FAA Pavement Design

Rigid Pavement FAARFIELD Design Example

Presented to: FAA Southwestern Region
2008 Partnership Conference

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Airport Engineering Division

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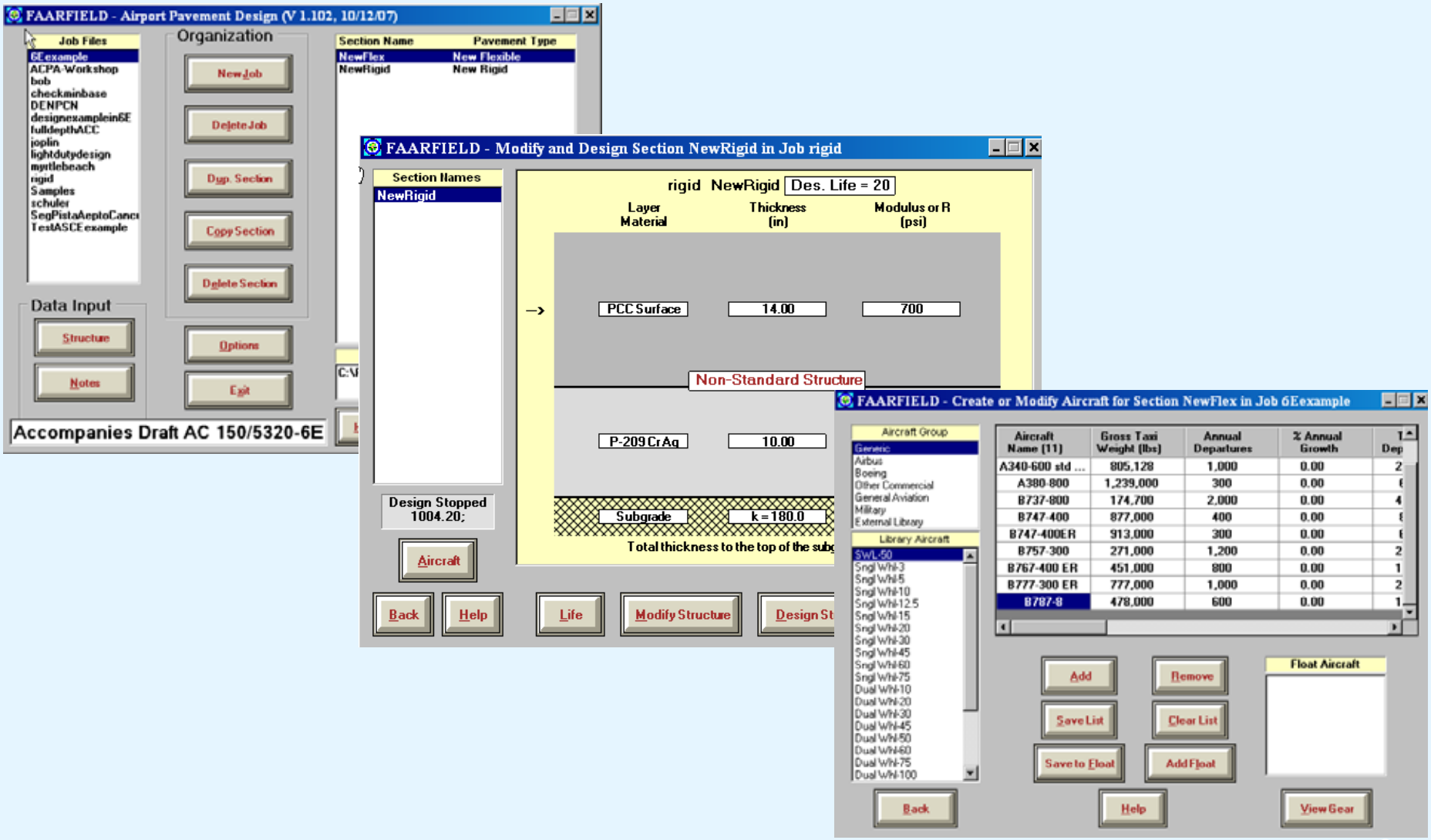
Federal Aviation Administration

FAARFIELD Rigid Pavement Design



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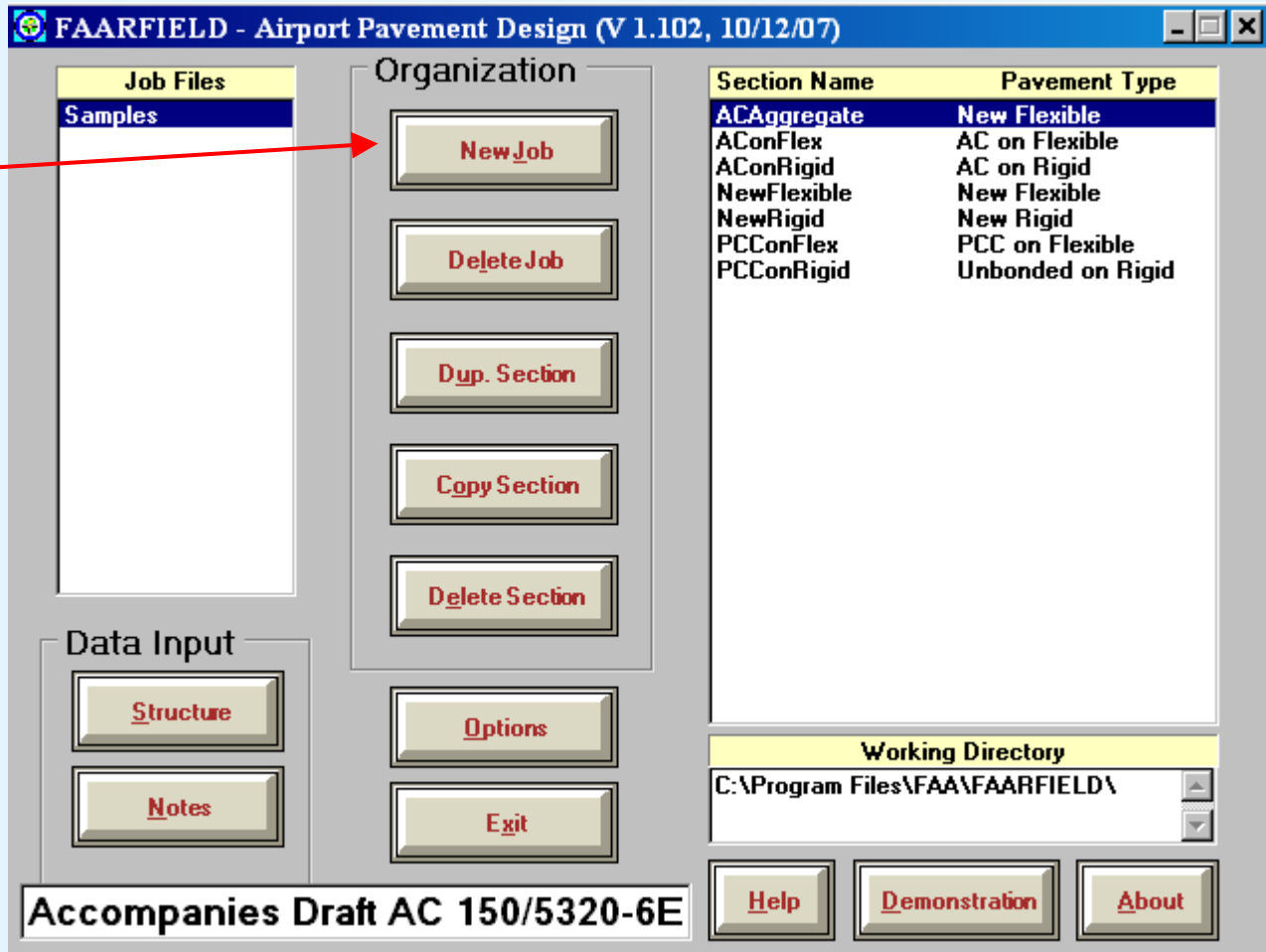
Starting Screen – No Job Files Created

Click on “New Job”



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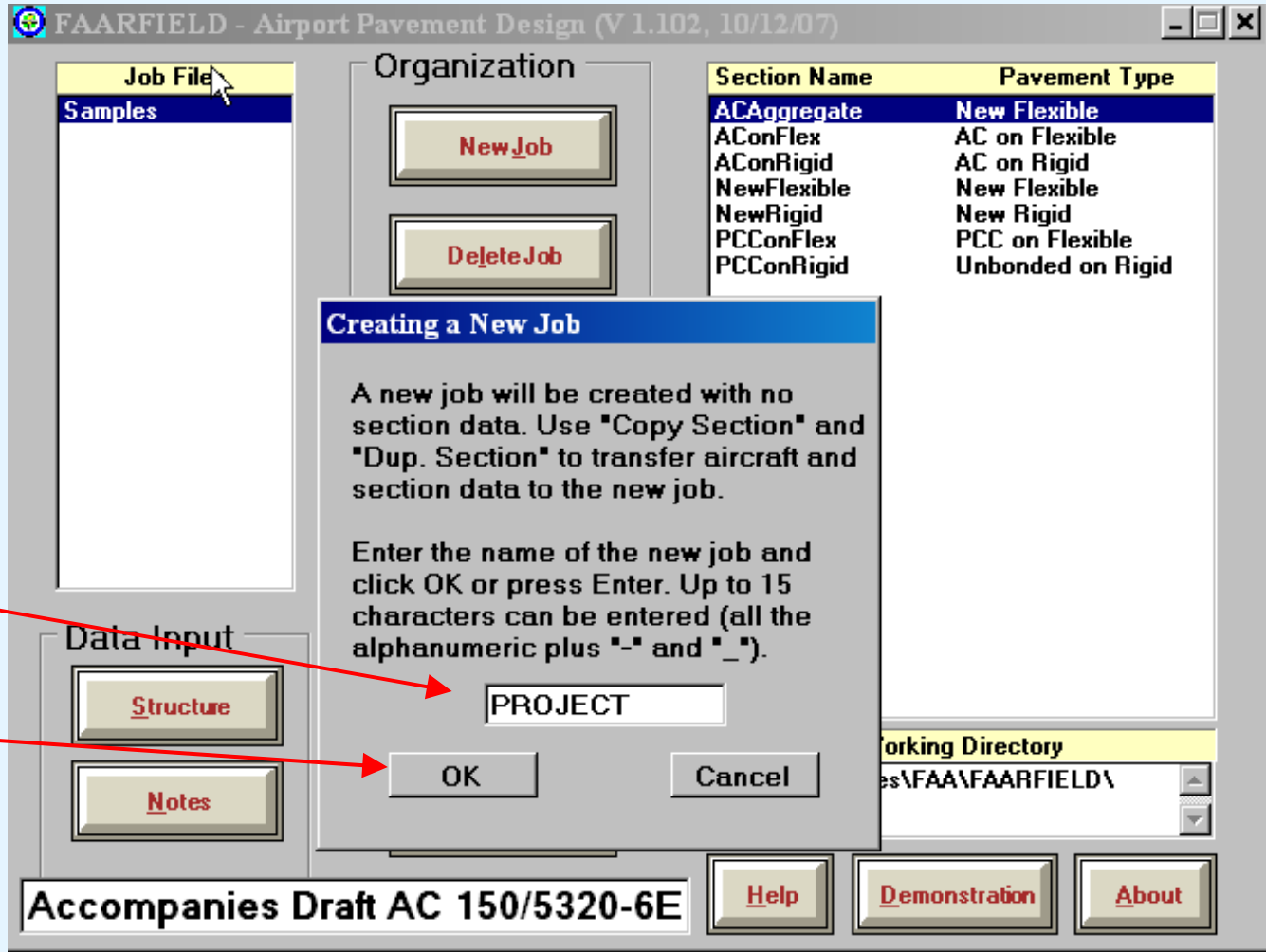
Creating / Naming a Job File



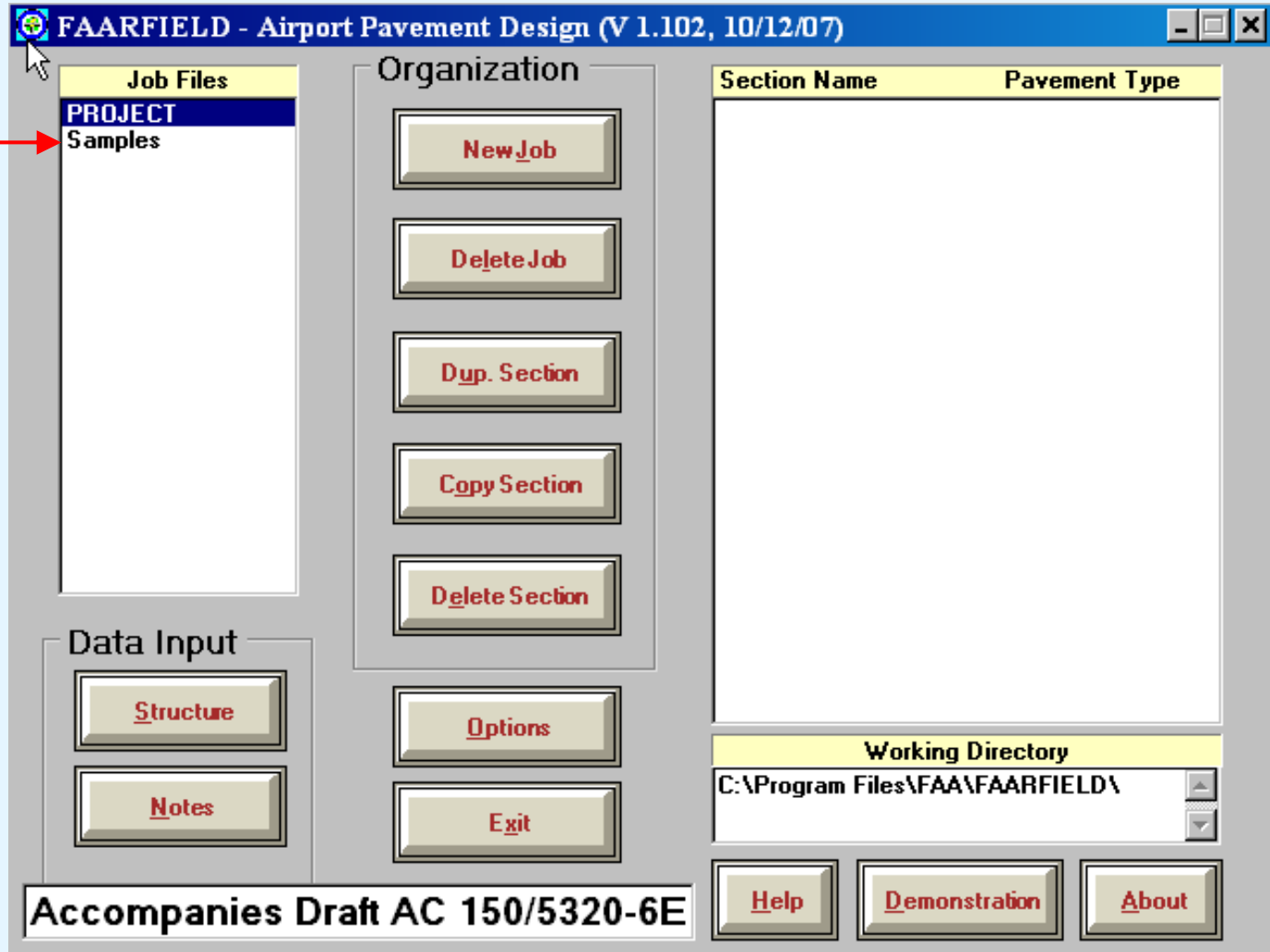
Enter Job Title

Click OK

FAARFIELD Rigid Pavement Design

Copy Basic Section/Pavement Type From Samples

Click on “samples”

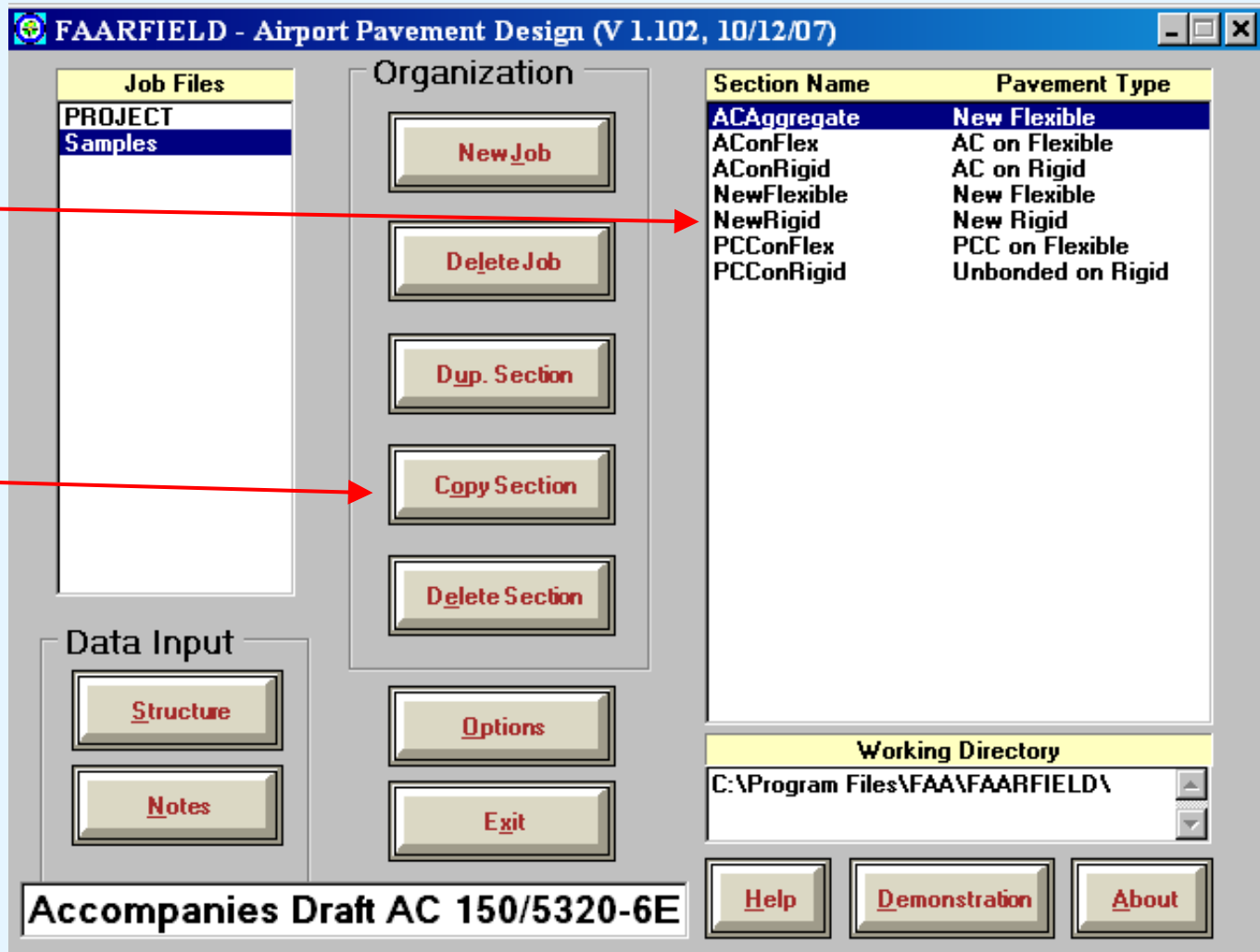


FAARFIELD Rigid Pavement Design

Copy Basic Section/Pavement Type From Samples

Default Basic Pavement Sections

Click on "Copy Section"



FAARFIELD Rigid Pavement Design

7 Basic Starting Structures in FAARFIELD

Section Name	Pavement Type
ACAggregate	New flexible on Aggregate base
AConFlex	Asphalt overlay on Flexible pavement
AConRigid	Asphalt overlay on Rigid pavement
NewFlexible	New Flexible on stabilized base
NewRigid	New Rigid on stabilized base
PCConFlex	PCC overlay on flexible
PCConRigid	Unbonded PCC on rigid

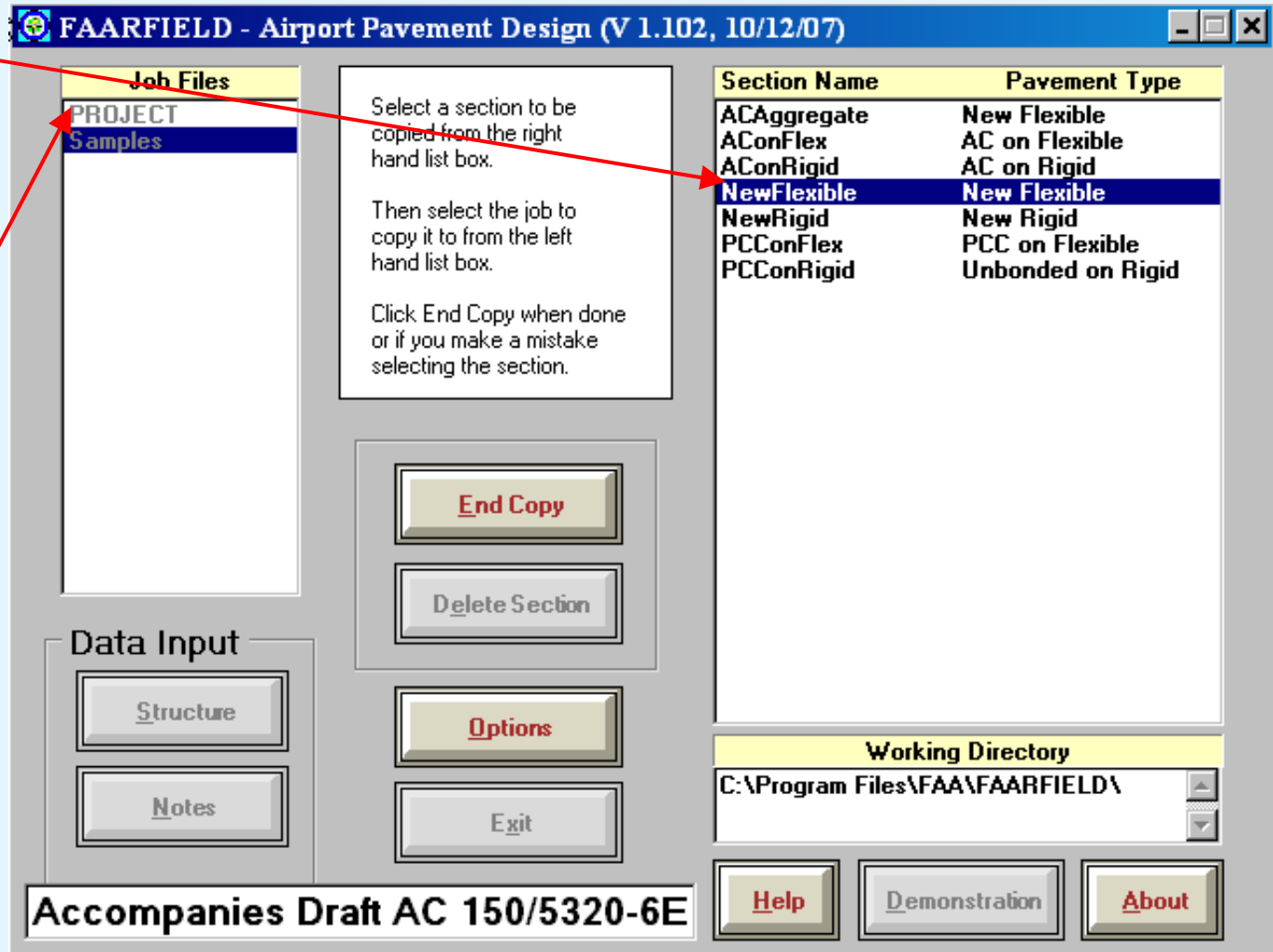
Be sure to select the pavement type that most correctly represents your pavement needs

FAARFIELD Rigid Pavement Design

Copy a Typical Pavement Section

Click on desired pavement section

Then click on the project where the section will be saved



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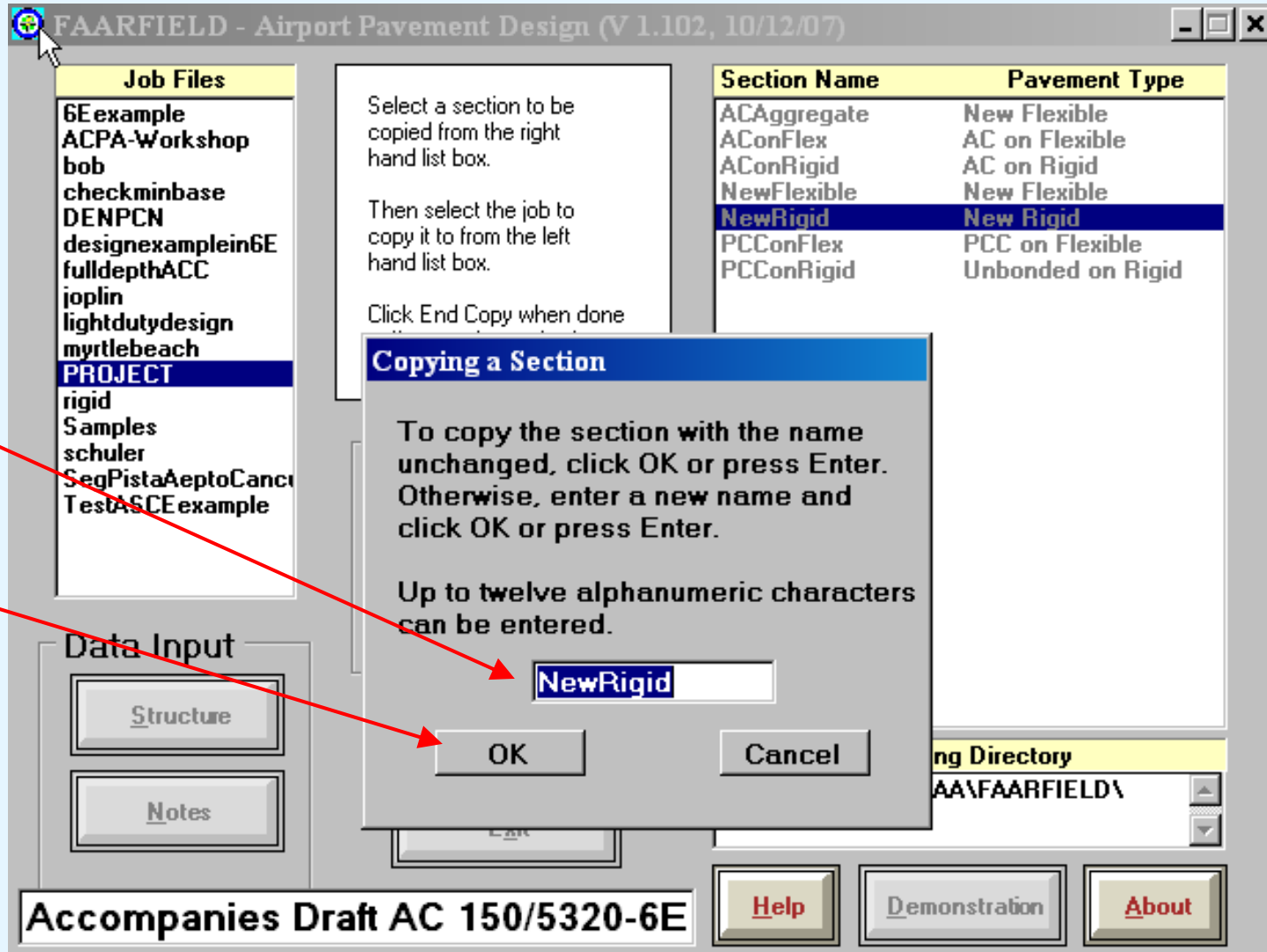
Create a New Job Title

