FAARFIELD 1.4

Design Examples - Flexible

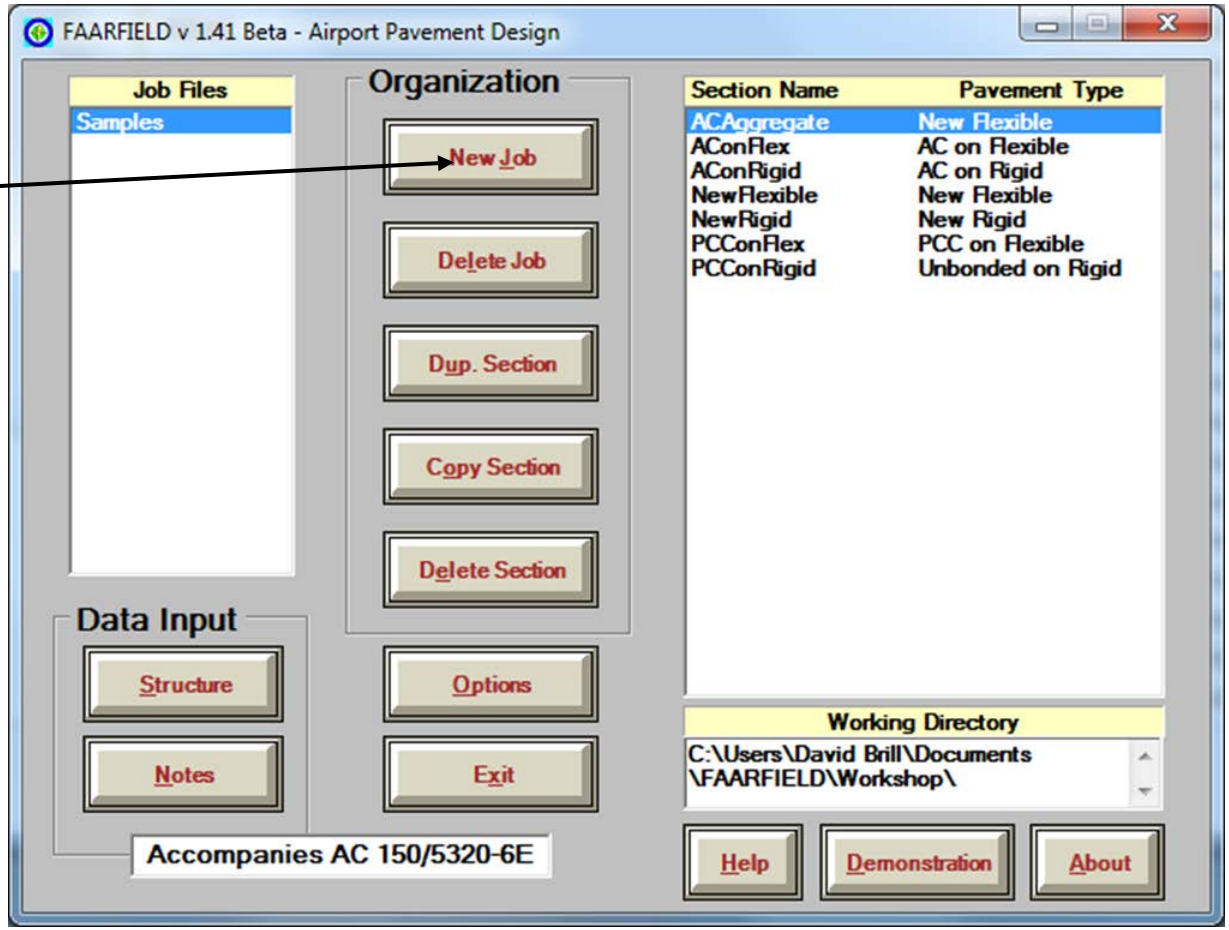
Presented to: XI ALACPA Seminar on Airport Pavements and IX FAA Workshop, Santiago de Chile

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

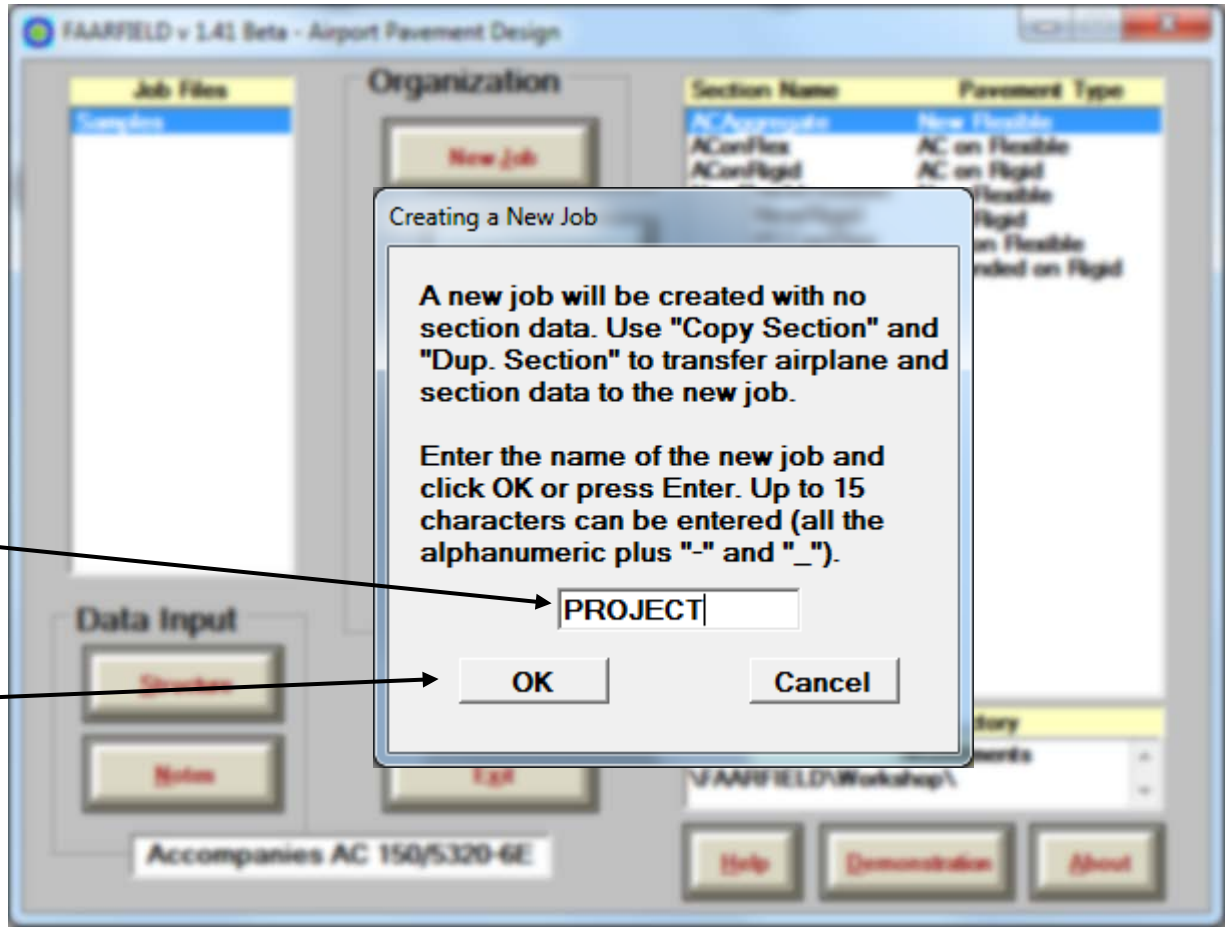
Date: 3 September, 2014

Starting Screen – No Job Files Created

Click on "New Job"



Creating/Naming a Job File

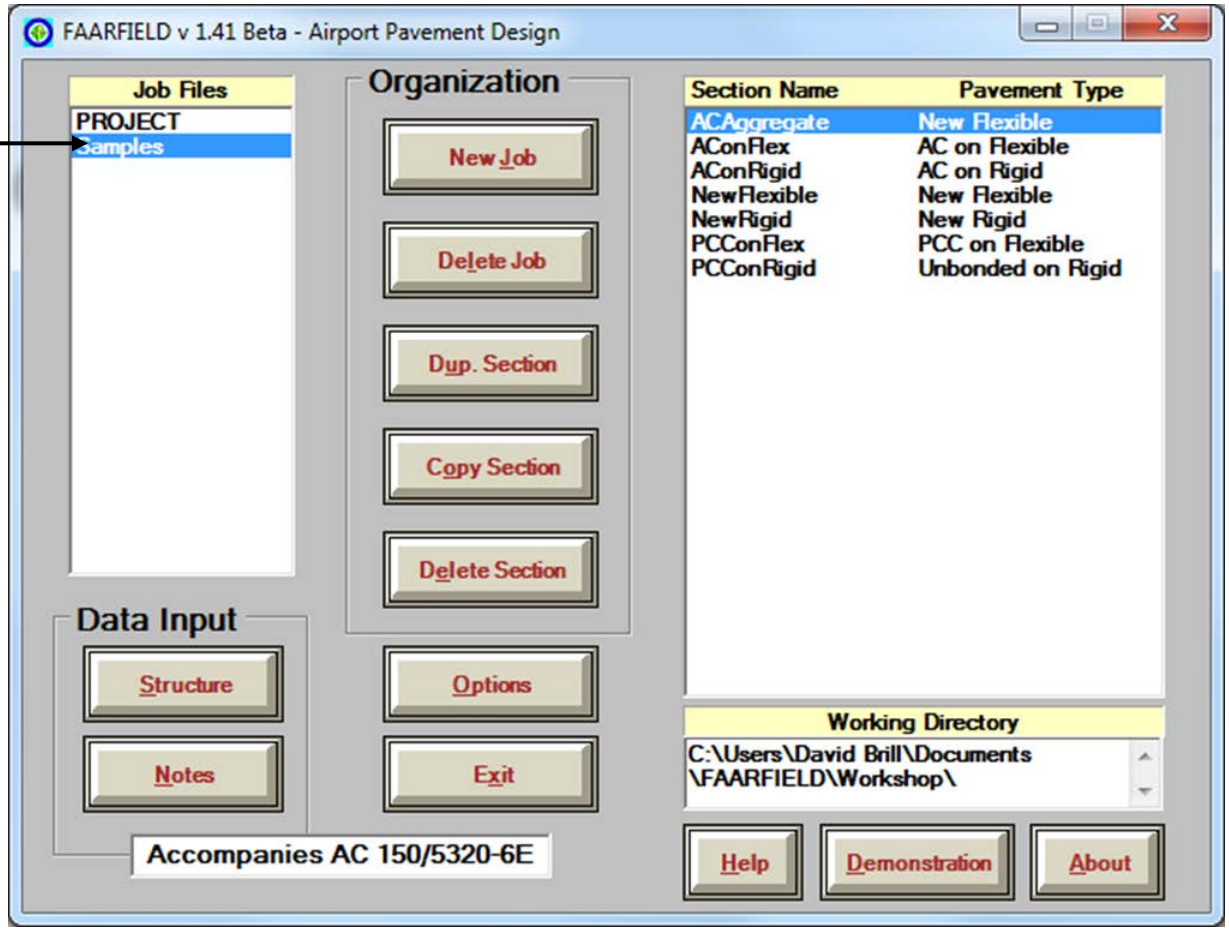


Enter Job Title

Click OK

Copy Basic Section/Pavement Type from Samples

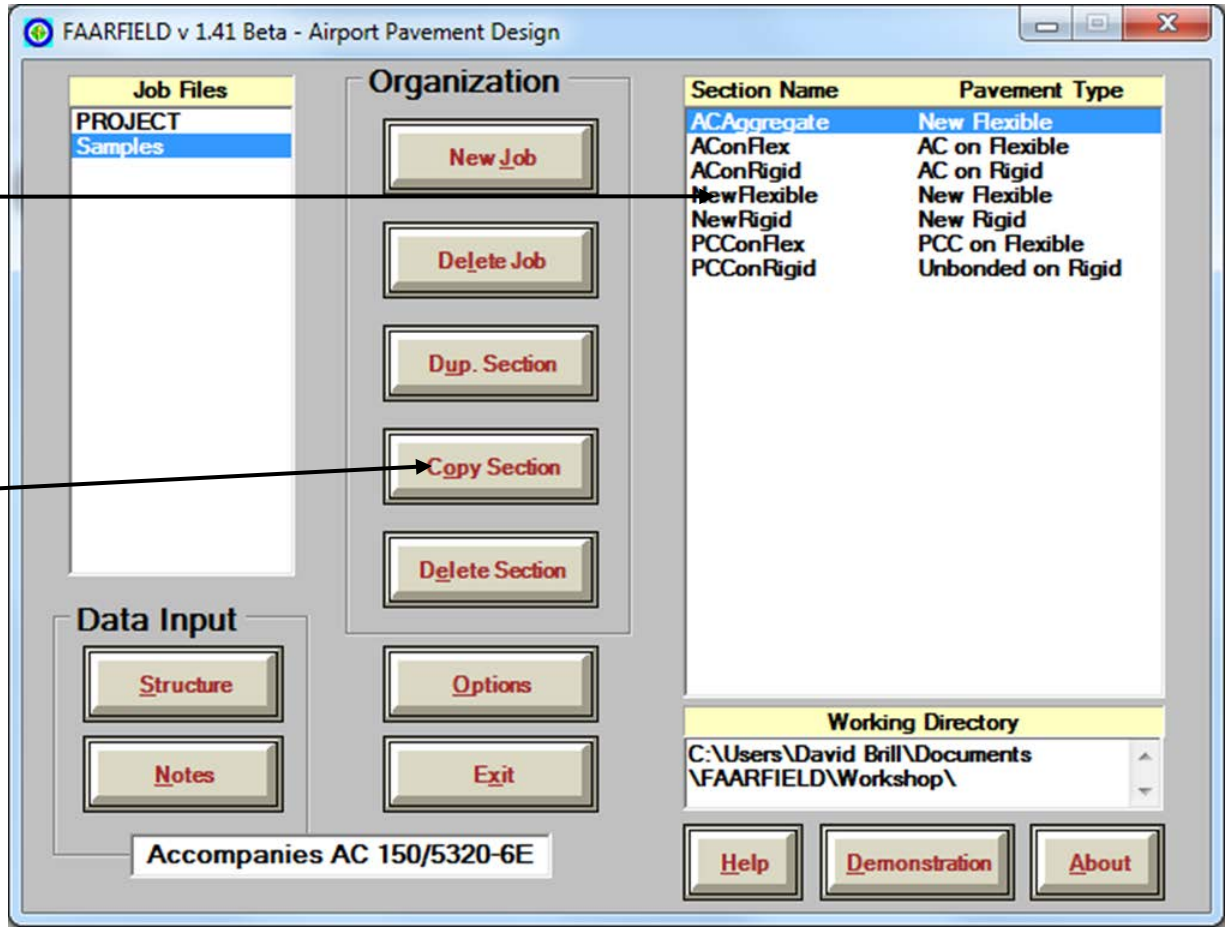
Click on "Samples"



Copy Basic Section/Pavement Type from Samples

Default Basic Pavement Sections

Click on "Copy Section"



