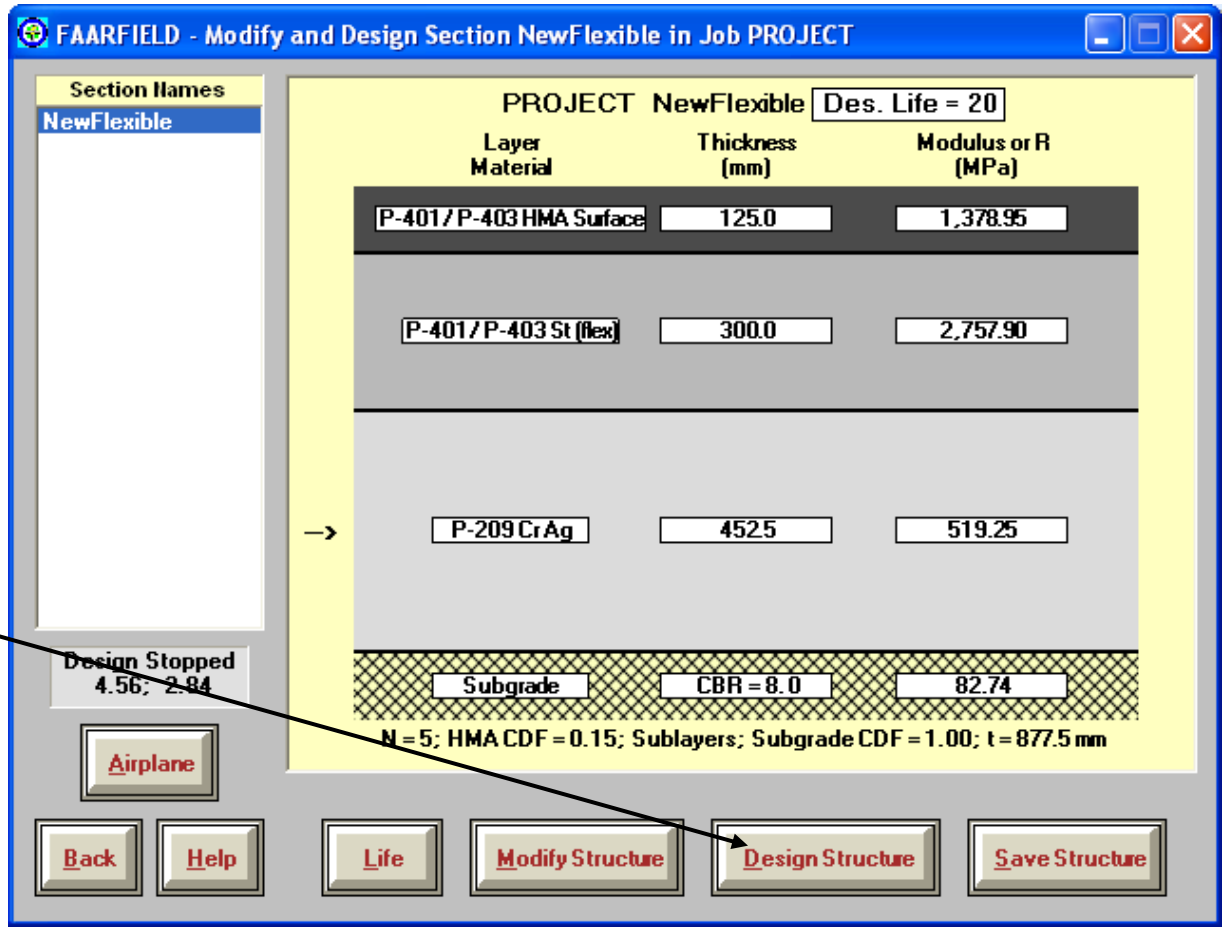
Uncheck "Enable Automatic Base Design)

Click OK



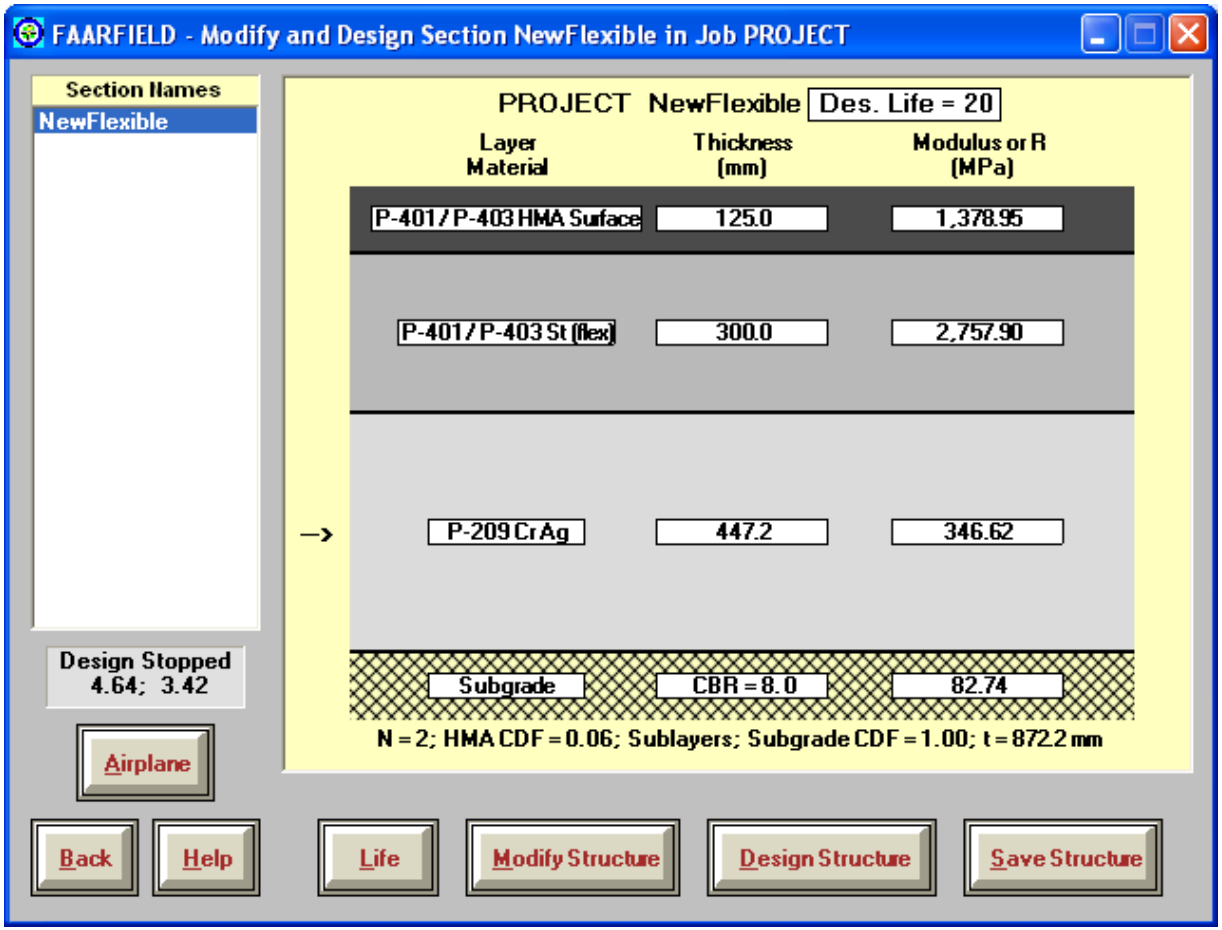
Final Thickness Design

Then click “Design Structure”



Final Thickness Design

The final layer thickness requirements are now visible.



Thank You

¡Gracias!

Questions?

¿Preguntas?