Enter Section Title

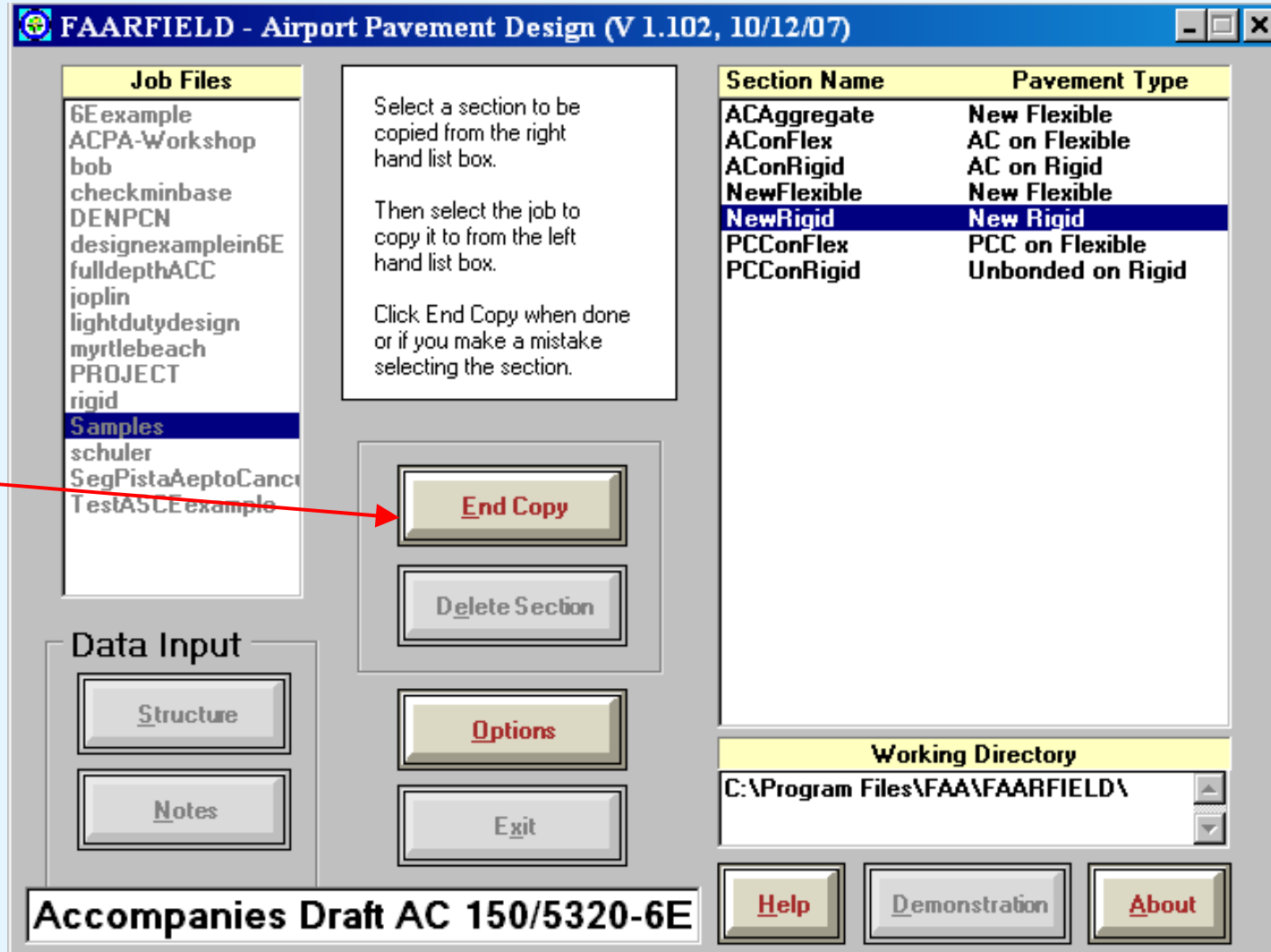
Click OK



FAARFIELD Rigid Pavement Design

Create a New Job Title

Click “End Copy”

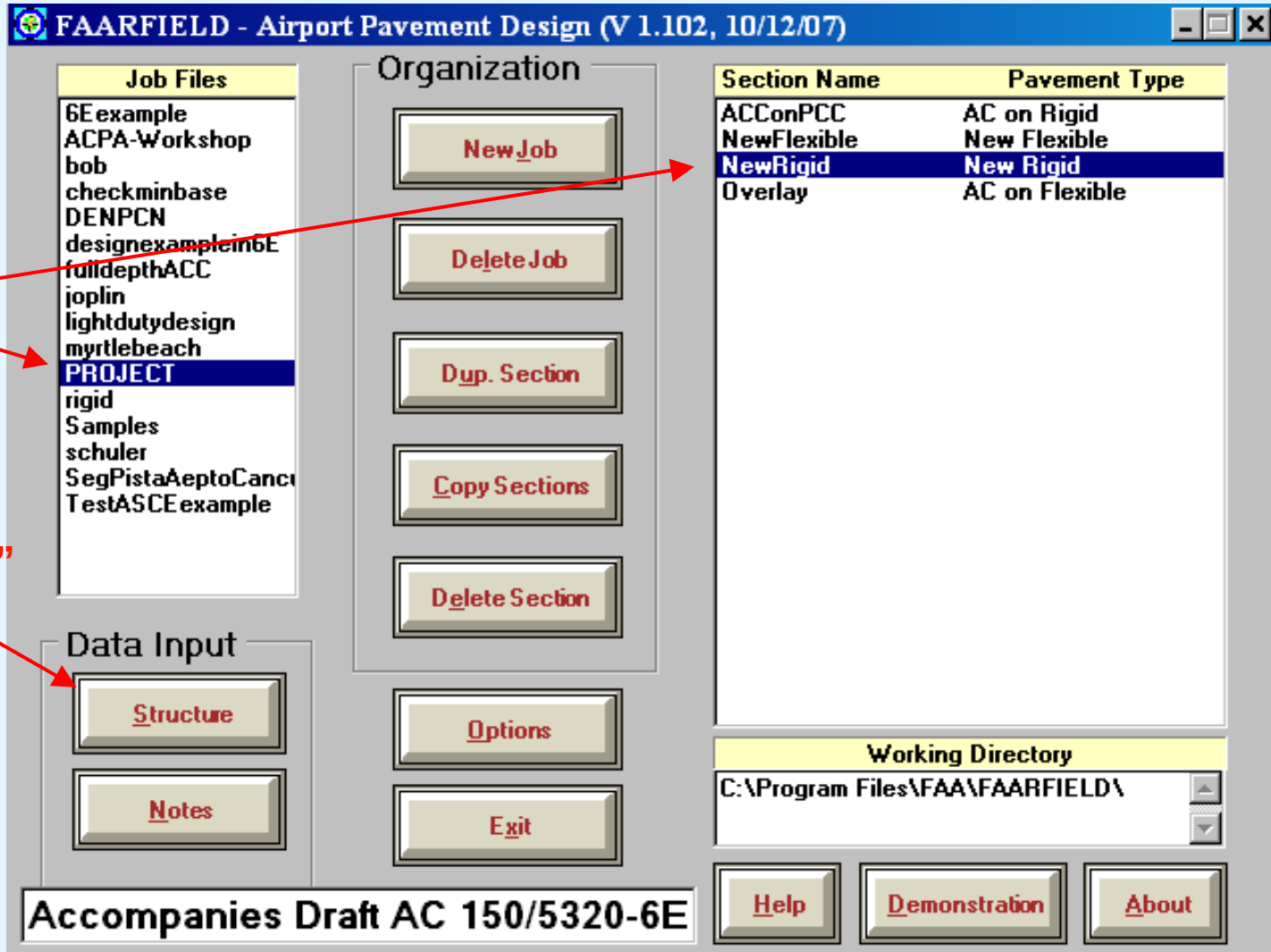


FAARFIELD Rigid Pavement Design

Working with a Design Structure

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

Click on “Structure” To open the file

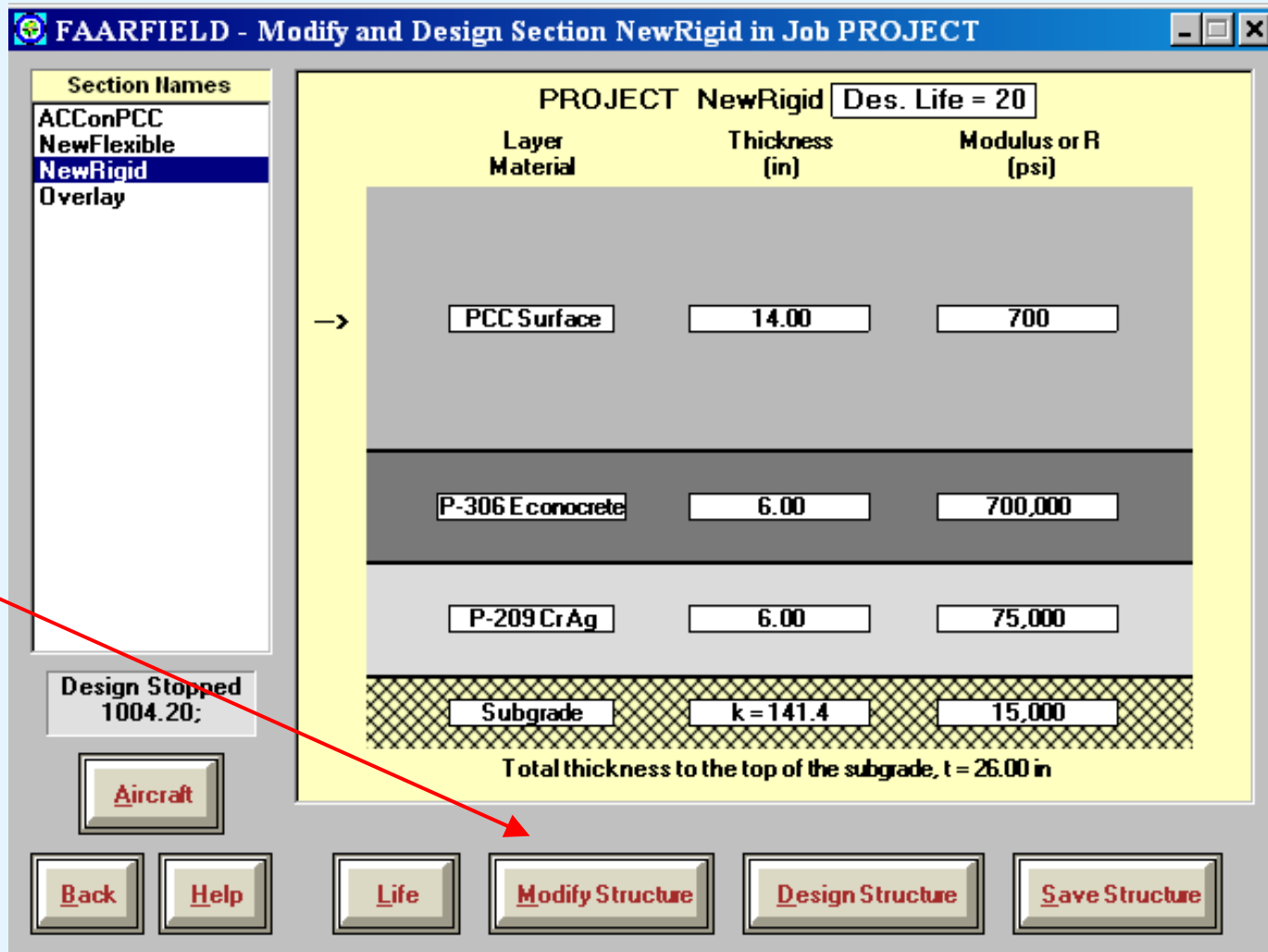


FAARFIELD Rigid Pavement Design

Working with a Pavement Section

The selected sample pavement will appear

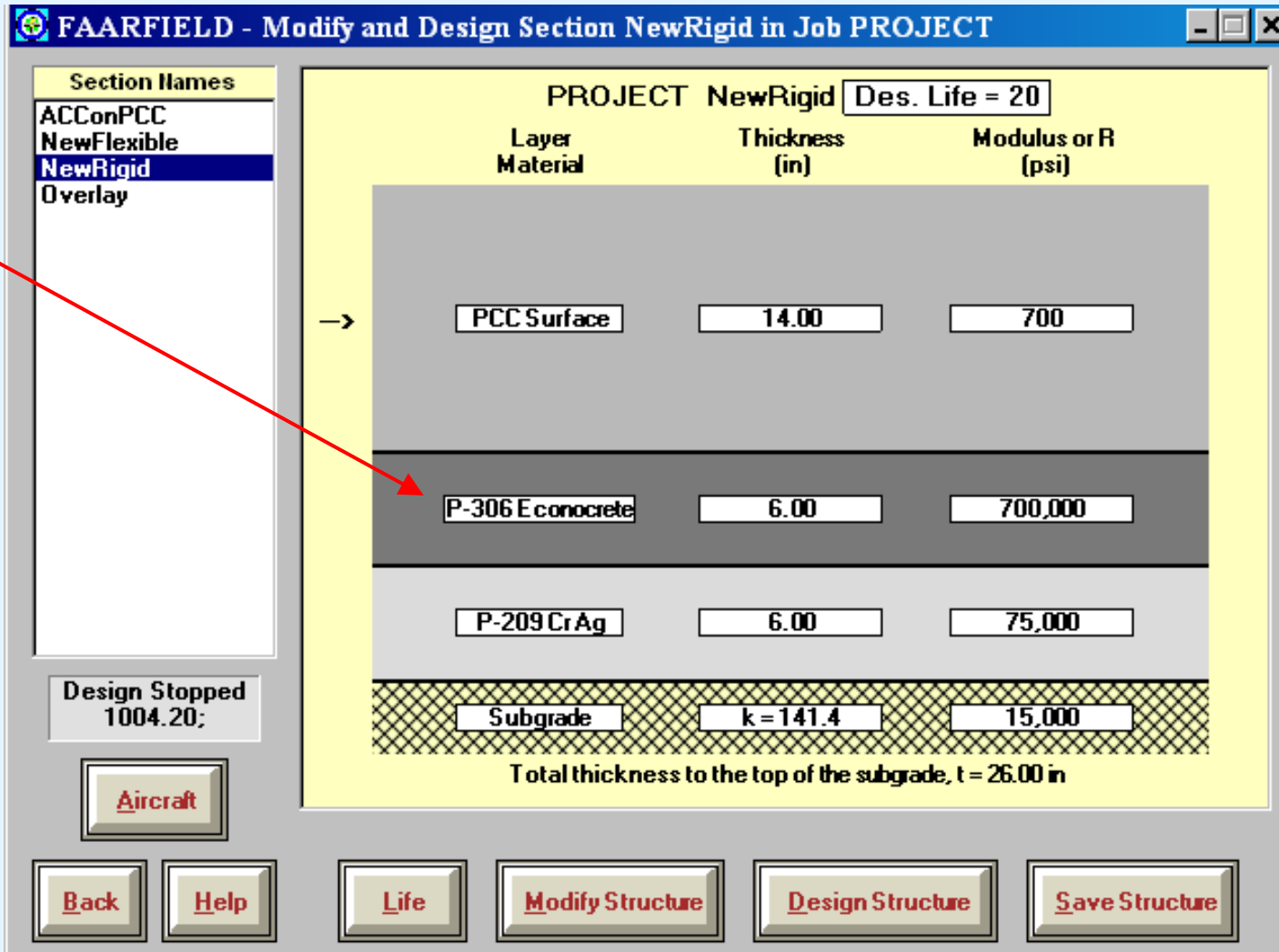
The structure may be modified if desired



FAARFIELD Rigid Pavement Design

Modifying a Pavement Section

Click on the box around the layer material you want to modify



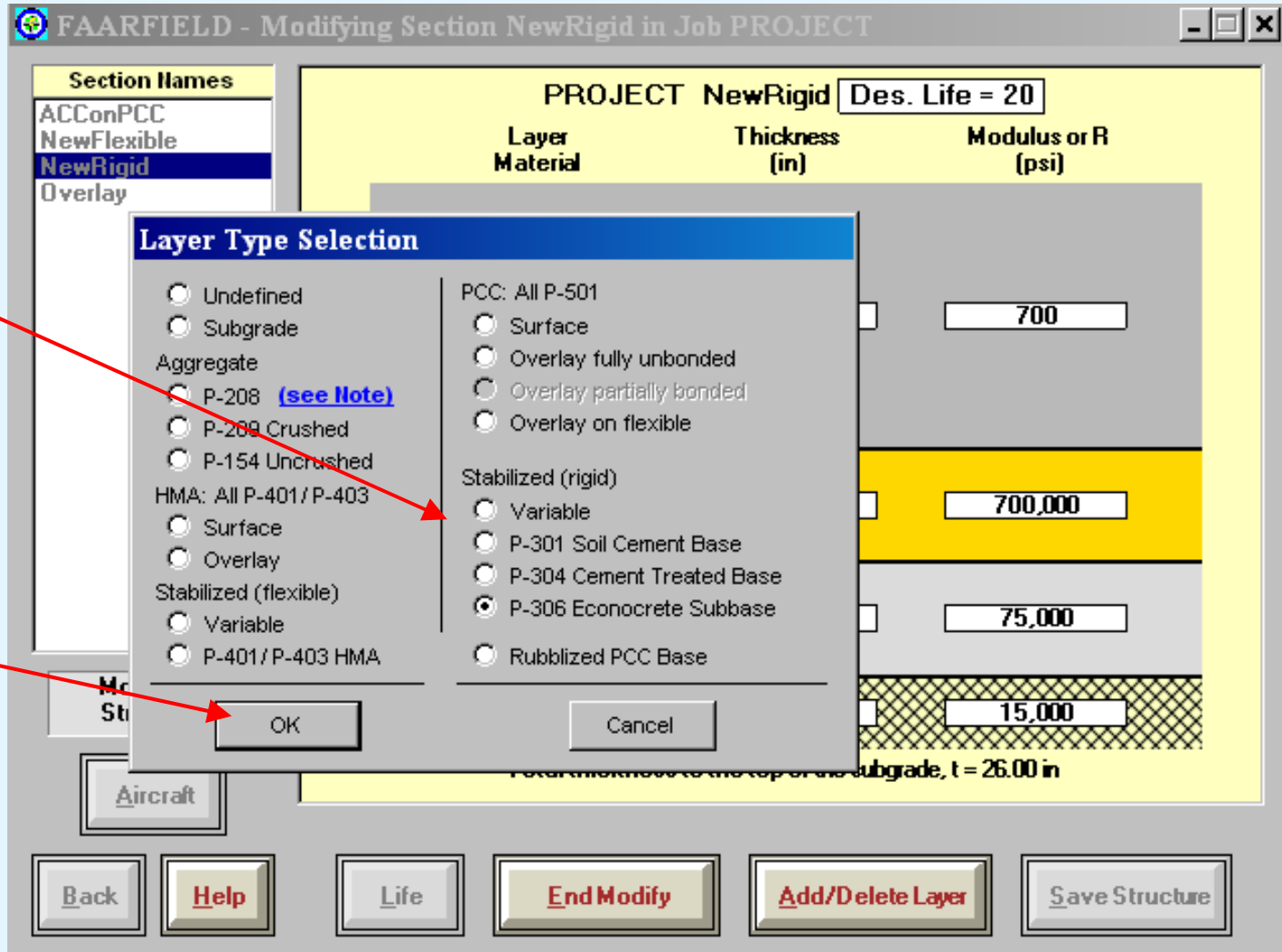
FAARFIELD Rigid Pavement Design

Modifying a Pavement Section

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

No modification required for this example

Click OK



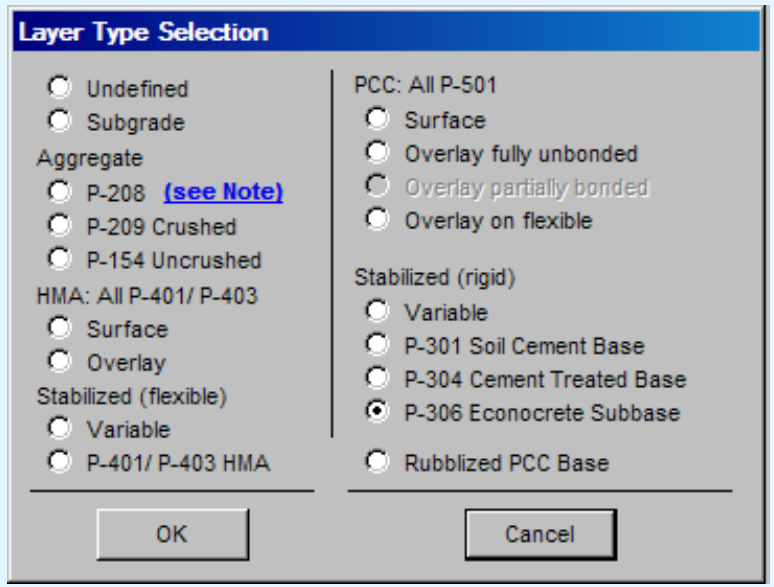
FAARFIELD Rigid Pavement Design

Limitations for Pavement Layers

The types of layers that may be used in FAARFIELD are limited to those shown.

Placement of layers may also be limited e.g. you couldn't put a P-501 surface layer at the bottom of a structure

The "Undefined" and "Variable" stabilized layers allow some customization of layers



FAARFIELD Rigid Pavement Design

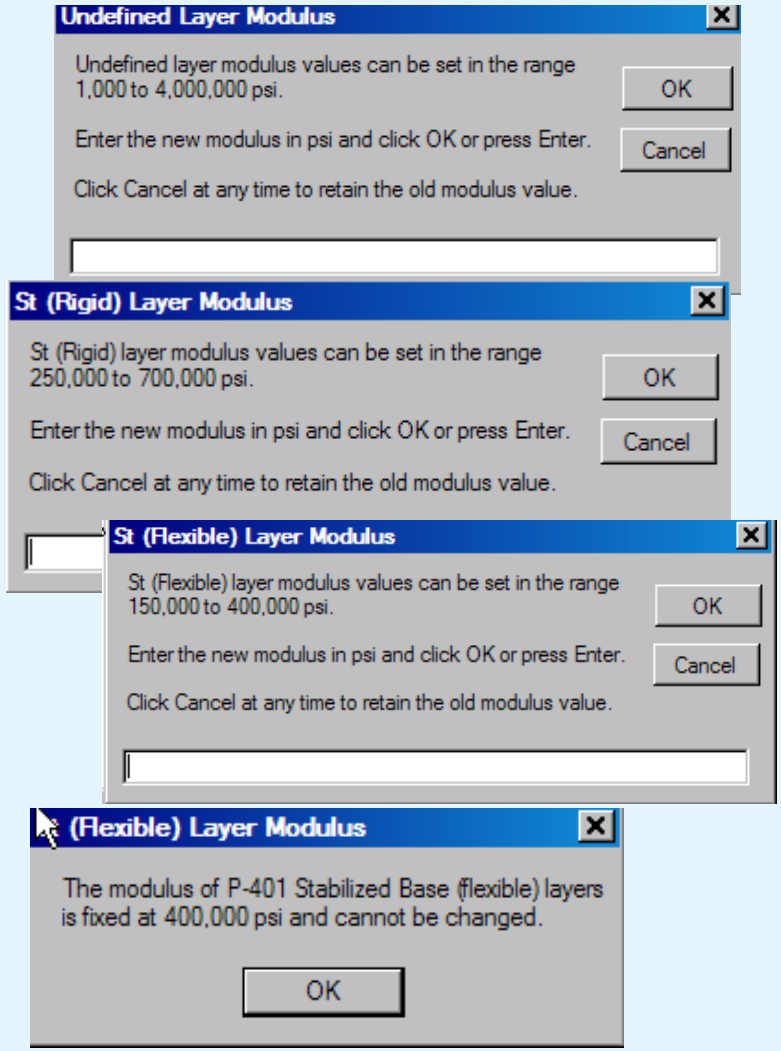
Undefined and Variable Pavement Layers

The “undefined” layer allows the modulus to range from 1,000 to 4,000,000 psi

The “Variable” (rigid) stabilized layer allows the modulus to range from 250,000 to 700,000

The “Variable” (flexible) stabilized layer allows the modulus to range from 150,000 to 400,000 psi