7 Basic Starting Structures in FAARFIELD

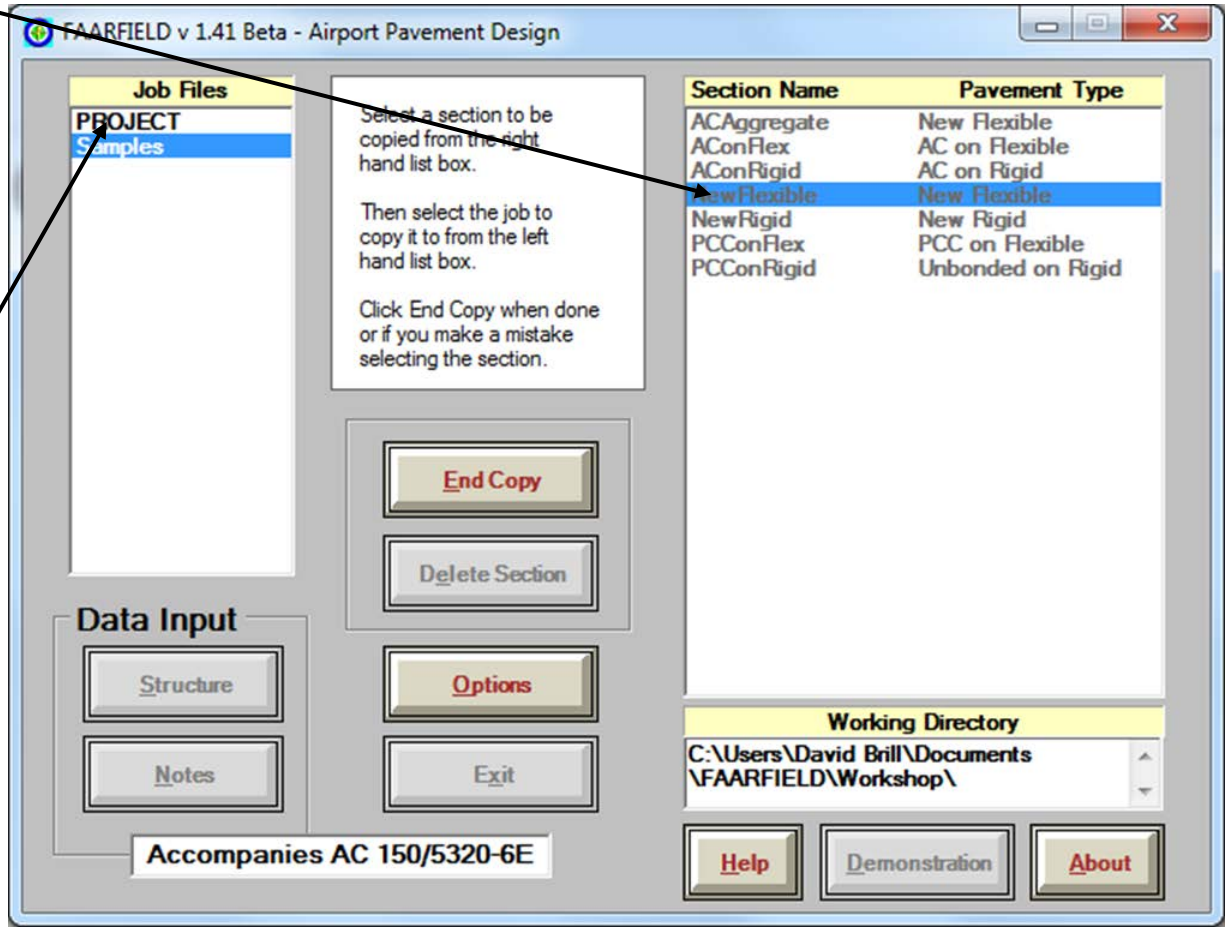
Section Name	Pavement Type
ACAggregate	New flexible on aggregate base
AConFlex	HMA overlay on flexible pavement
AConRigid	HMA overlay on rigid pavement
NewFlexible	New flexible on stabilized base
New Rigid	New rigid on stabilized base
PCConFlex	PCC Overlay on flexible
PCConRigid	Unbonded PCC on rigid

Select the pavement type that most correctly represents your design requirements.

Copy a Sample Pavement Section

Click on desired pavement section.

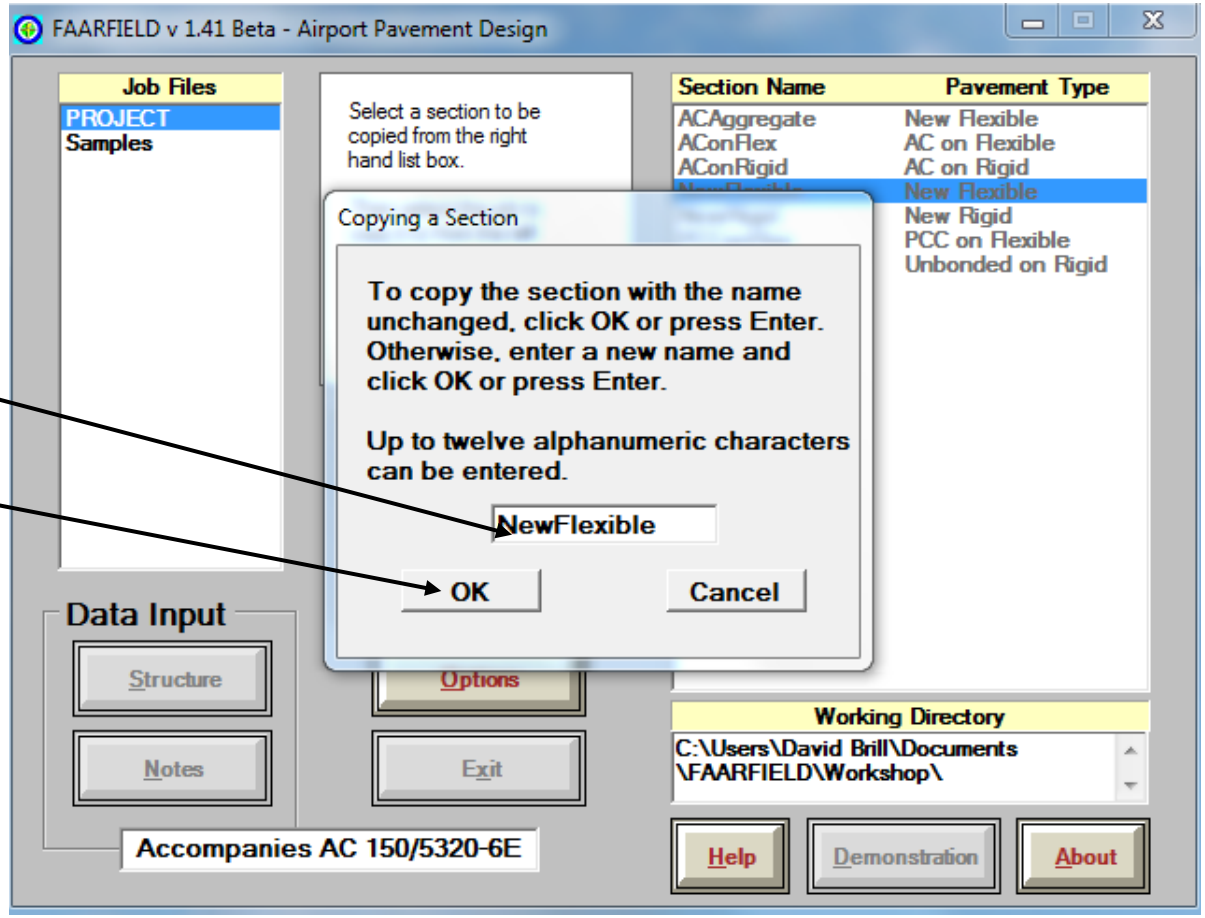
Then click on the project where the section will be saved.



Create a New Job Title

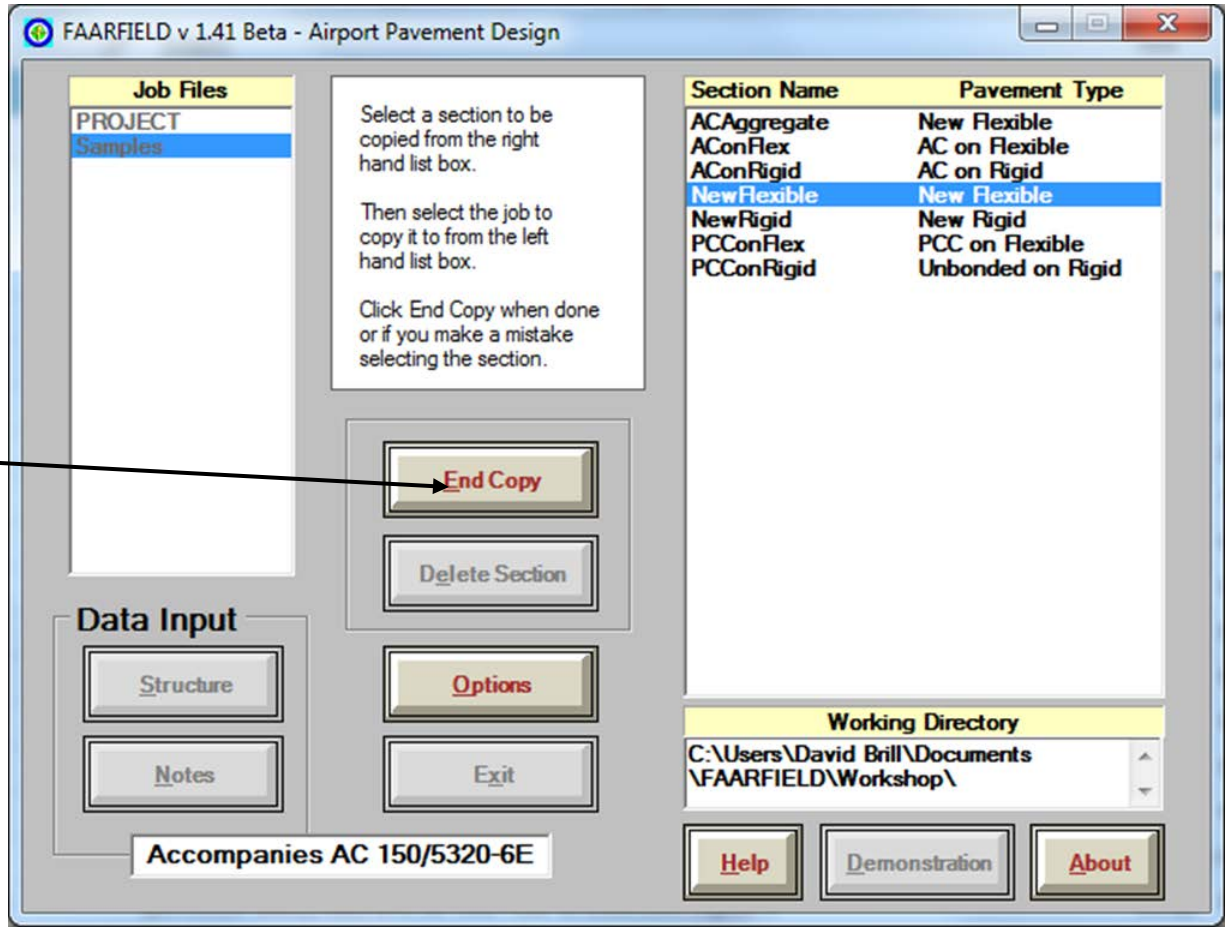
Enter job title

Click OK



Create a New Job Title

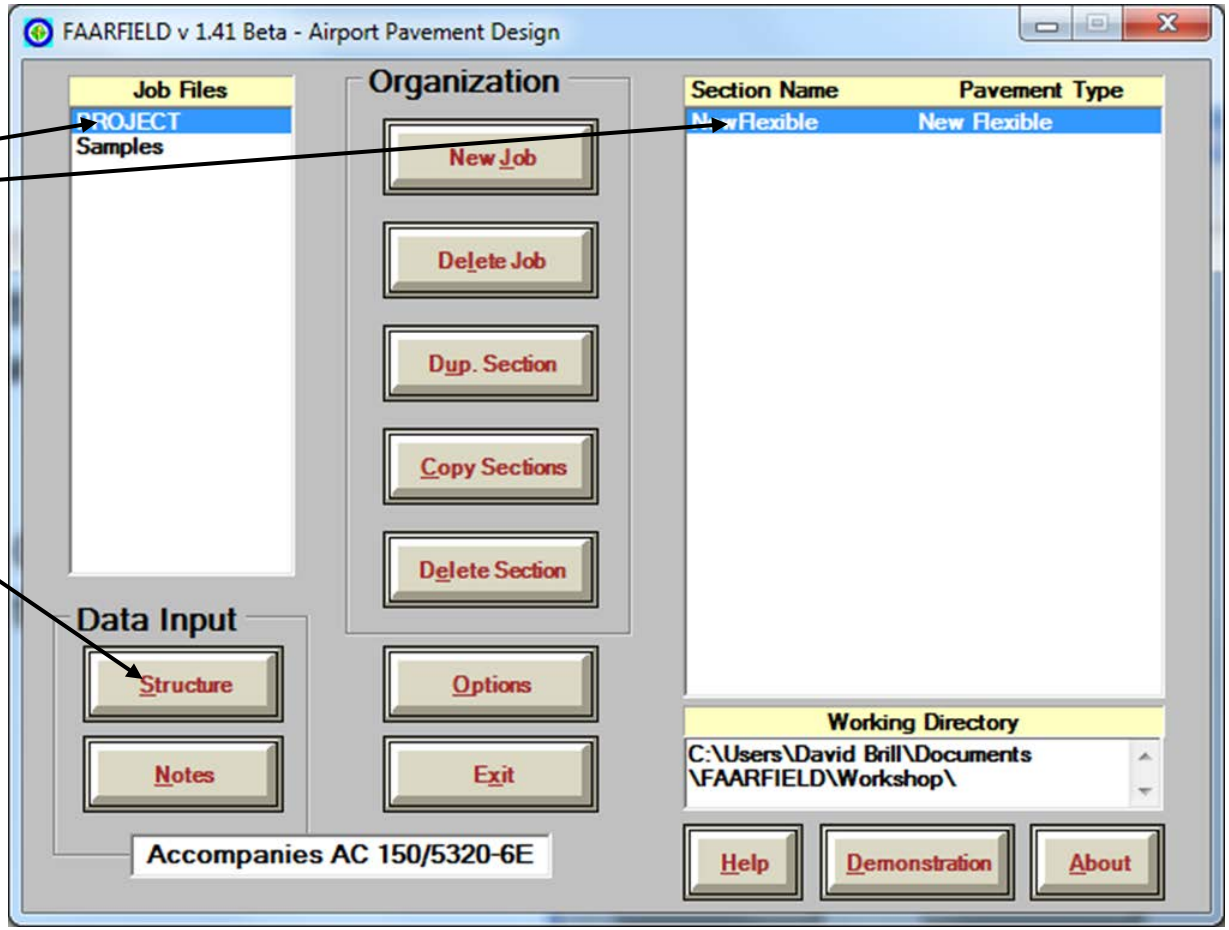
Click “End Copy”