Flexible Overlay Design

FAARFIELD 1.305

Hands-On Training

Federal Aviation Administration

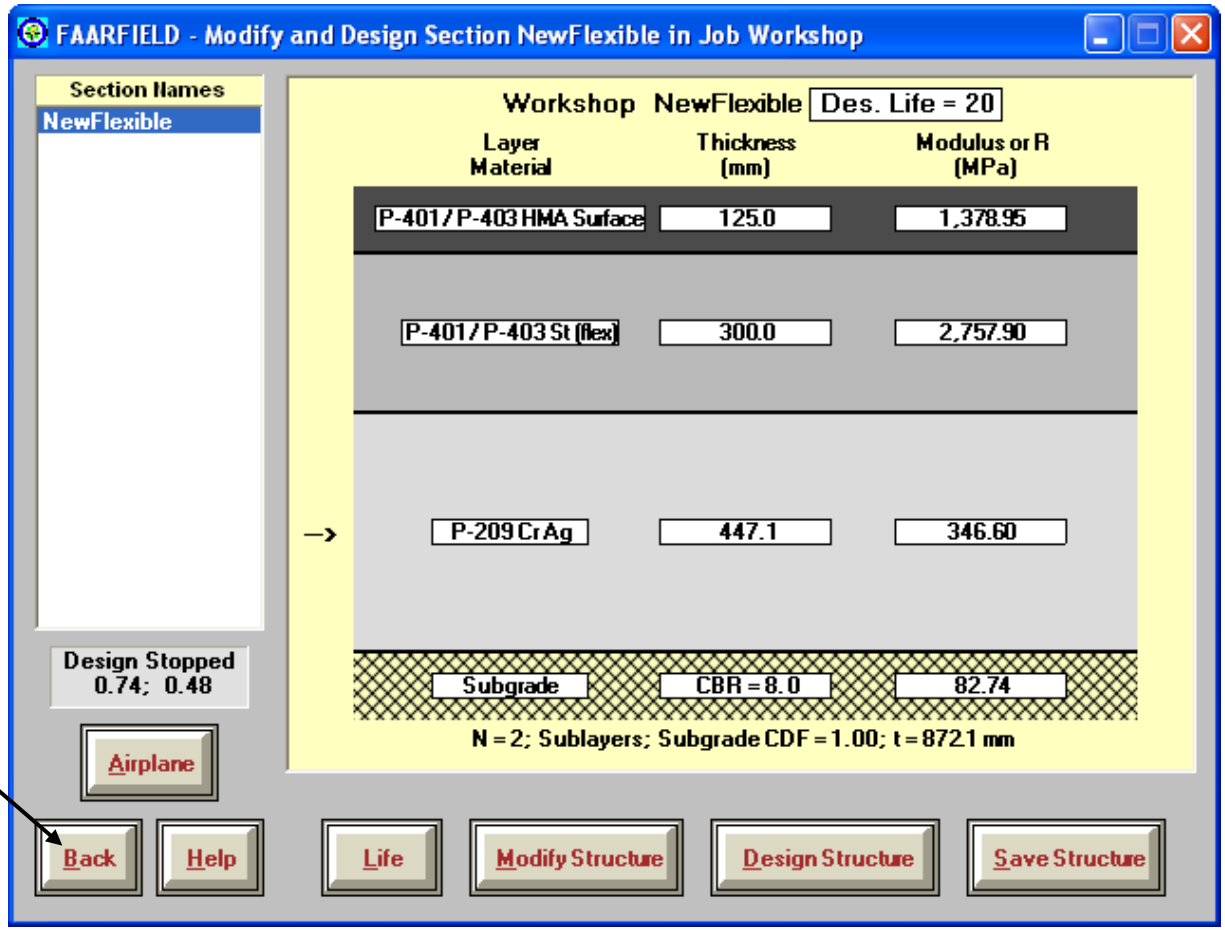
Presented to: IX ALACPA Seminar on Airport Pavements
Ciudad de Panamá, Panamá

By: David R. Brill, P.E., Ph.D.

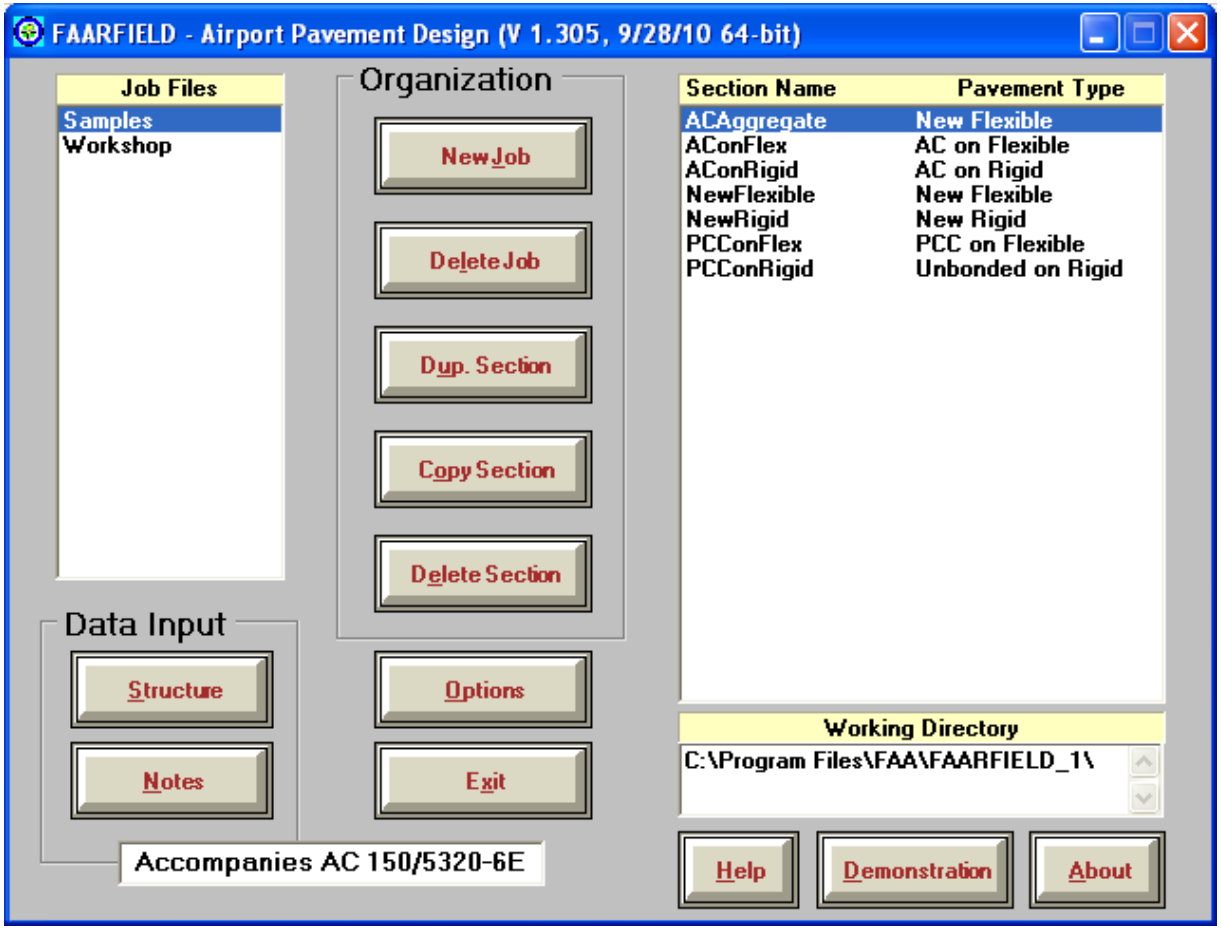
Date: September 13, 2012

Asphalt Overlay Design

Click “Back”

