

FAARFIELD 1.4

Design Examples - Flexible

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

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Date: 3 September, 2014

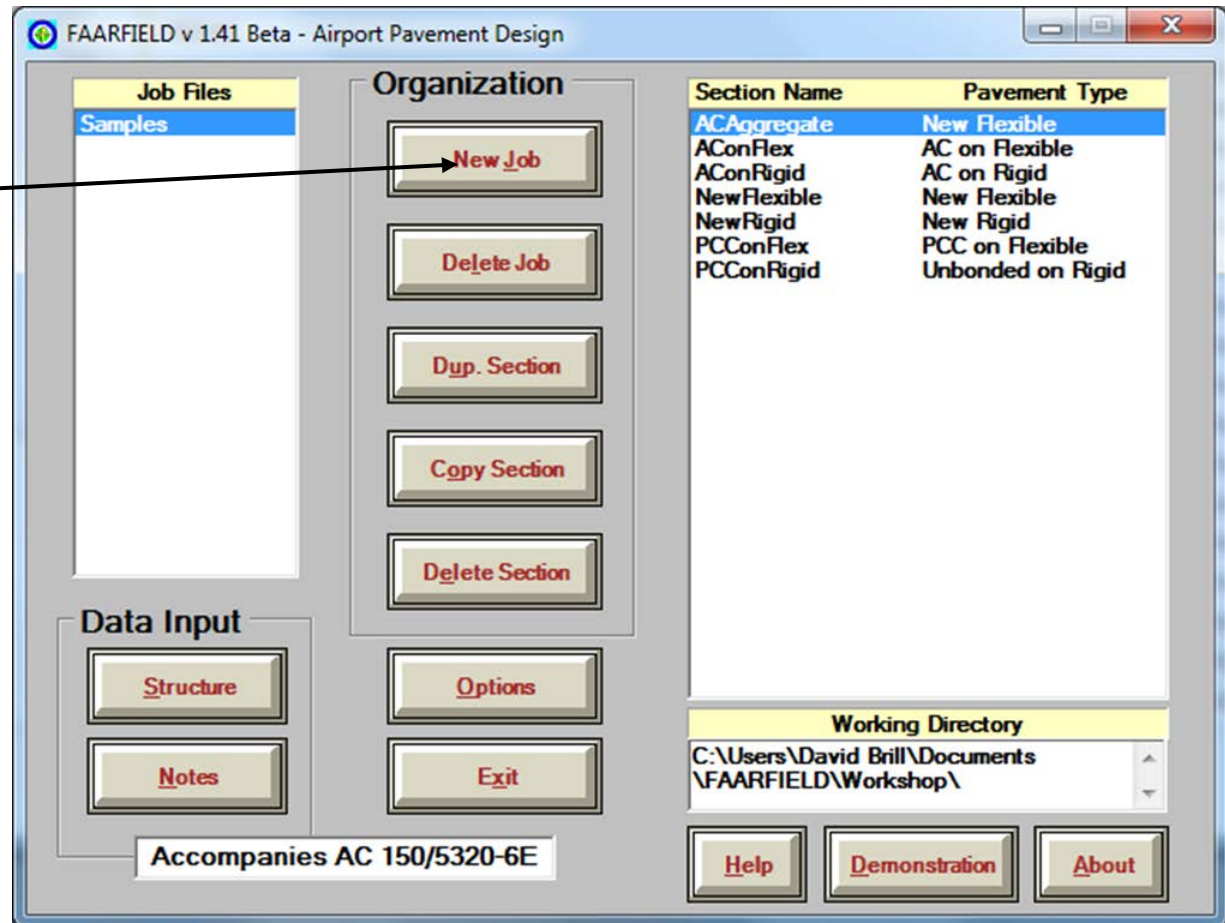


**Federal Aviation
Administration**

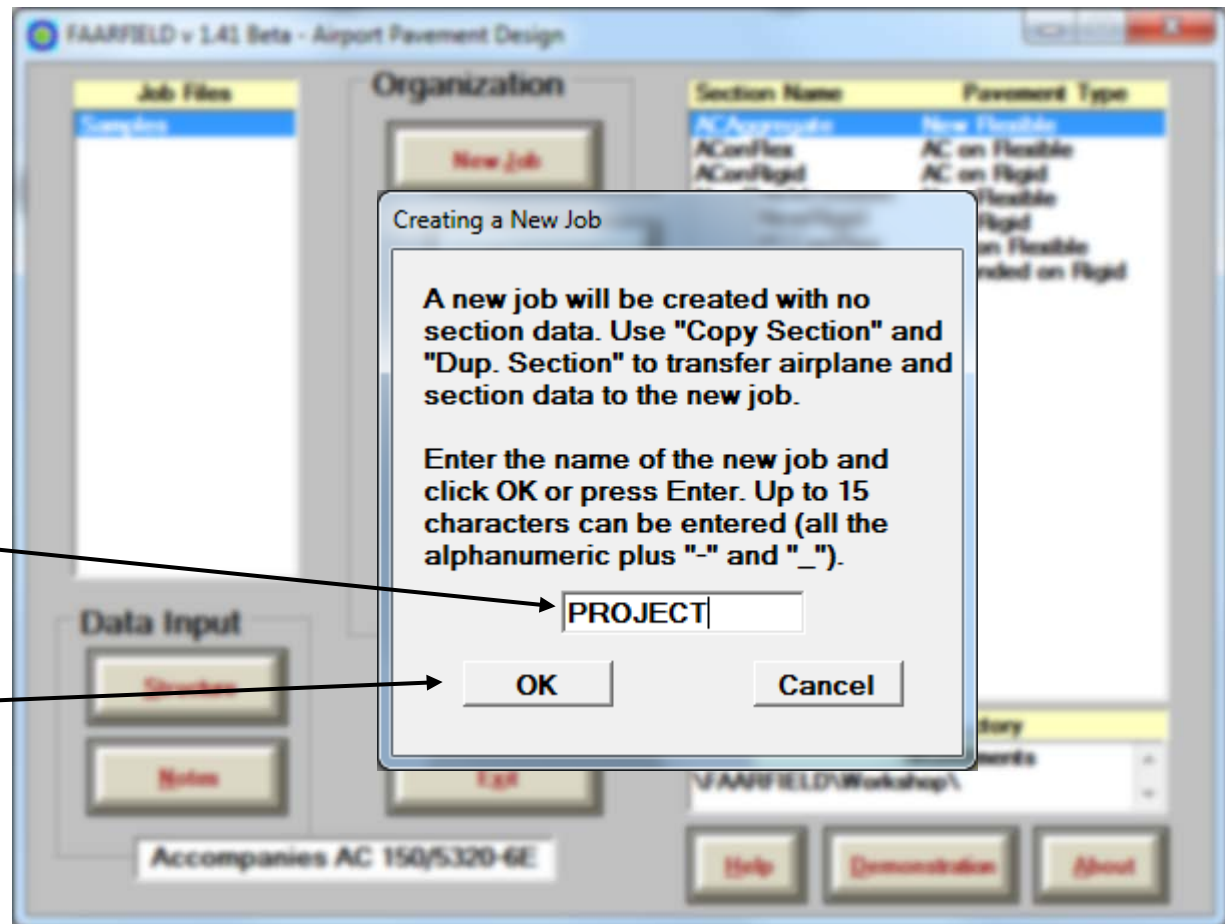


Starting Screen – No Job Files Created

Click on “New Job”