Working With a Pavement Section

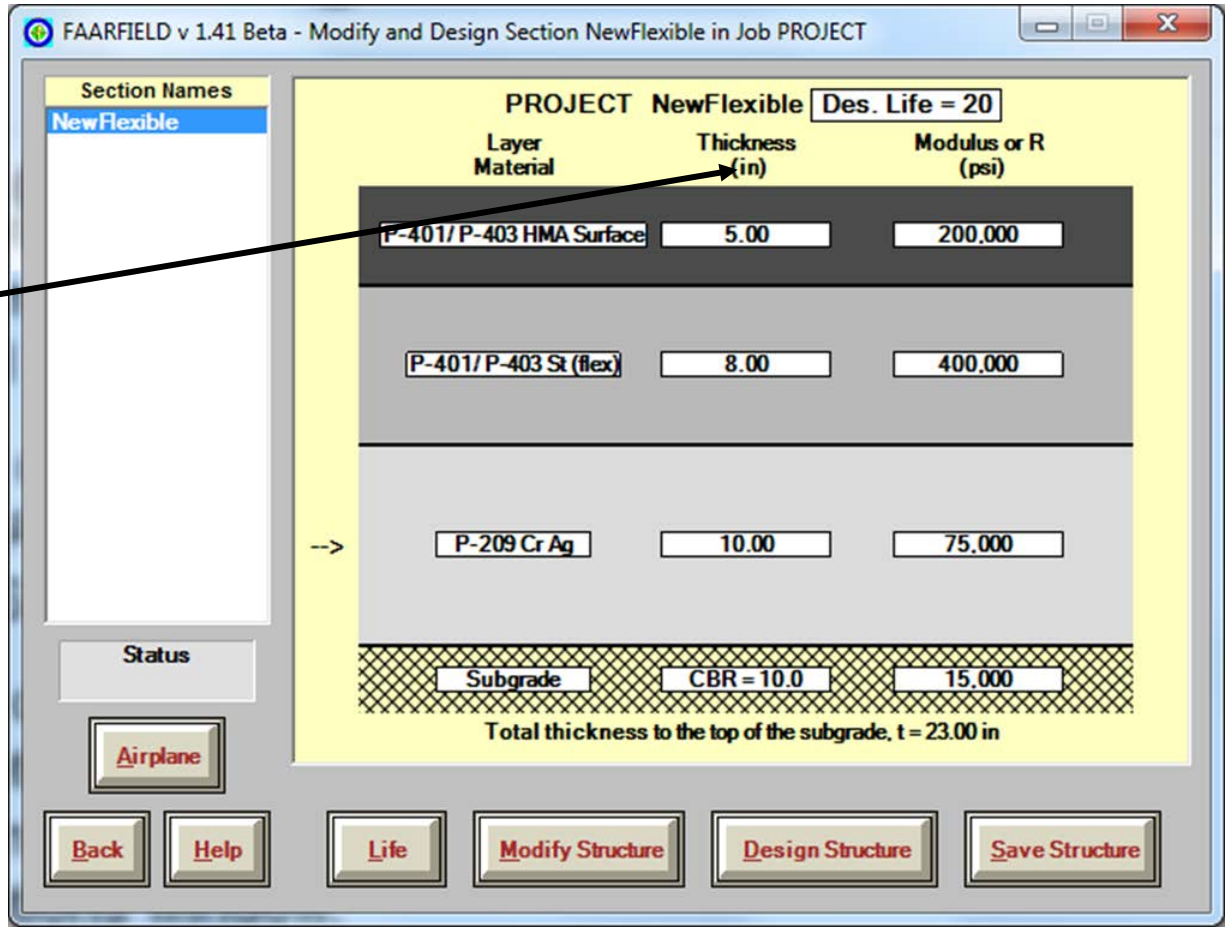
Select the job and then the section you want to analyze.

Click on "Structure" to open the file.



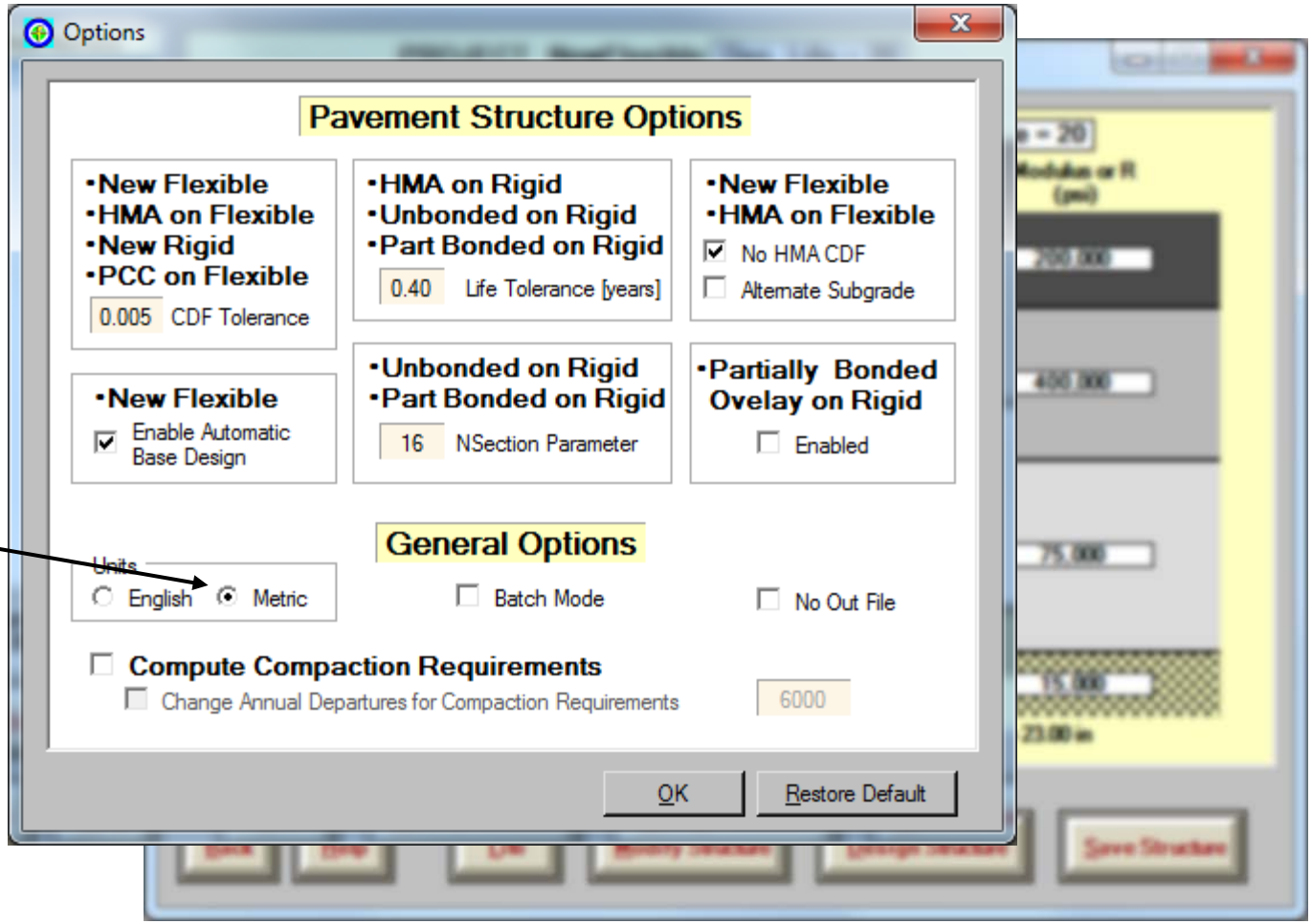
Working With a Pavement Section

- 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.



Working With a Pavement Section

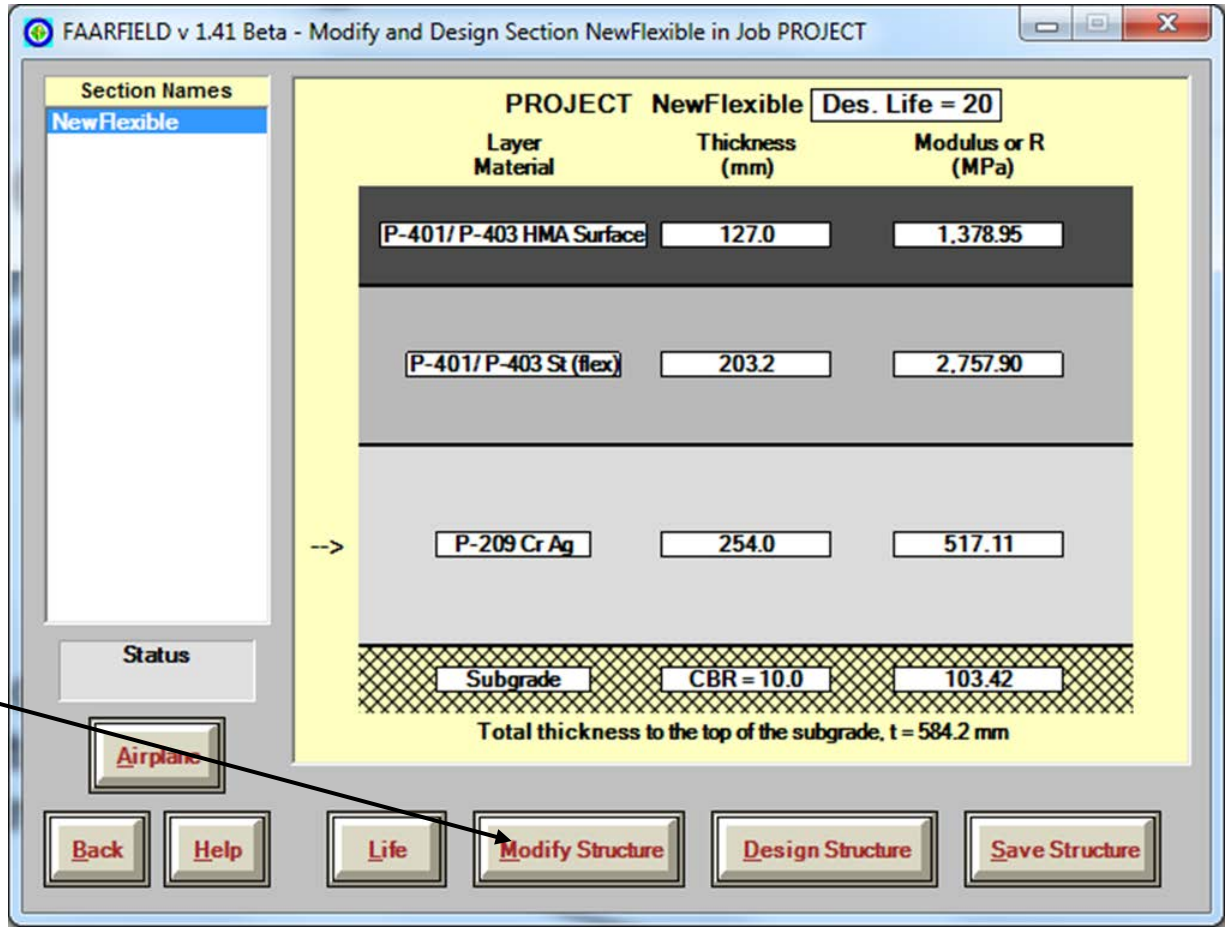
Select "Metric" and hit OK



Working With a Pavement Section

Thickness and modulus are now given in metric units.

Click on "Modify Structure" to modify the structure.

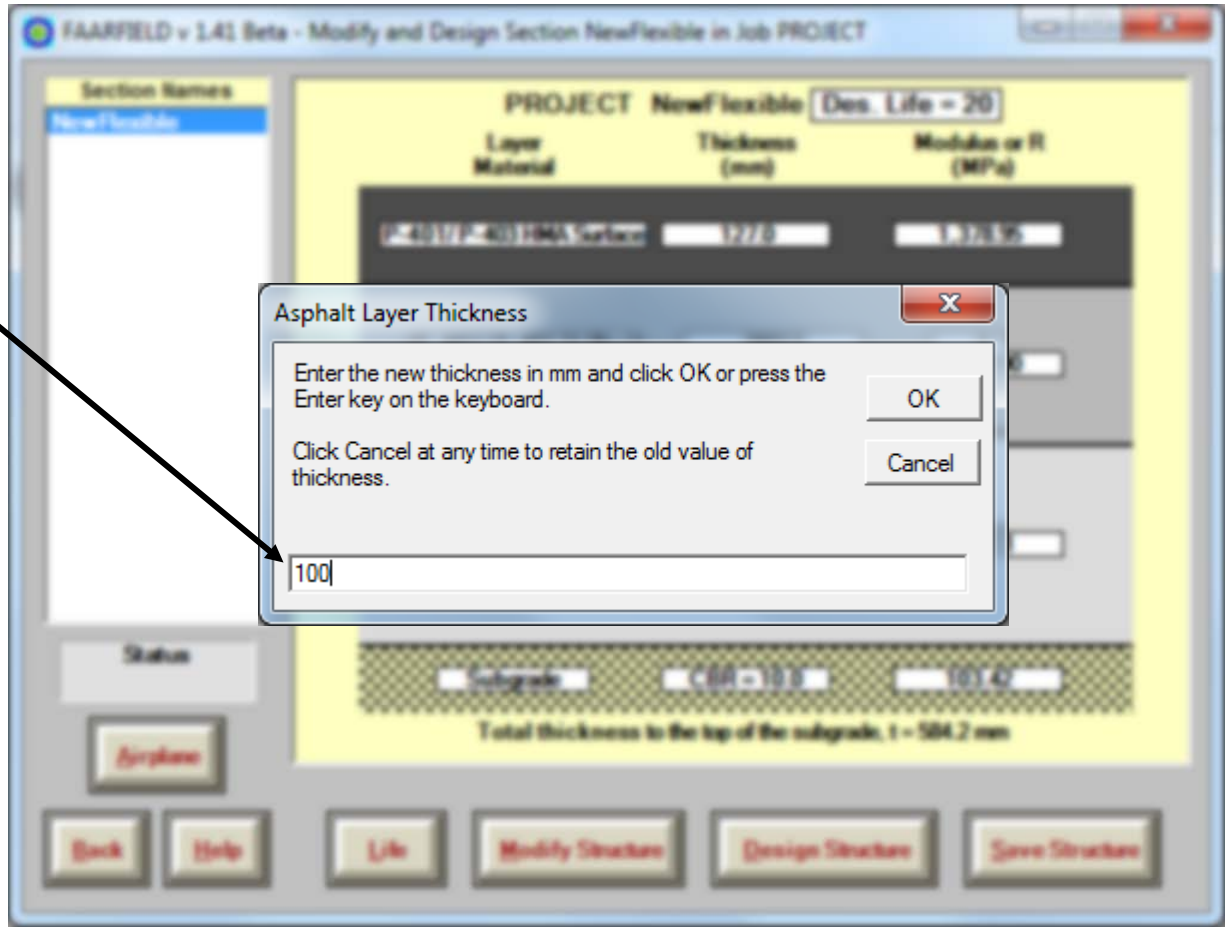


Layer Placement Restrictions

- **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

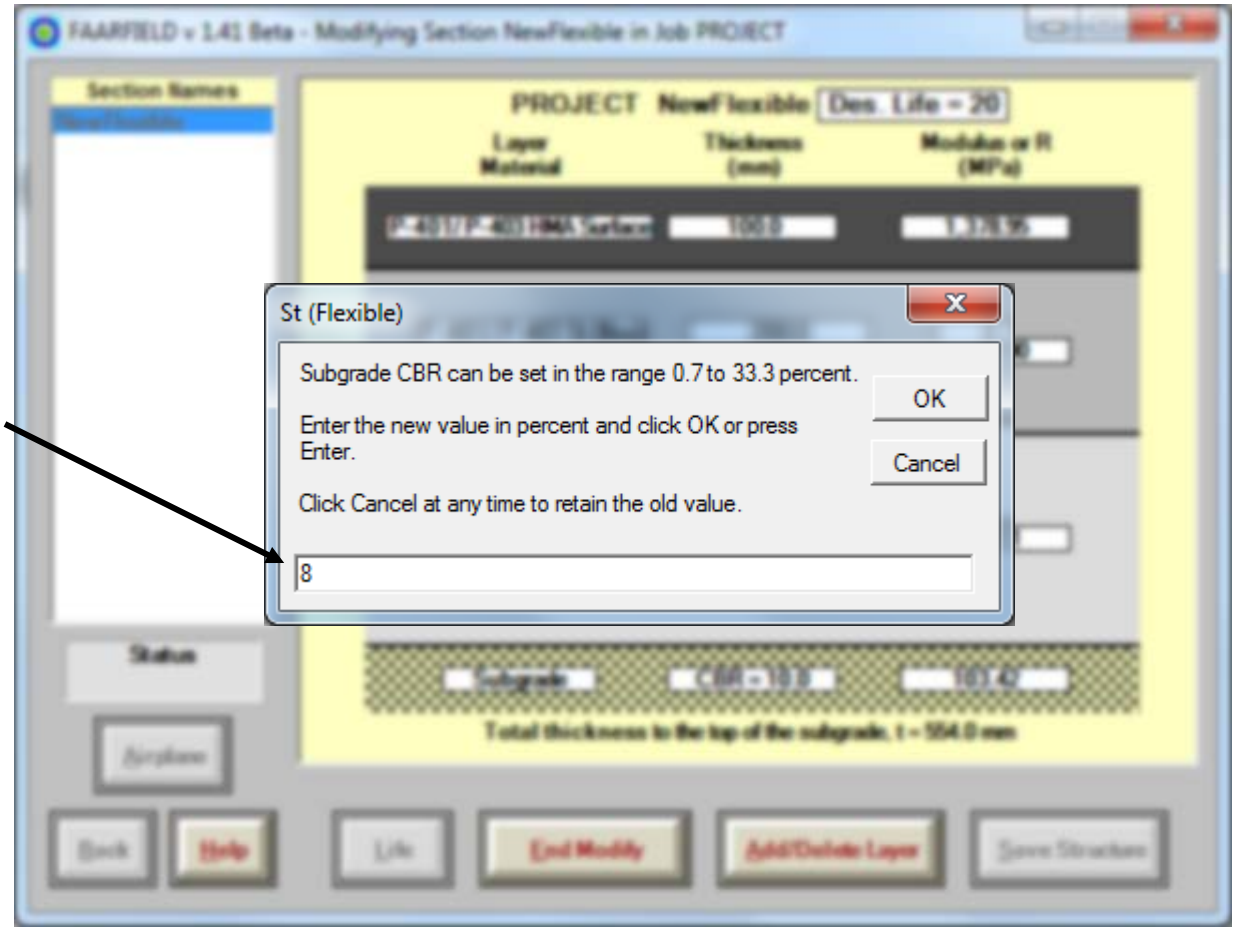
- Minimum asphalt surface thickness is 100 mm.
- Click on the P-401 Surface thickness.
- Enter the new value of 100 mm.
- Hit OK.
- Next, change the P-401/P-403 stabilized base layer to 200 mm.