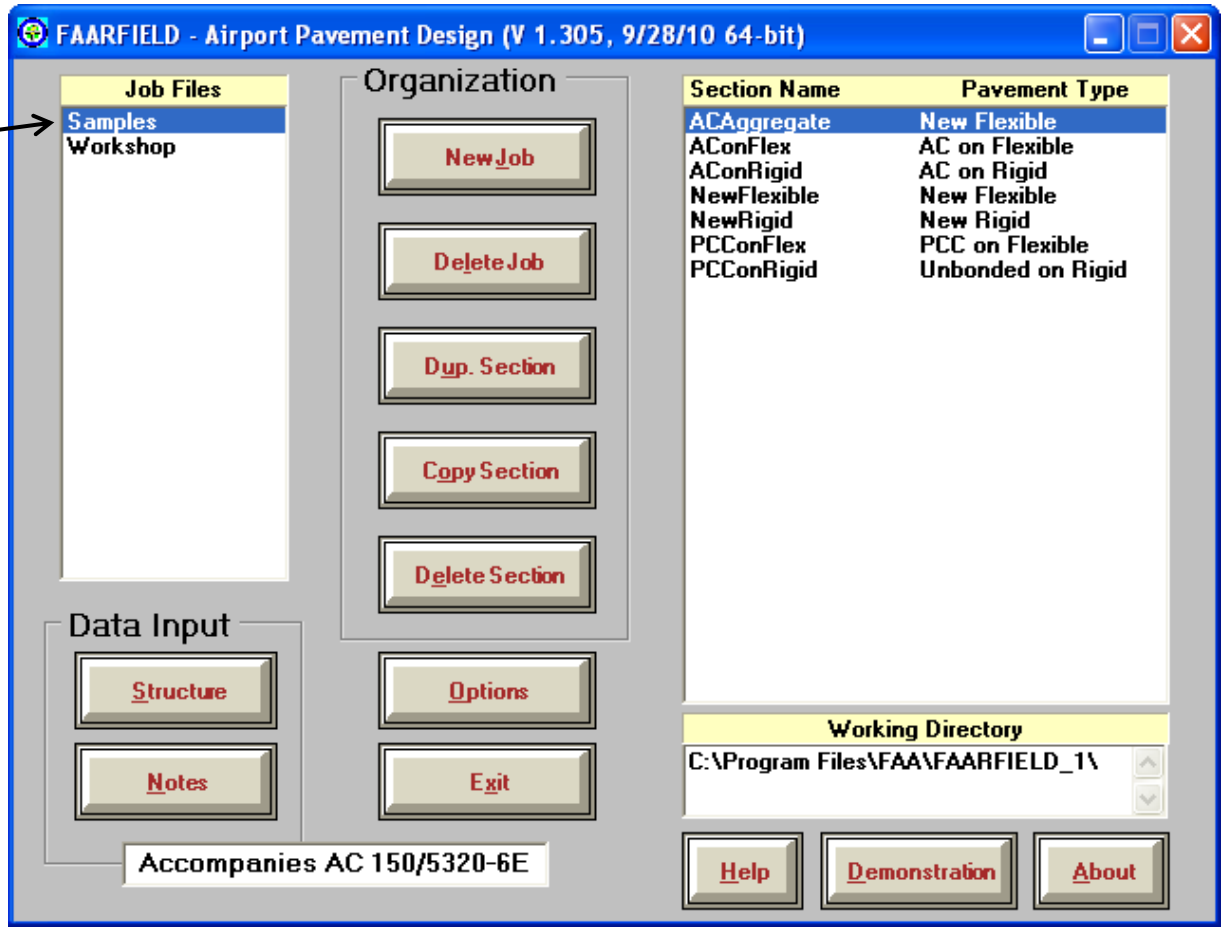


Asphalt Overlay Design



Asphalt Overlay Design - Copy Basic Section

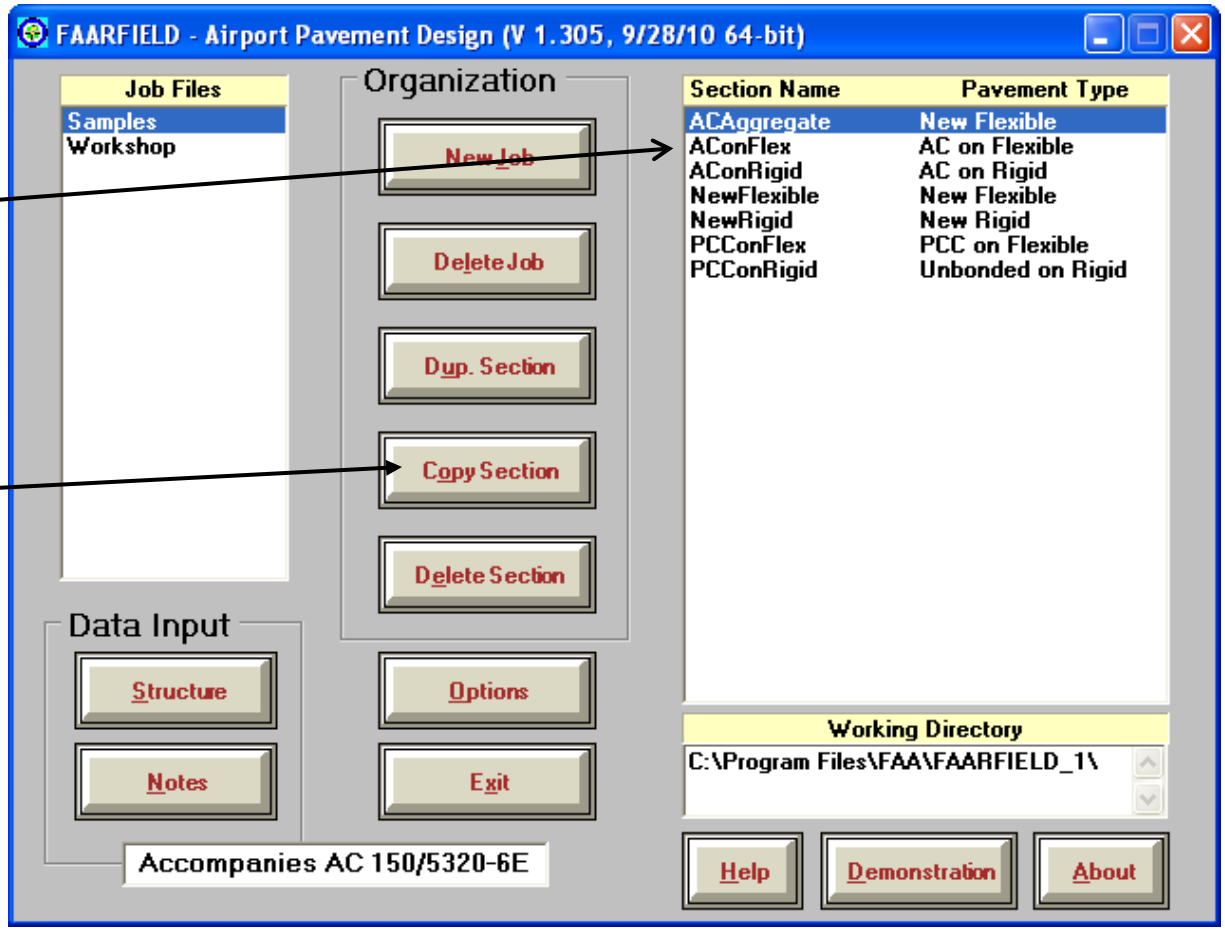
Click on "Samples"



Asphalt Overlay Design - Copy Basic Section

Default Basic Pavement Sections

Click on "Copy Section"