Creating/Naming a Job File

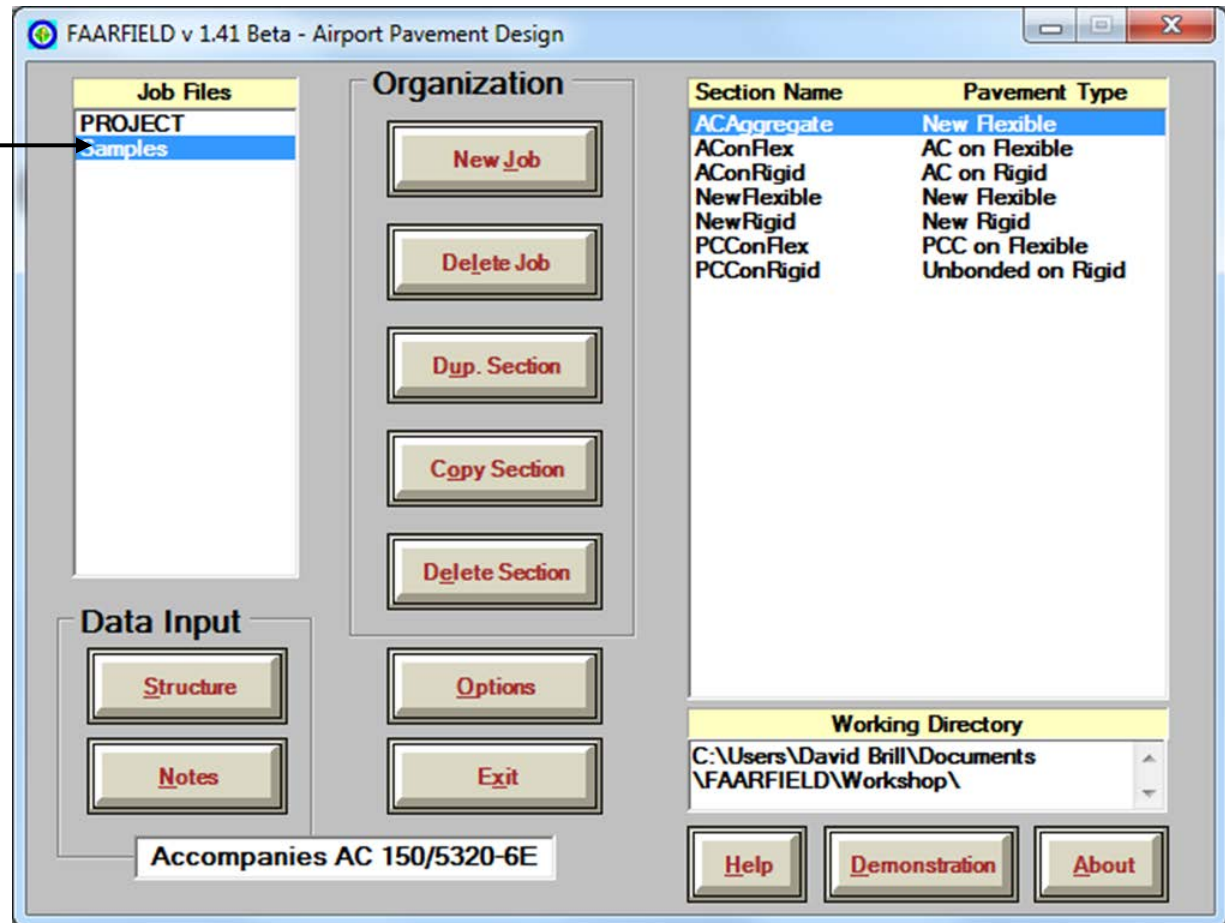


Enter Job Title

Click OK

Copy Basic Section/Pavement Type from Samples

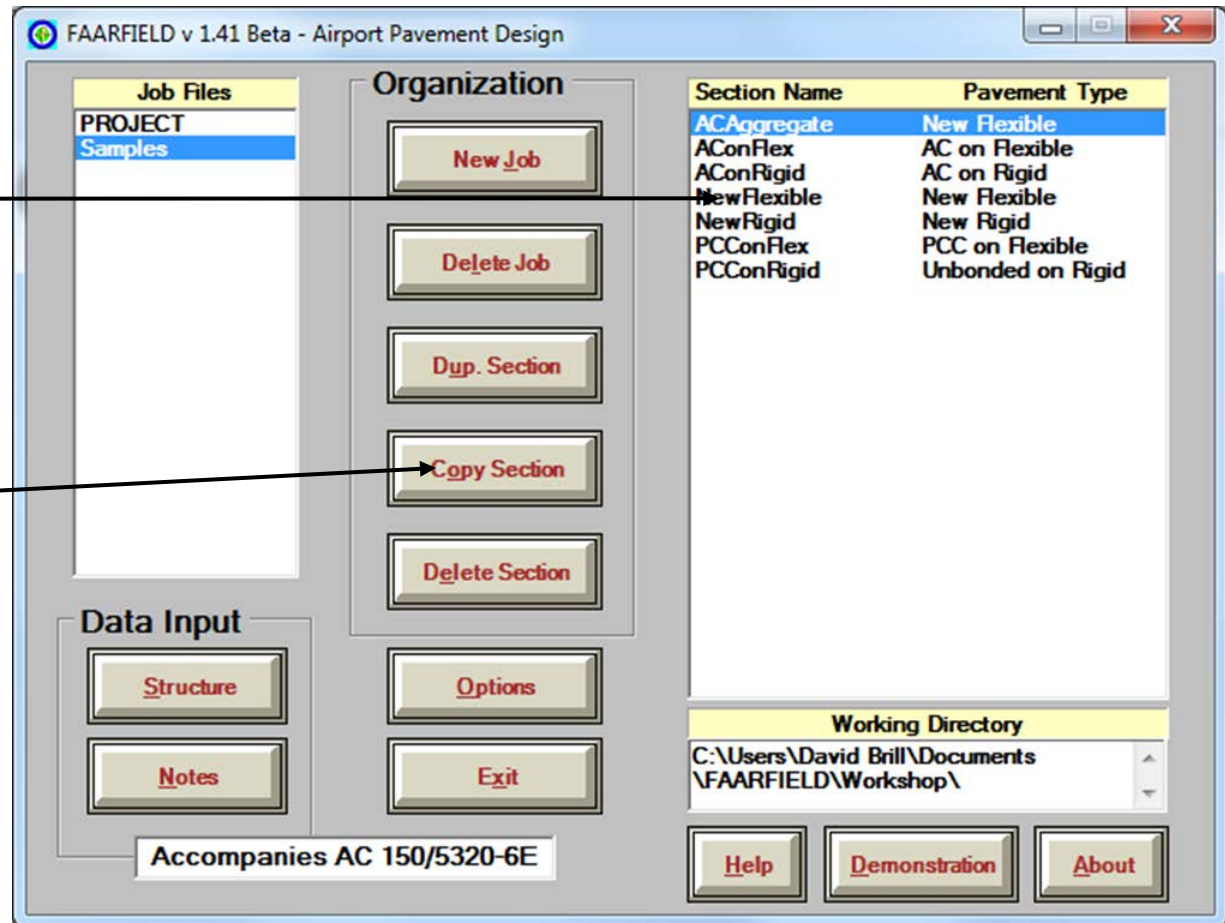
Click on “Samples”



Copy Basic Section/Pavement Type from Samples

Default Basic
Pavement Sections

Click on “Copy
Section”



7 Basic Starting Structures in FAARFIELD

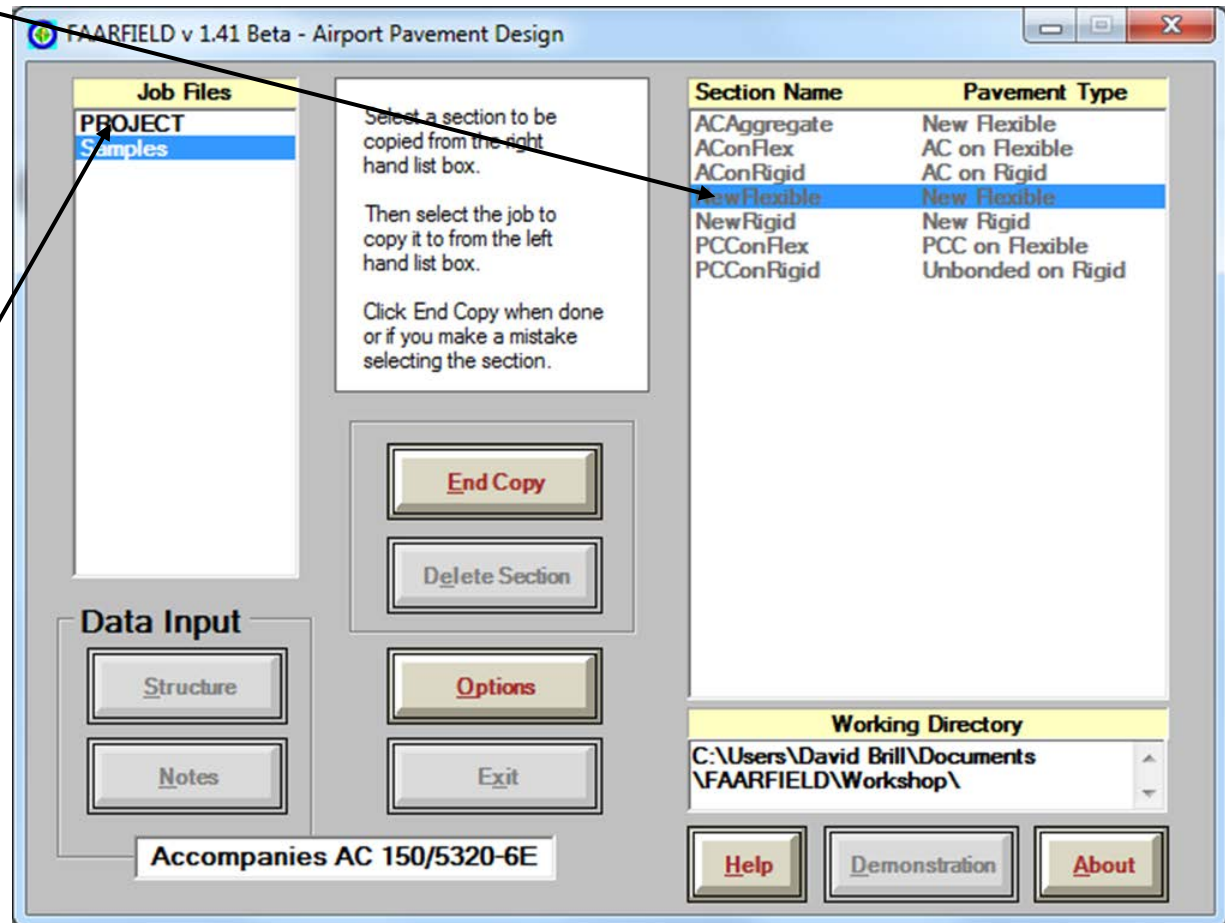
<u>Section Name</u>	<u>Pavement Type</u>
ACAggregate	New flexible on aggregate base
AConFlex	HMA overlay on flexible pavement
AConRigid	HMA overlay on rigid pavement
NewFlexible	New flexible on stabilized base
New Rigid	New rigid on stabilized base
PCConFlex	PCC Overlay on flexible
PCConRigid	Unbonded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