Modifying a Pavement Section

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

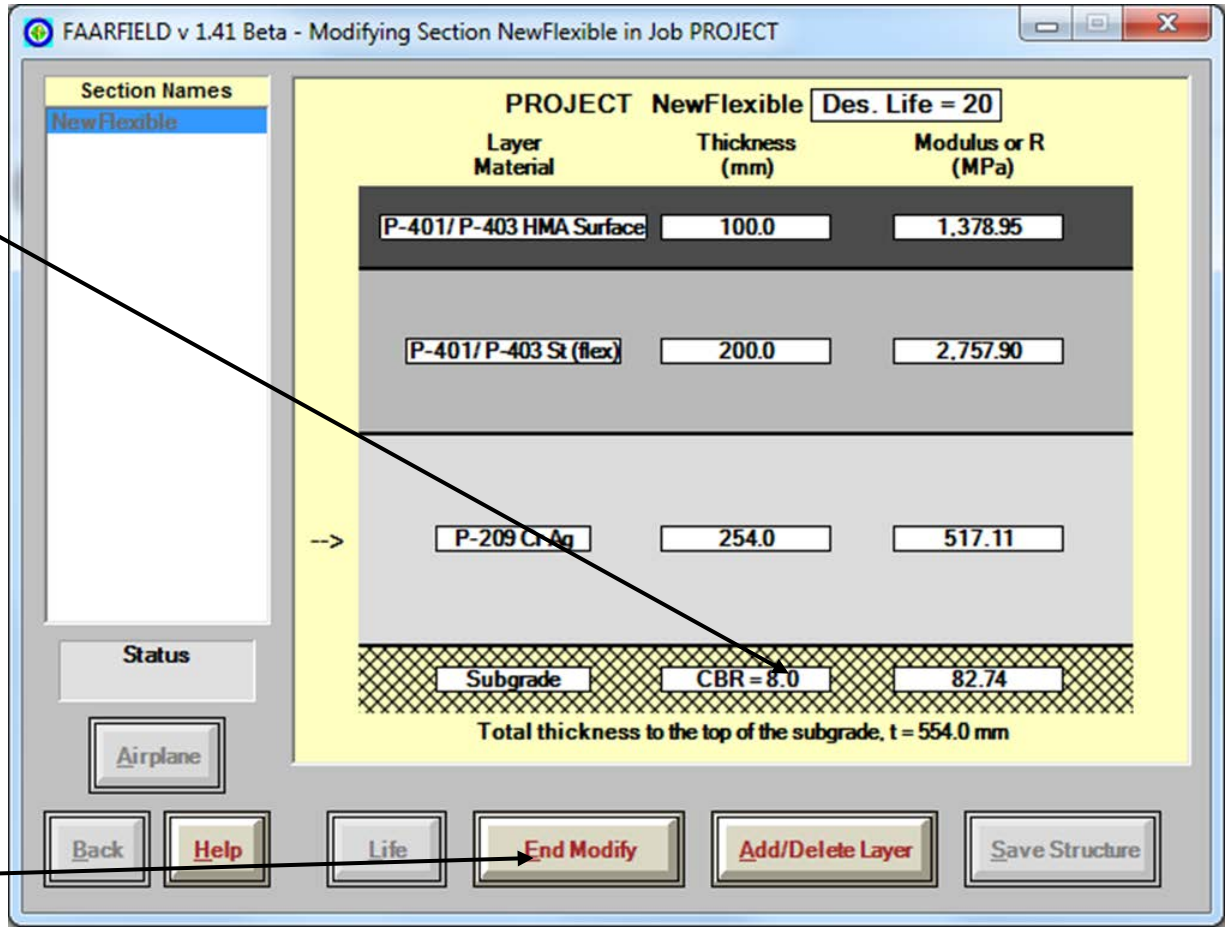
*****Some materials will have limits on allowable values.***



Modifying a Pavement Section

New values appear in the structure window.

When done changing properties, click End Modify



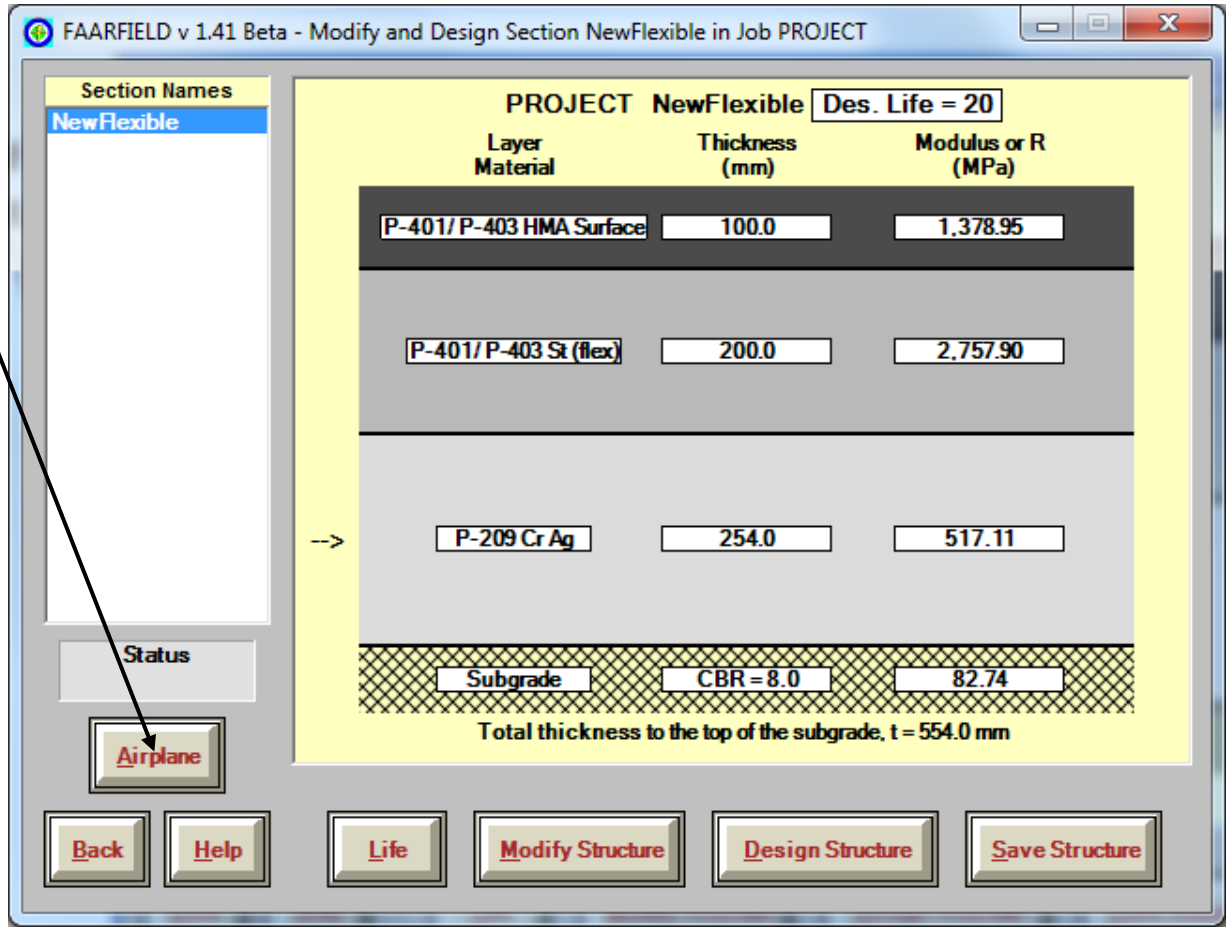
Layer Types in FAARFIELD

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.