7 Basic Starting Structures in FAARFIELD

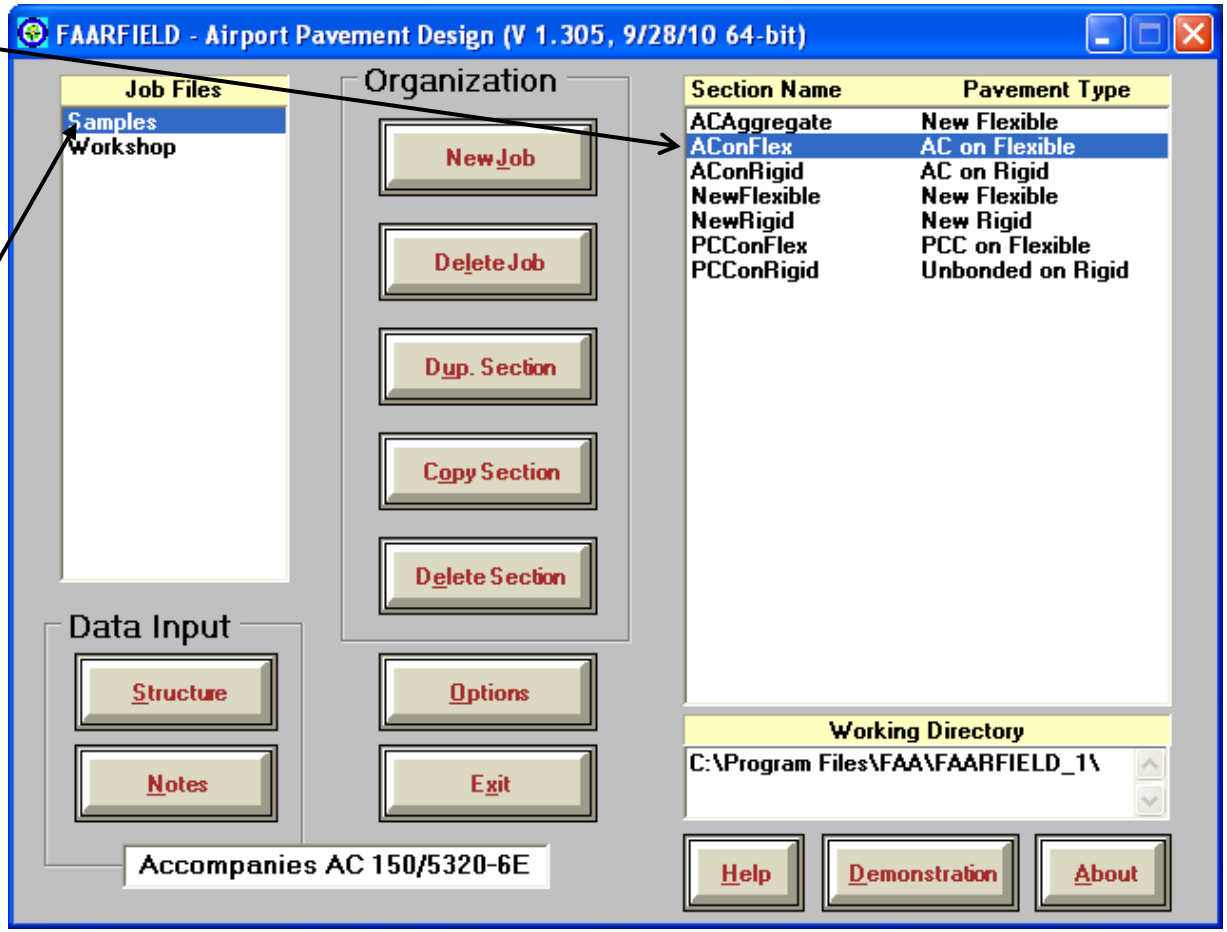
Section Name	Pavement Type
ACAggregate	New flexible on aggregate base
AConFlex	HMA overlay on flexible pavement
AConRigid	HMA overlay on rigid pavement
NewFlexible	New flexible on stabilized base
New Rigid	New rigid on stabilized base
PCConFlex	PCC Overlay on flexible
PCConRigid	Unbonded PCC on rigid

Be sure to select the pavement type that most correctly represents your design requirements.

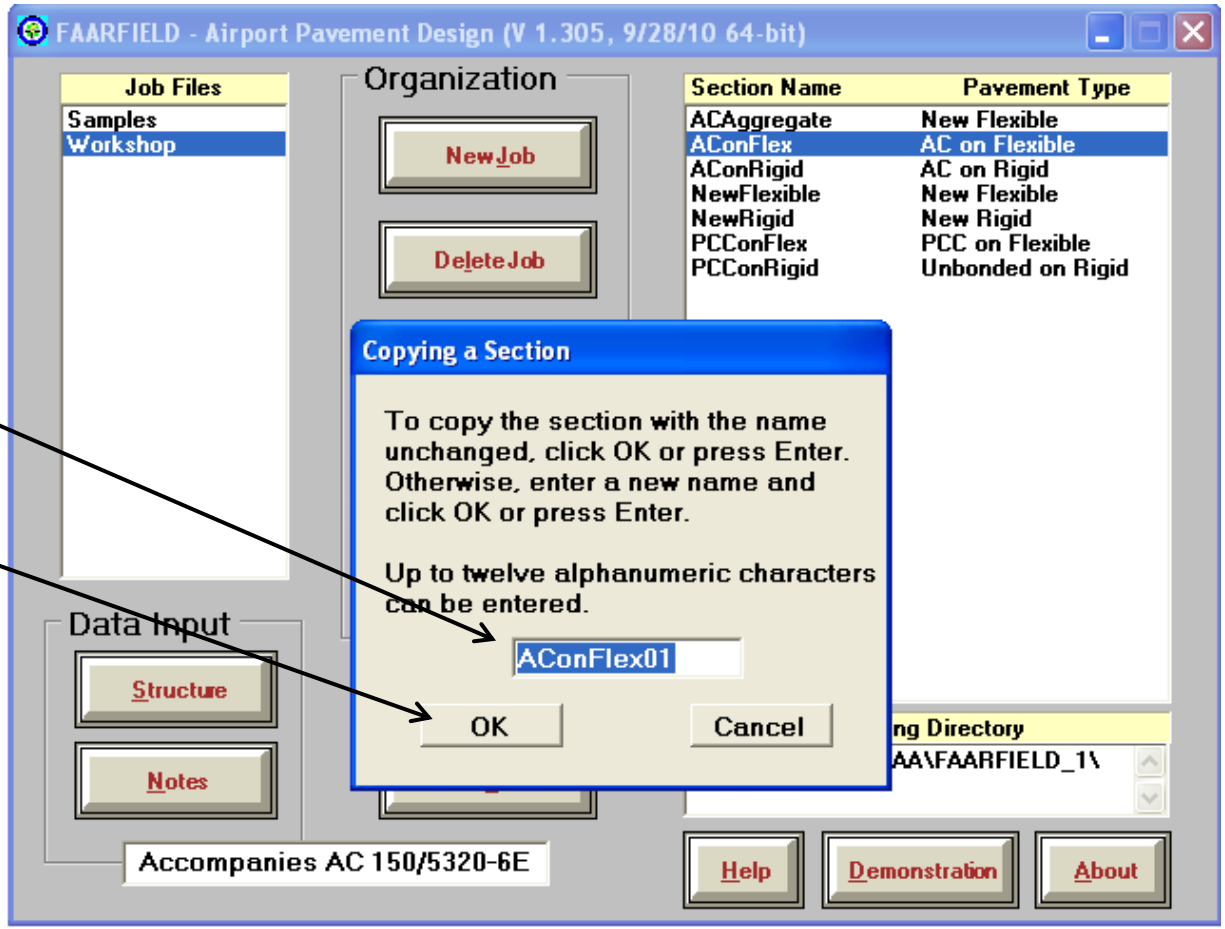
Asphalt Overlay Design / Copy a Sample Pavement Section

Click on desired pavement section.