The “P-401 Asphalt” stabilized layer has a fixed modulus of 400,000 psi

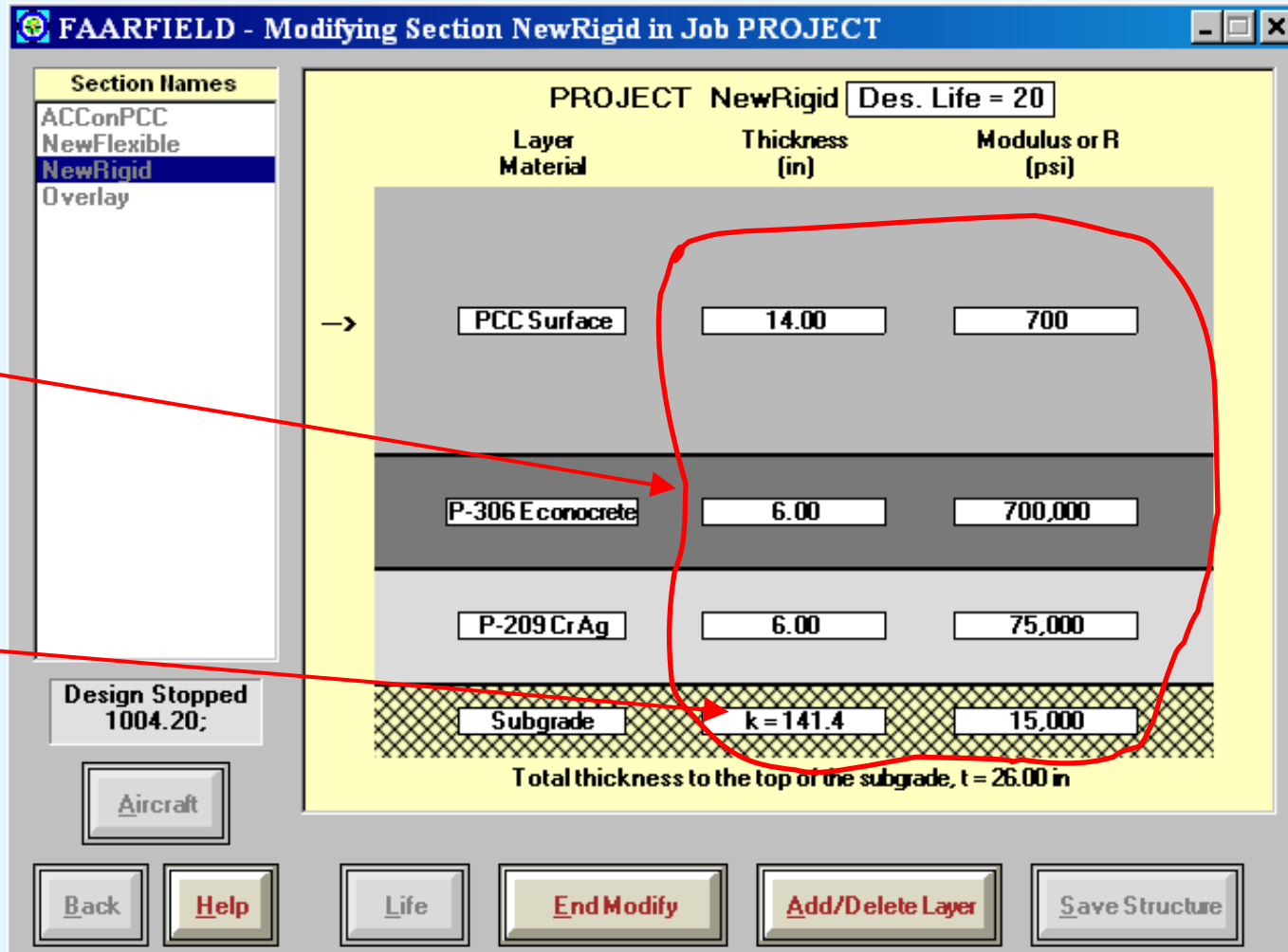


FAARFIELD Rigid Pavement Design

Modifying a Pavement Section

Click on a property to modify any of the layer properties

Confirm the subgrade k-value for this example



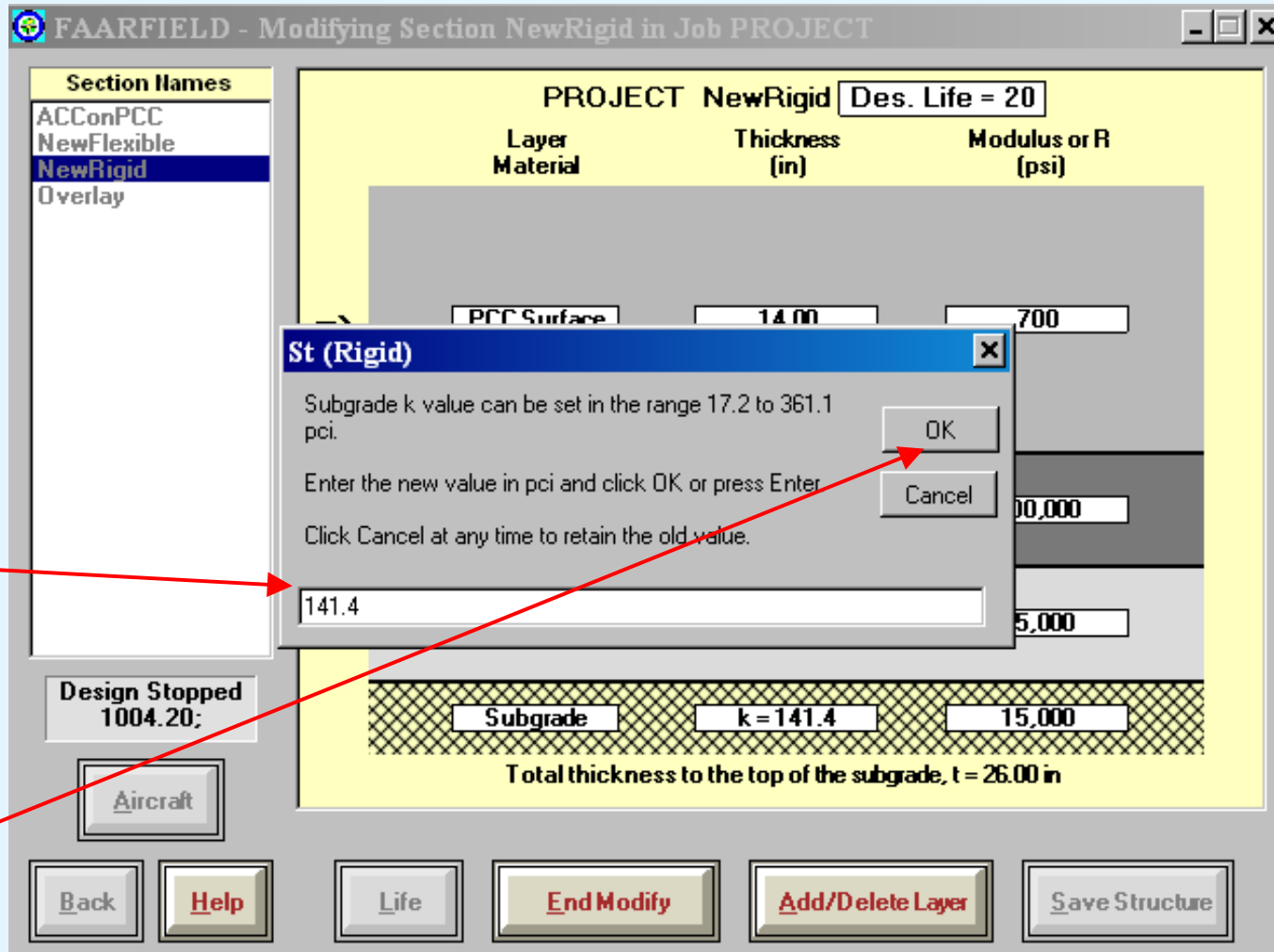
FAARFIELD Rigid Pavement Design

Modifying a Pavement Section

Enter the new value for the material property
***** some materials will have limits on property values***

use 141.4 for this example

Click OK



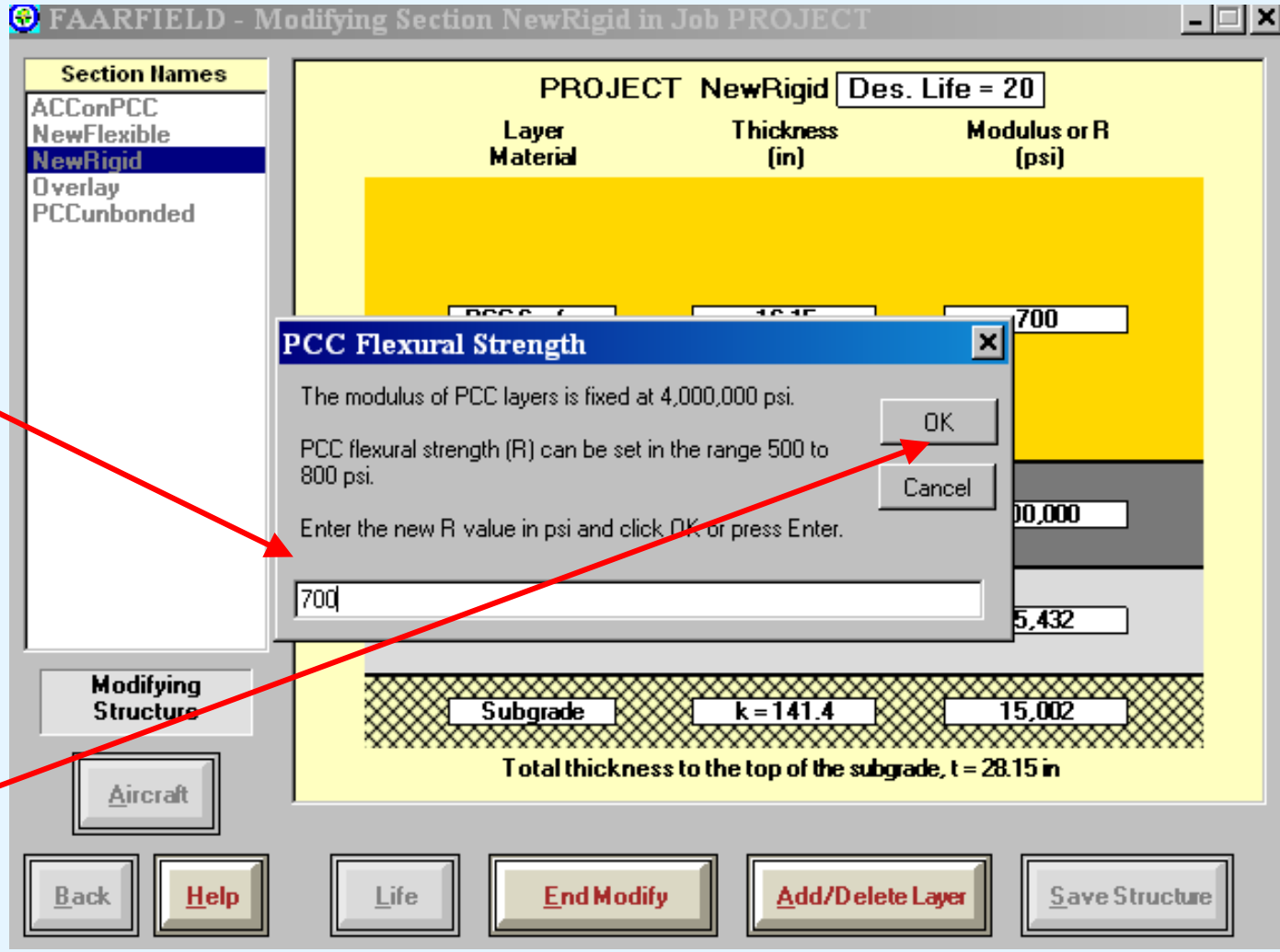
FAARFIELD Rigid Pavement Design

Modifying a Pavement Section

Note: PCC strength range 500 – 800 psi

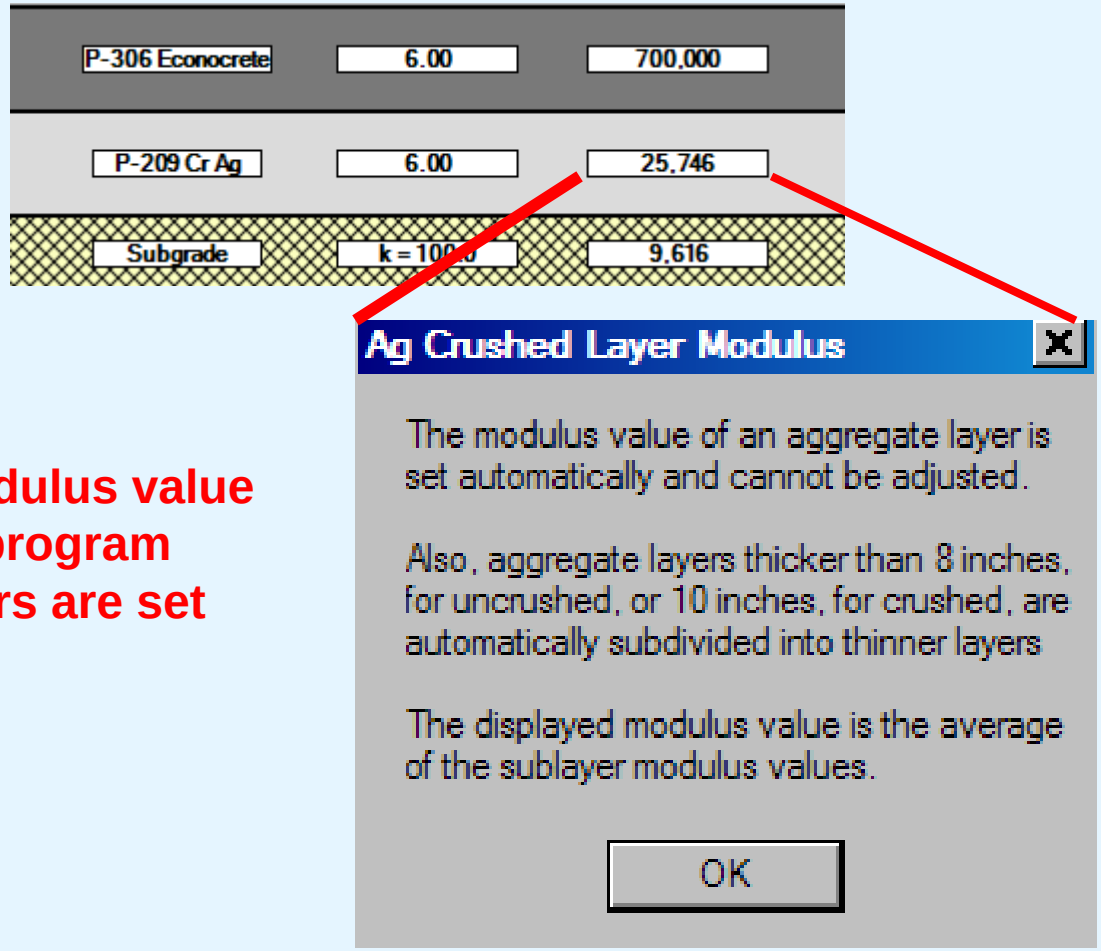
Enter the desired flexural strength

Click “OK”



FAARFIELD Rigid Pavement Design

Using FAARFIELD – Layer Properties



Note:

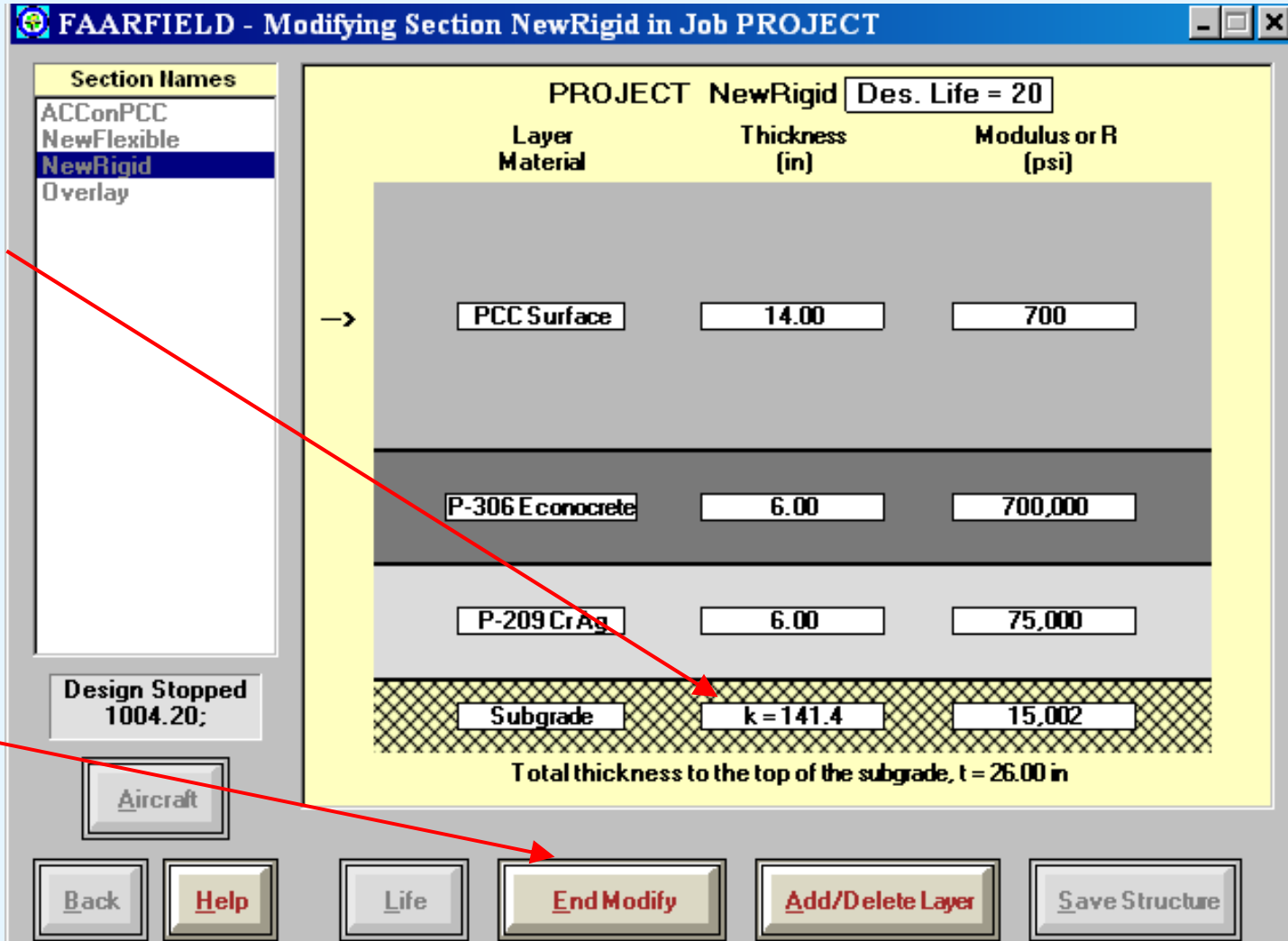
If you try to change the modulus value for an aggregate layer the program notifies you that these layers are set automatically.

FAARFIELD Rigid Pavement Design

Modifying a Pavement Section

New values appear in the structure window

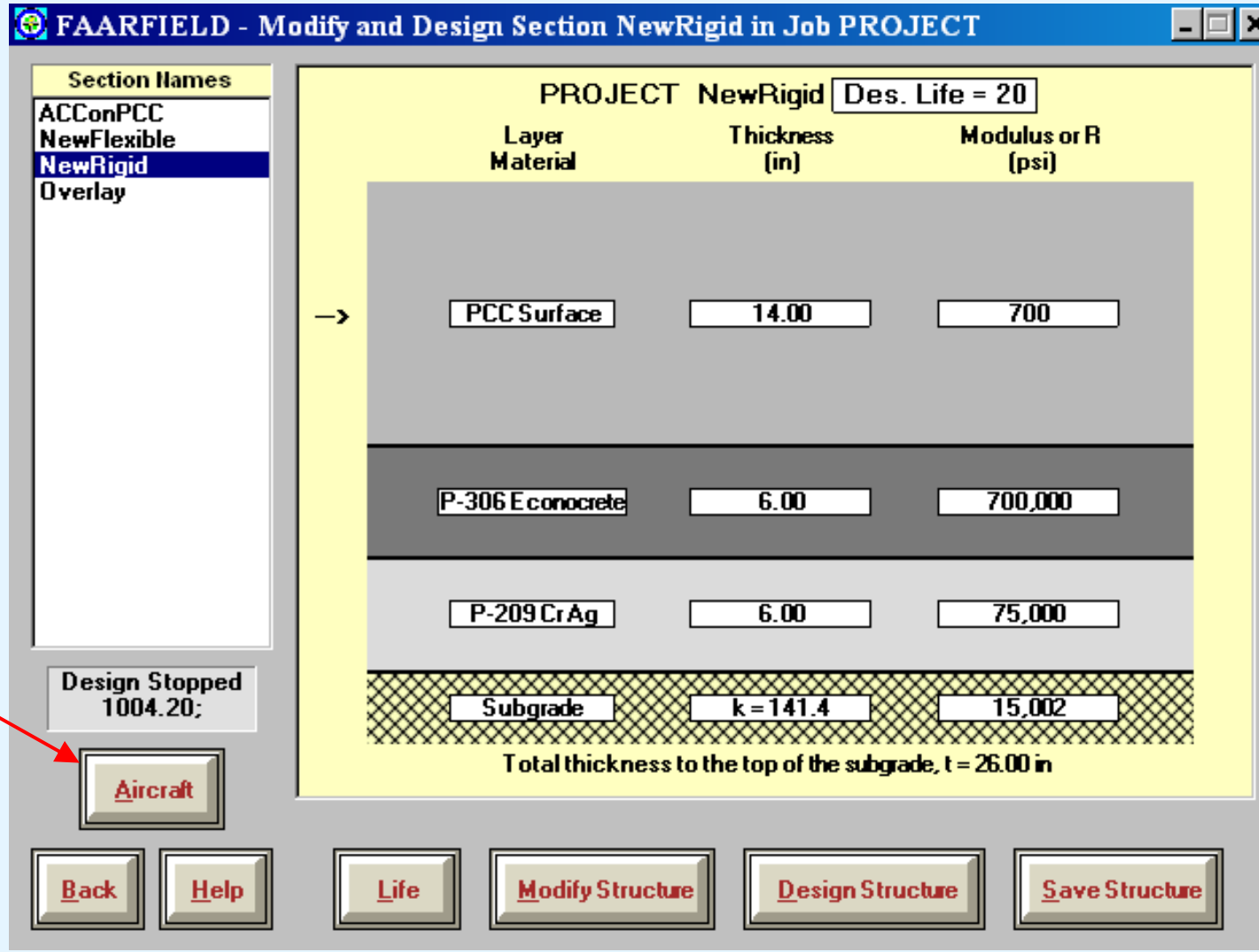
Click End Modify



FAARFIELD Rigid Pavement Design

Enter Traffic Mixture

Click on “Aircraft”
To enter traffic mix

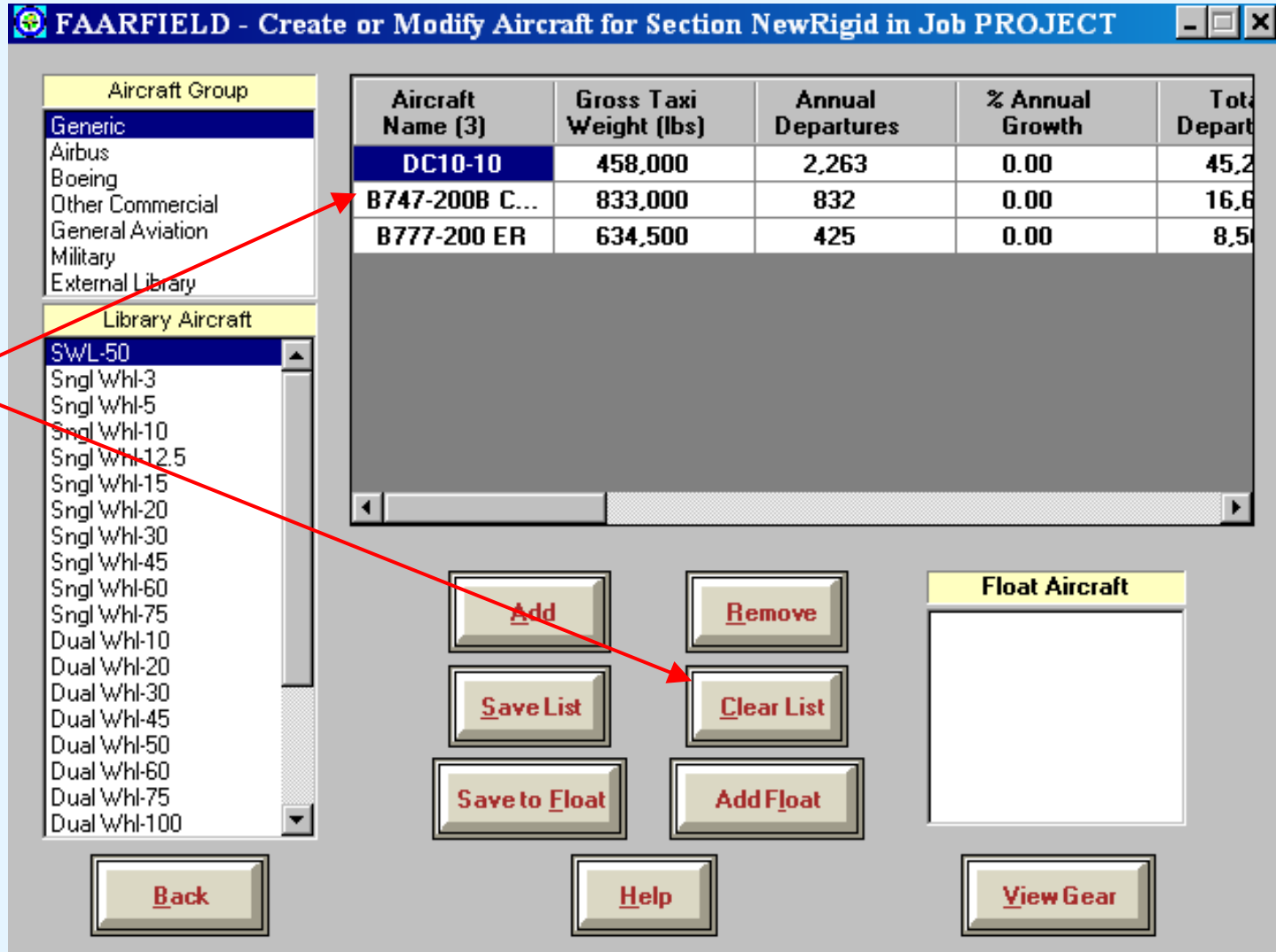


FAARFIELD Rigid Pavement Design

Enter Traffic Mixture

You may want to clear any existing aircraft

f



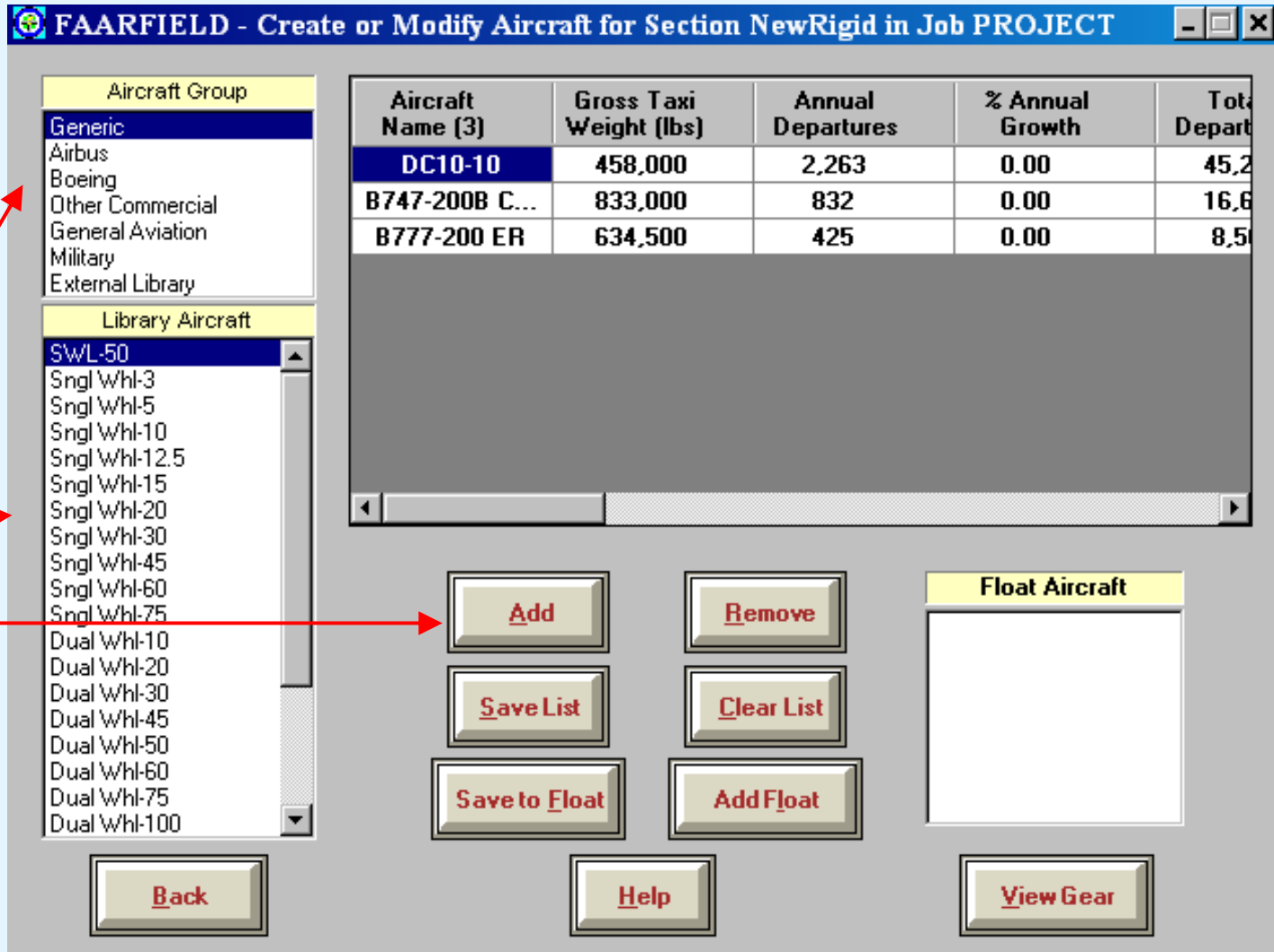
FAARFIELD Rigid Pavement Design

Enter Traffic Mixture

Click on the aircraft group desired.