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

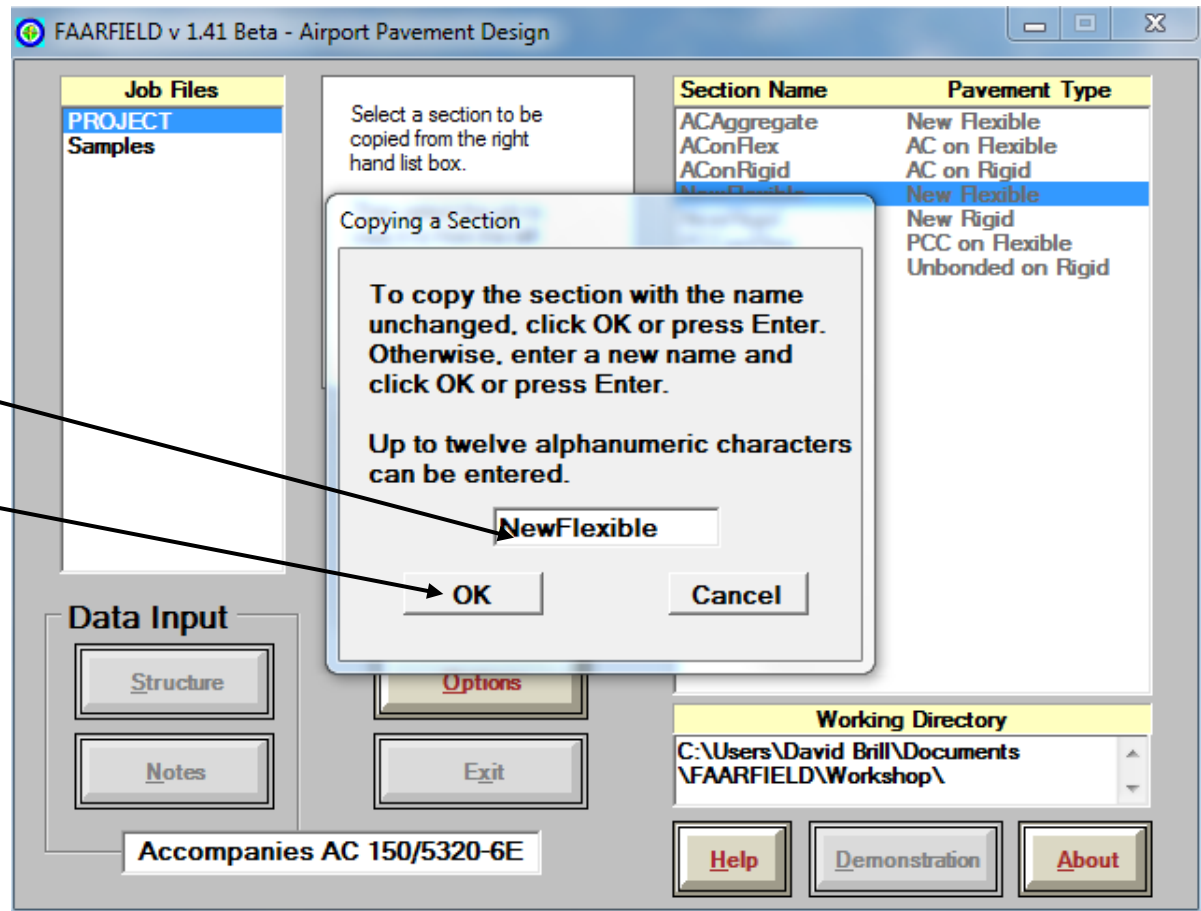
Copy a Sample Pavement Section

Click on desired pavement section.