Then click on the project where the section will be saved.



Asphalt Overlay Design / Create a New Job Title

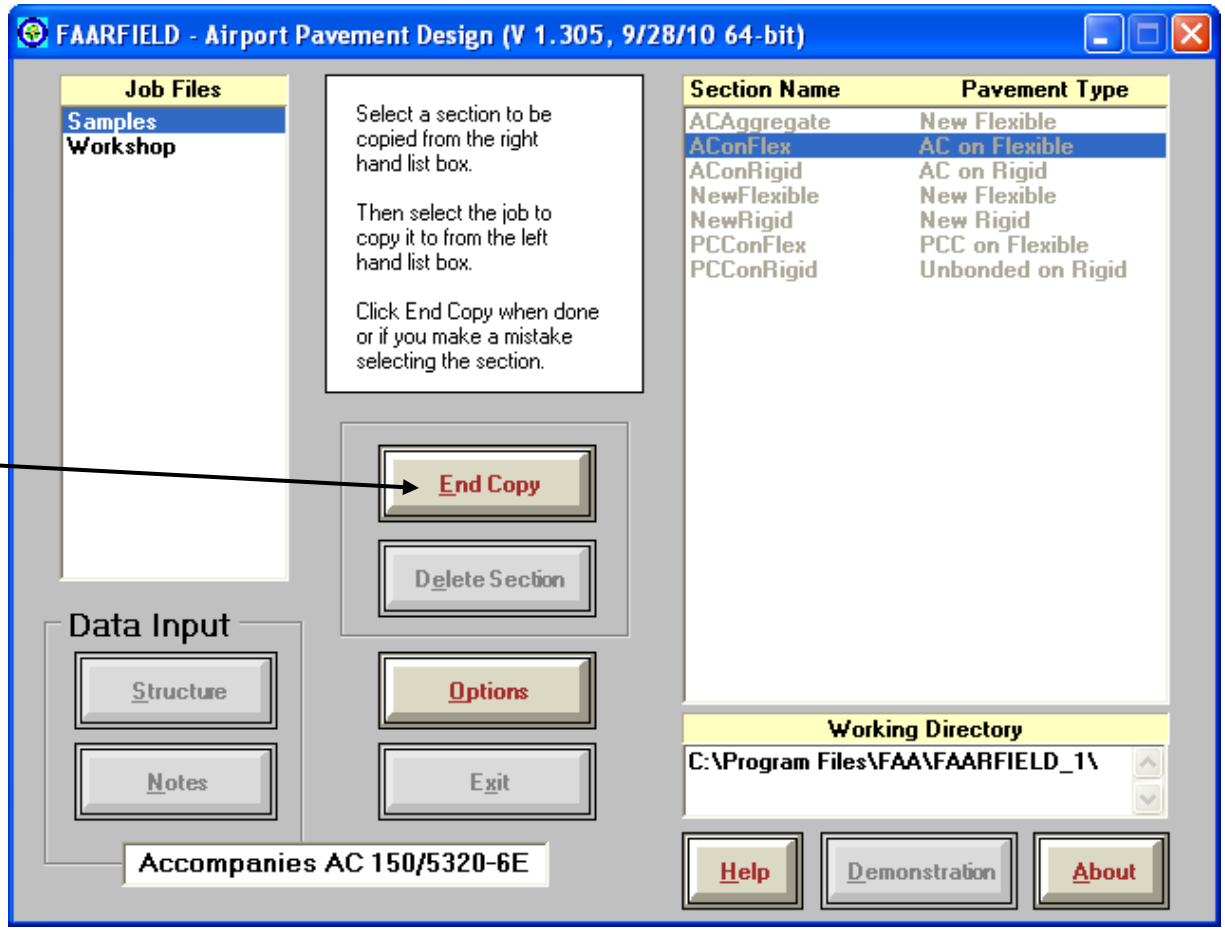


Enter job title

Click OK

Asphalt Overlay Design / Create a New Job Title

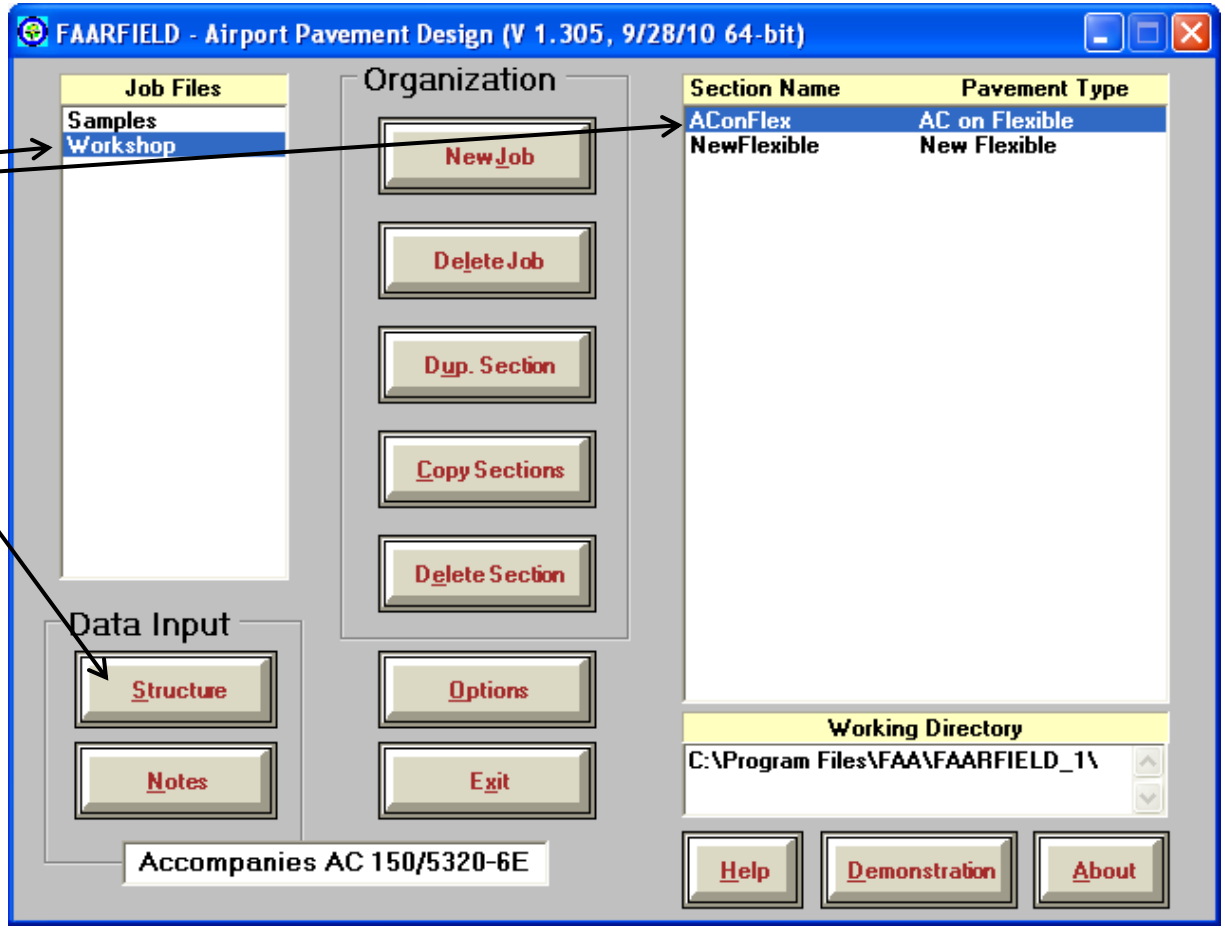
Click “End Copy”



Asphalt Overlay Design / Working With a Pavement Section

Select the job and then the section you want to analyze.