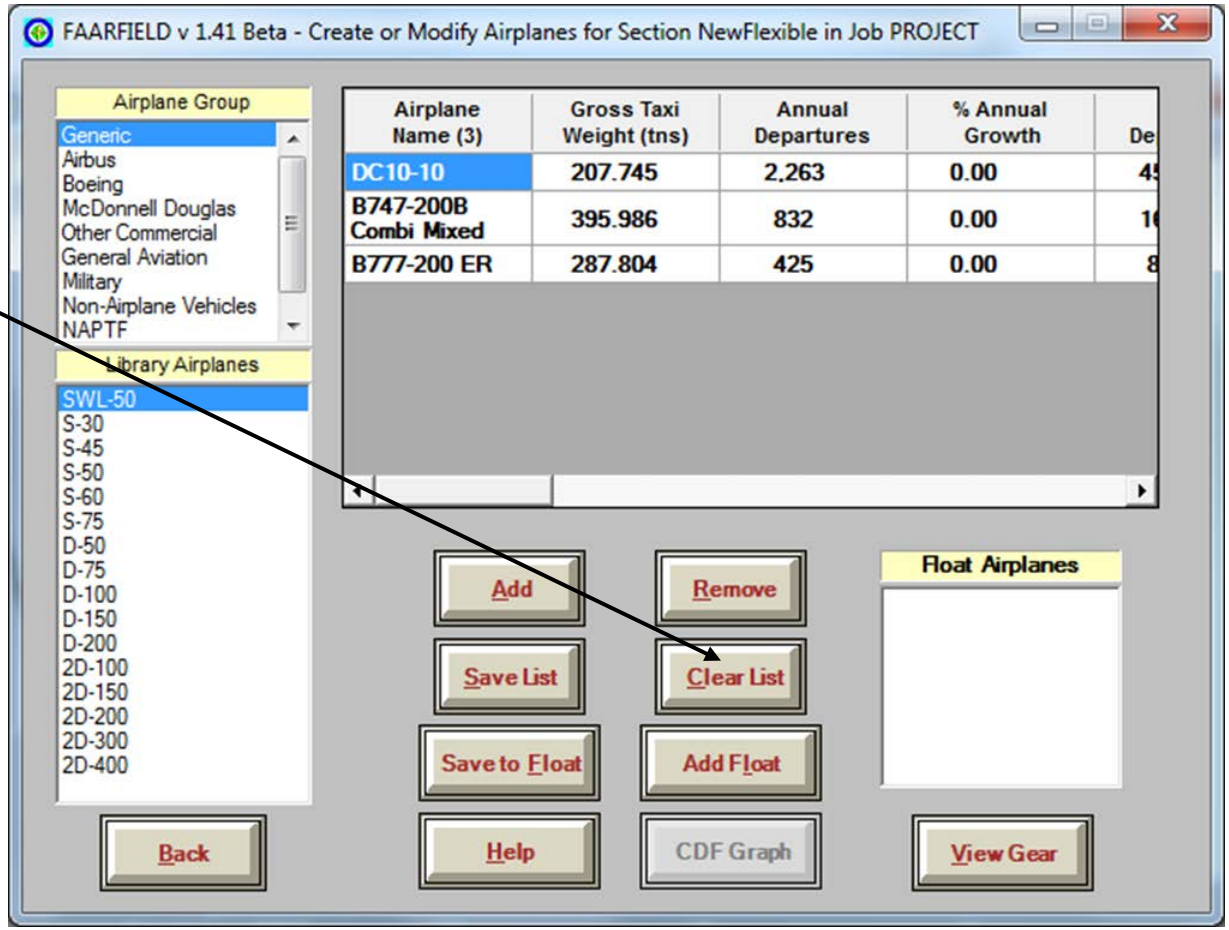
Enter Traffic Mixture

Click on "Airplane" to enter traffic mix



Enter Traffic Mixture

Use "Clear List" to clear the existing airplanes



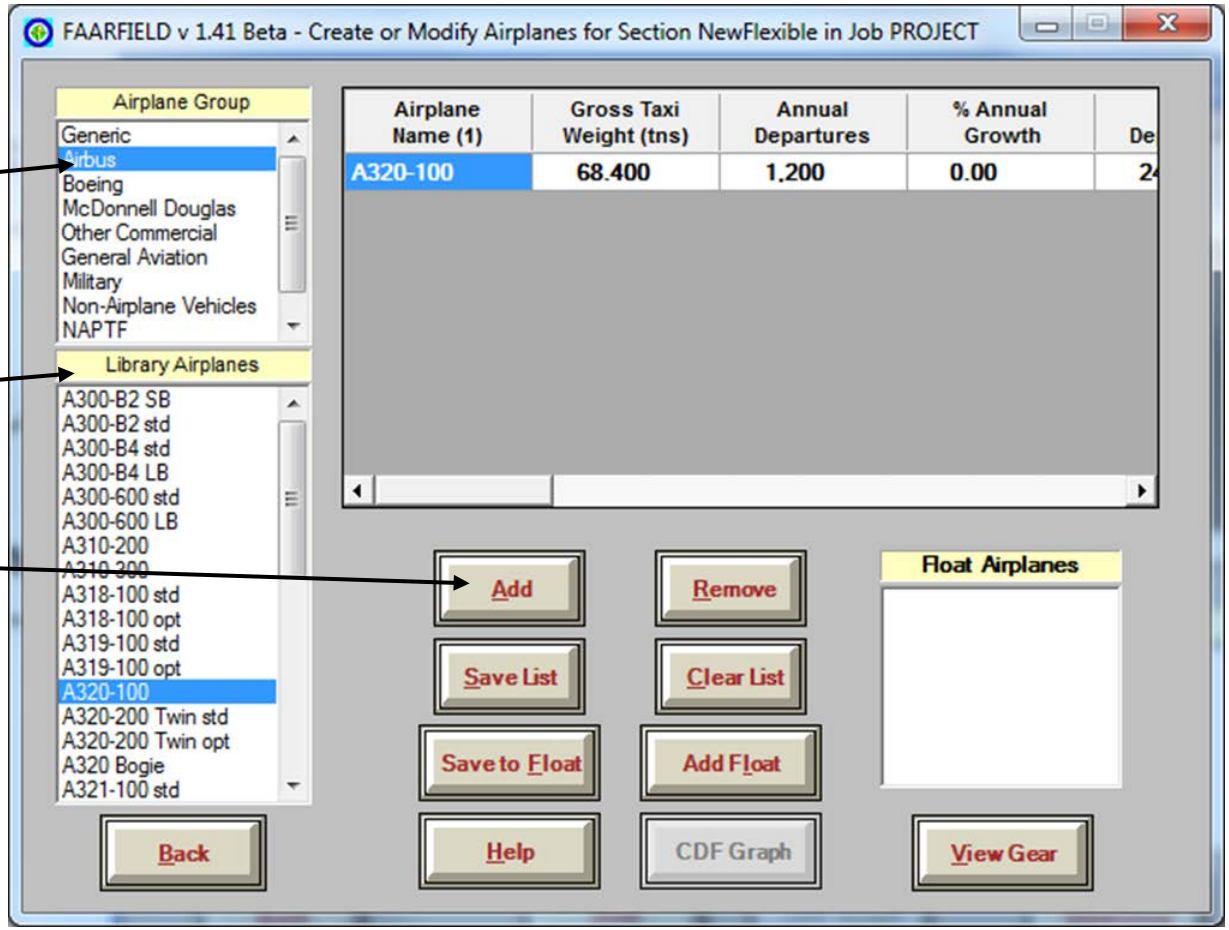
Enter Traffic Mixture

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

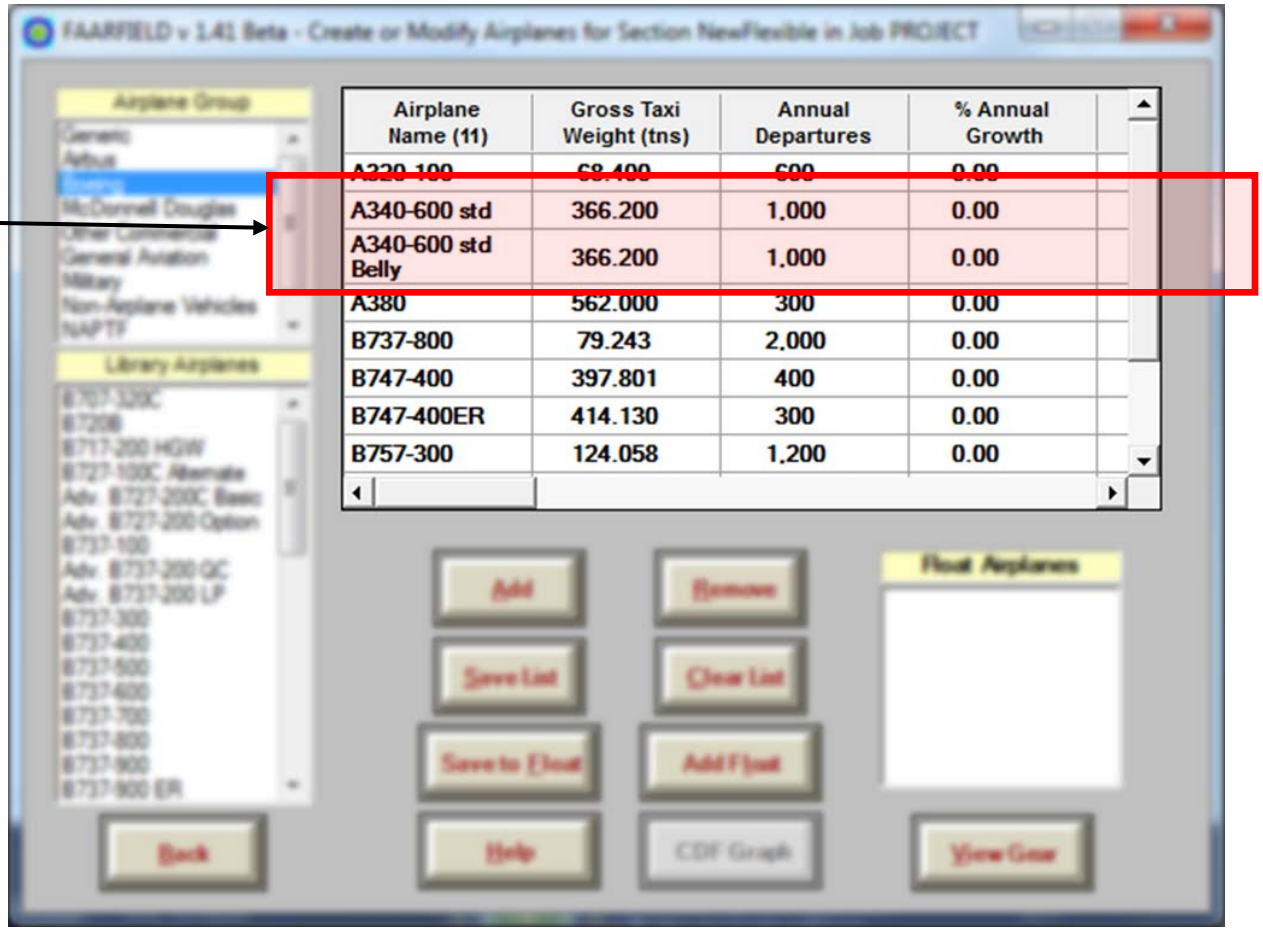
No.	Name	Gross Wt., tns.	Annual Departures	Annual Growth, %
1	A320-100	68.400	600	0.00
2	A340-600 std	366.200	1,000	0.00
3	A340-600 std Belly	366.200	1,000	0.00
4	A380	562.000	300	0.00
5	B737-800	79.243	2,000	0.00
6	B747-400	397.801	400	0.00
7	B747-400 ER	414.130	300	0.00
8	B757-300	124.058	1,200	0.00
9	B767-400 ER	204.570	800	0.00
10	B777-300 ER	352.441	1,000	0.00
11	B787-8	228.384	600	0.00

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.



Adjusting Airplane Information

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

Airplane Name (11)	Gross Taxi Weight (tns)	Annual Departures	% Annual Growth
A320-100	68.400	600	0.00
A340-600 std	366.200	1,000	0.00
A340-600 std Belly	366.200	1,000	0.00
A380	562.000	300	0.00
B737-800	79.243	2,000	0.00
B747-400	397.801	400	0.00
B747-400ER	414.130	300	0.00
B757-300	124.058	1,200	0.00

Allowable Ranges:

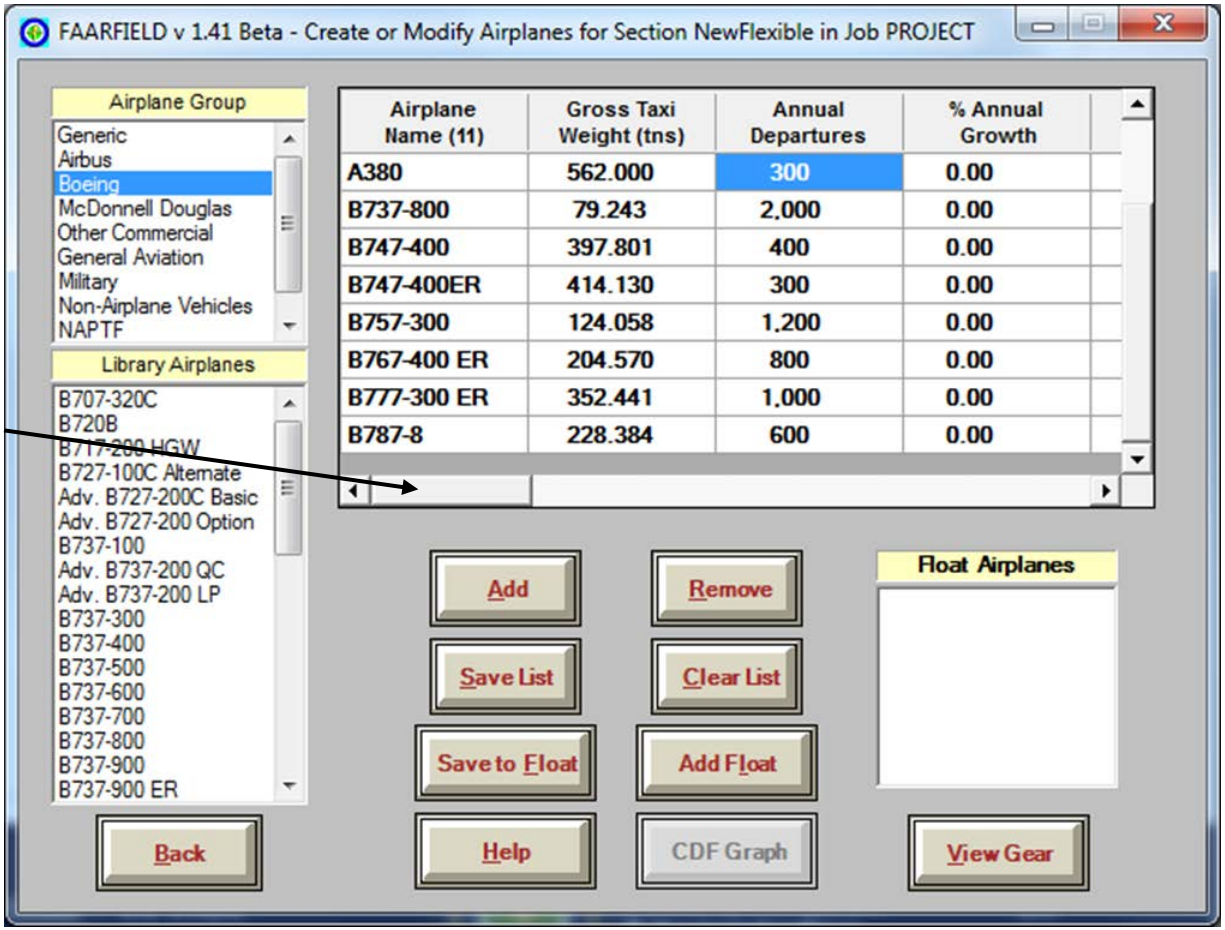
- **Gross Taxi Weight: Default Weight -40% to +25%**
- **Annual Departures: 0 to 100,000**
- **% Annual Growth: +/- 10% (default is zero)**

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.

Viewing Airplane Information

Scroll over to reveal additional columns of information.



Viewing Airplane Information

Available in FAARFIELD Airplane Screen:

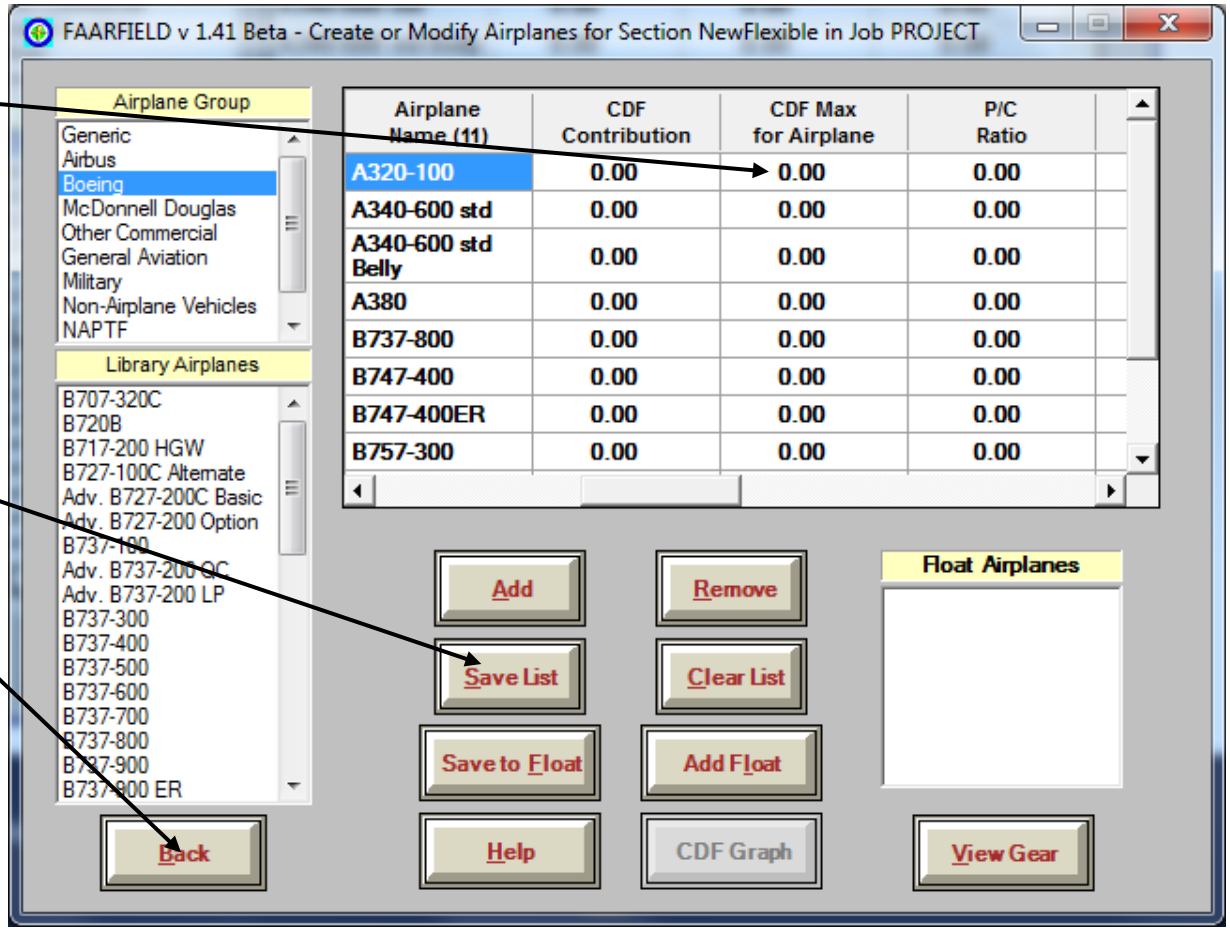
Airplane Name (11)	Gross Taxi Weight (tns)	Annual Departures	% Annual Growth	Total Departures	CDF Contribution	CDF Max for Airplane
A320-100	68.400	600	0.00	12,000	0.00	0.00
A340-600 std	366.200	1,000	0.00	20,000	0.00	0.00
A340-600 std Belly	366.200	1,000	0.00	20,000	0.00	0.00
A380	562.000	300	0.00	6,000	0.00	0.00
B737-800	79.243	2,000	0.00	40,000	0.00	0.00
B747-400	397.801	400	0.00	8,000	0.00	0.00
B747-400ER	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	115,442.6
0.00	1,610	32.9	1,397.0	1,981.2	381.9	611.0	183,232.4
0.00	1,531	29.3	1,168.4	1,981.2	261.4	418.3	85,888.6
0.00	1,500	95.0	1,348.7	1,699.3	372.6	596.2	174,491.0
0.00	1,407	47.5	863.6	0.0	323.1	517.0	131,218.2
0.00	1,379	95.0	1,117.6	1,473.2	365.6	585.0	167,973.6
0.00	1,586	95.0	1,117.6	1,473.2	347.9	556.6	152,059.8
0.00	1,379	47.5	863.6	1,143.0	288.7	462.0	104,768.0