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



Create a New Job Title

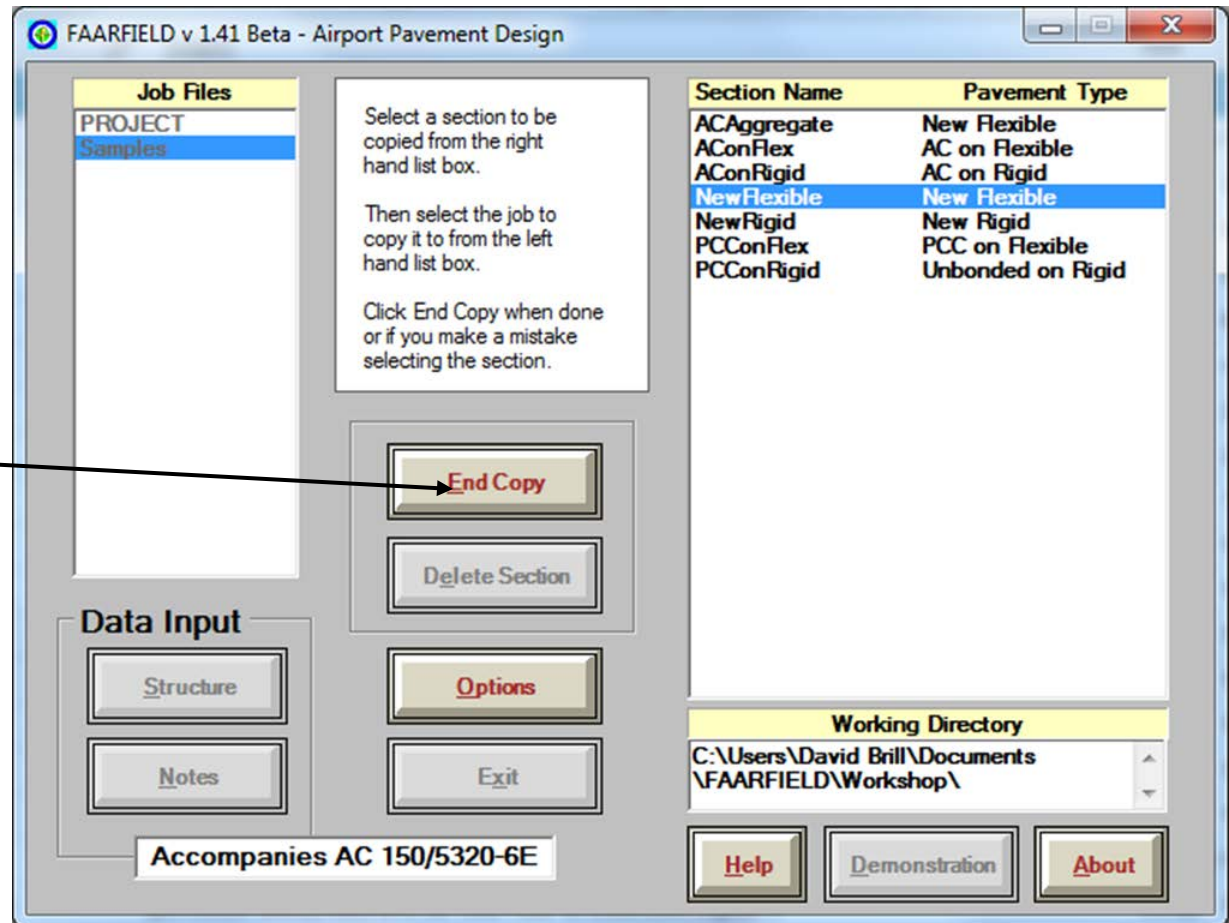


Enter job title

Click OK

Create a New Job Title

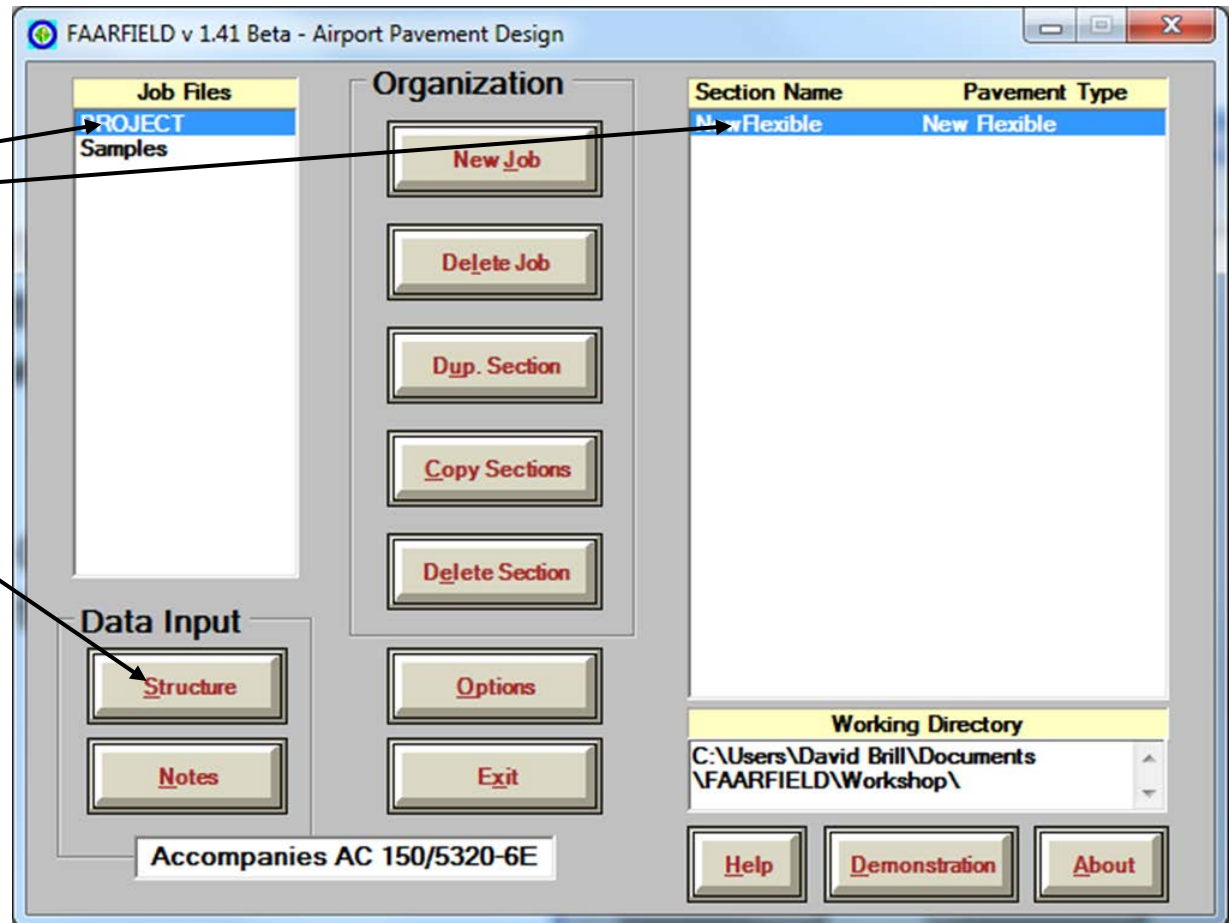
Click “End Copy”



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.

FAARFIELD v 1.41 Beta - Modify and Design Section NewFlexible in Job PROJECT

Section Names
NewFlexible

PROJECT NewFlexible Des. Life = 20

Layer Material	Thickness (in)	Modulus or R (psi)
P-401/ P-403 HMA Surface	5.00	200,000
P-401/ P-403 St (flex)	8.00	400,000
P-209 Cr Ag	10.00	75,000
Subgrade	CBR = 10.0	15,000

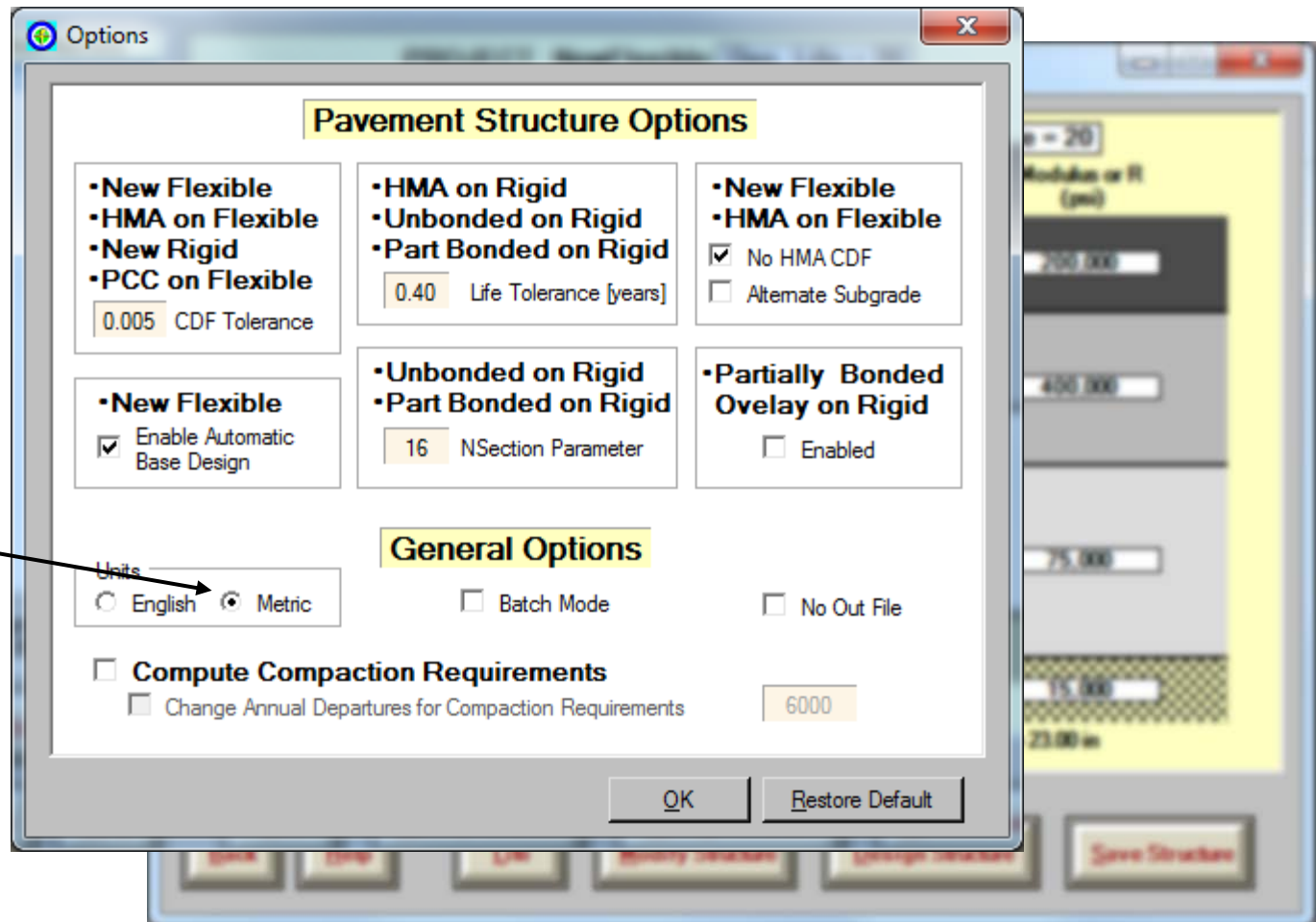
Total thickness to the top of the subgrade, t = 23.00 in

Status

Airplane

Back Help Life Modify Structure Design Structure Save Structure

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.

The screenshot shows the FAARFIELD v 1.41 Beta software interface. The title bar reads "FAARFIELD v 1.41 Beta - Modify and Design Section NewFlexible in Job PROJECT". The main window is divided into several sections:

- Section Names:** A list box containing "NewFlexible".
- PROJECT NewFlexible:** A section with a "Des. Life = 20" input field.
- Table of Pavement Layers:** A table with three columns: "Layer Material", "Thickness (mm)", and "Modulus or R (MPa)".
- Buttons:** A row of buttons at the bottom including "Back", "Help", "Life", "Modify Structure", "Design Structure", and "Save Structure".