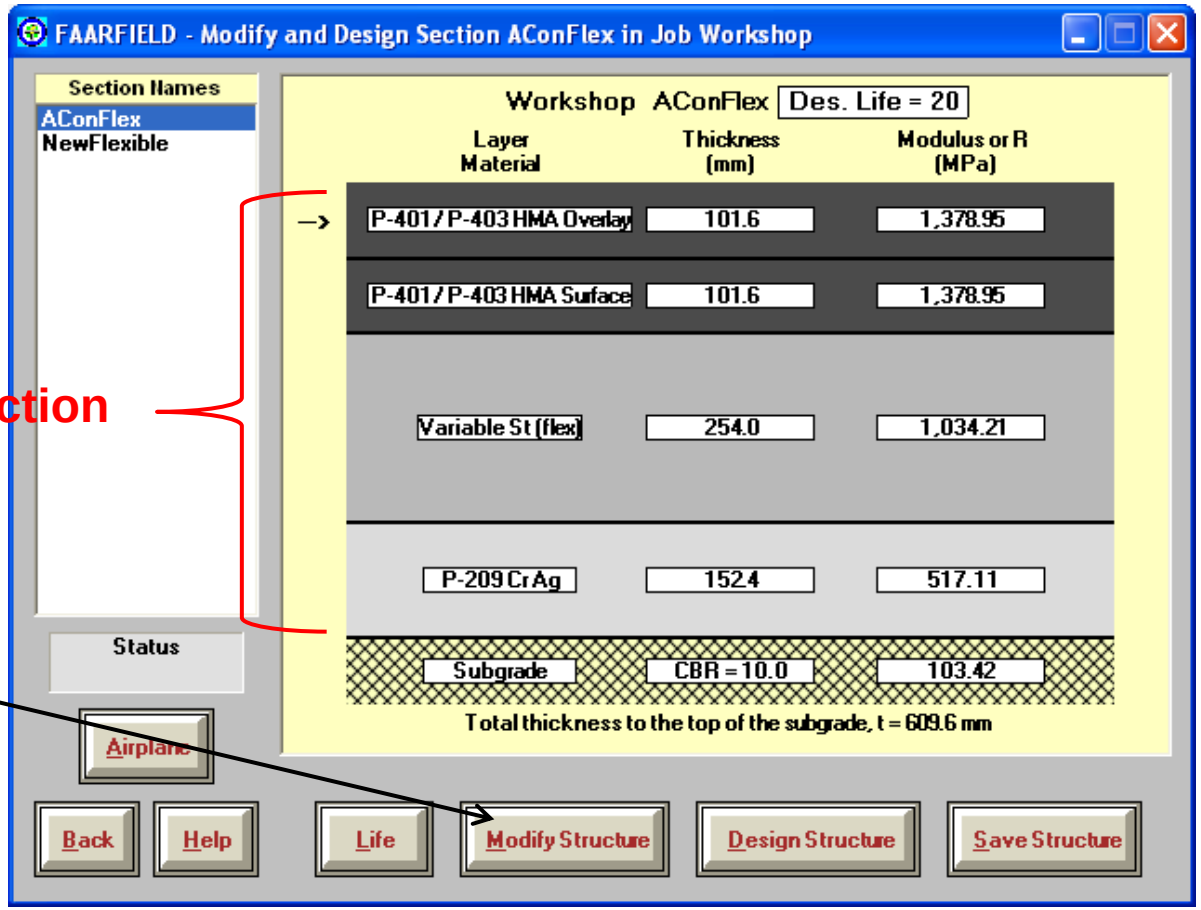
Click on "Structure" to open the file.



Asphalt Overlay Design

Default Cross Section

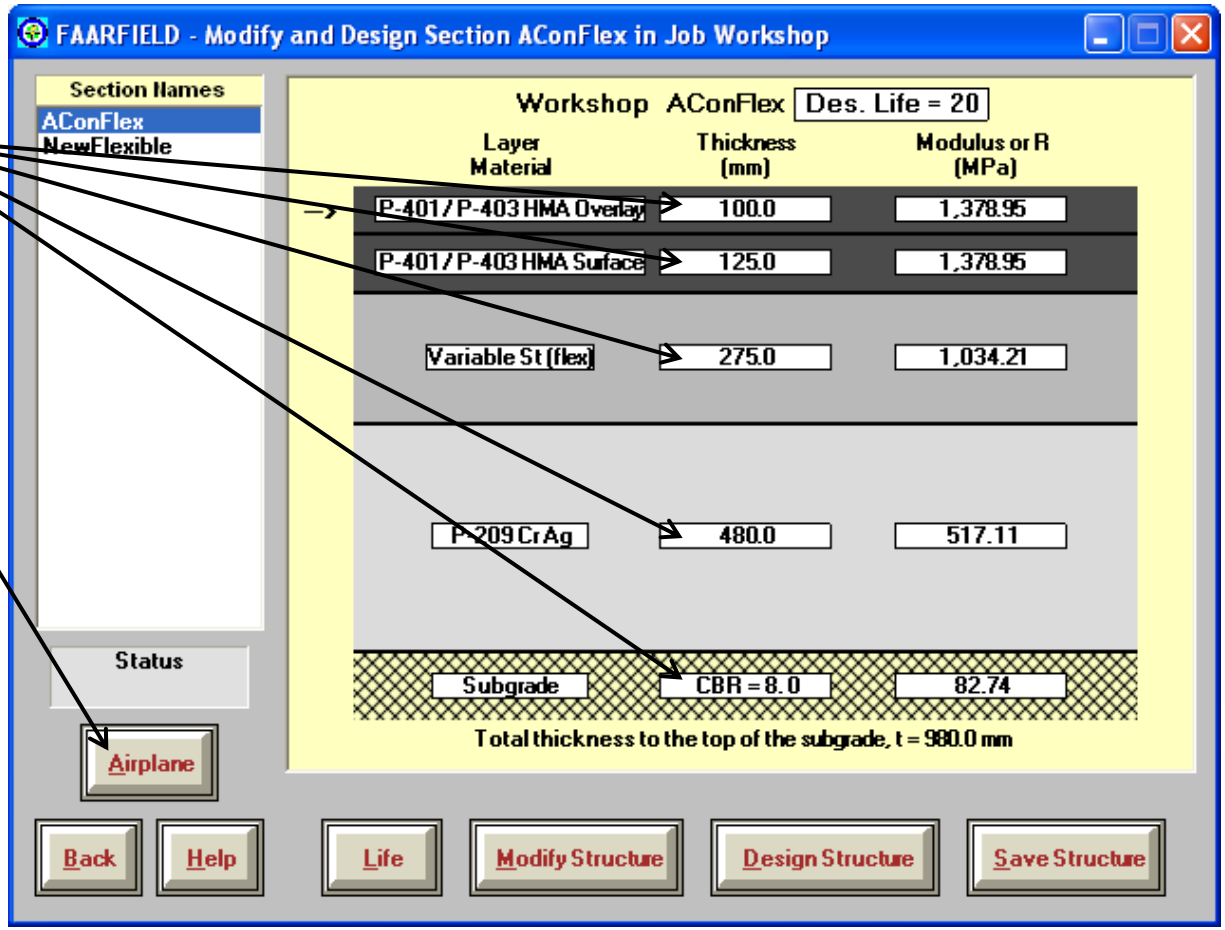
Click on "Modify Structure".



Asphalt Overlay Design

Modify the cross section to reflect the existing structure.