Then select the desired aircraft and click “Add”

Repeat for complete traffic mixture



FAARFIELD Rigid Pavement Design

Traffic Mix for this Example

Aircraft Name	Gross Taxi Weight, lb	Annual Departures	Annual Growth, %
Adv. B727-200 Option	210,000	1200	0.0
B747-400	877,000	800	0.0
B777-200 ER	657,000	1200	0.0

FAARFIELD Rigid Pavement Design

Enter Traffic Mixture

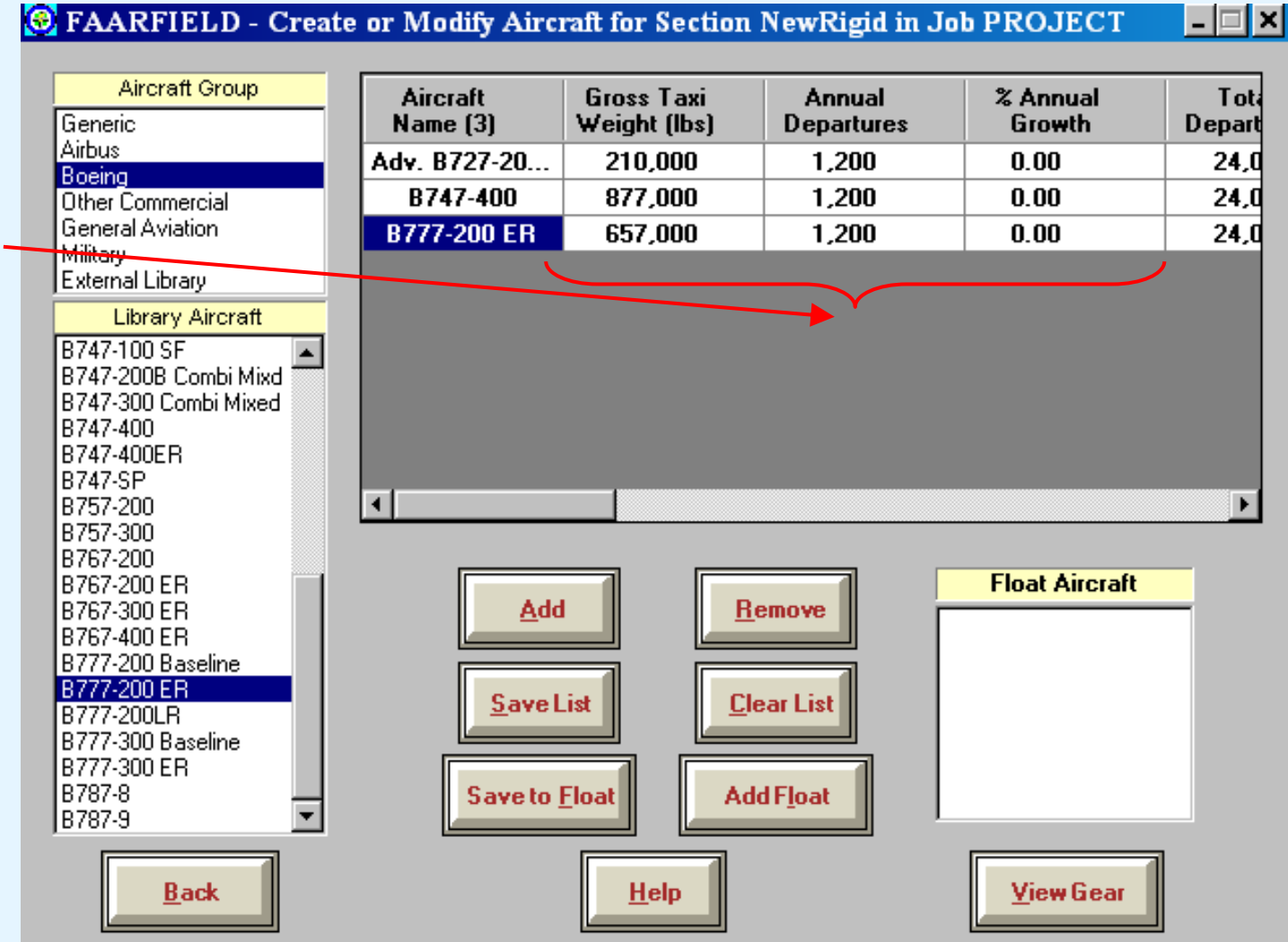
The user can modify:

Gross Weight

Annual Departures

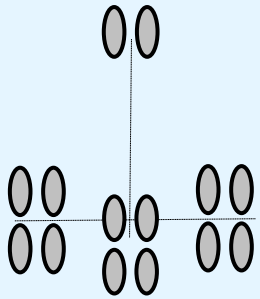
% Annual Growth

Other necessary airplane information is stored internally and can not be modified



FAARFIELD Rigid Pavement Design

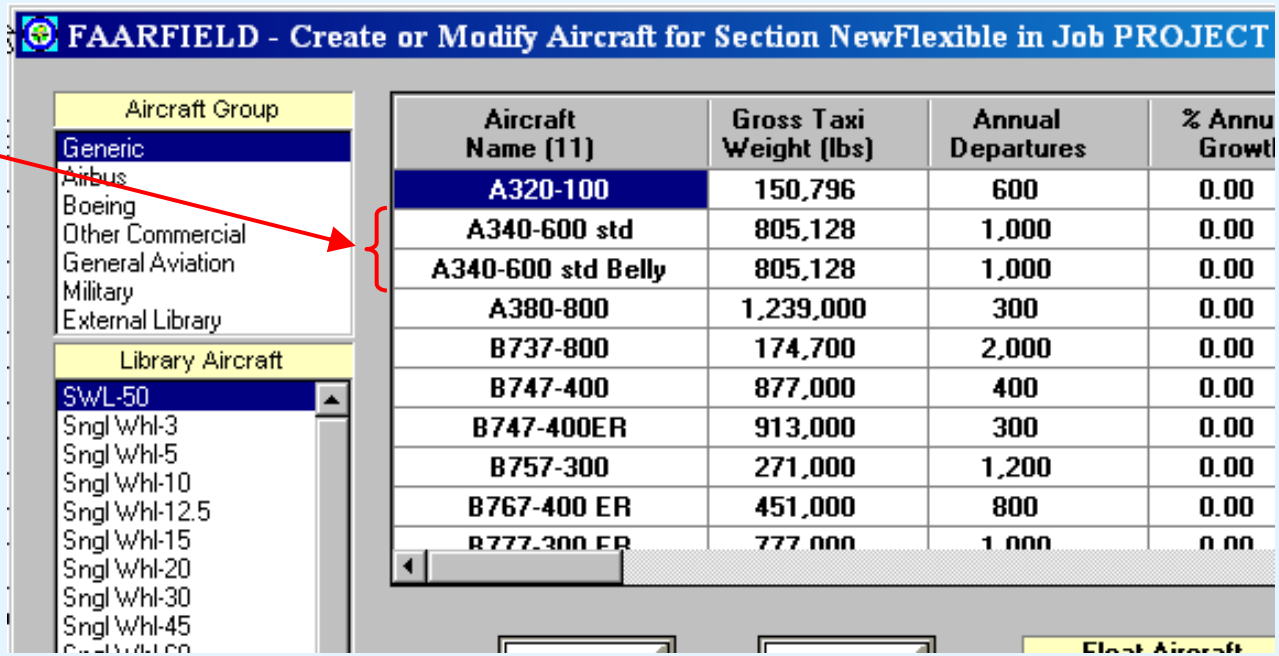
Enter Traffic Mixture



2D/2D1
A340-600

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

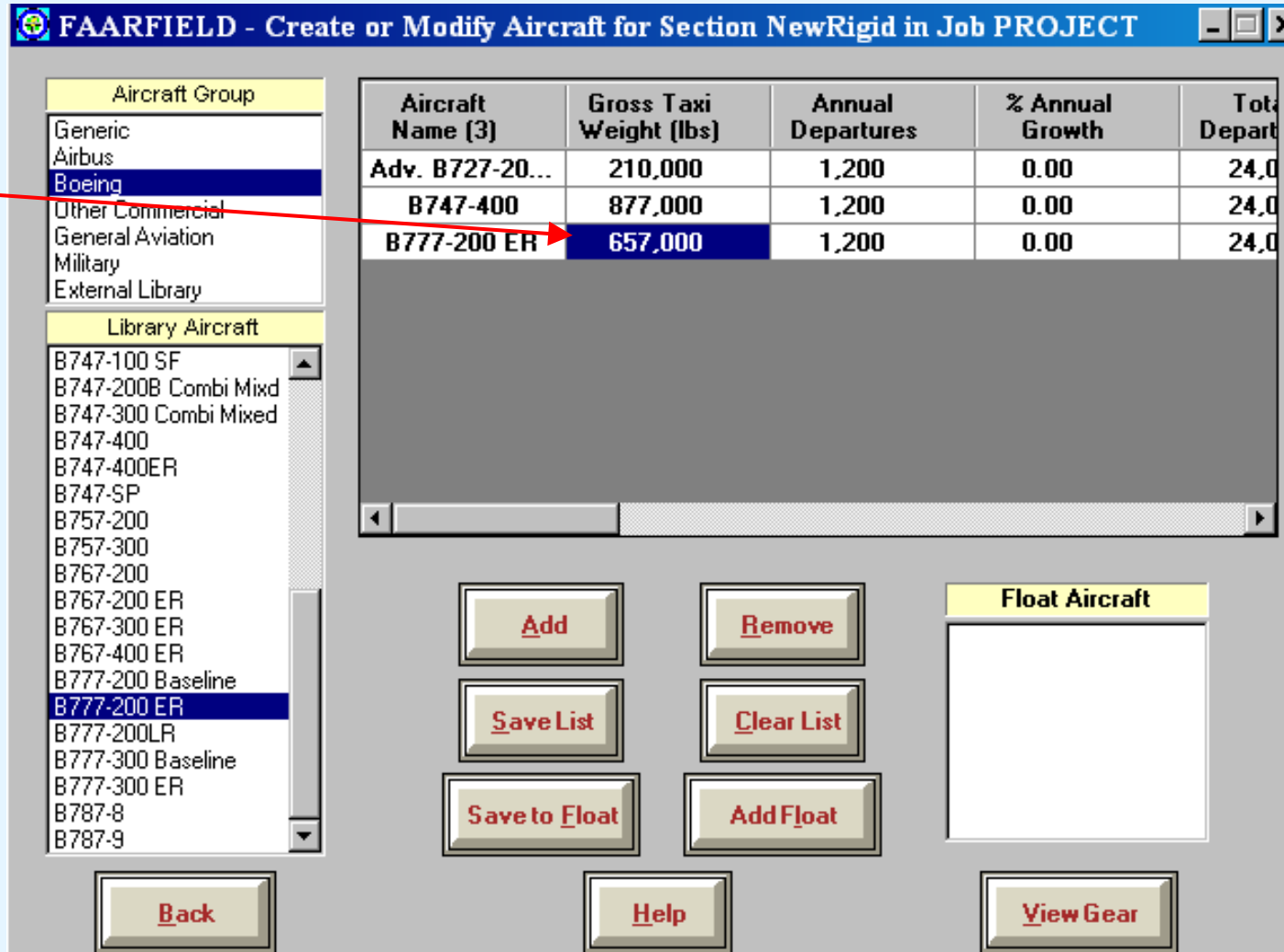
FAARFIELD treats these as two aircraft however the weight and departures are interlocked



FAARFIELD Rigid Pavement Design

Adjusting Aircraft Information – Gross Weight

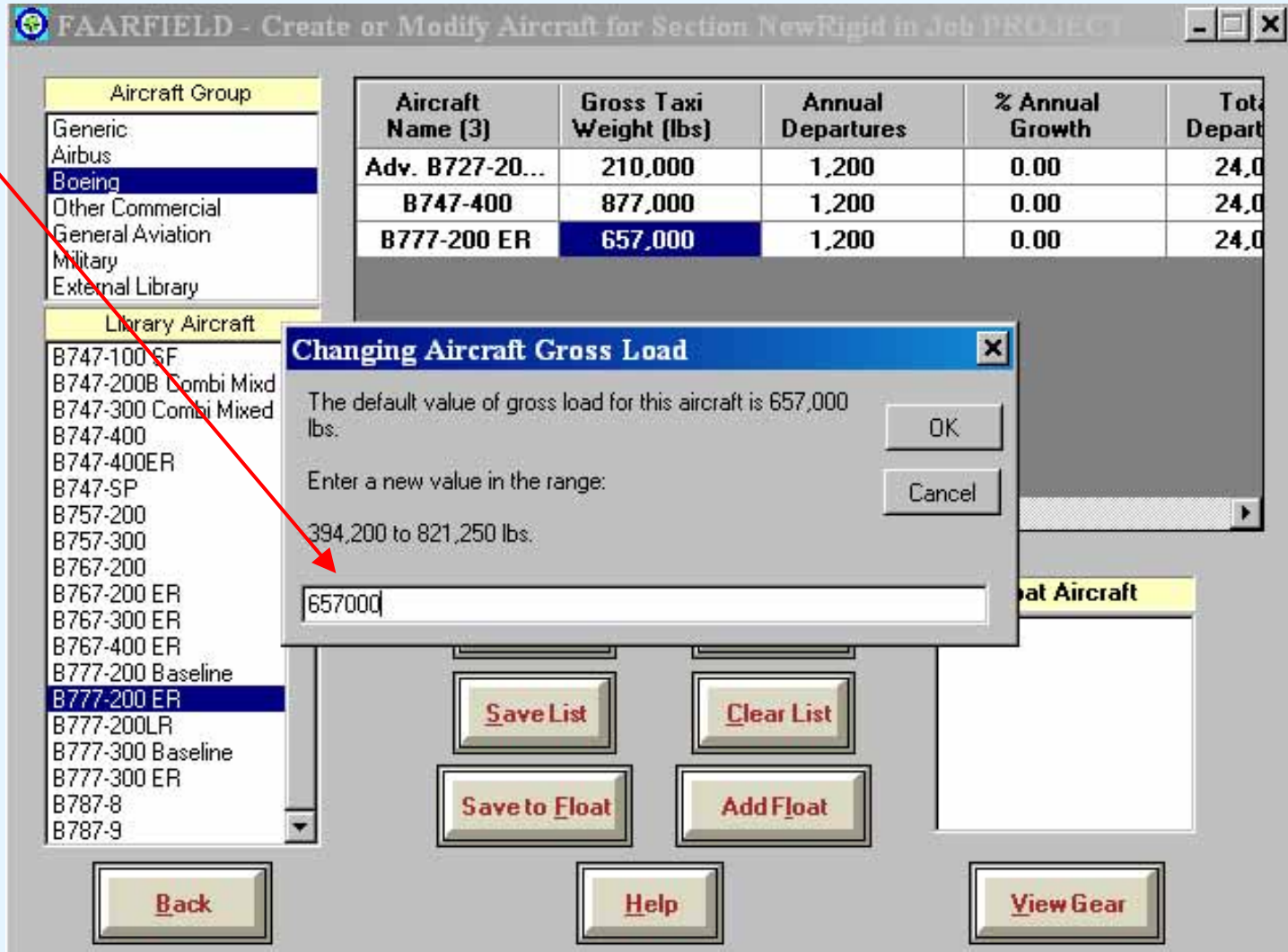
Click on the aircraft gross weight to change the weight



FAARFIELD Rigid Pavement Design

Adjusting Aircraft Information – Gross Weight

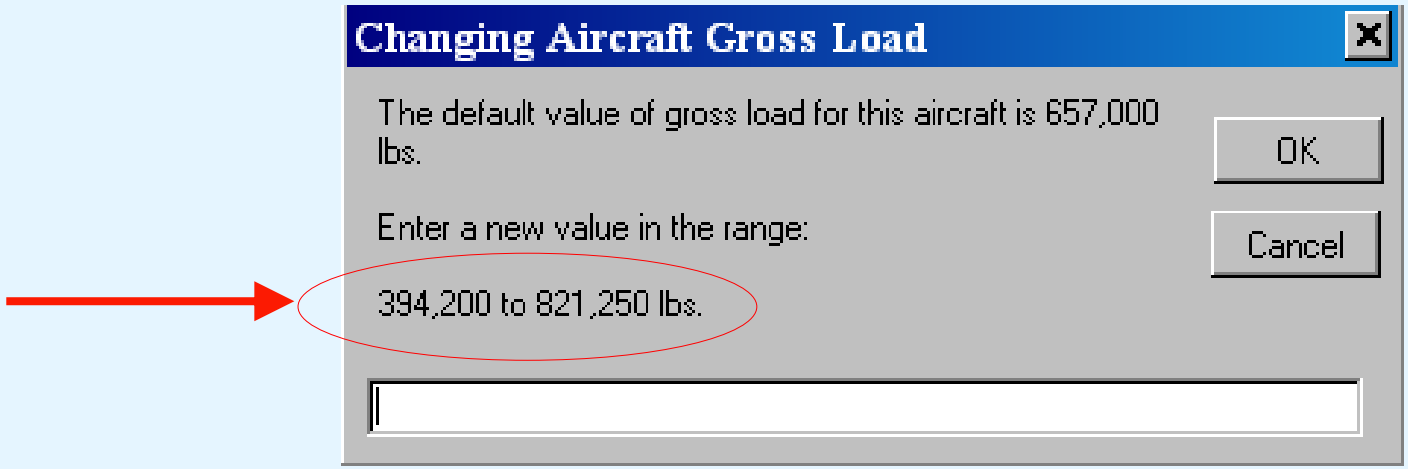
Enter the new weight and click OK



Airplane Information – Gross Weight Limitations

There are limitations on changes to aircraft gross weights.

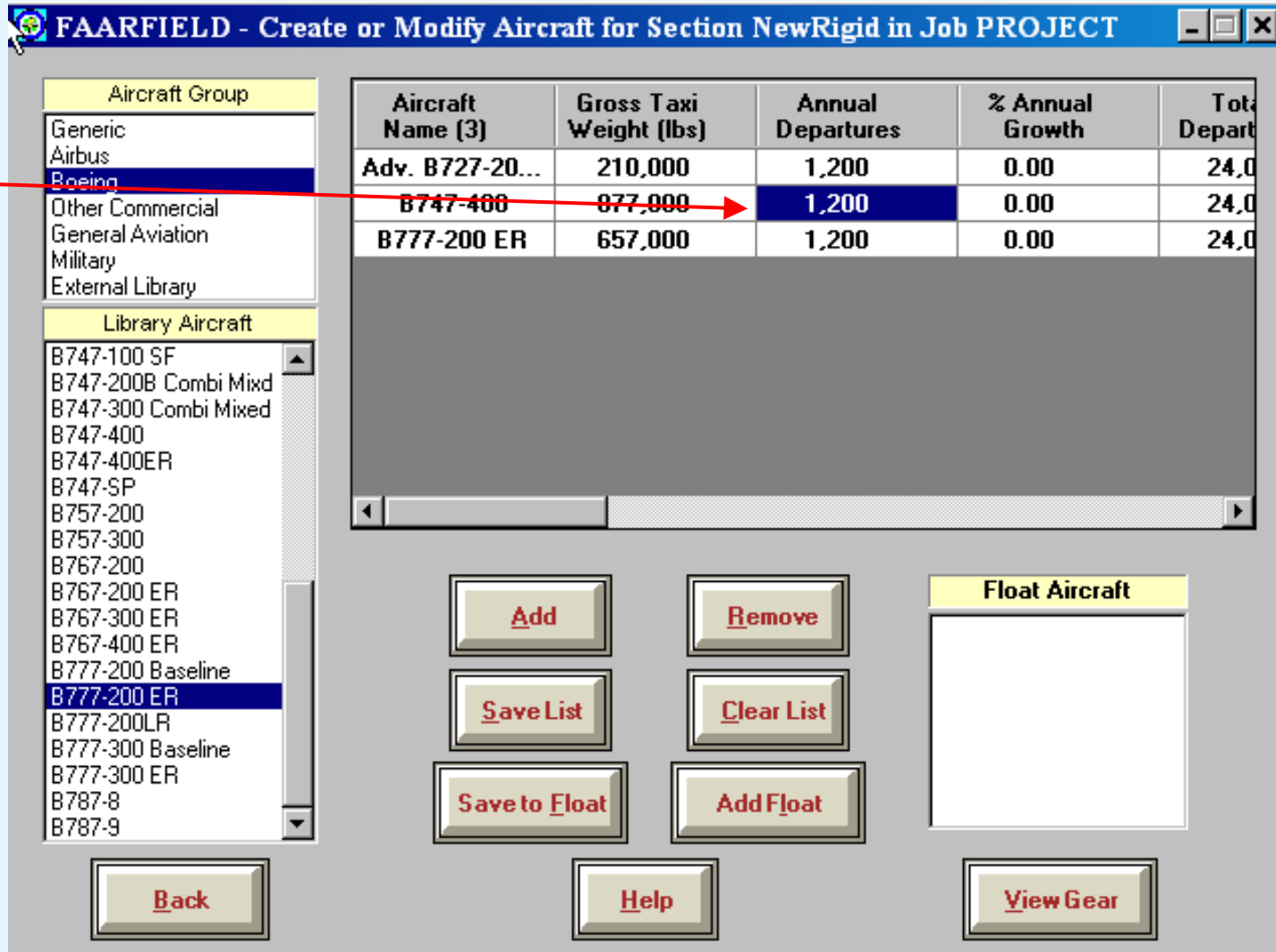
A range is provided for each aircraft which represents reasonable weights for the aircraft