The table data is as follows:

Layer Material	Thickness (mm)	Modulus or R (MPa)
P-401/ P-403 HMA Surface	127.0	1,378.95
P-401/ P-403 St (flex)	203.2	2,757.90
P-209 Cr Ag	254.0	517.11
Subgrade	CBR = 10.0	103.42

Below the table, it states: "Total thickness to the top of the subgrade, t = 584.2 mm".

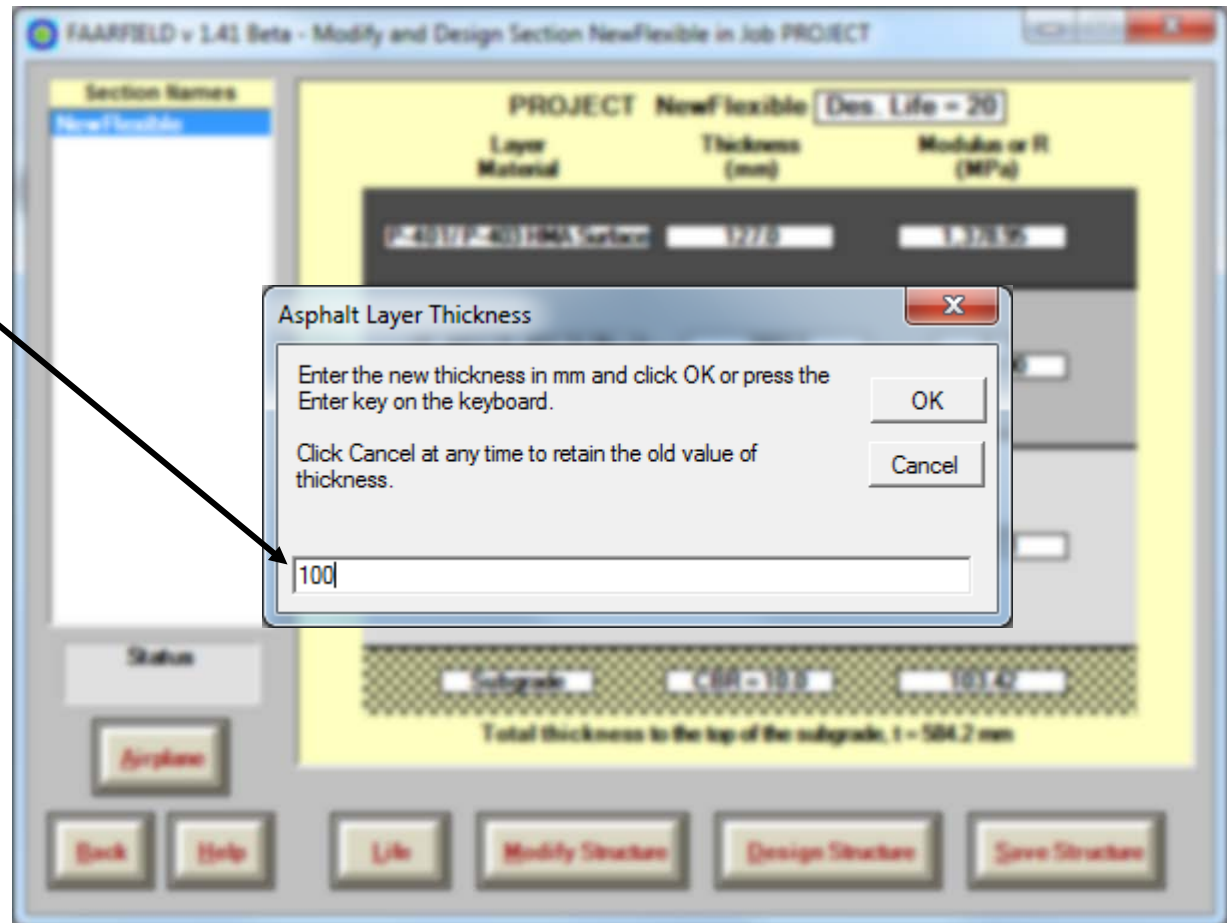
Layer Placement Restrictions

- **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



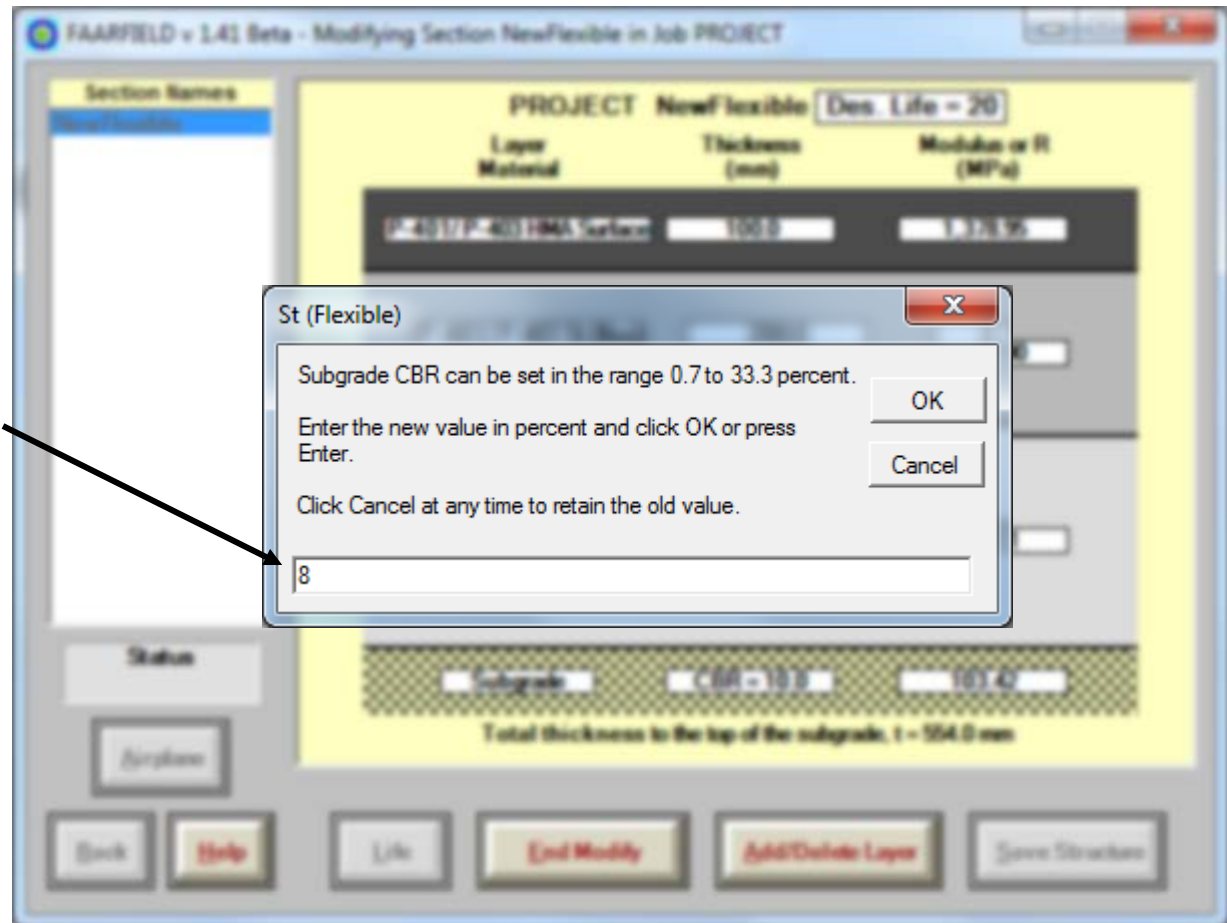
- Minimum asphalt surface thickness is 100 mm.
- Click on the P-401 Surface thickness.
- Enter the new value of 100 mm.
- Hit OK.
- Next, change the P-401/P-403 stabilized base layer to 200 mm.