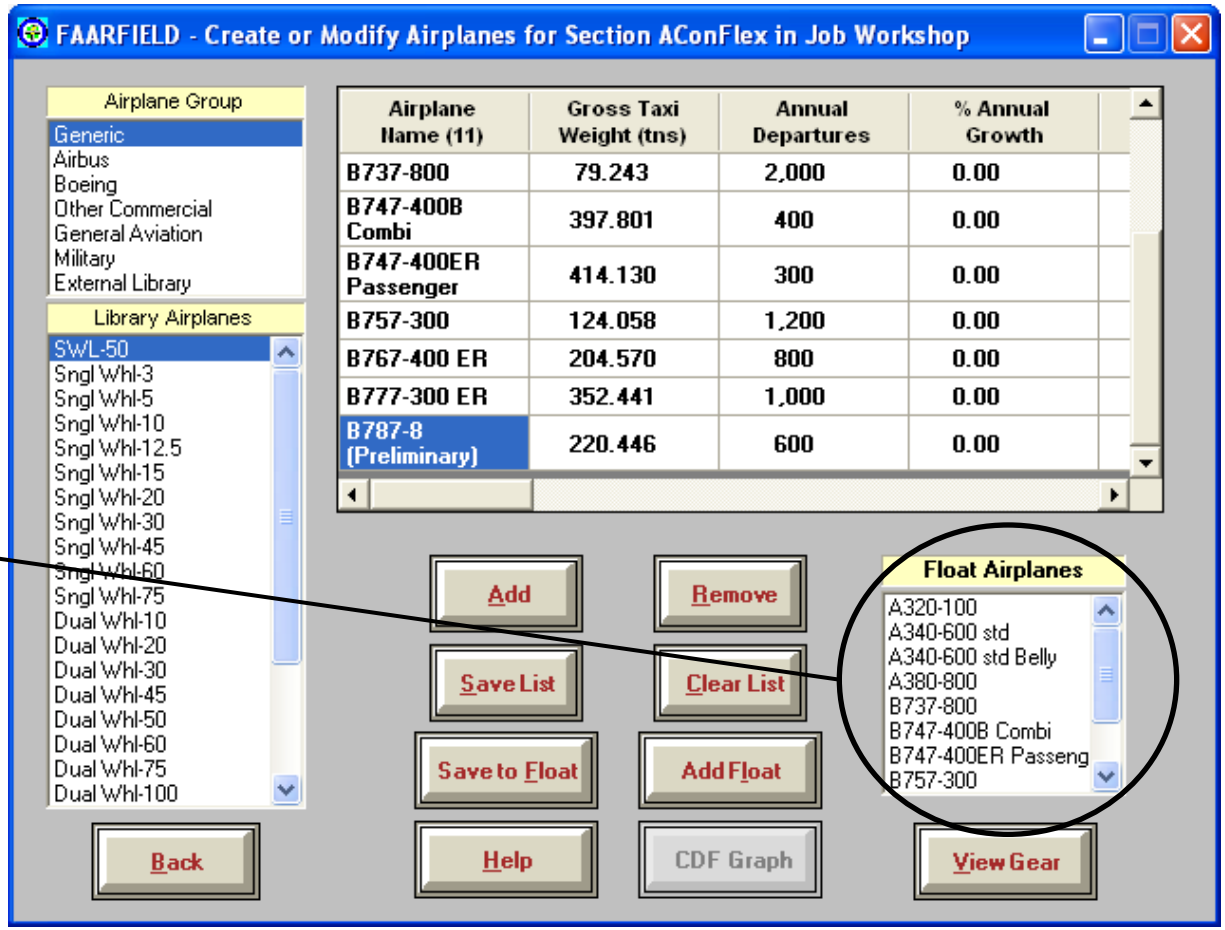
Click on “Airplane”.



Asphalt Overlay Design
Add Airplane Information

Use the traffic mix from the new flexible pavement example.

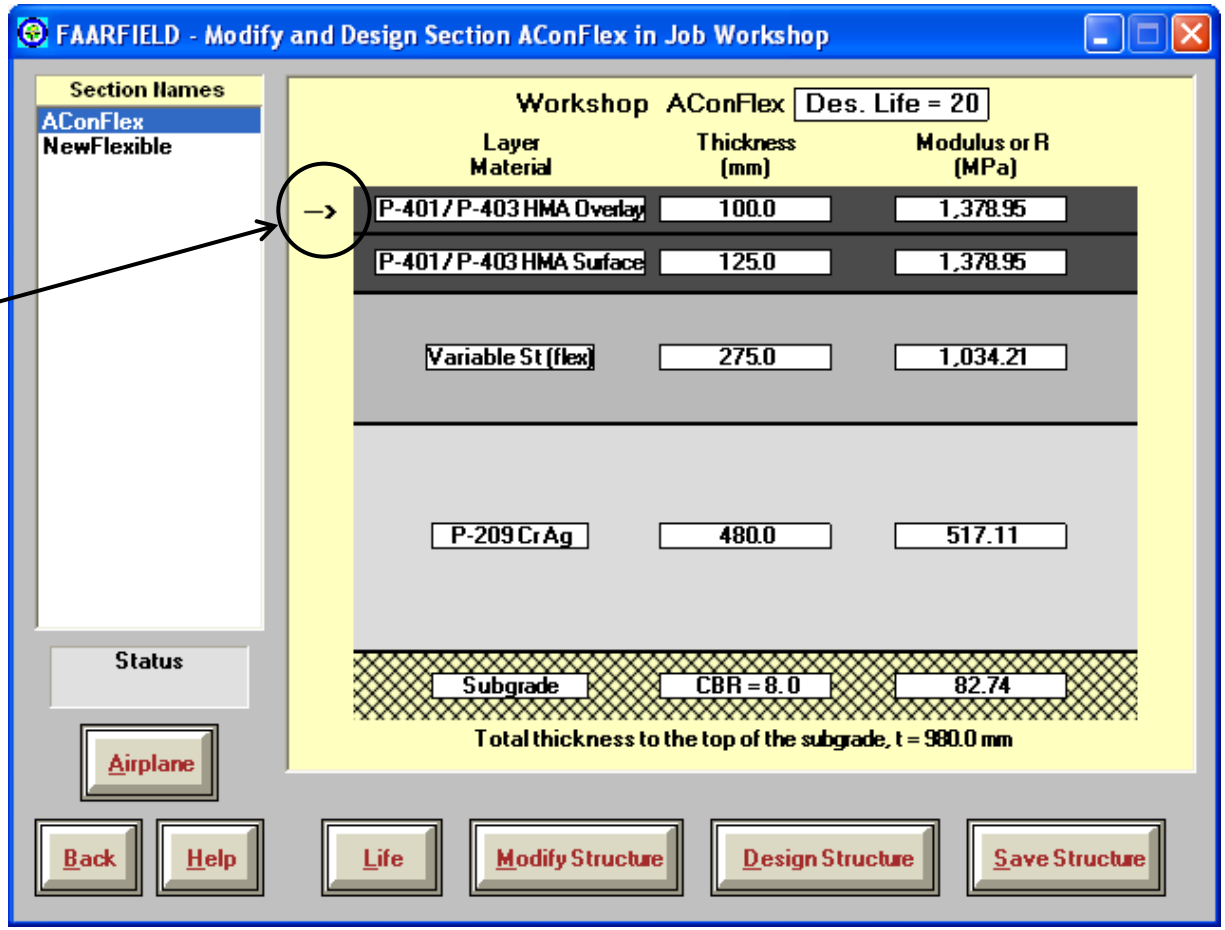
Use the "Float Airplanes" functions to do this without having to enter the data a second time.



Performing Overlay Design

The layer with the small arrow is the layer that will be adjusted to provide the structural design.