FAARFIELD Rigid Pavement Design

Adjusting Aircraft Information – Annual Departures

Click on “Annual Departures” to change departures for an aircraft

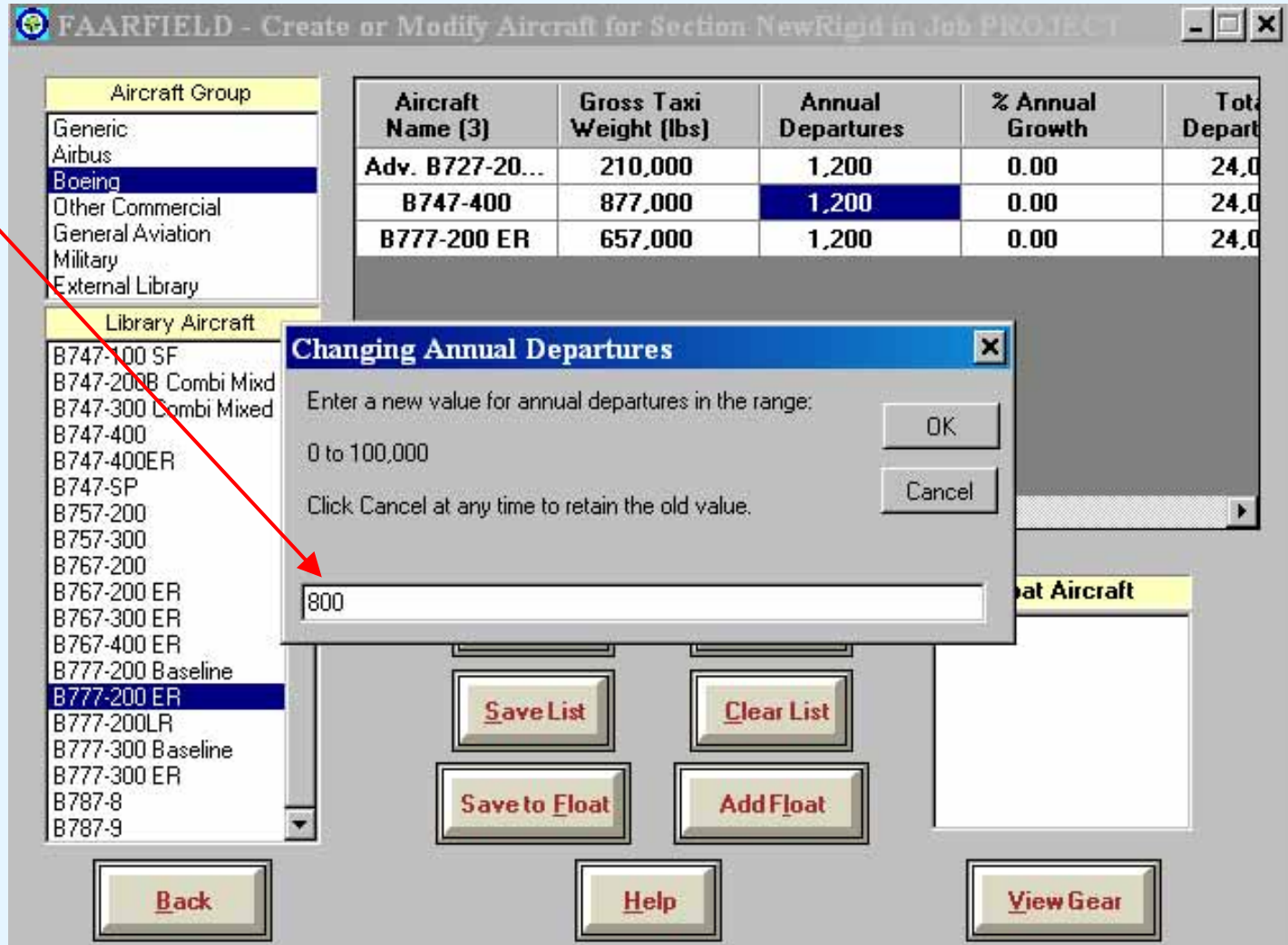


FAARFIELD Rigid Pavement Design

Adjusting Aircraft Information – Annual Departures

Enter the annual departures of the aircraft
Click OK

Current program limits on annual departures:
0 to 100,000



FAARFIELD Rigid Pavement Design

Annual Departures in FAARFIELD

- **Annual departures has the same meaning as the previous design procedure.**
- **Arrivals are ignored.**
- **For design purposes FAARFIELD uses the total annual departures, adjusted for growth, multiplied by the total design period in years**

  e.g. 1200 annual departures X 20 years = 24,000 departures

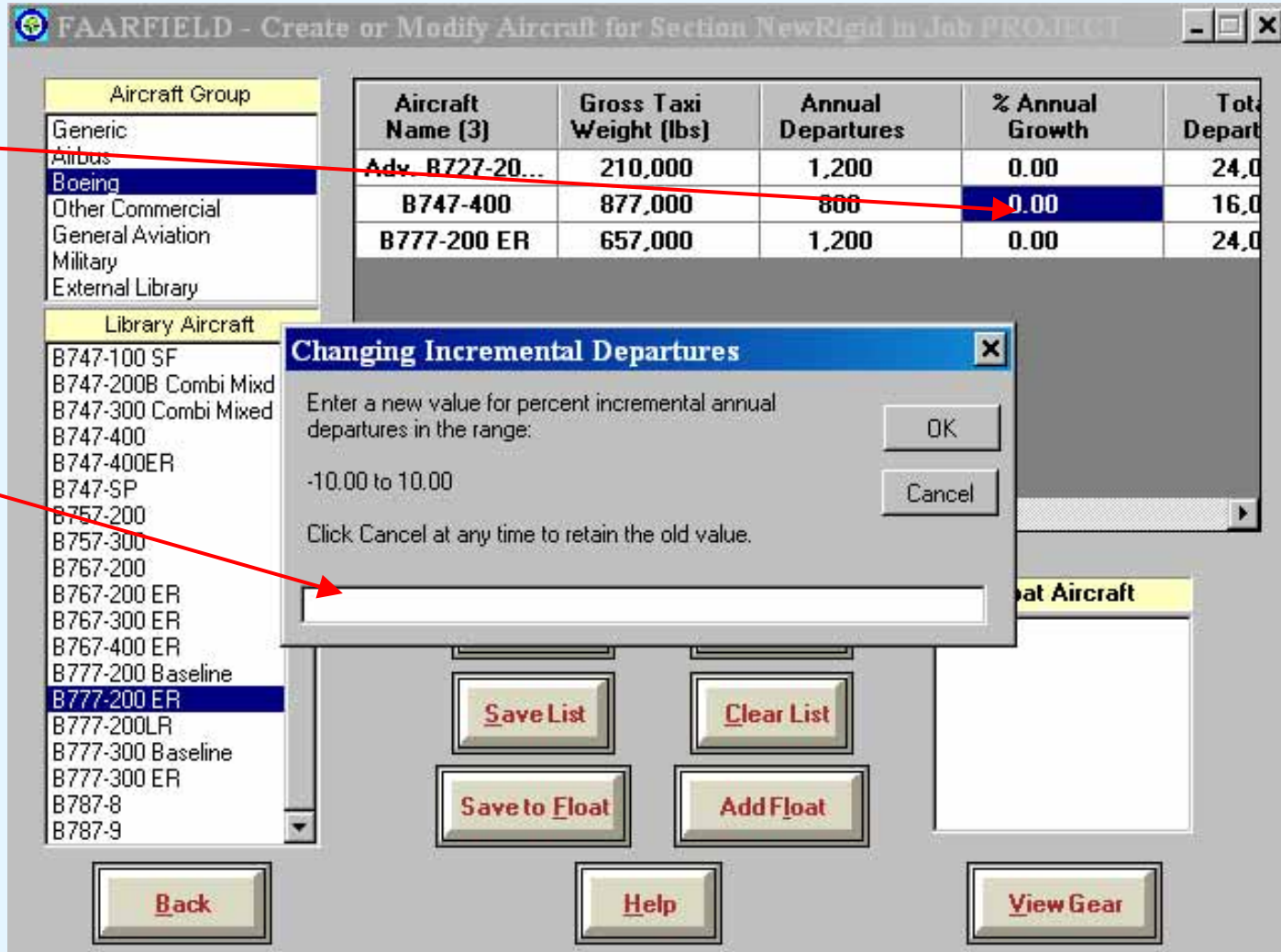
FAARFIELD Rigid Pavement Design

Adjusting Airplane Information –

% Annual Growth of Annual Departures

Click on the annual growth value to bring up the pop-up box.

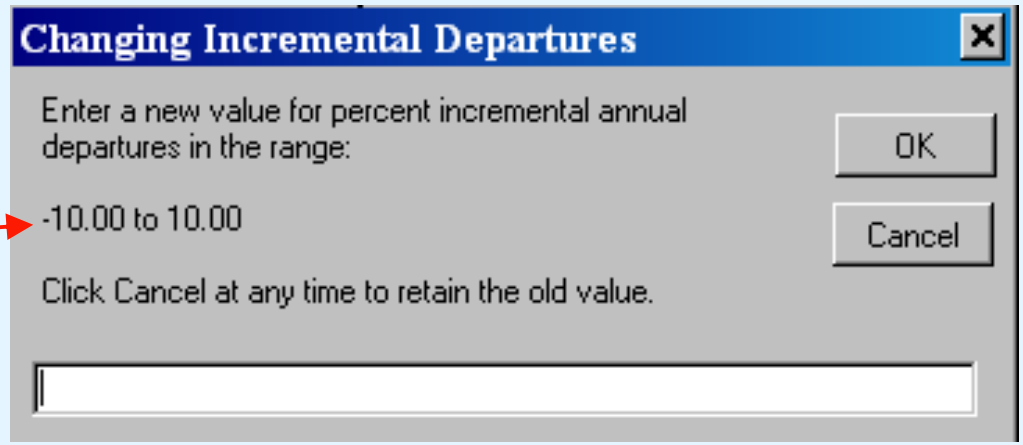
Enter the percent annual growth and click OK



FAARFIELD Rigid Pavement Design

Adjusting Aircraft Information – % Annual Growth of Annual Departures

Allowable range of percent annual growth is +/- 10%

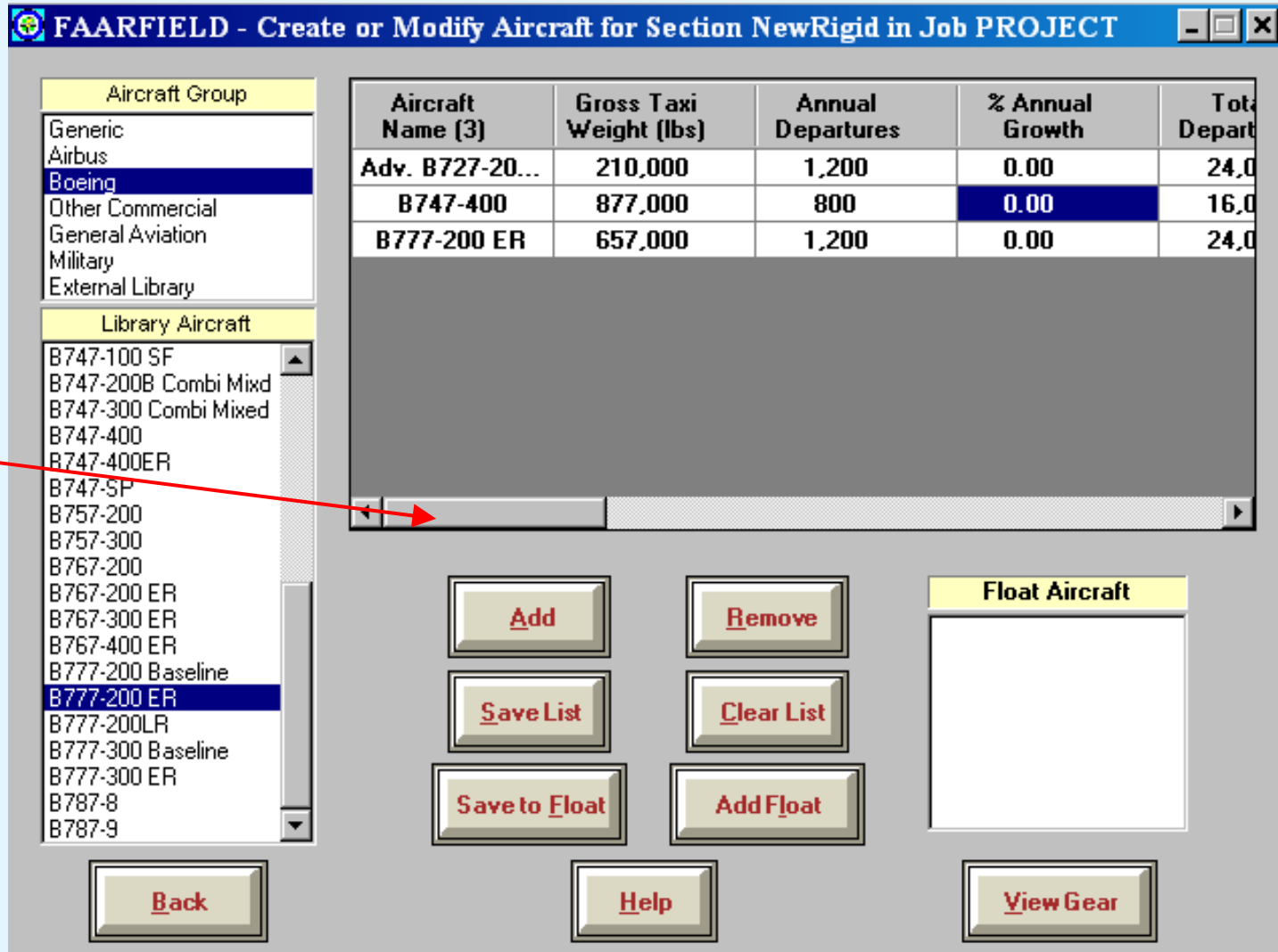


You can create the same effect by modifying the annual departures such that the total annual departures results in the desired total.

FAARFIELD Rigid Pavement Design

Viewing Aircraft Information

Scroll over to reveal additional columns of information



FAARFIELD Rigid Pavement Design

Aircraft Information

Available in FAARFIELD aircraft screen

User can modify

Aircraft Name (3)	Gross Taxi Weight (lbs)	Annual Departures	% Annual Growth
Adv. B727-20...	210,000	1,200	0.00
B747-400	877,000	800	0.00
B777-200 ER	657,000	1,200	0.00

Calculated values

Total Departures	CDF Contribution	CDF Max for Aircraft	P/C Ratio
24,000	0.00	0.00	0.00
16,000	0.00	0.00	0.00
24,000	0.00	0.00	0.00

Airplane information stored in FAARFIELD

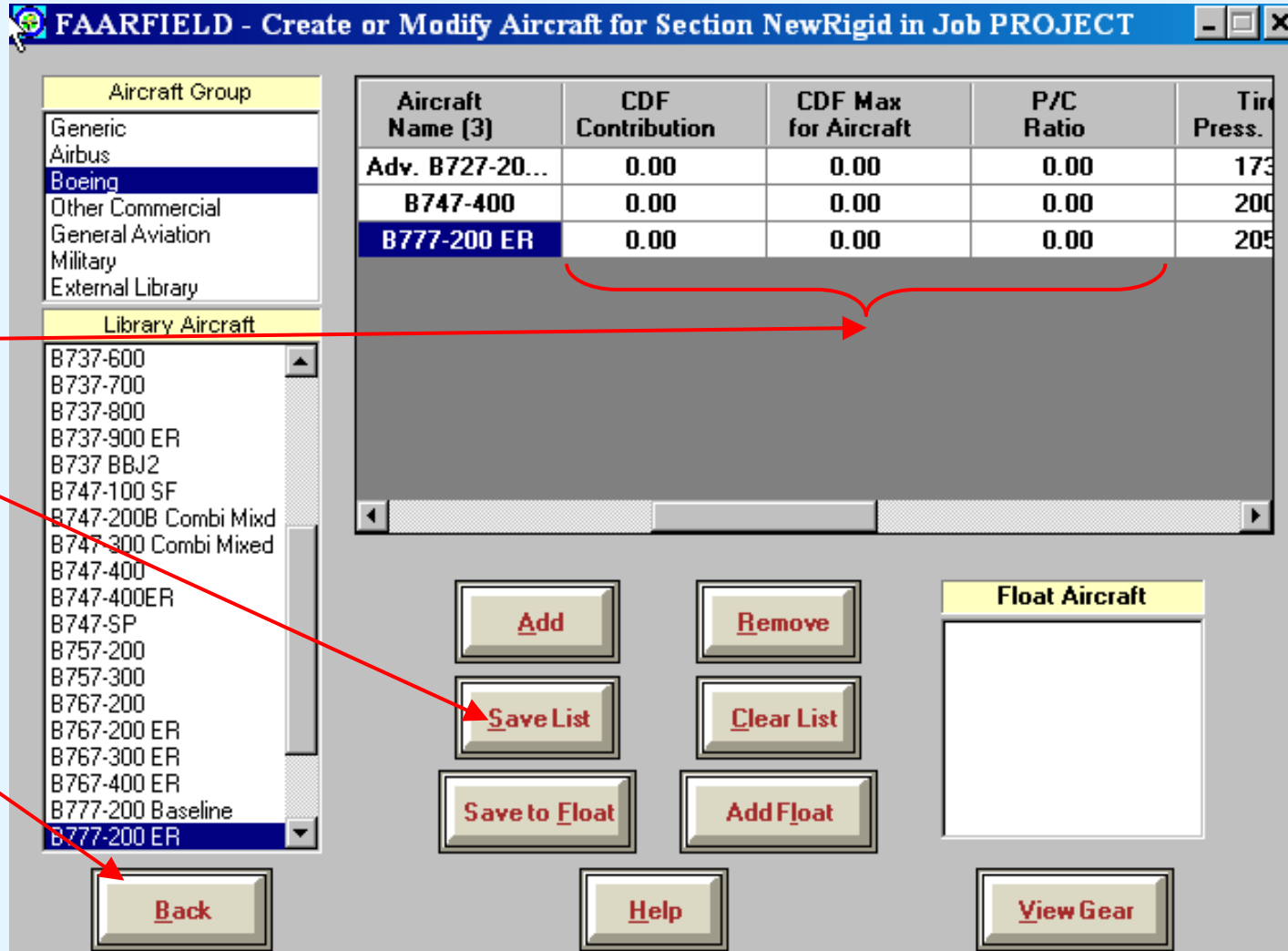
Tire Press. (psi)	Percent GW on Gear	Dual Spacing (in)	Tandem Spacing (in)	Tire Contact Width (in)	Tire Contact Length (in)
173	47.5	34.00	0.00	15.15	24.23
200	95.0	44.00	58.00	14.39	23.03
205	47.5	55.00	57.00	14.21	22.73

FAARFIELD Rigid Pavement Design

Viewing Aircraft Information

CDF columns and P/C ratio will be zero when aircraft are first entered

Save the list when finished entering airplanes then click the back button

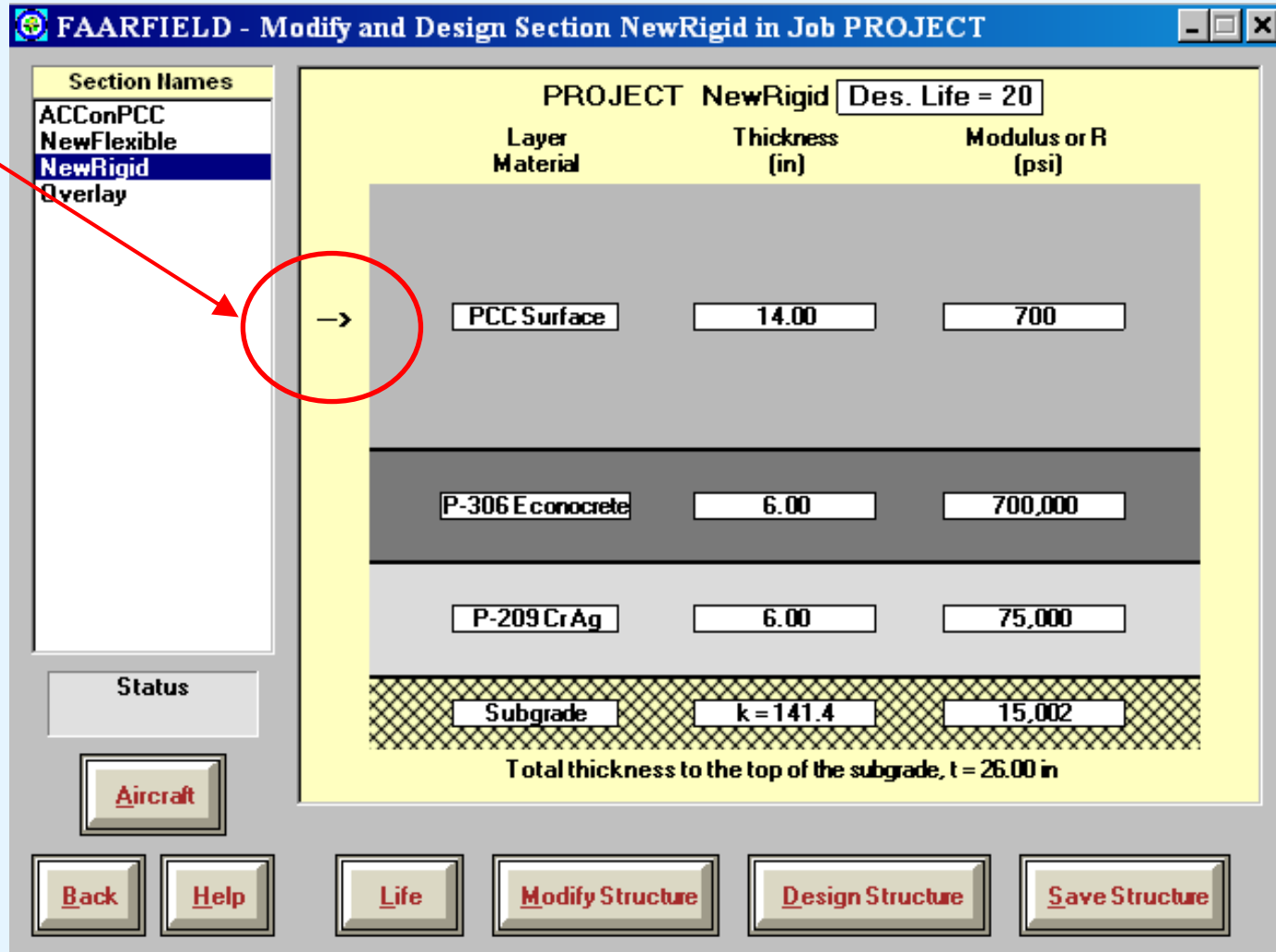


FAARFIELD Rigid Pavement Design

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 pavement structure



FAARFIELD Rigid Pavement Design

Layer 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 during “modify design” mode.

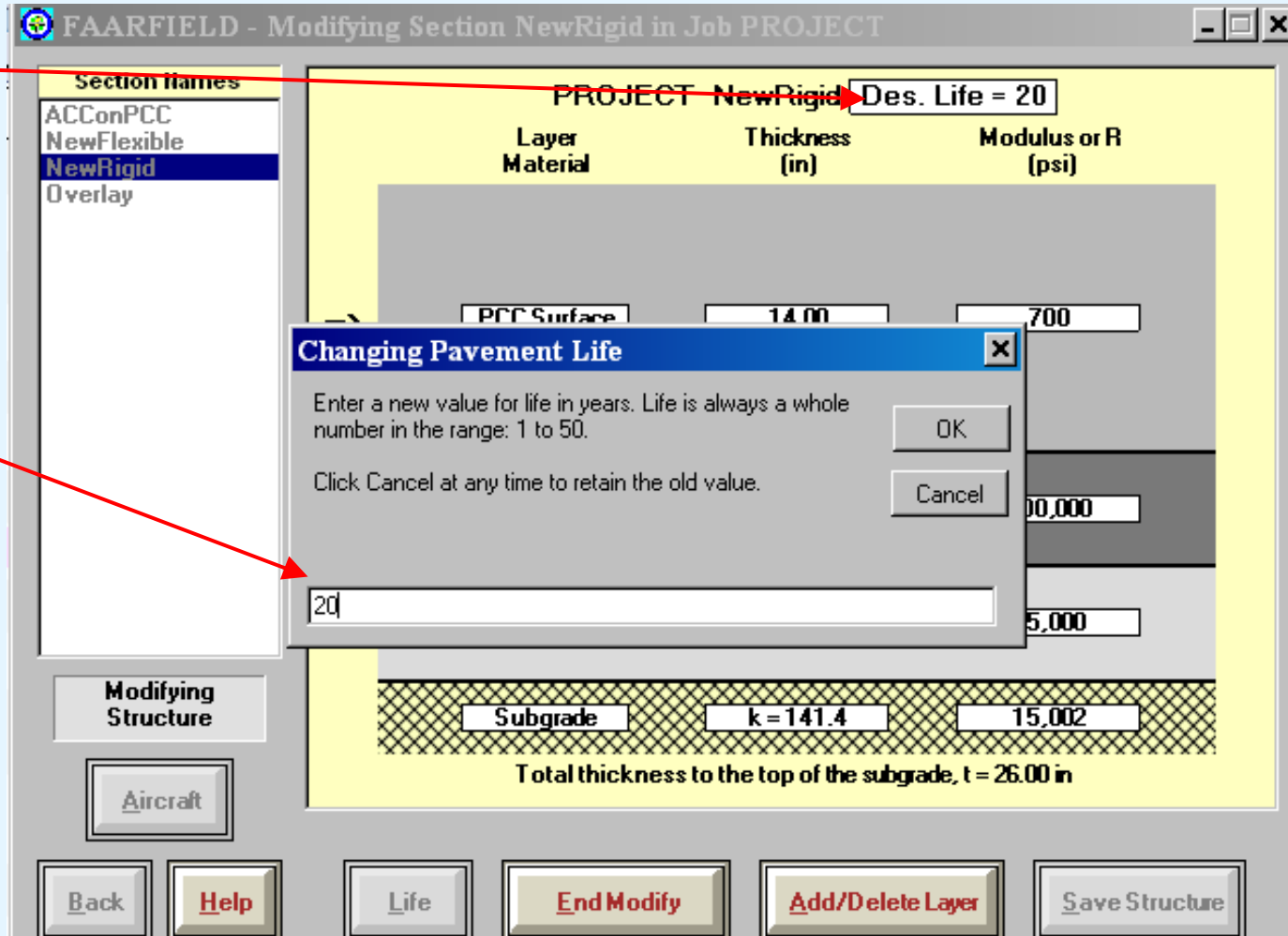
FAARFIELD Rigid Pavement Design

Design Life

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

When the pop-up box appears, enter the desired number of years.