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

FAARFIELD v 1.41 Beta - Modifying Section NewFlexible in Job PROJECT

Section Names
NewFlexible

PROJECT NewFlexible Des. Life = 20

Layer Material	Thickness (mm)	Modulus or R (MPa)
P-401/P-403 HMA Surface	100.0	1,378.95
P-401/P-403 St (flex)	200.0	2,757.90
P-209 Cr Ag	254.0	517.11
Subgrade	CBR = 8.0	82.74

Total thickness to the top of the subgrade, t = 554.0 mm

Status

Airplane

Back Help Life End Modify Add/Delete Layer Save Structure

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

FAARFIELD v 1.41 Beta - Modify and Design Section NewFlexible in Job PROJECT

Section Names
NewFlexible

PROJECT NewFlexible Des. Life = 20

Layer Material	Thickness (mm)	Modulus or R (MPa)
P-401/ P-403 HMA Surface	100.0	1,378.95
P-401/ P-403 St (flex)	200.0	2,757.90
P-209 Cr Ag	254.0	517.11
Subgrade	CBR = 8.0	82.74

Total thickness to the top of the subgrade, t = 554.0 mm

Status

Airplane

Back Help Life Modify Structure Design Structure Save Structure

Enter Traffic Mixture

Use “Clear List” to clear the existing airplanes

FAARFIELD v 1.41 Beta - Create or Modify Airplanes for Section NewFlexible in Job PROJECT

Airplane Group	Airplane Name (3)	Gross Taxi Weight (tns)	Annual Departures	% Annual Growth	De
Generic	DC10-10	207.745	2,263	0.00	45
Airbus	B747-200B	395.986	832	0.00	10
Boeing	Combi Mixed				
McDonnell Douglas	B777-200 ER	287.804	425	0.00	8
Other Commercial					
General Aviation					
Military					
Non-Airplane Vehicles					
NAPTF					

Library Airplanes

- SWL-50
- S-30
- S-45
- S-50
- S-60
- S-75
- D-50
- D-75
- D-100
- D-150
- D-200
- 2D-100
- 2D-150
- 2D-200
- 2D-300
- 2D-400

Buttons: Add, Remove, Save List, Clear List, Save to Float, Add Float, Back, Help, CDF Graph, View Gear

Float 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.

FAARFIELD v 1.41 Beta - Create or Modify Airplanes for Section NewFlexible in Job PROJECT

Airplane Group

- Generic
- Airbus**
- Boeing
- McDonnell Douglas
- Other Commercial
- General Aviation
- Military
- Non-Airplane Vehicles
- NAPTF

Library Airplanes

- A300-B2 SB
- A300-B2 std
- A300-B4 std
- A300-B4 LB
- A300-600 std
- A300-600 LB
- A310-200
- A310-300
- A318-100 std
- A318-100 opt
- A319-100 std
- A319-100 opt
- A320-100**
- A320-200 Twin std
- A320-200 Twin opt
- A320 Bogie
- A321-100 std

Airplane Name (1)	Gross Taxi Weight (tns)	Annual Departures	% Annual Growth	De
A320-100	68.400	1,200	0.00	24

Buttons: Add, Remove, Save List, Clear List, Save to Float, Add Float, Back, Help, CDF Graph, View Gear

Float Airplanes

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.

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

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 \times 20 years = 24,000 departures.

Viewing Airplane Information

Scroll over to reveal additional columns of information.

FAARFIELD v 1.41 Beta - Create or Modify Airplanes for Section NewFlexible in Job PROJECT

Airplane Group	Airplane Name (11)	Gross Taxi Weight (tns)	Annual Departures	% Annual Growth
Generic	A380	562.000	300	0.00
Airbus	B737-800	79.243	2,000	0.00
Boeing	B747-400	397.801	400	0.00
McDonnell Douglas	B747-400ER	414.130	300	0.00
Other Commercial	B757-300	124.058	1,200	0.00
General Aviation	B767-400 ER	204.570	800	0.00
Military	B777-300 ER	352.441	1,000	0.00
Non-Airplane Vehicles	B787-8	228.384	600	0.00
NAPTF				

Library Airplanes

- B707-320C
- B720B
- B717-200 HGW
- B727-100C Alternate
- Adv. B727-200C Basic
- Adv. B727-200 Option
- B737-100
- Adv. B737-200 QC
- Adv. B737-200 LP
- B737-300
- B737-400
- B737-500
- B737-600
- B737-700
- B737-800
- B737-900
- B737-900 ER

Buttons: Add, Remove, Save List, Clear List, Save to Float, Add Float, Back, Help, CDF Graph, View Gear

Float Airplanes

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.

FAARFIELD v 1.41 Beta - Create or Modify Airplanes for Section NewFlexible in Job PROJECT

Airplane Group	Airplane Name (11)	CDF Contribution	CDF Max for Airplane	P/C Ratio
Generic	A320-100	0.00	0.00	0.00
Airbus	A340-600 std	0.00	0.00	0.00
Boeing	A340-600 std Belly	0.00	0.00	0.00
McDonnell Douglas	A380	0.00	0.00	0.00
Other Commercial	B737-800	0.00	0.00	0.00
General Aviation	B747-400	0.00	0.00	0.00
Military	B747-400ER	0.00	0.00	0.00
Non-Airplane Vehicles	B757-300	0.00	0.00	0.00
NAPTF				

Library Airplanes

- B707-320C
- B720B
- B717-200 HGW
- B727-100C Alternate
- Adv. B727-200C Basic
- Adv. B727-200 Option
- B737-100
- Adv. B737-200 QC
- Adv. B737-200 LP
- B737-300
- B737-400
- B737-500
- B737-600
- B737-700
- B737-800
- B737-900
- B737-900 ER

Buttons: Add, Remove, Save List, Clear List, Save to Float, Add Float, Back, Help, CDF Graph, View Gear

Float Airplanes

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.

Layer Material	Thickness (mm)	Modulus or R (MPa)
P-401/ P-403 HMA Surface	100.0	1,378.95
P-401/ P-403 St (flex)	200.0	2,757.90
P-209 Cr Ag	254.0	517.11
Subgrade	CBR = 8.0	82.74

Total thickness to the top of the subgrade, t = 554.0 mm

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

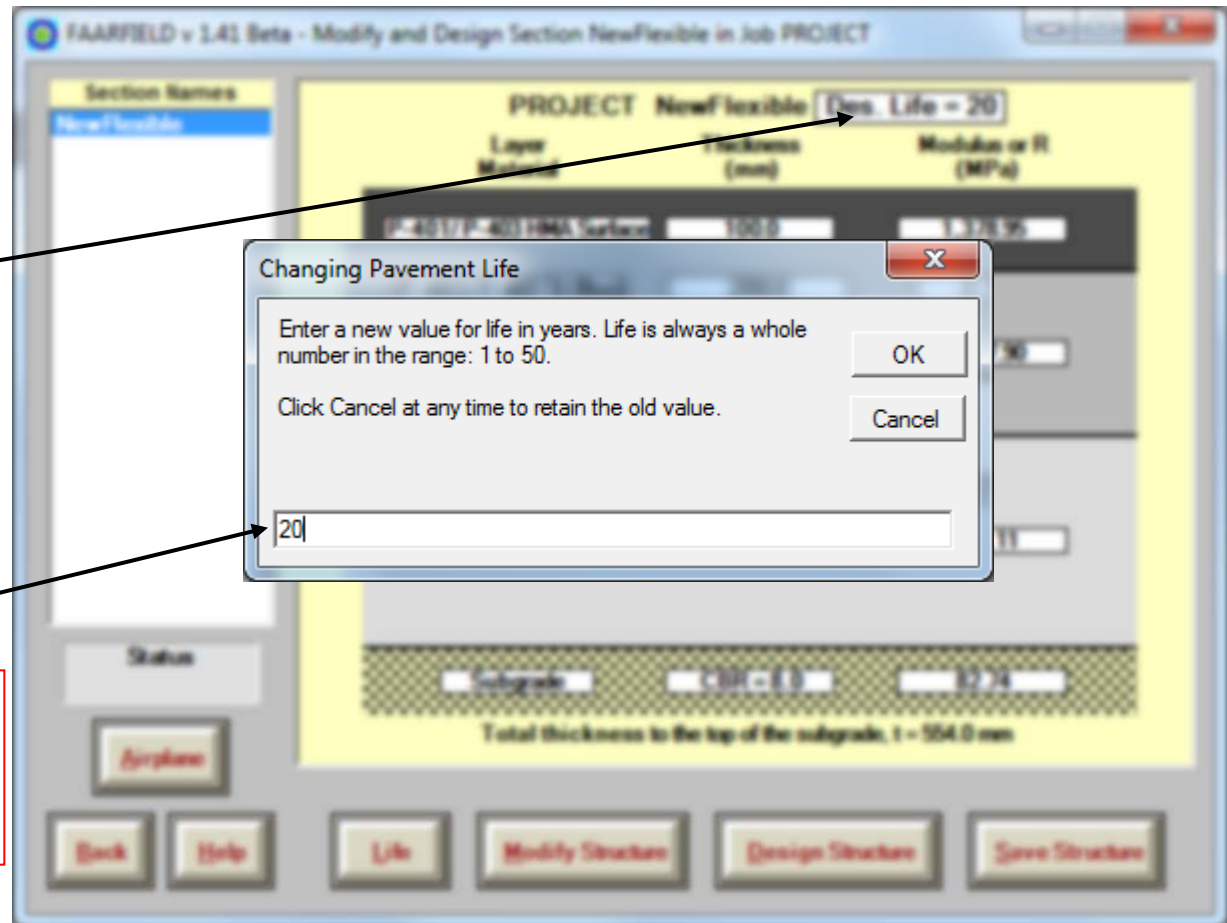
For new flexible sections, the arrow can be moved by double-clicking next to the desired base or subbase layer in “modify structure” mode.