Viewing Airplane Information

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

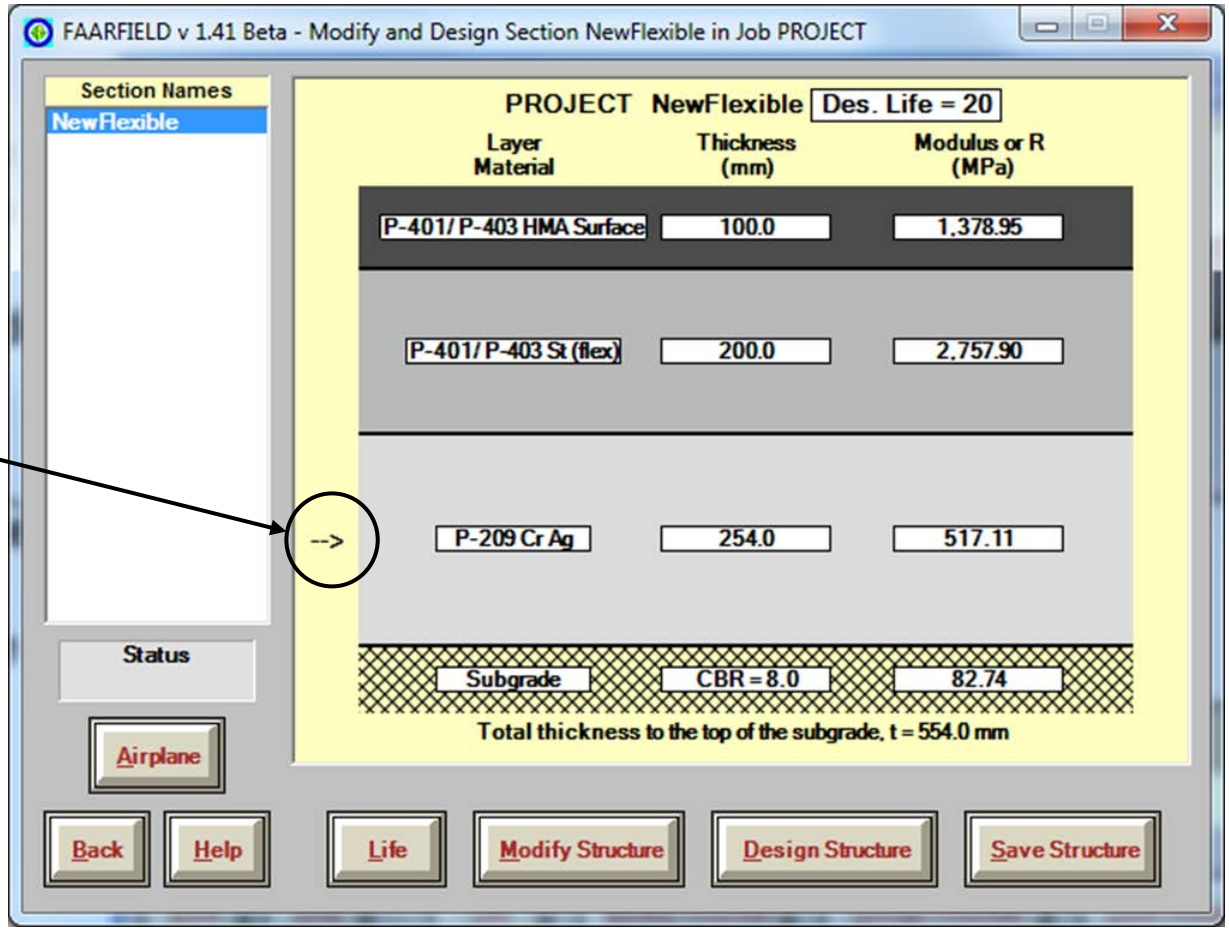
Save the list when finished entering, then click the Back button.



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

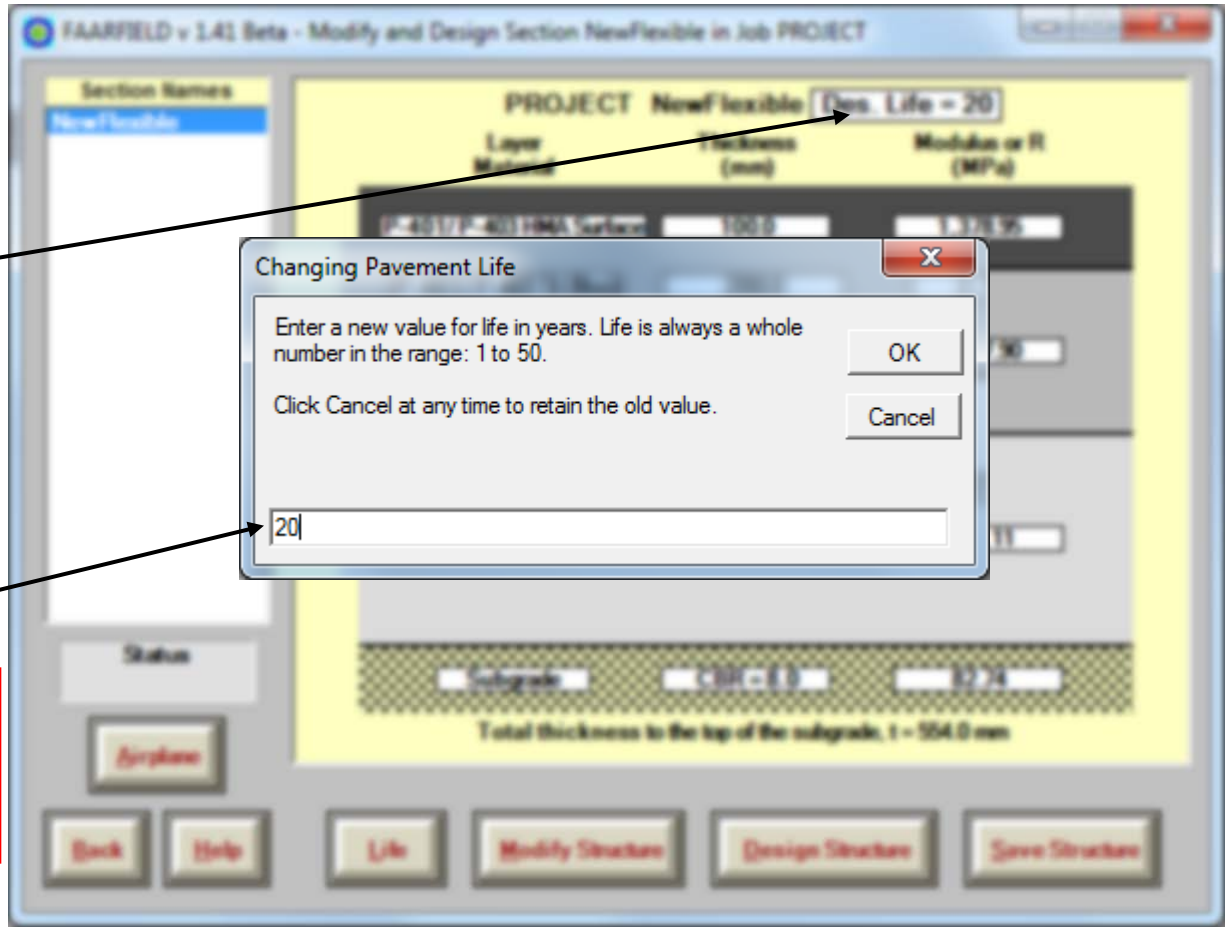
For new flexible sections, the arrow can be moved by double-clicking next to the desired base or subbase layer in “modify structure” mode.

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.

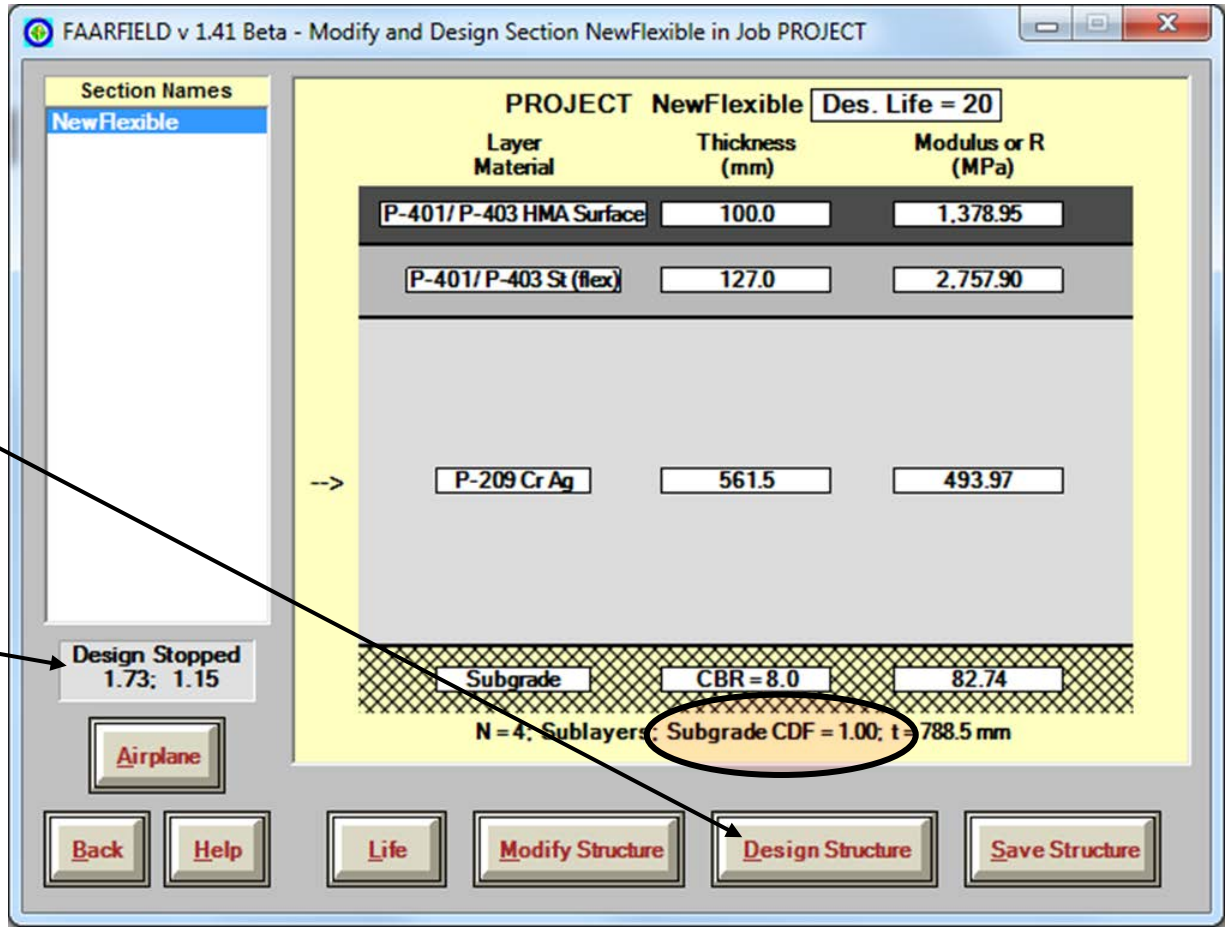


Performing the Pavement Design

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.

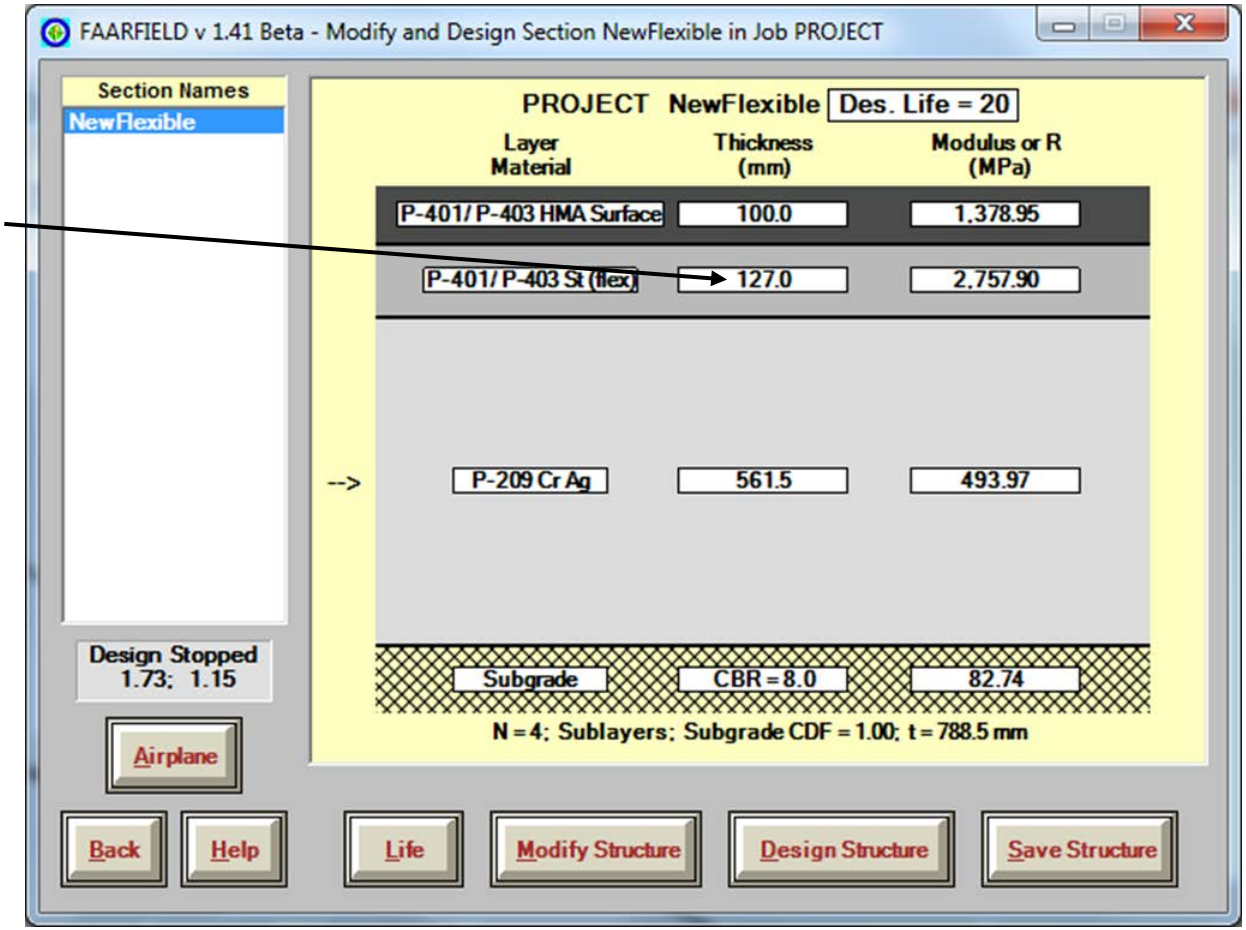
The program will adjust the design layer until a CDF of 1.0 is achieved.



Result of the Pavement Design

The program has also determined the minimum base layer requirement.

For standard stabilized base (P-403) with high-quality subbase (P-209), the minimum base thickness is 127 mm (5 inches).