NOTE: the standard FAA design is for 20 years

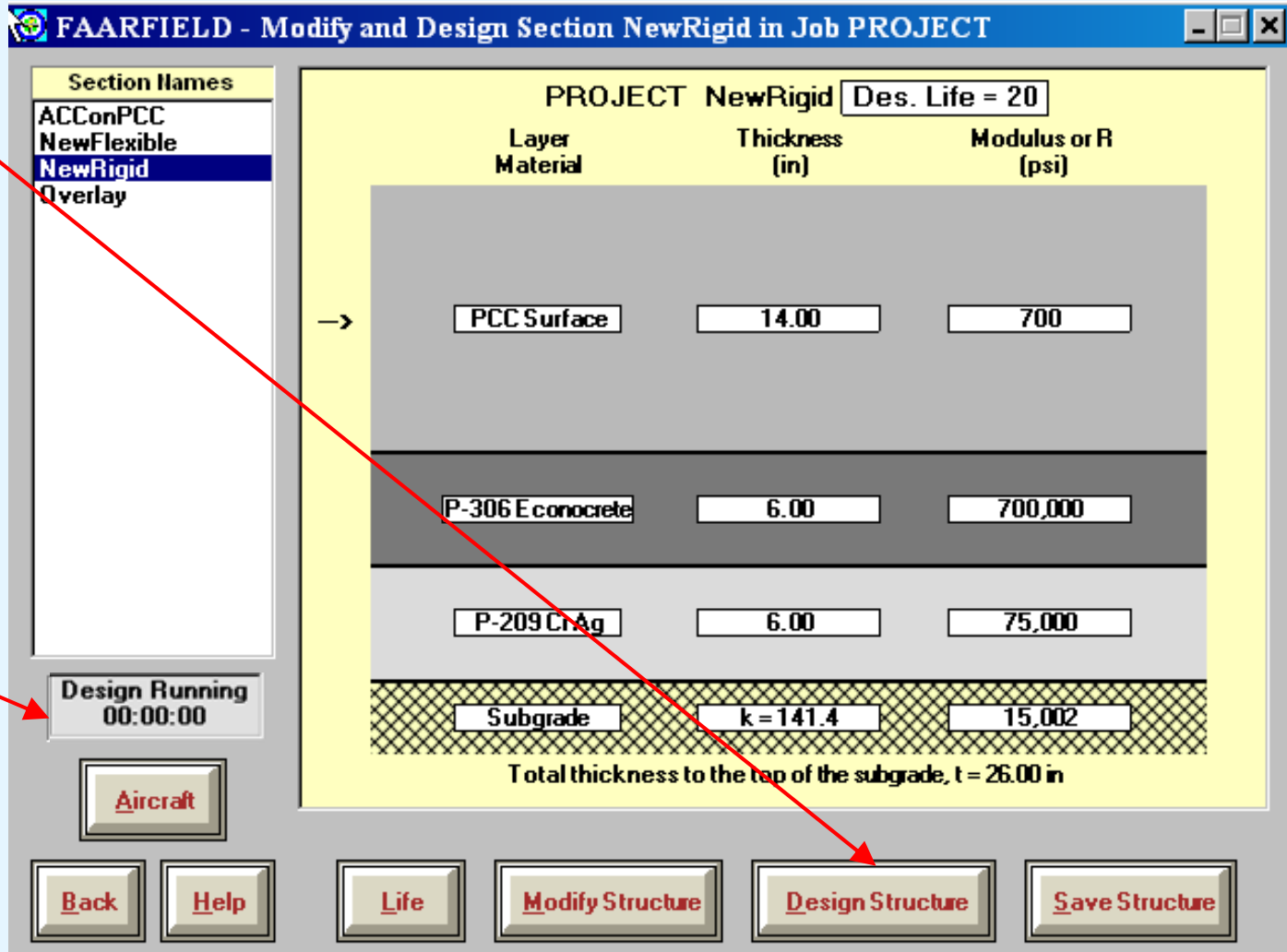


FAARFIELD Flexible Pavement Design

Performing the Pavement Design

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

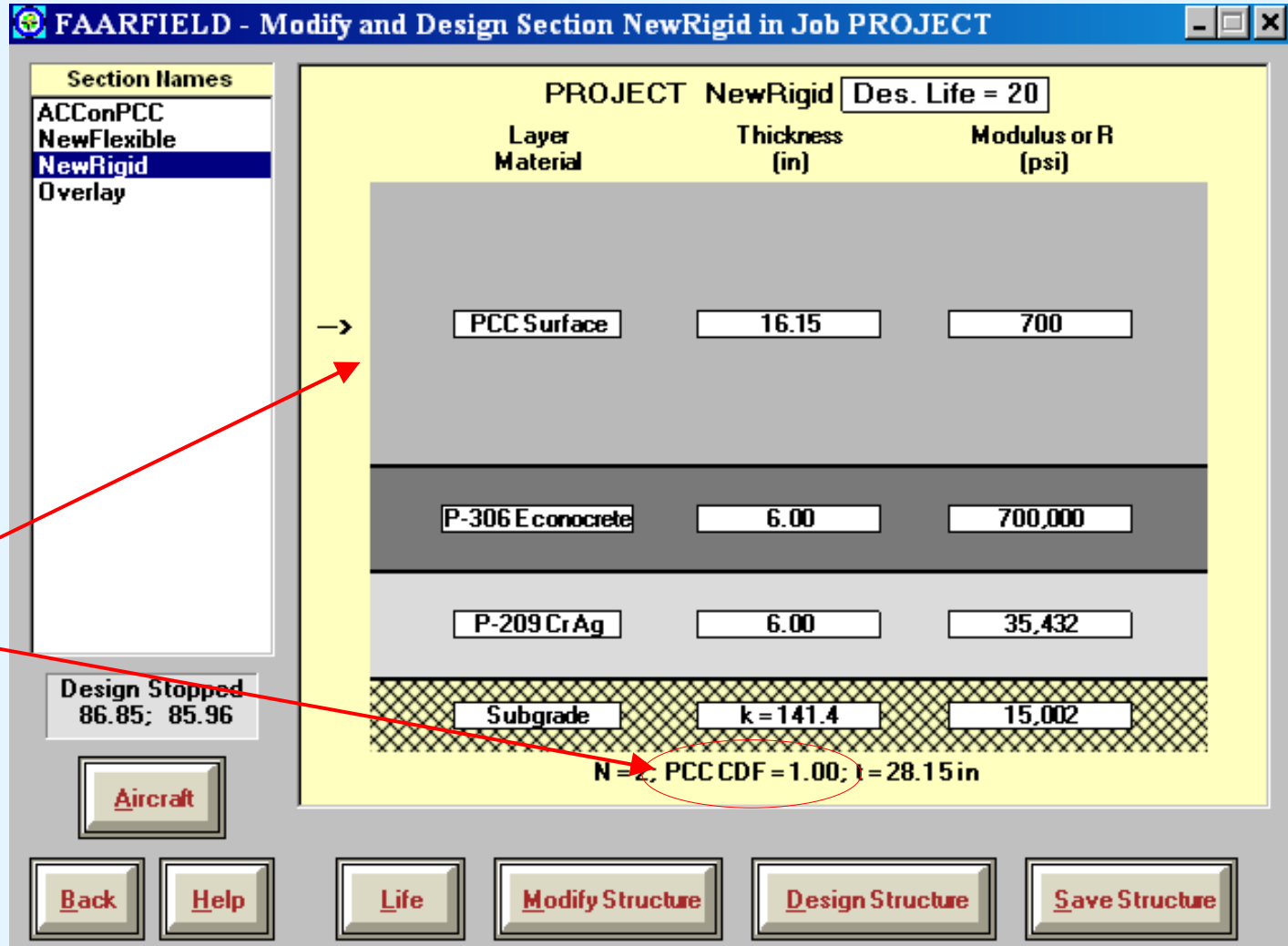
The program will keep you informed about the status of the design



FAARFIELD Rigid Pavement Design

Result of the Pavement Design

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

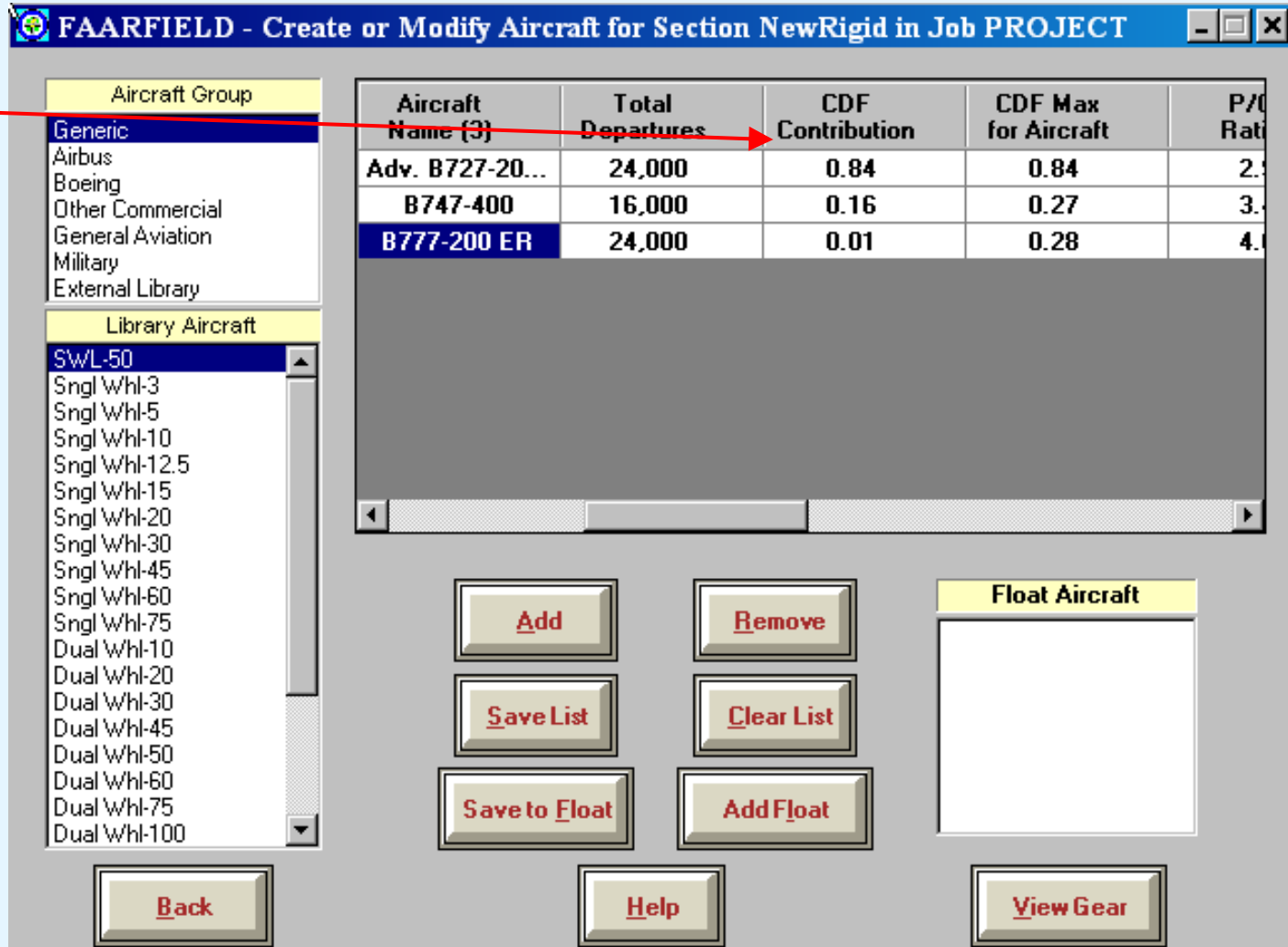


FAARFIELD Rigid Pavement Design

Reviewing Aircraft Data After Completing the Design

CDF and P/C ratio information is now available

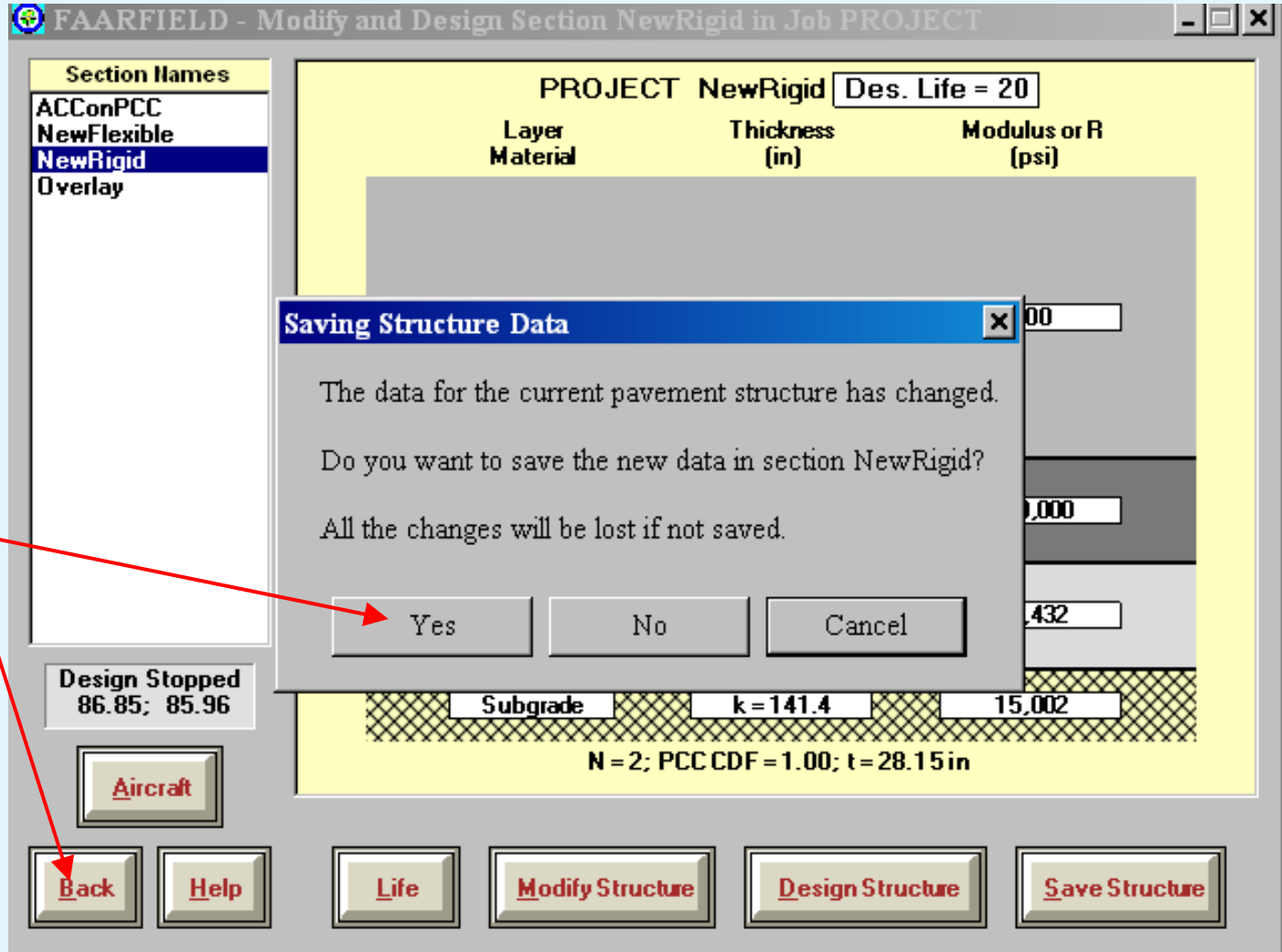
This information allows you to see which aircraft have the largest impact on the pavement structure



FAARFIELD Rigid Pavement Design

Saving and Reviewing the Pavement Design Data

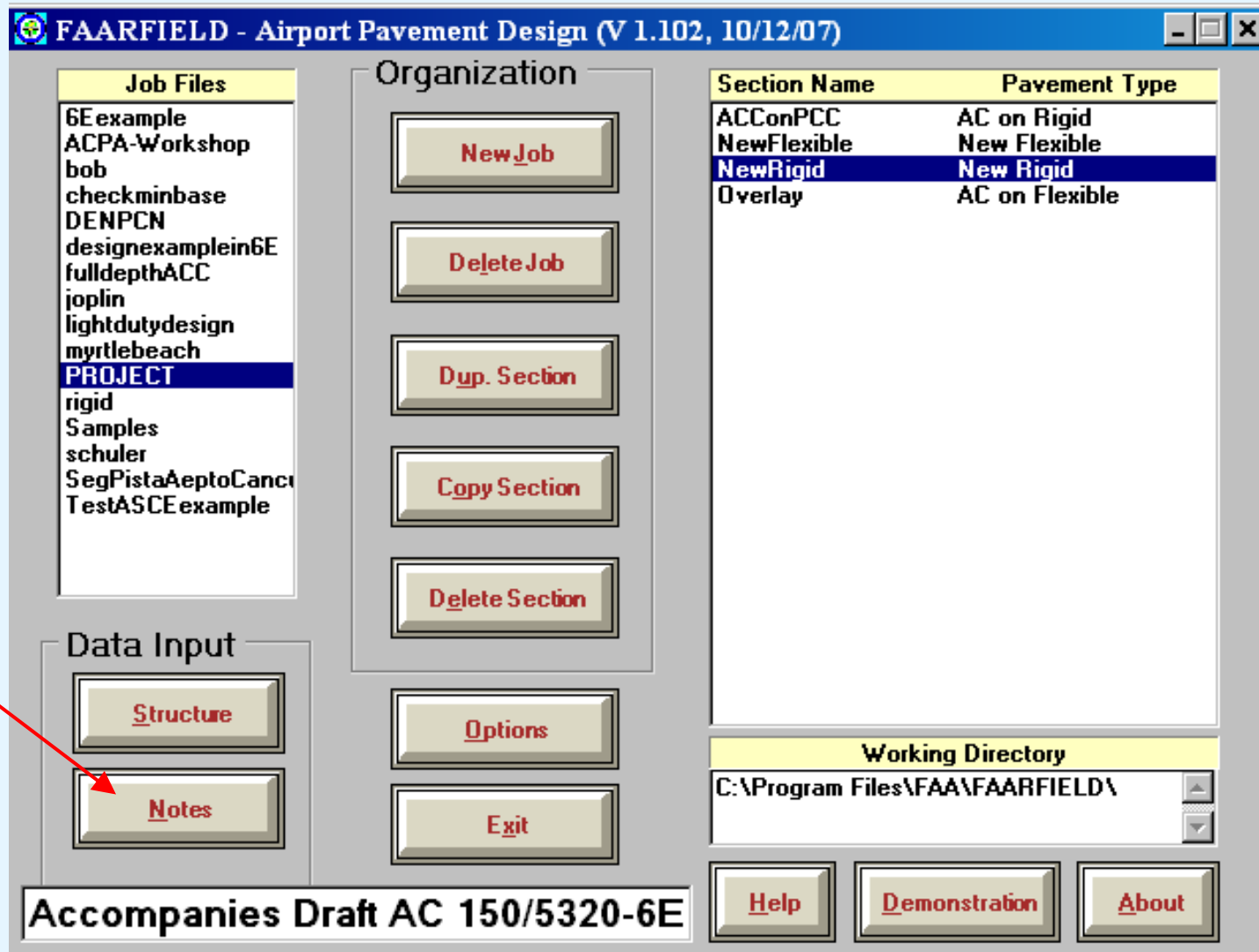
When finished with the design, click the "Back" button and select whether you want to save the data



FAARFIELD Rigid Pavement Design

Reviewing Design Information

To view a summary of the design click the "Notes" button

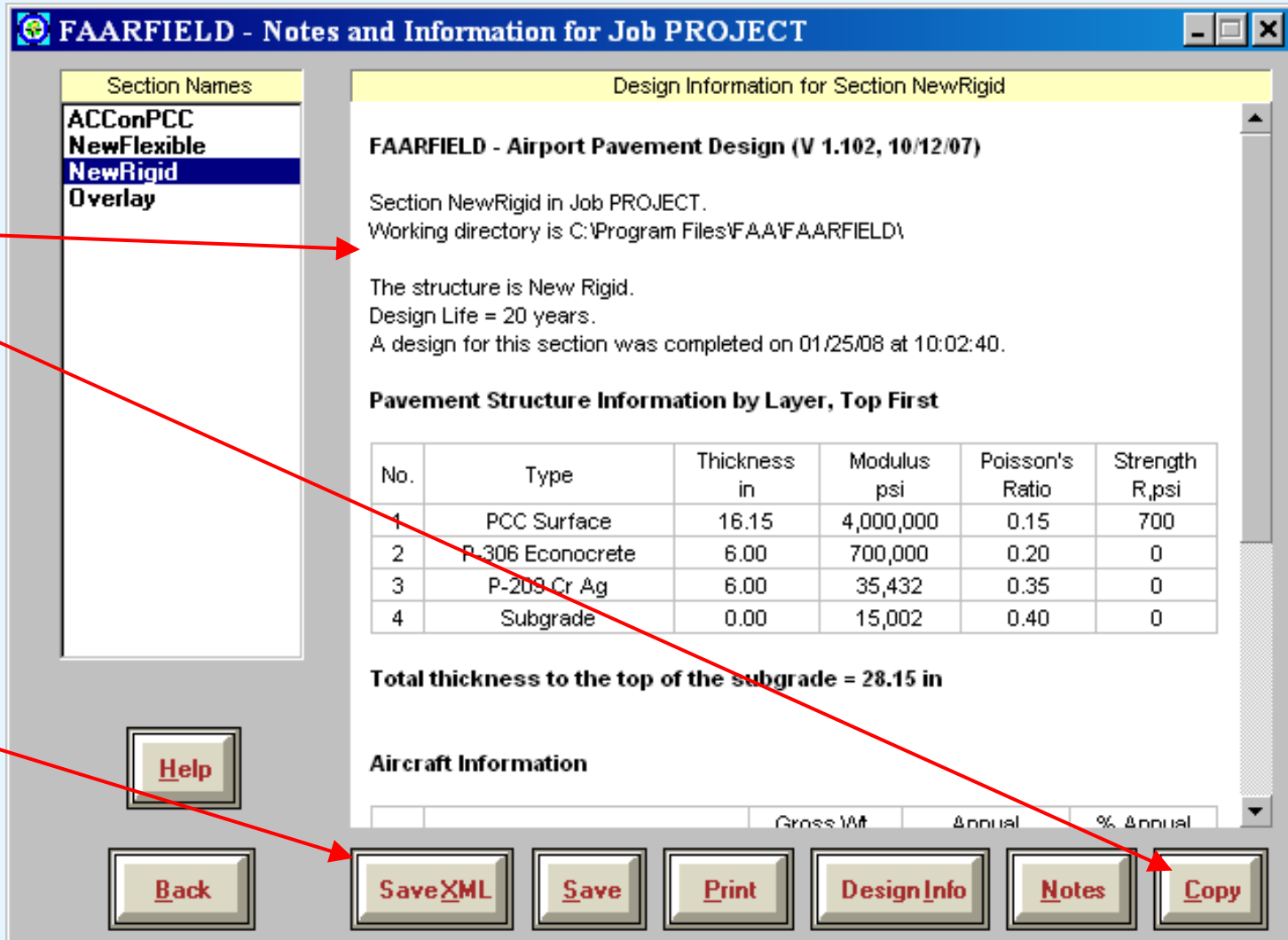


FAARFIELD Rigid Pavement Design

Reviewing Design Information

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

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



FAARFIELD Rigid Pavement Design

Reviewing Design Information

FAARFIELD - Airport Pavement Design (V 1.102, 10/12/07)

Section NewRigid in Job PROJECT.
Working directory is C:\Program Files\FAA\FAARFIELD\

The structure is New Rigid.
Design Life = 20 years.
A design for this section was completed on 01/25/08 at 10:02:40.

Pavement Structure Information by Layer, Top First

No.	Type	Thickness in	Modulus psi	Poisson's Ratio	Strength R,psi
1	PCC Surface	16.15	4,000,000	0.15	700
2	P-306 Econocrete	6.00	700,000	0.20	0
3	P-209 Cr Ag	6.00	35,432	0.35	0
4	Subgrade	0.00	15,002	0.40	0

Total thickness to the top of the subgrade = 28.15 in

Aircraft Information

No.	Name	Gross Wt. lbs	Annual Departures	% Annual Growth	CDF Contribution	CDF Max for Aircraft	P/C Ratio
1	Adv. B727-200 Option	210,000	1,200	0.00	0.84	0.84	2.97
2	B747-400	877,000	800	0.00	0.16	0.27	3.46
3	B777-200 ER	657,000	1,200	0.00	0.01	0.28	4.04

FAARFIELD - Sample PCC Overlay Design

Overlay design is very similar to new pavement design except that the design is only allowed to iterate on the overlay layer

The steps and options are similar to that of a new flexible design

FAARFIELD - Sample PCC Overlay Design

There are 4 basic overlay structures in FAARFIELD

Section Name	Pavement Type
AConFlex	Asphalt overlay on Flexible pavement
AConRigid	Asphalt overlay on Rigid pavement
PCConFlex	PCC overlay on flexible
PCConRigid	Unbonded PCC on rigid

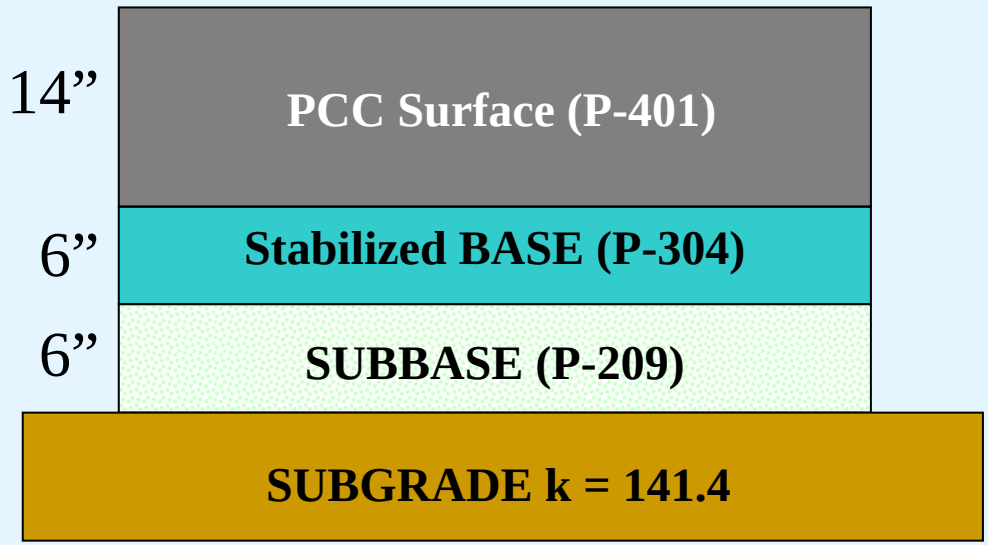
FAARFIELD – PCC Unbonded Overlay Design

For this example, assume the pavement section is to be strengthened for a new traffic mix.