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.

FAARFIELD v 1.41 Beta - Modify and Design Section NewFlexible in Job PROJECT

Section Names
NewFlexible

PROJECT NewFlexible Des. Life = 20

Layer Material	Thickness (mm)	Modulus or R (MPa)
P-401/P-403 HMA Surface	100.0	1,378.95
P-401/P-403 St (flex)	127.0	2,757.90
→		
P-209 Cr Ag	561.5	493.97
Subgrade CBR = 8.0 82.74		
N = 4; Sublayers: Subgrade CDF = 1.00; t = 788.5 mm		

Design Stopped 1.73; 1.15

Airplane

Back Help Life Modify Structure Design Structure Save Structure

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).

FAARFIELD v 1.41 Beta - Modify and Design Section NewFlexible in Job PROJECT

Section Names
NewFlexible

PROJECT NewFlexible Des. Life = 20

Layer Material	Thickness (mm)	Modulus or R (MPa)
P-401/P-403 HMA Surface	100.0	1,378.95
P-401/P-403 St (flex)	127.0	2,757.90
P-209 Cr Ag	561.5	493.97
Subgrade	CBR = 8.0	82.74

N = 4; Sublayers; Subgrade CDF = 1.00; t = 788.5 mm

Design Stopped 1.73; 1.15

Airplane

Back Help Life Modify Structure Design Structure Save Structure

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 additional 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

FAARFIELD v 1.41 Beta - Modify and Design Section NewFlexible in Job PROJECT

Section Names
NewFlexible

PROJECT NewFlexible Des. Life = 20

Layer Material	Thickness (mm)	Modulus or R (MPa)
P-401/ P-403 HMA Surface	100.0	1,378.95
P-401/ P-403 St (flex)	257.4	2,757.90
P-154 UnCr Ag	393.3	133.86
Subgrade	CBR = 8.0	82.74

N = 3; Sublayers; Subgrade CDF = 1.00; t = 750.7 mm

Design Stopped 2.76; 1.86

Airplane

Back Help Life Modify Structure Design Structure Save Structure

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.

FAARFIELD v 1.41 Beta - Create or Modify Airplanes for Section NewFlexible in Job PROJECT

Airplane Group	Airplane Name (11)	CDF Contribution	CDF Max for Airplane	P/C Ratio
Generic	A380	0.00	0.00	0.46
Airbus	B737-800	0.00	0.00	1.25
Boeing	B747-400	0.00	0.00	0.58
McDonnell Douglas	B747-400ER	0.00	0.00	0.59
Other Commercial	B757-300	0.00	0.00	0.69
General Aviation	B767-400 ER	0.01	0.01	0.59
Military	B777-300 ER	0.92	0.92	0.43
Non-Airplane Vehicles	B787-8	0.03	0.03	0.61
NAPT				

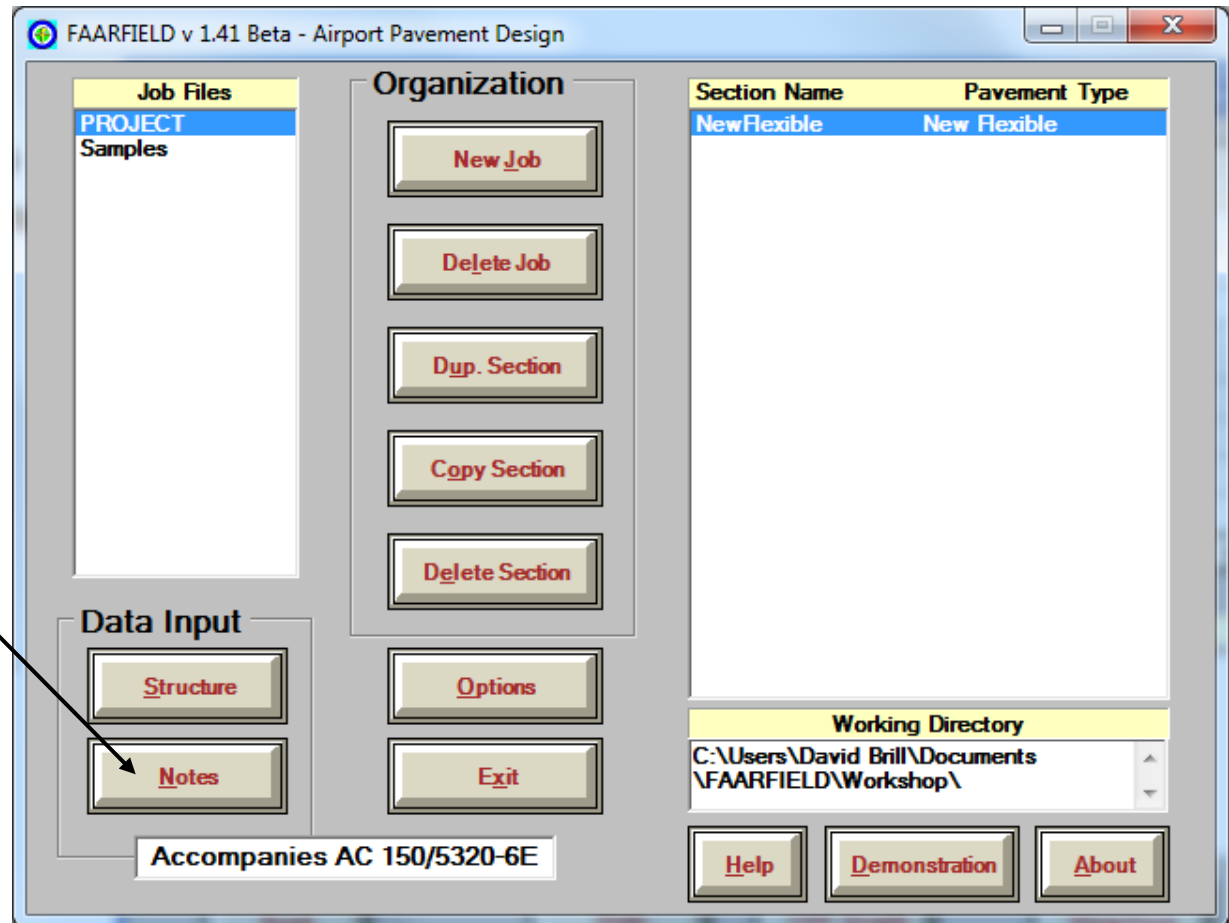
Library Airplanes

- B747-8F
- B747-SP
- B757-200
- B757-300
- B767-200
- B767-200 ER
- B767-300
- B767-300 ER
- B767-300 ER Freighter
- B767-400 ER
- B777-200 Baseline
- B777-200 ER
- B777-200 LR
- B777-300 Baseline
- B777-300 ER
- B777 Freighter (Preliminary)
- B787-8

Buttons: Add, Remove, Save List, Clear List, Save to Float, Add Float, Back, Help, CDF Graph, View Gear

Float Airplanes

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.

FAARFIELD v 1.41 Beta - Notes and Information for Job PROJECT

Section Names
NewFlexible

Design Information for Section NewFlexible

FAARFIELD v 1.41 Beta - Airport Pavement Design

Section NewFlexible in Job PROJECT.
Working directory is C:\Users\David Brill\Documents\FAARFIELD\Workshop\

The structure is New Flexible. Asphalt CDF was not computed.
Design Life = 20 years.
A design for this section was completed on 08/27/14 at 10:42:04.