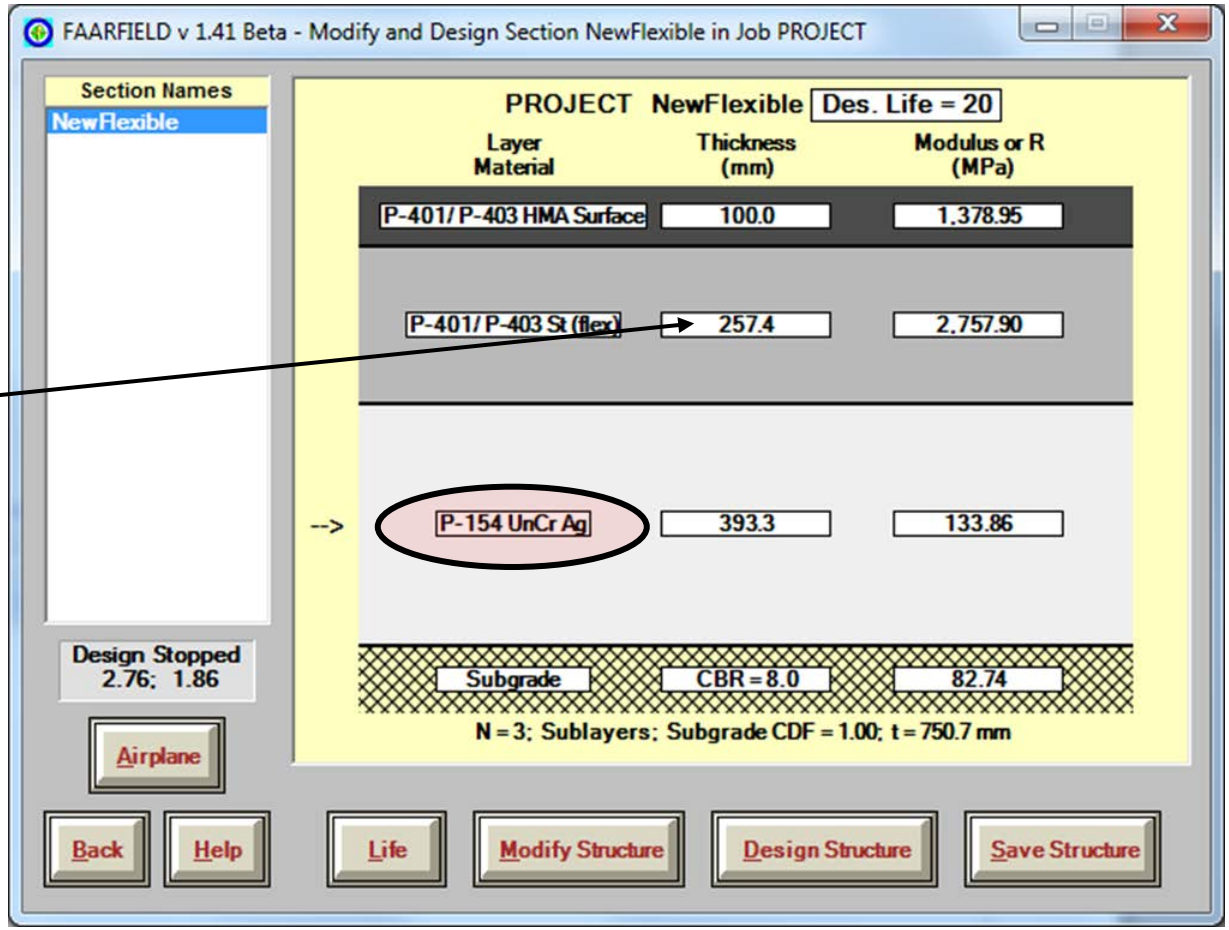


Base Thickness Design

If standard subbase material (P-154) is used instead of high-quality subbase (P-209), then FAARFIELD 1.4 automatically computes an <u>additional</u> base thickness requirement.

This is the minimum thickness of P-403 needed to protect the subbase, assuming CBR 20 at the top of the subbase.

Note - Changed from FAARFIELD 1.3

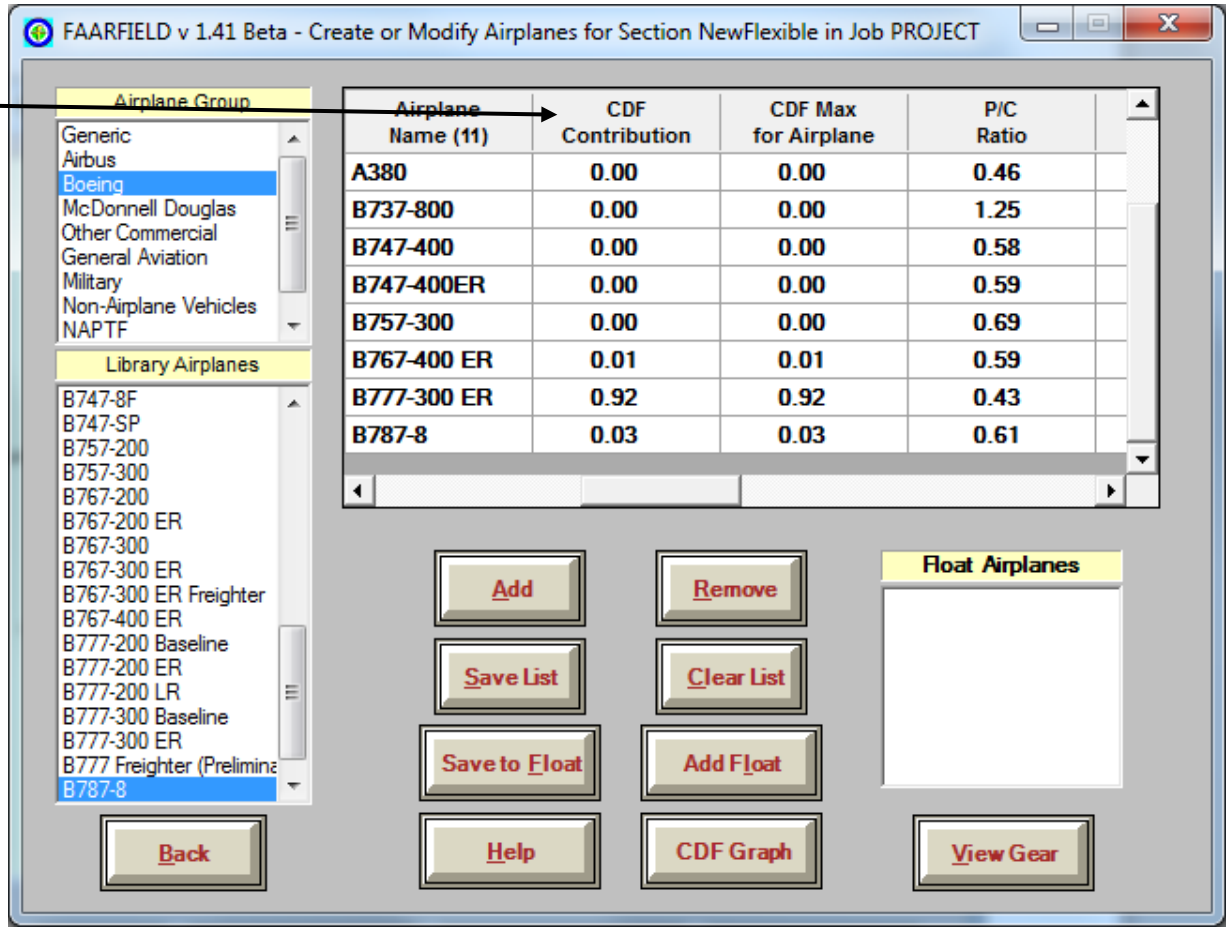


Reviewing Airplane Data

After Completing the Design

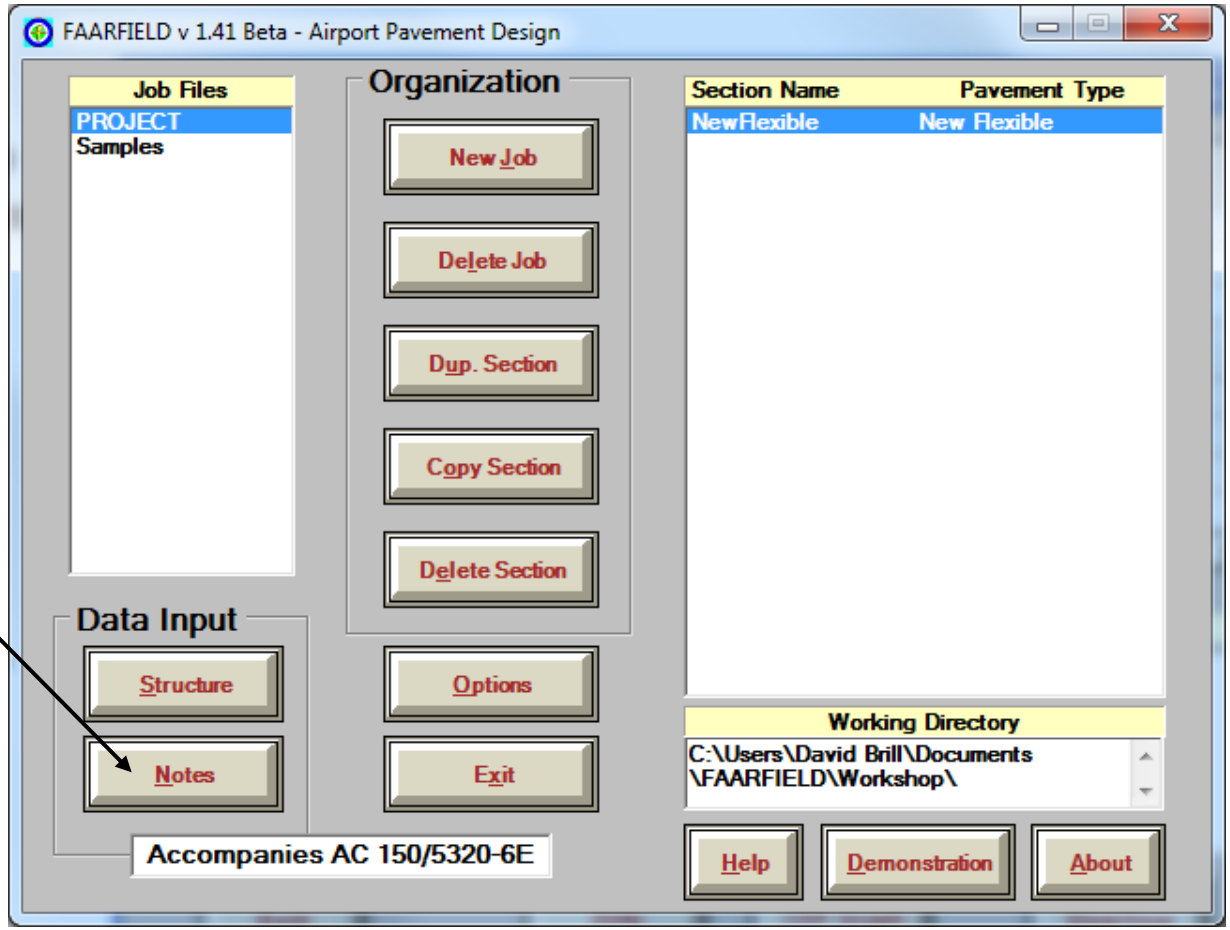
CDF and P/C ratio information is now available.

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.

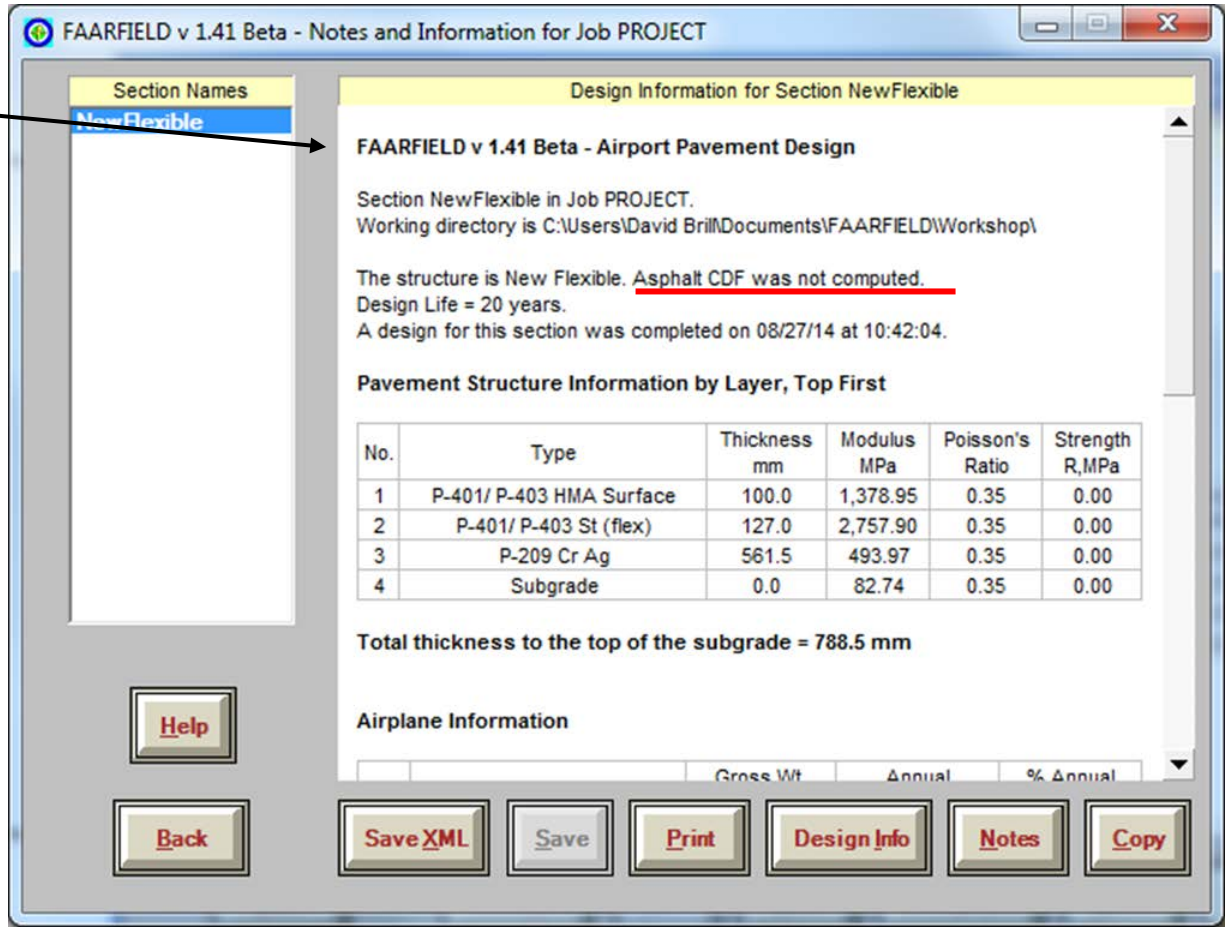


Reviewing Design Information

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

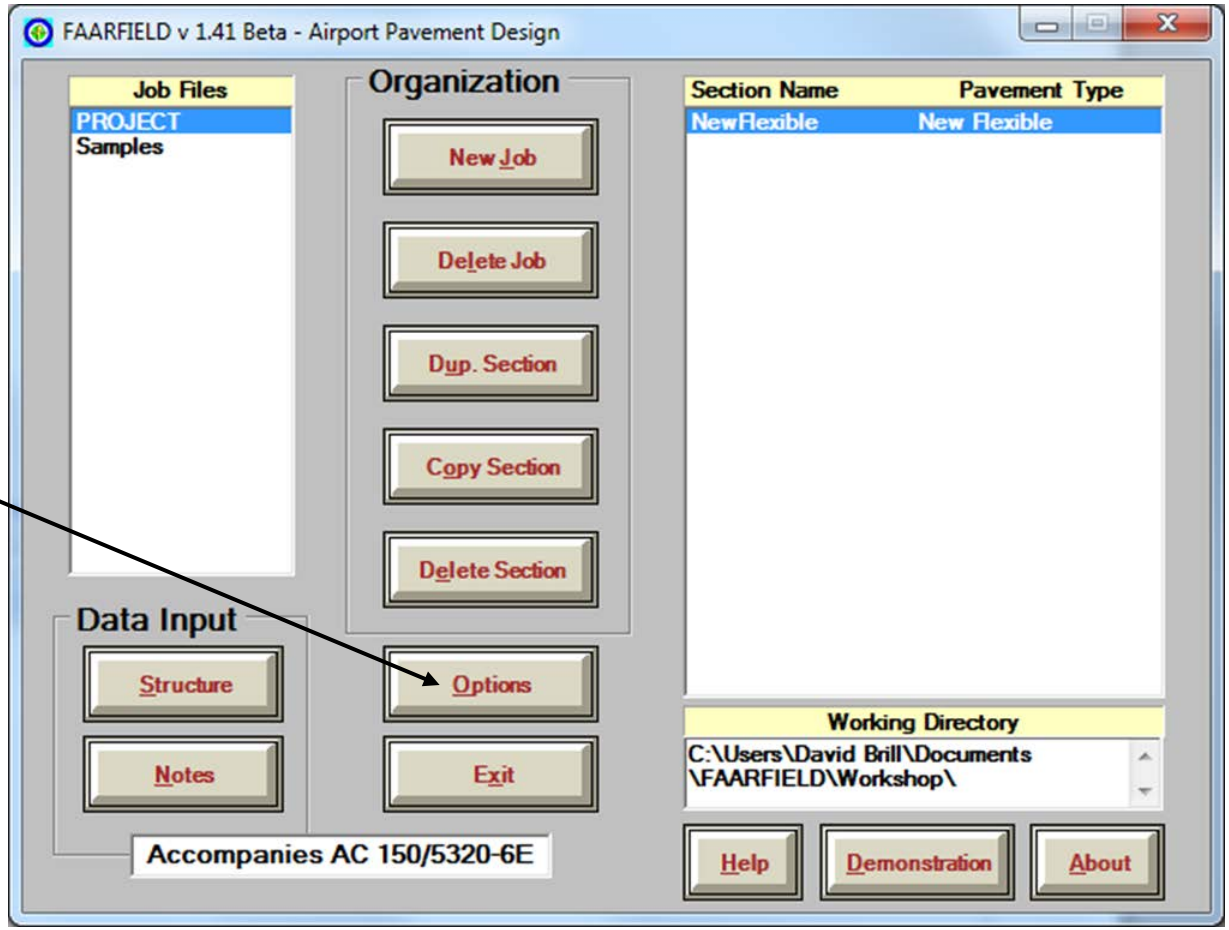
Note the statement: "*Asphalt CDF was not computed*."