PCC flexural strength = 700 psi

Current SCI = 40

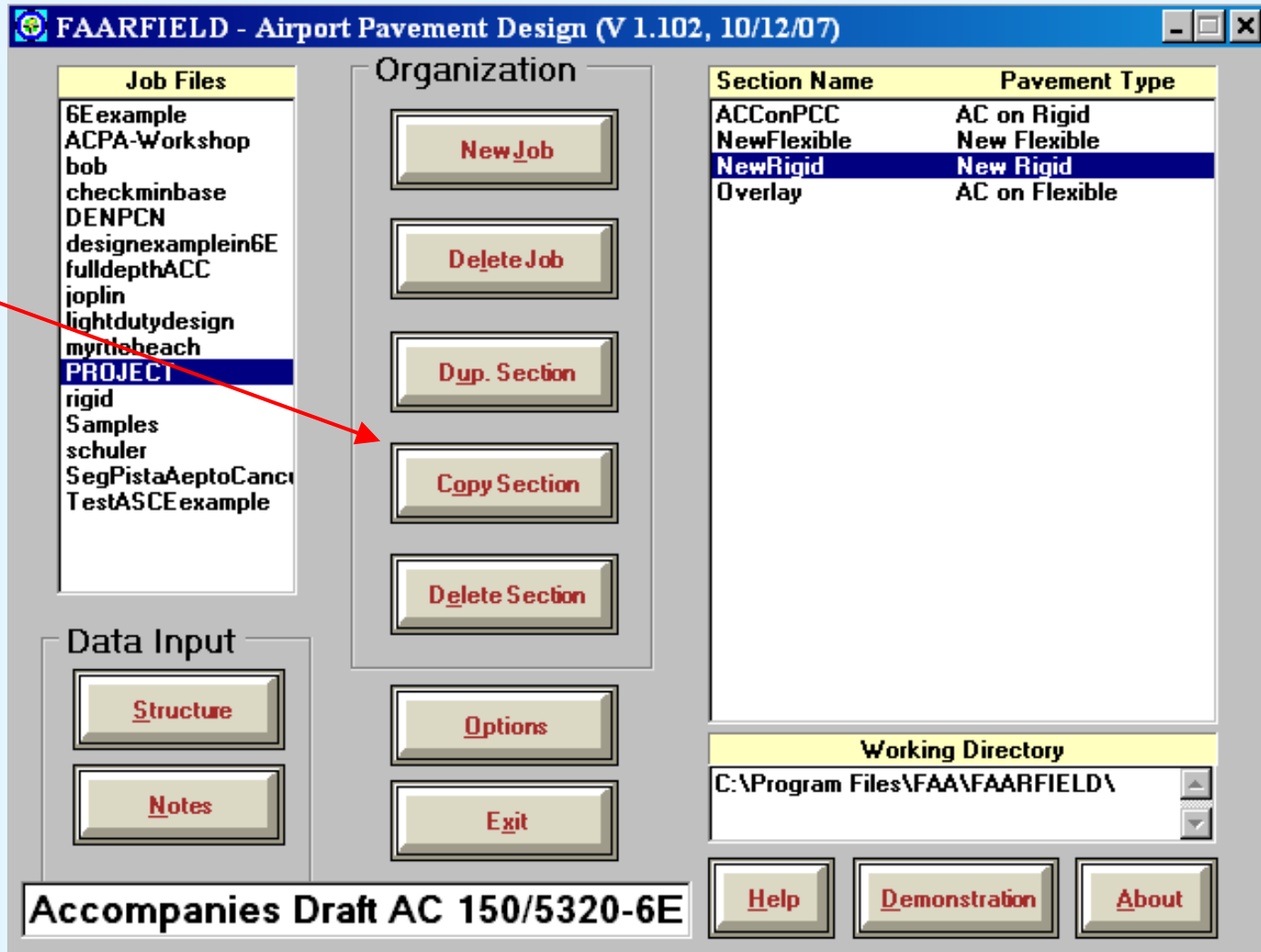
Existing Pavement Section



FAARFIELD – PCC Unbonded Overlay Design

Create Existing Pavement Section for Overlay Design

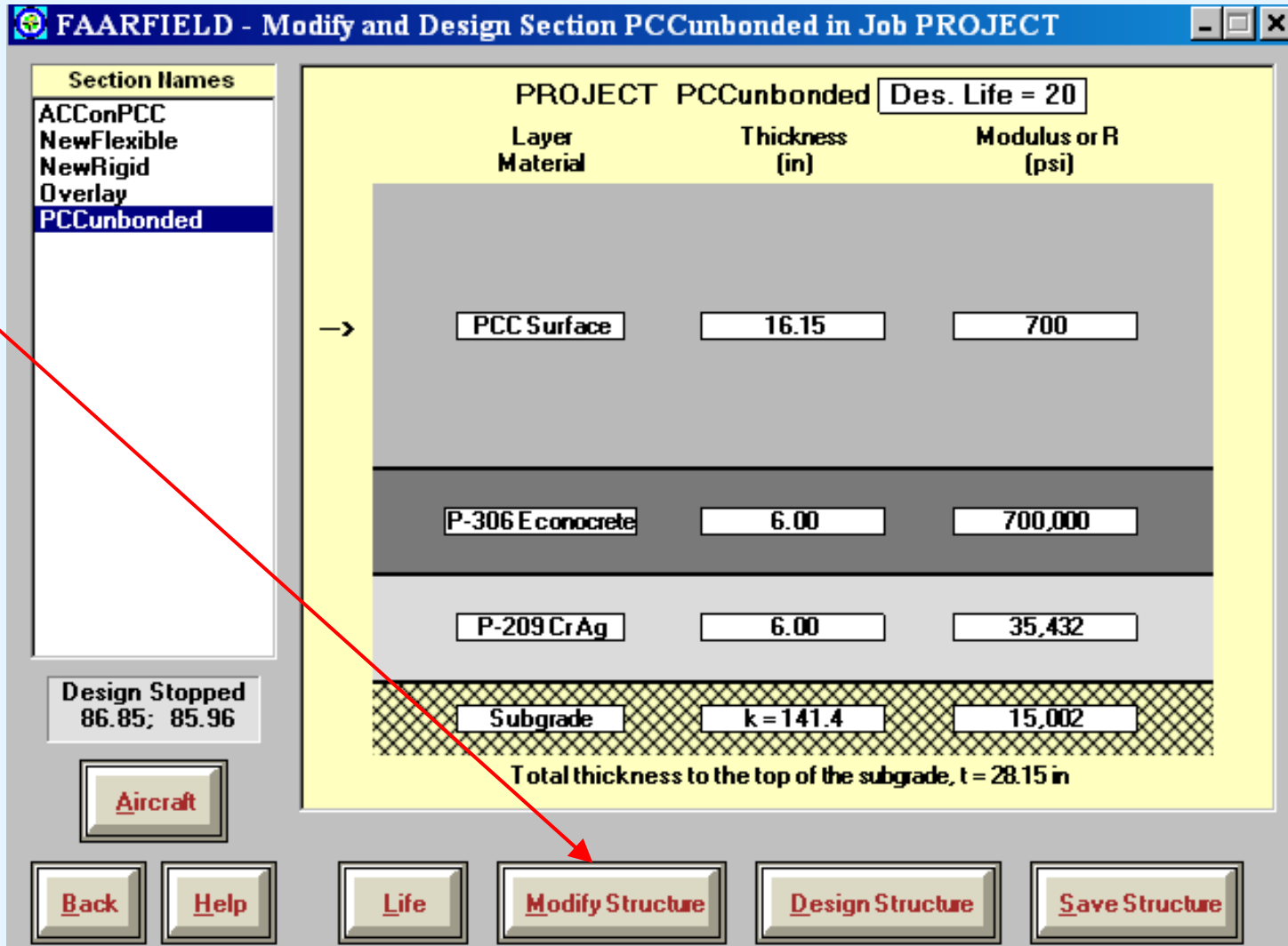
Copy a similar pavement section or create a new section to represent the existing pavement



FAARFIELD – PCC Unbonded Overlay Design

Create Existing Pavement Section for Overlay Design

Start with the original pavement section – go to "Modify Structure"

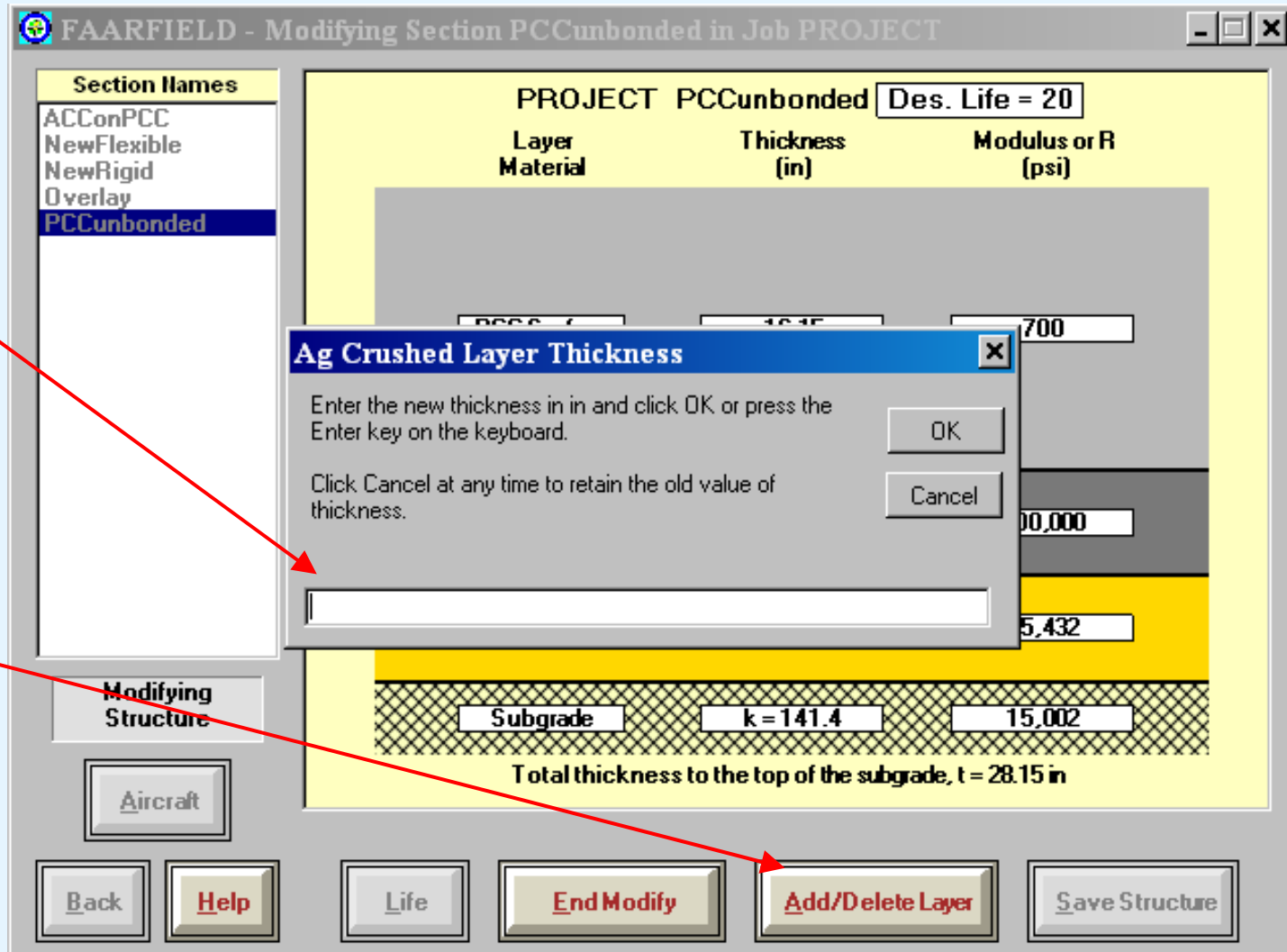


FAARFIELD – PCC Unbonded Overlay Design

Create Existing Pavement Section for Overlay Design

Click on the subbase layers to adjust thickness to match the existing pavement structure

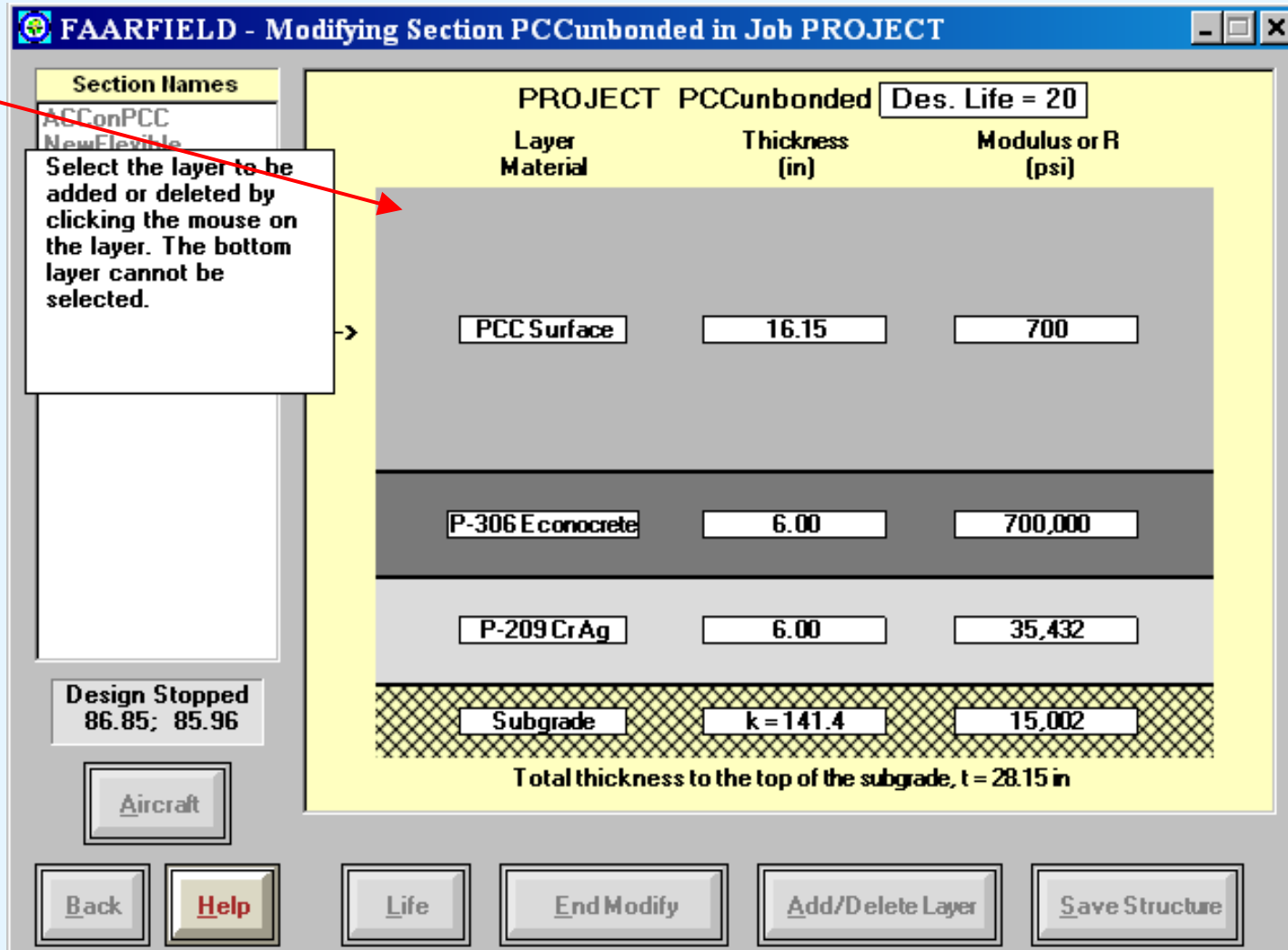
Then click on "Add/Delete Layer"



FAARFIELD – PCC Unbonded Overlay Design

Create Overlay Layer

Click on the P501 surface layer to add a section layer

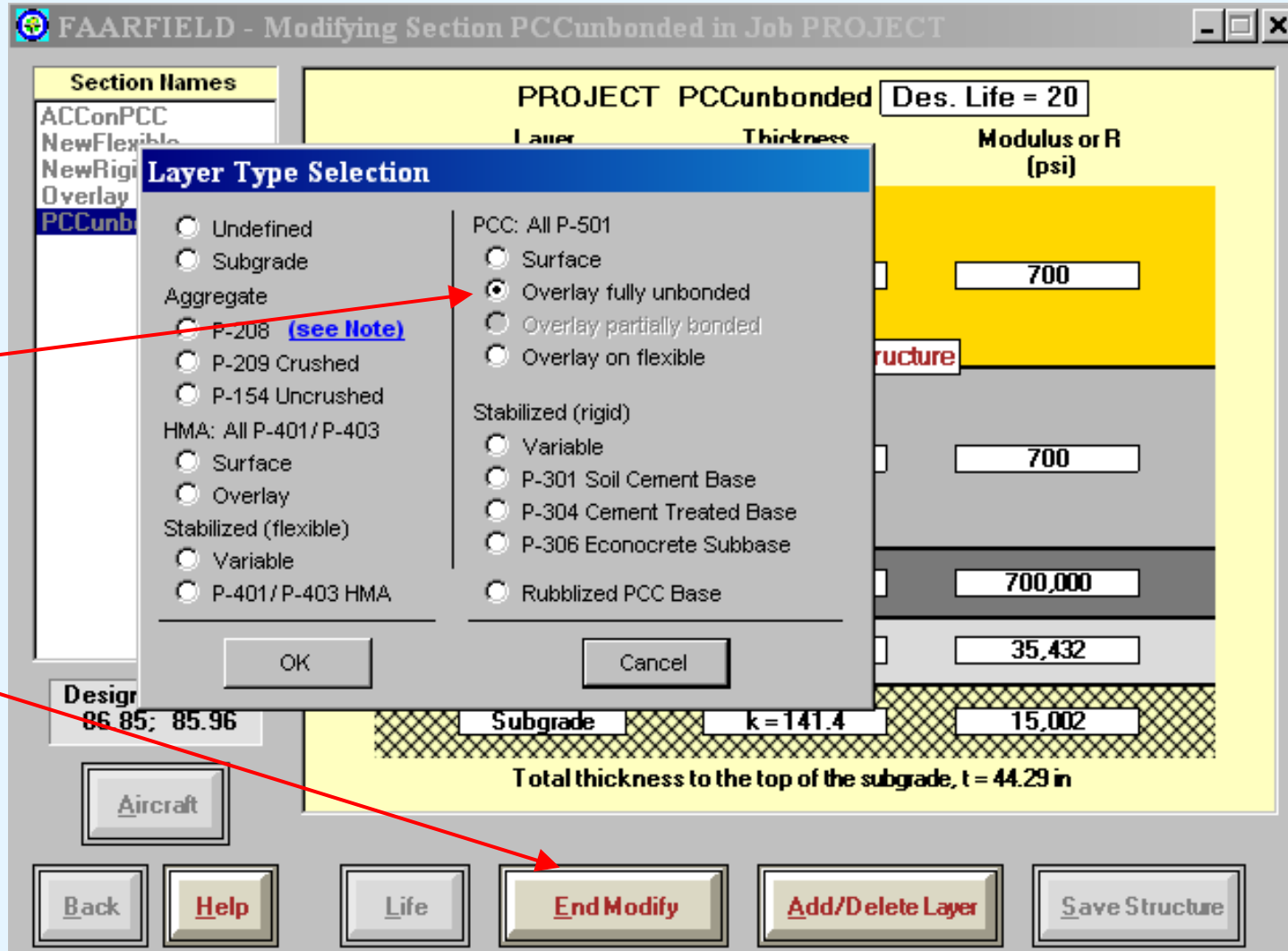


FAARFIELD – PCC Unbonded Overlay Design

Create Overlay Layer

Click on the top layer and change its properties to PCC P501 "Overlay fully unbonded"

Then click on "End Modify" to return to design mode

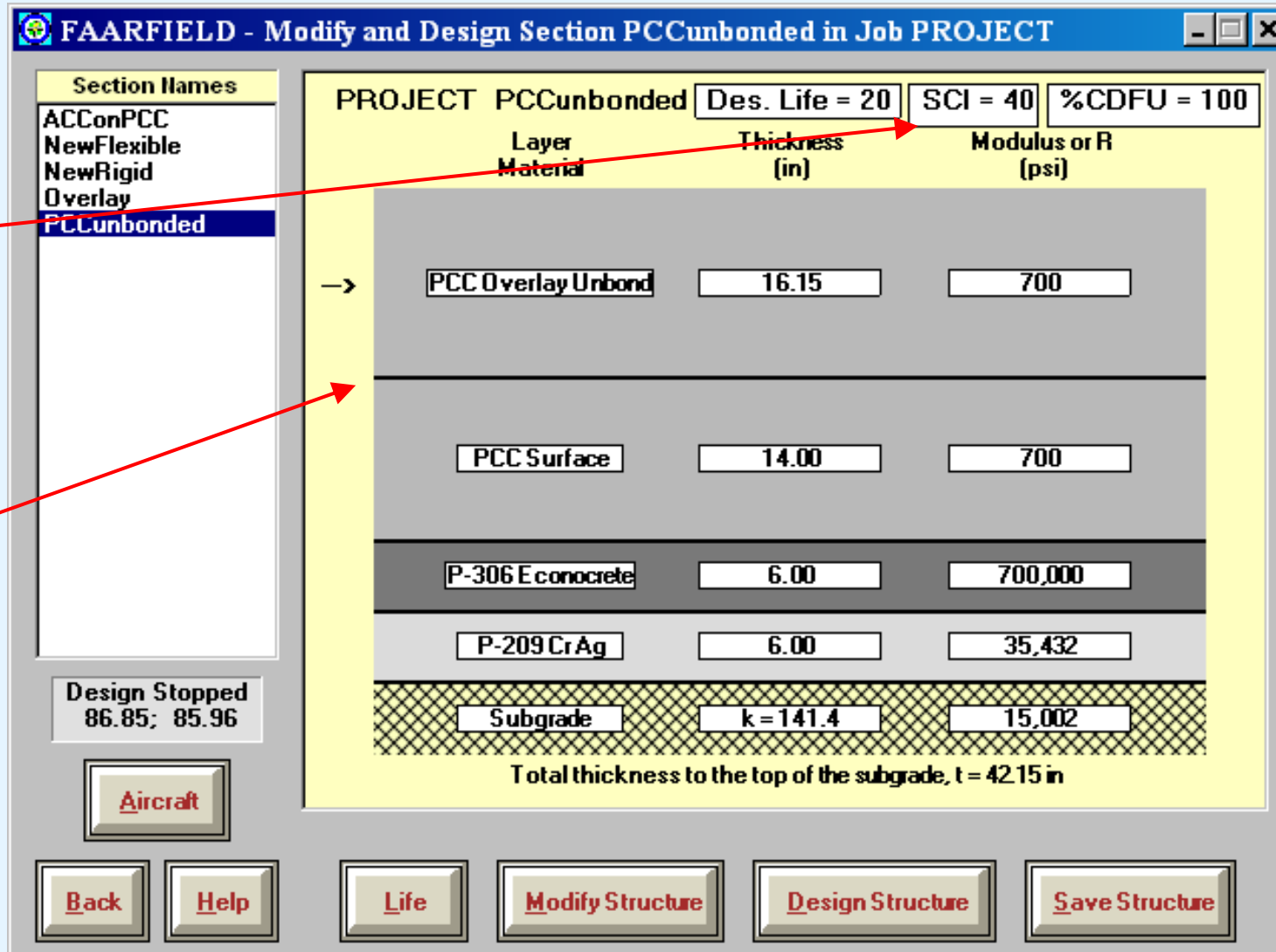


FAARFIELD – PCC Unbonded Overlay Design

Create Overlay Layer

Confirm the SCI and CDFU values – adjust as necessary

Note: FAARFIELD does not show or include the debonding layer in thickness calculations



FAARFIELD – PCC Unbonded Overlay Design

Structural Condition Index (SCI)

- SCI derived from the Pavement Condition Index as determined by ASTM D 5340 Airport Pavement Condition Index Surveys
- SCI is computed using only structural components from the PCI survey (6 of 15 distress types)

  SCI will always be less than or equal to the PCI
- SCI = 80 – FAA definition of structural failure

  50% of slabs with structural crack

FAARFIELD – PCC Unbonded Overlay Design

Structural Condition Index (SCI)

TABLE 4-1. RIGID PAVEMENT DISTRESS TYPES USED TO CALCULATE THE STRUCTURAL CONDITION INDEX, (SCI)

Distress	Severity Level
Corner Break	Low, Medium, High
Longitudinal/Transverse/Diagonal Cracking	Low, Medium, High
Shattered Slab	Low, Medium, High
Shrinkage Cracks (cracking partial width of slab)*	Low
Spalling–Joint	Low, Medium, High
Spalling–Corner	Low, Medium, High

FAARFIELD – PCC Unbonded Overlay Design

Cumulative Damage Factor Used (CDFU)

SCI = 100 when there is no visible distress contributing to reduction in SCI (no structural distress types)

Condition of existing pavement described by CDFU

FAARFIELD – PCC Unbonded Overlay Design

Cumulative Damage Factor Used (CDFU)

CDFU defines amount of structural life used

For structures with aggregate base

$$CDFU = \frac{L_U}{0.75\,L_D} \quad \text{when } L_U < 0.75\,L_D$$

$$= \quad 1 \quad \text{when } L_U \geq 0.75\,L_D$$

LU = number of years of operation of the existing pavement until overlay

LD = design life of the existing pavement in years

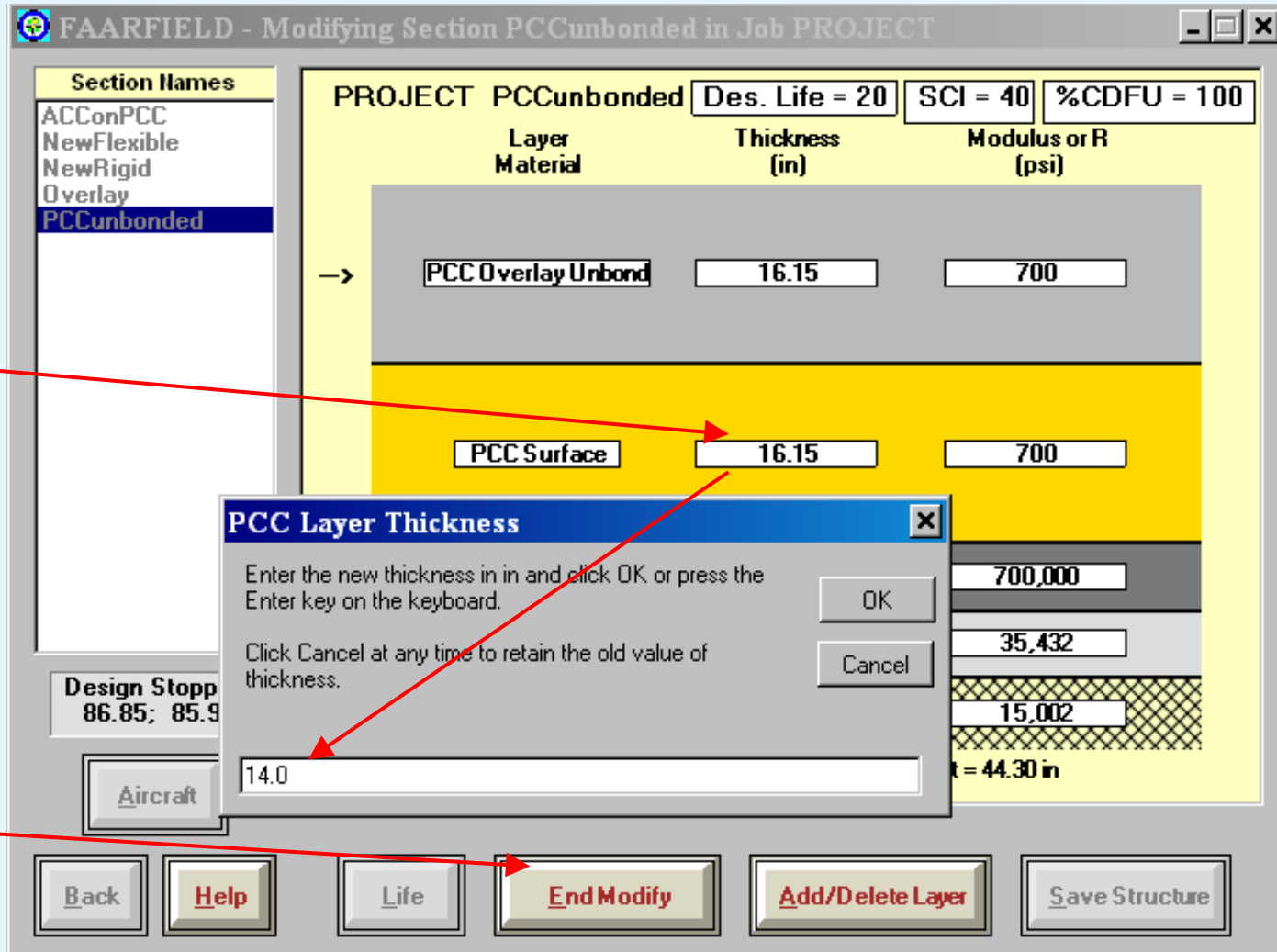
FAARFIELD modifies this relationship for stabilized subbase to reflect improved performance