Pavement Structure Information by Layer, Top First

No.	Type	Thickness mm	Modulus MPa	Poisson's Ratio	Strength R, MPa
1	P-401/ P-403 HMA Surface	100.0	1,378.95	0.35	0.00
2	P-401/ P-403 St (flex)	127.0	2,757.90	0.35	0.00
3	P-209 Cr Ag	561.5	493.97	0.35	0.00
4	Subgrade	0.0	82.74	0.35	0.00

Total thickness to the top of the subgrade = 788.5 mm

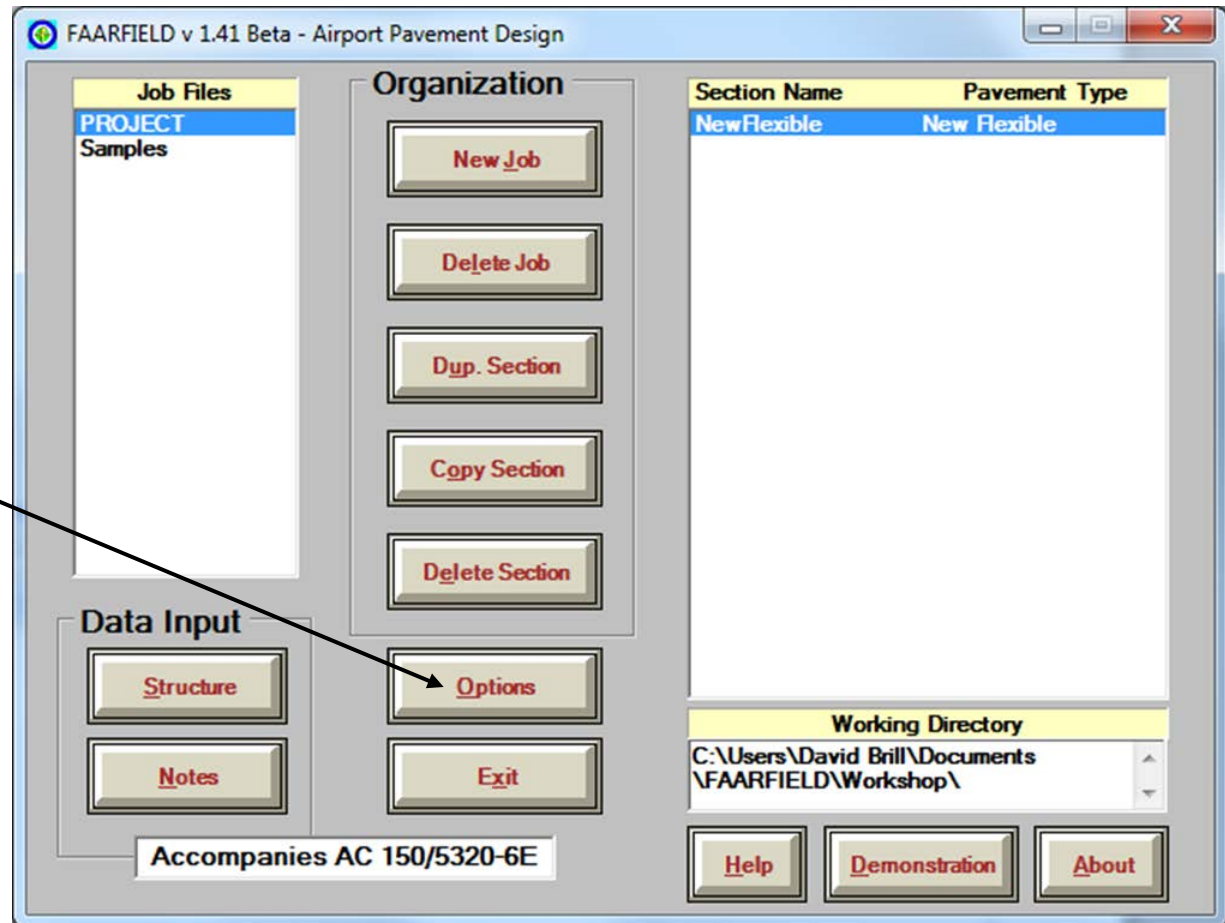
Airplane Information

	Gross Wt	Annual	% Annual

Help Back Save XML Save Print Design Info Notes Copy

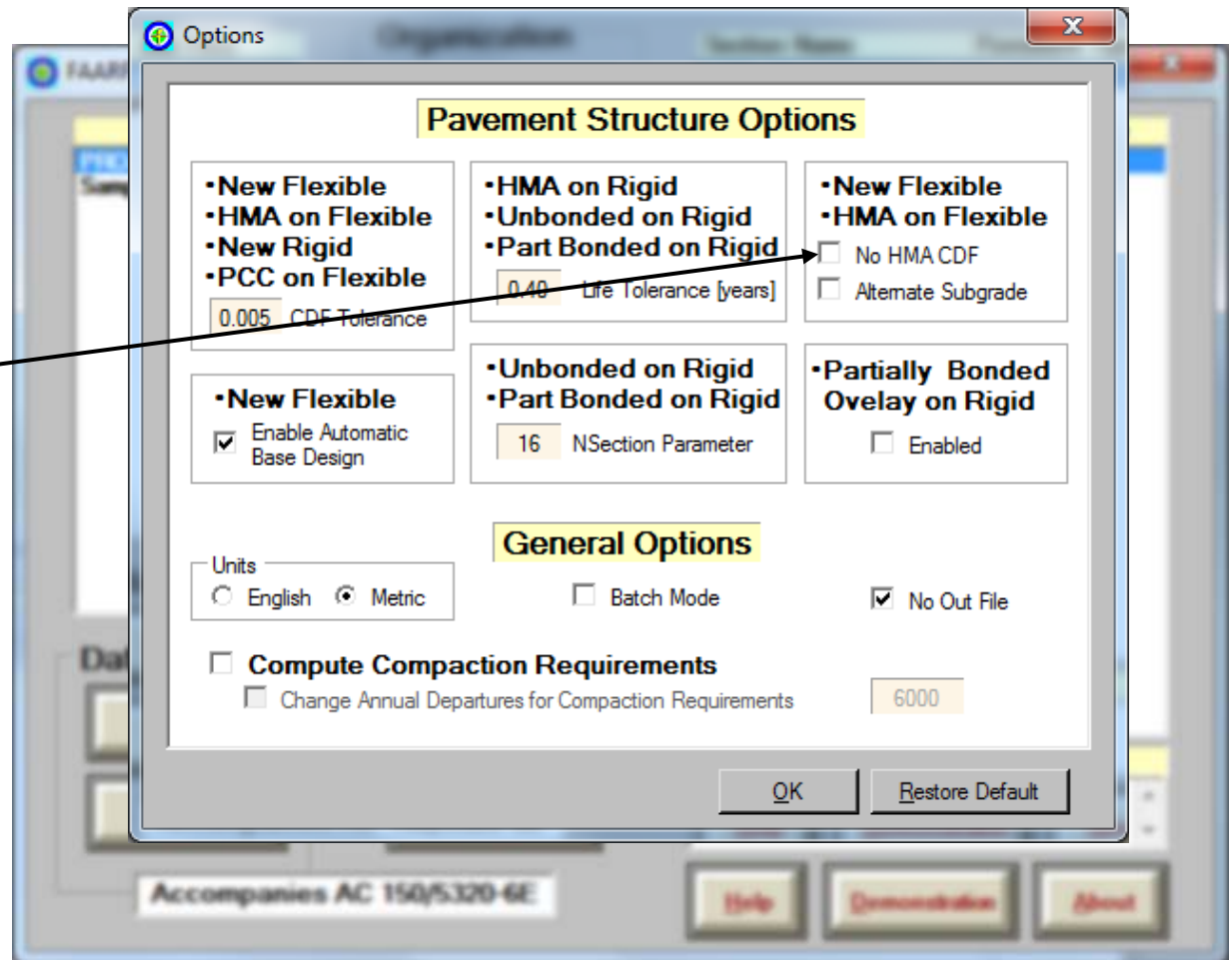
Fatigue in the HMA Layers

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.

FAARFIELD v 1.41 Beta - Modify and Design Section NewFlexible in Job PROJECT

Section Names
NewFlexible

PROJECT NewFlexible Des. Life = 20

Layer Material	Thickness (mm)	Modulus or R (MPa)
P-401/P-403 HMA Surface	100.0	1,378.95
P-401/P-403 St (flex)	127.0	2,757.90
→		
P-209 Cr Ag	561.5	493.97
Subgrade CBR = 8.0 82.74		

Design Stopped 7.10; 4.62

→ N=0; HMA CDF = 0.08; Sublayers: Subgrade CDF = 1.00; t = 788.5 mm

Airplane

Back Help Life Modify Structure Design Structure Save Structure

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).

FAARFIELD v 1.41 Beta - Notes and Information for Job PROJECT

Section Names

NewFlexible

Design Information for Section NewFlexible

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

P-401/P-403 St (flex) CDF

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

Help

Back

Save XML

Save

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Design Info

Notes

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Thank You! ¡Muchas Gracias!

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