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



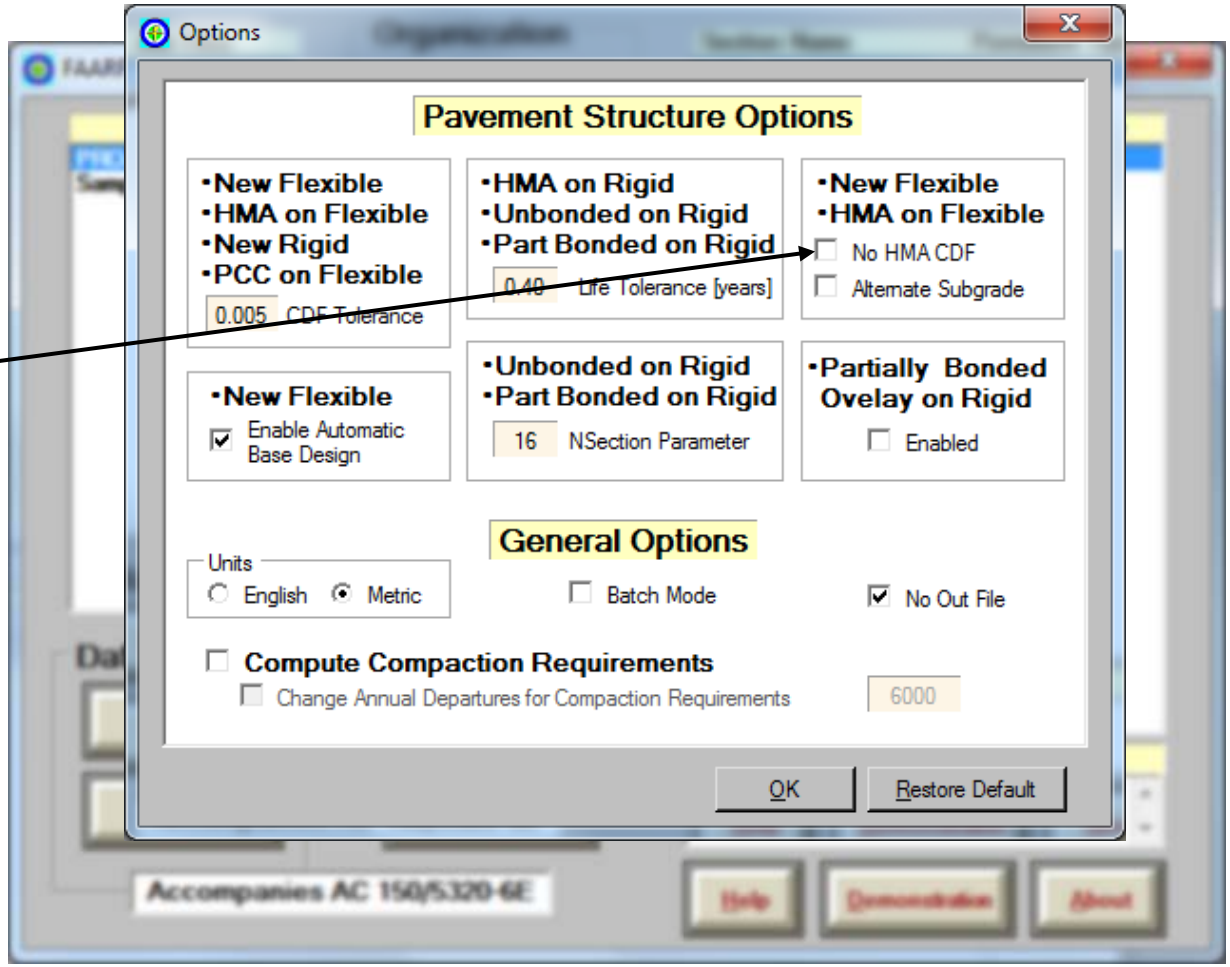
Fatigue in the HMA Layers

To access the optional program features, click on the Options button from the starting screen, or press ALT-O from anywhere in the program.



Fatigue in the HMA Layers

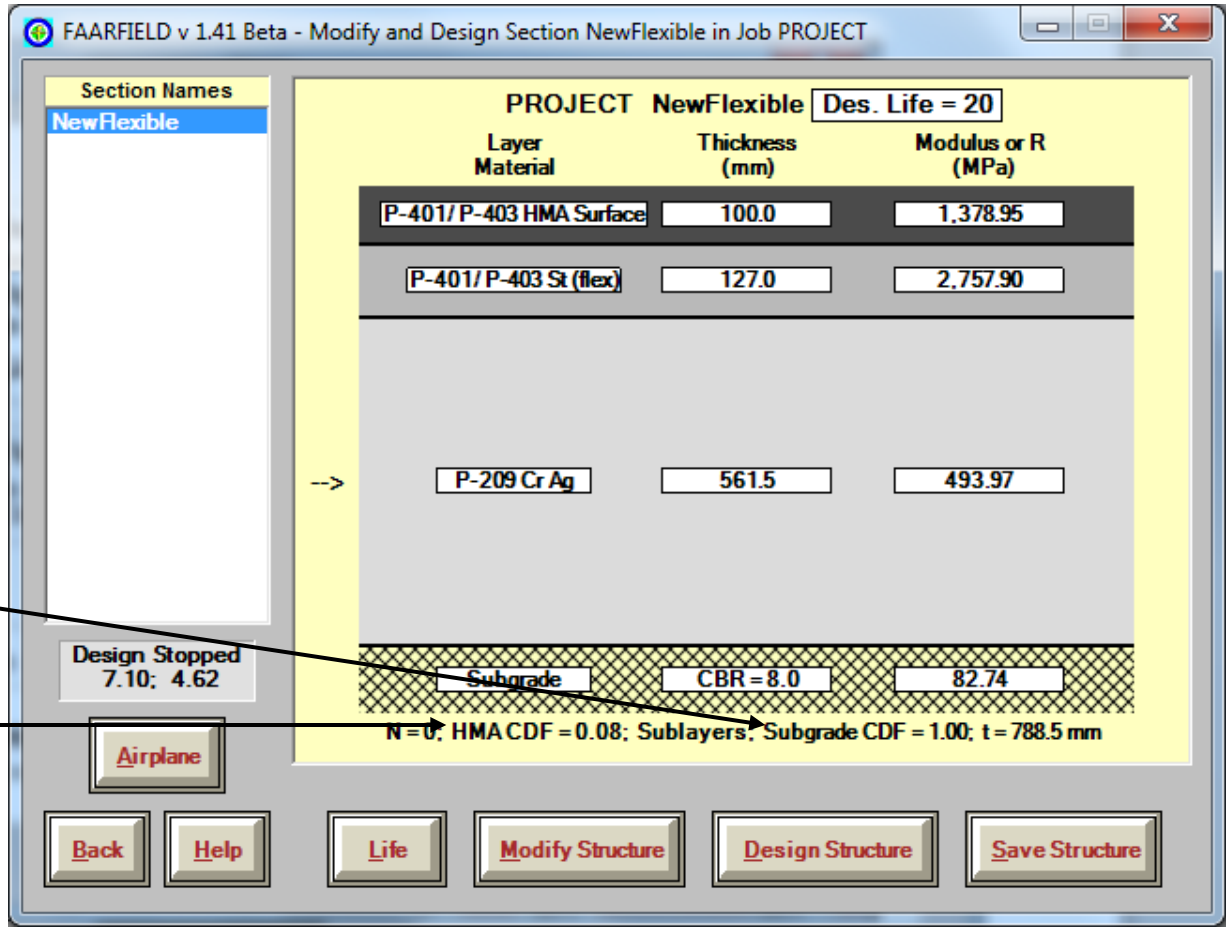
To compute the HMA fatigue, uncheck the "No HMA CDF" box and re-run the design.



Fatigue in the HMA Layers

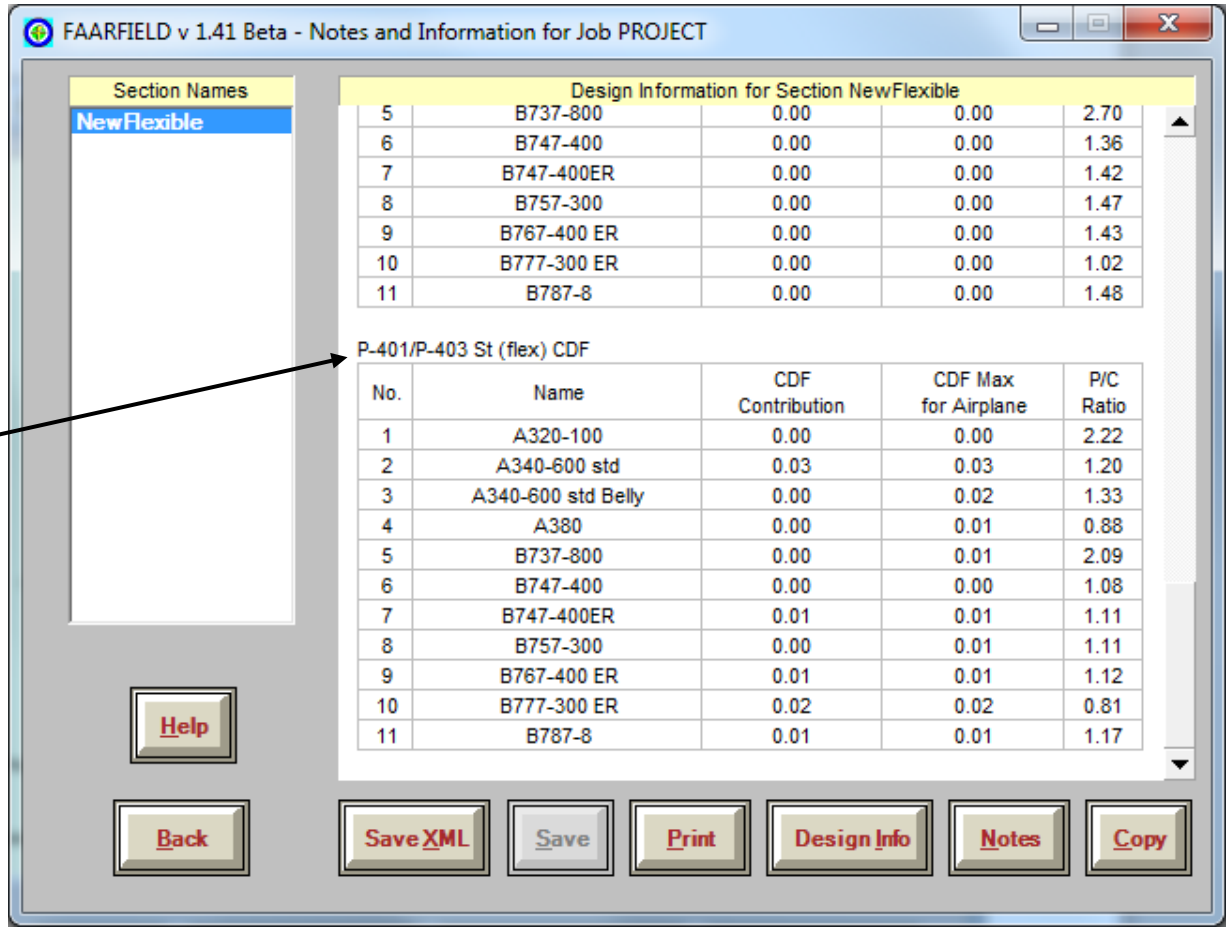
NEW FAARFIELD 1.4 uses a new HMA fatigue model. Fatigue damage is now computed at the bottom of all HMA layers.

In this example, the subgrade CDF has reached 1.0 (failure) while the HMA CDF is still 0.08.



Fatigue in the HMA Layers

In this example, the maximum asphalt fatigue damage (HMA CDF) is computed in the stabilized base layer (not the surface layer).



5	B737-800	0.00	0.00	2.70
6	B747-400	0.00	0.00	1.36
7	B747-400ER	0.00	0.00	1.42
8	B757-300	0.00	0.00	1.47
9	B767-400 ER	0.00	0.00	1.43
10	B777-300 ER	0.00	0.00	1.02
11	B787-8	0.00	0.00	1.48

No.	Name	CDF Contribution	CDF Max for Airplane	P/C Ratio
1	A320-100	0.00	0.00	2.22
2	A340-600 std	0.03	0.03	1.20
3	A340-600 std Belly	0.00	0.02	1.33
4	A380	0.00	0.01	0.88
5	B737-800	0.00	0.01	2.09
6	B747-400	0.00	0.00	1.08
7	B747-400ER	0.01	0.01	1.11
8	B757-300	0.00	0.01	1.11
9	B767-400 ER	0.01	0.01	1.12
10	B777-300 ER	0.02	0.02	0.81
11	B787-8	0.01	0.01	1.17

Thank You! ¡Muchas Gracias!

http://www.airporttech.tc.faa.gov/

david.brill@faa.gov

Acknowledgments:

FAA Airport Technology R&D Branch:
Dr. Michel Hovan, Branch Manager;
Jeff Gagnon, Airport Pavement Section Manager;
Dr. Navneet Garg; Al Larkin; Dr. Charles Ishee; Murphy Flynn; Ryan Rutter; Quinn Jia, Wilfredo Villafane

FAA Airport Engineering Division:
Doug Johnson; Greg Cline

SRA International:
Jerry Connelly; Dr. Izydor Kawa; Dr. Qiang Wang; Dr. Yuanguo Chen; Dr. Kairat Tuleubekov, Jeff Stein

Gemini:
Dr. Hao Yin

Consultants:
Dr. Edward Guo; Dr. Maria Lopez; Roy McQueen; Dr. Shelley Stoffels