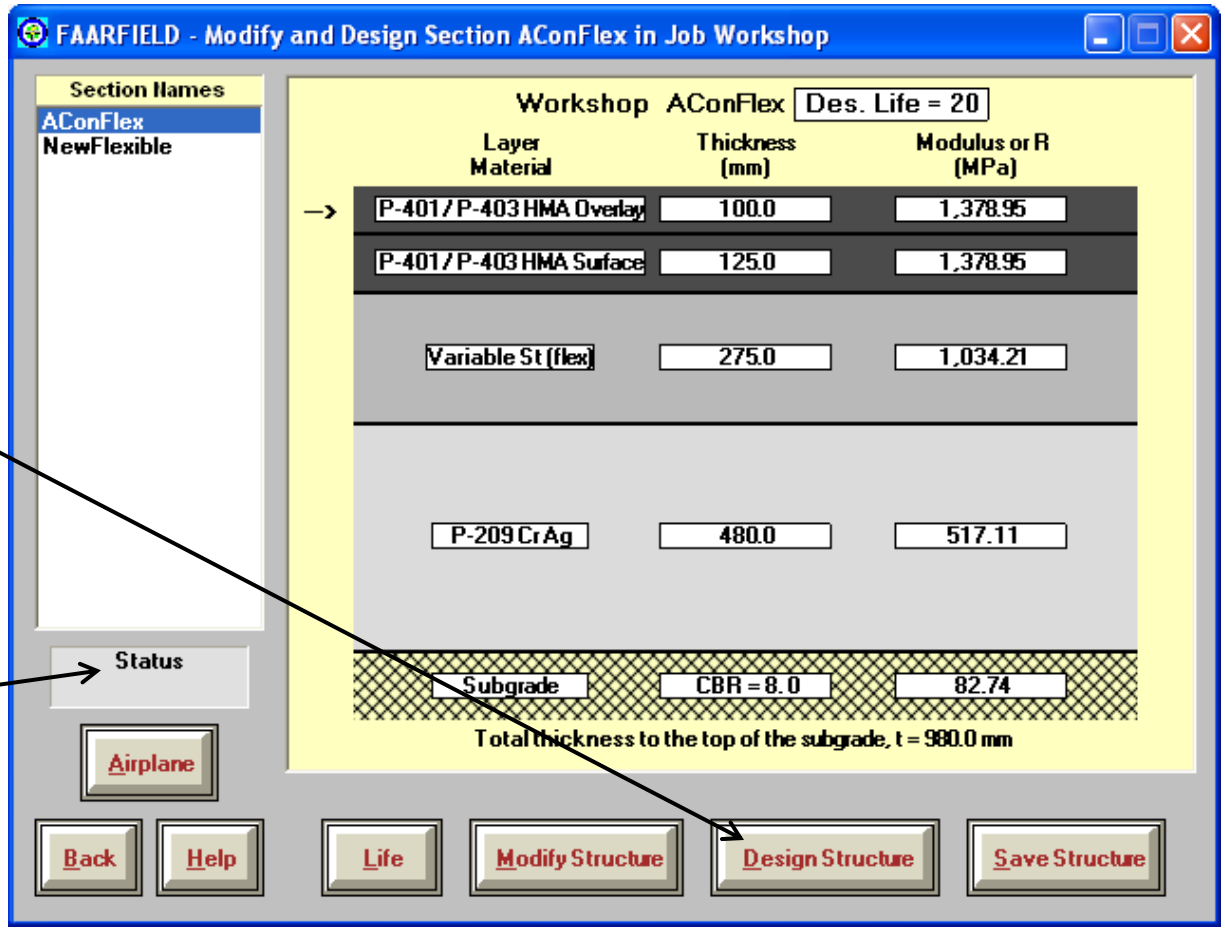
The location of the arrow is determined by the type of structure.



Performing Overlay Design

You are now ready to design the structure. Simply click on "Design Structure."

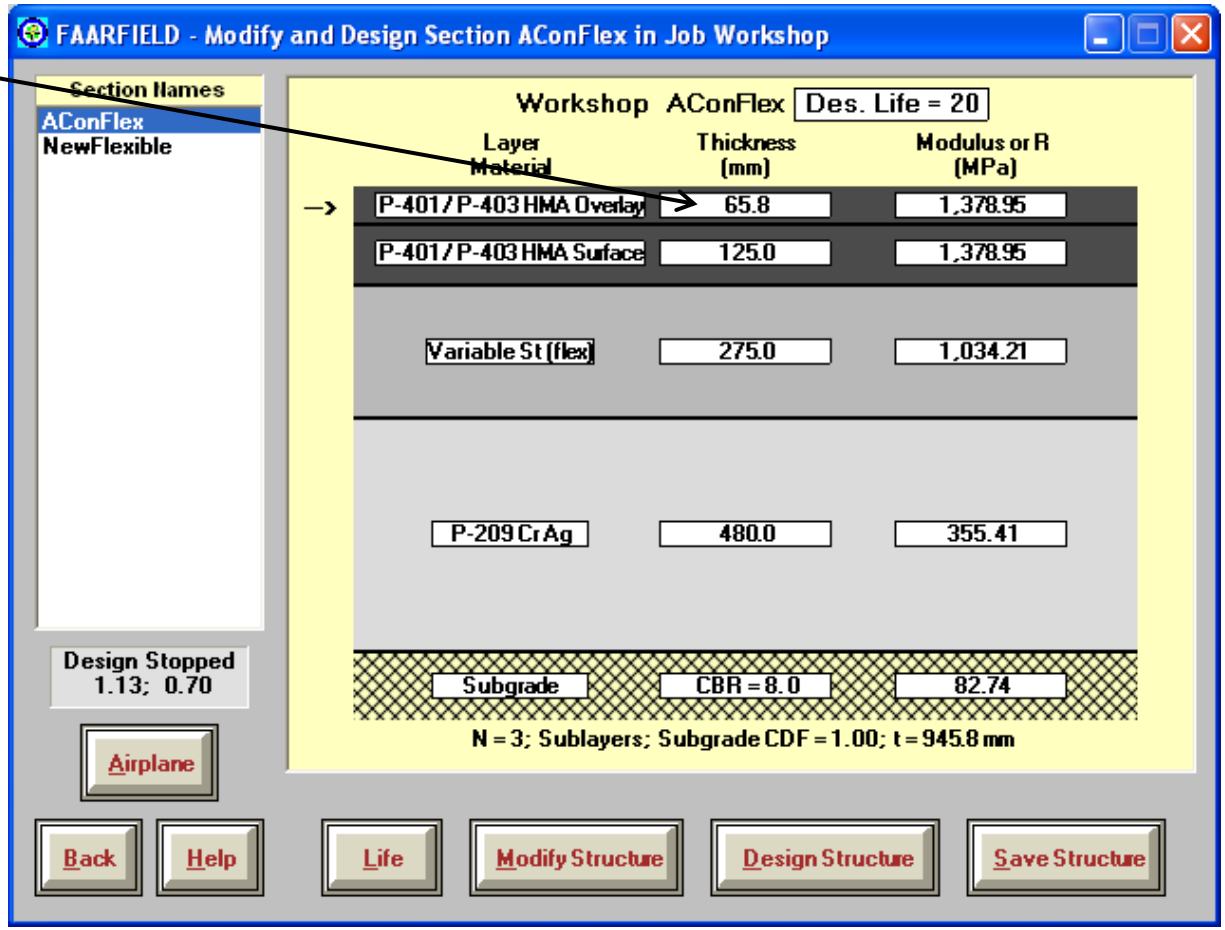
The program will keep you informed about the status of the design.



Result of Overlay Design

65.8 mm (2.6 in.)

P-401 HMA Overlay



Software Available at:

- http://www.faa.gov/airports/engineering/design_software/
- http://www.airporttech.tc.faa.gov/naptf/download/index1.asp

Thank You

¡Gracias!

Questions?

¿Preguntas?