FAARFIELD – PCC Unbonded Overlay Design

Create Overlay Layer

With the overlay layer in place you can now adjust the thickness of the existing PCC

Then click on "End Modify" to return to design mode

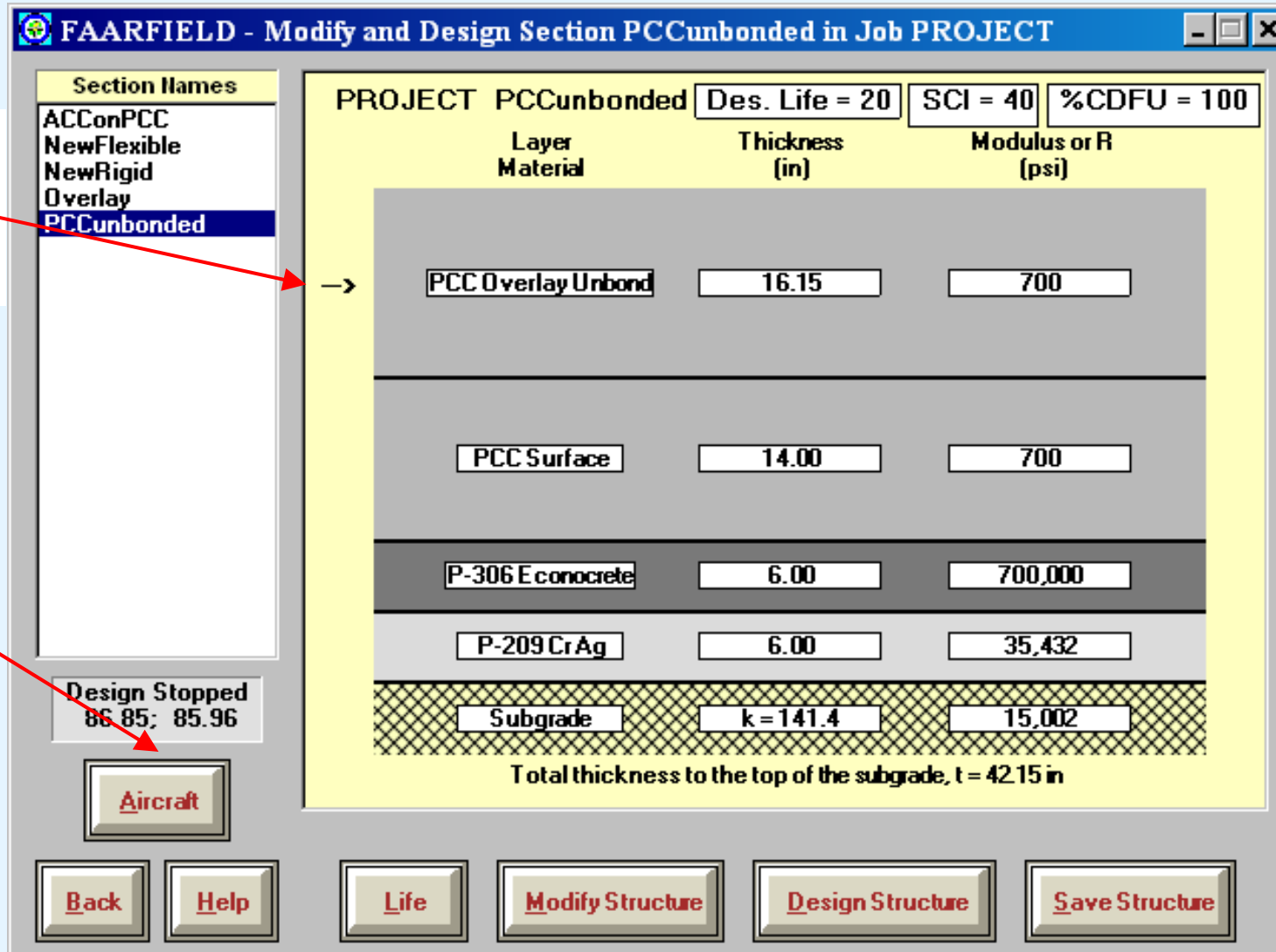


FAARFIELD – PCC Unbonded Overlay Design

Create Overlay Layer

Notice the arrow has relocated to the overlay layer

Confirm or modify the aircraft information



FAARFIELD Rigid Pavement Design

Traffic Mix for Unbonded Overlay Example

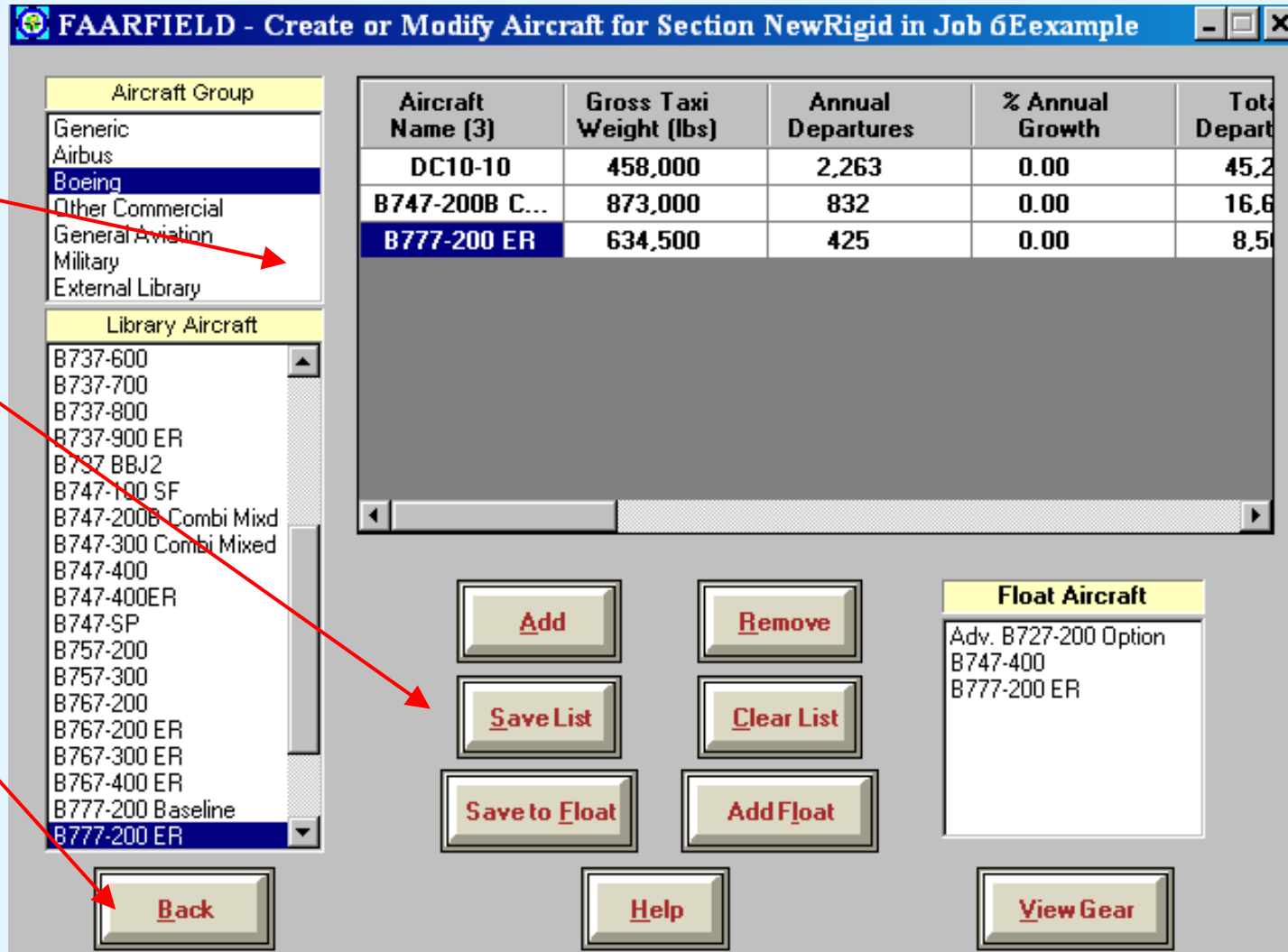
Aircraft Name	Gross Taxi Weight, lb	Annual Departures	Annual Growth, %
DC 10-10	458,000	2.263	0.0
B747-200B Combi	873,000	823	0.0
B777-200 ER	634.500	425	0.0

FAARFIELD – PCC Unbonded Overlay Design

Create Overlay Layer – Traffic Mixture

Enter aircraft and modify properties as required

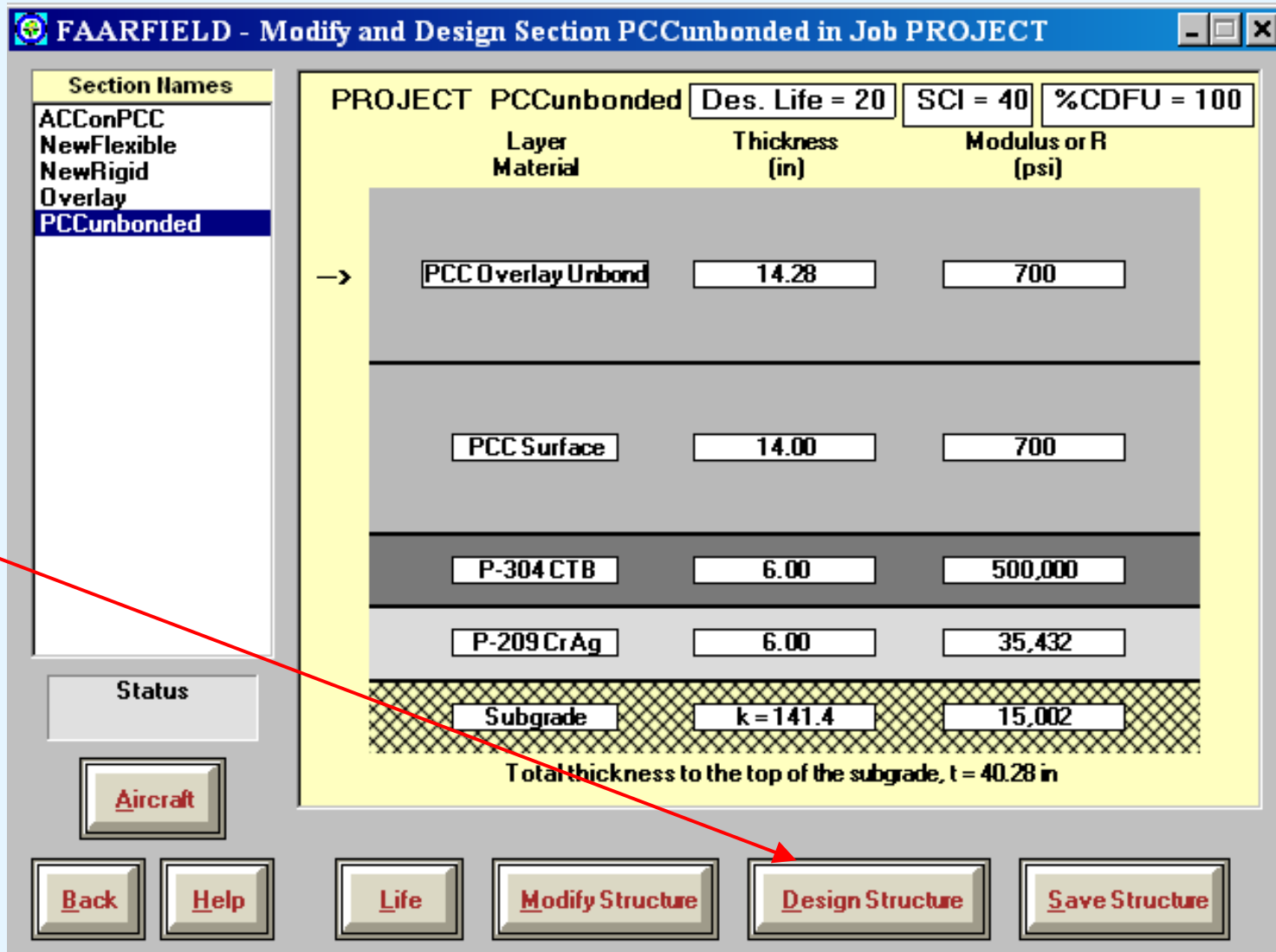
Then click "Save List" and return to the structure screen



FAARFIELD – PCC Unbonded Overlay Design

Create Overlay Layer

When finished modifying layer properties and traffic mixture select “Design Structure”

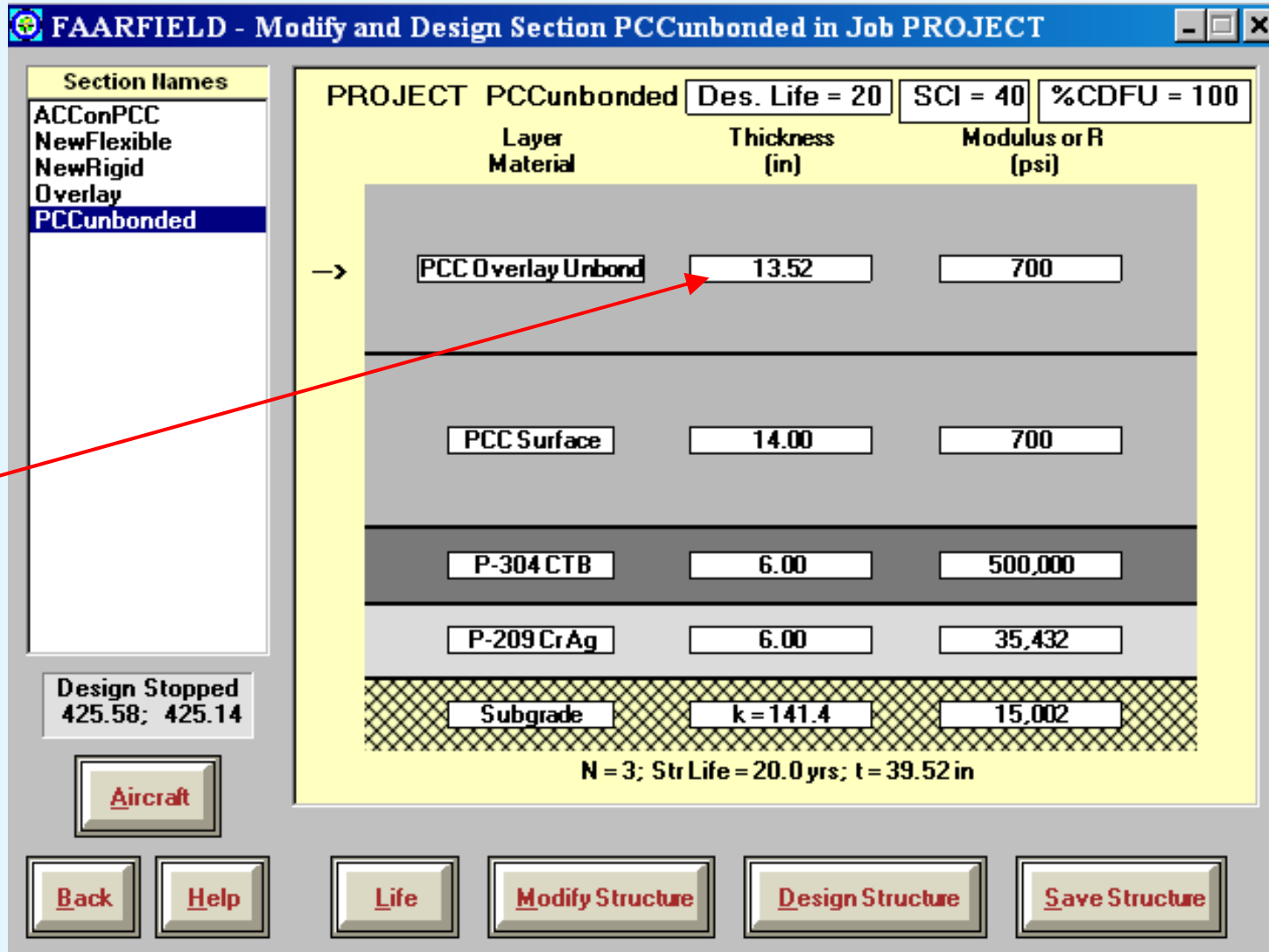


FAARFIELD – PCC Unbonded Overlay Design

Create Overlay Layer

The final overlay thickness is 13.52 inches

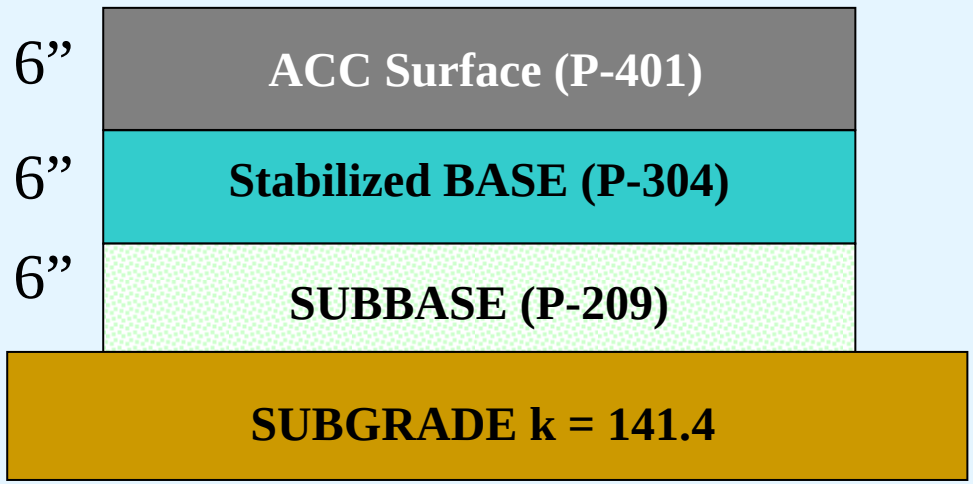
This would be rounded to 13.5 ***(nearest half inch)***



FAARFIELD – PCC Over Existing Flexible

Assume the pavement section is to be strengthened by a placing a PCC overlay on the existing flexible pavement

Existing Pavement Section



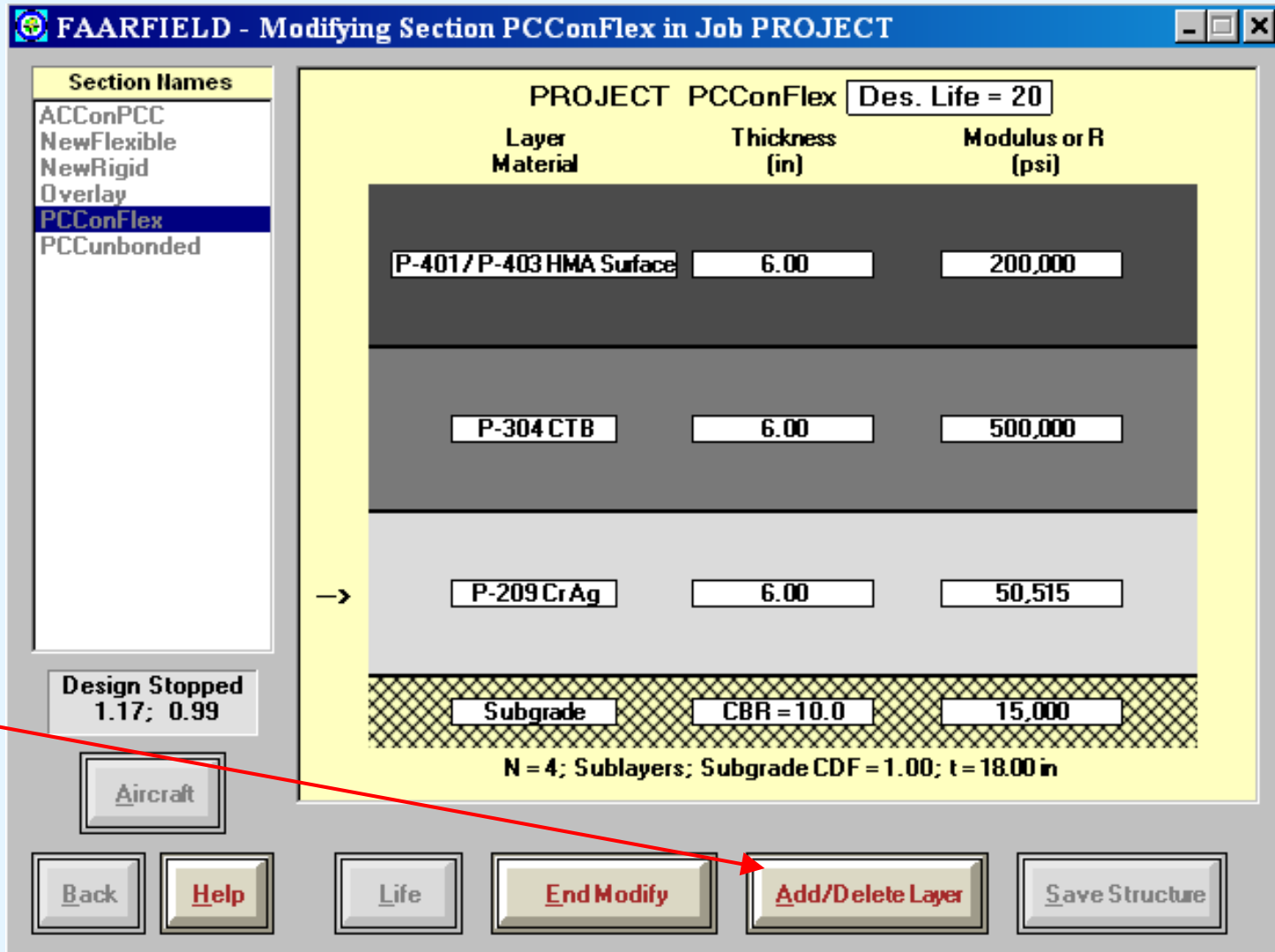
FAARFIELD – PCC Over Existing Flexible

Create Existing Pavement Section

Create the existing pavement section prior to the overlay

Adjust layer properties as required

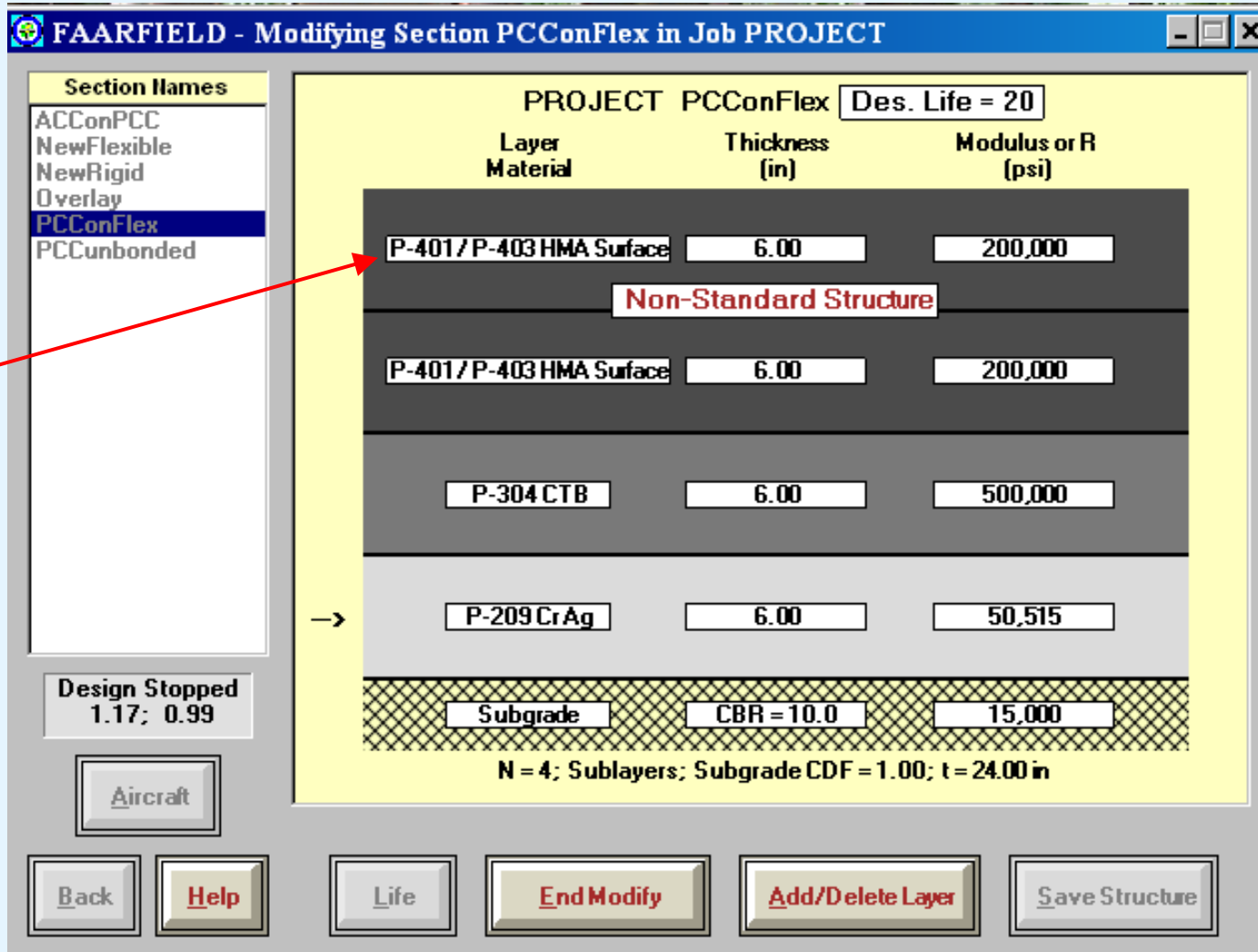
Click “Add/Delete Layer” to add the PCC Overlay



FAARFIELD – PCC Over Existing Flexible

Add Overlay Section

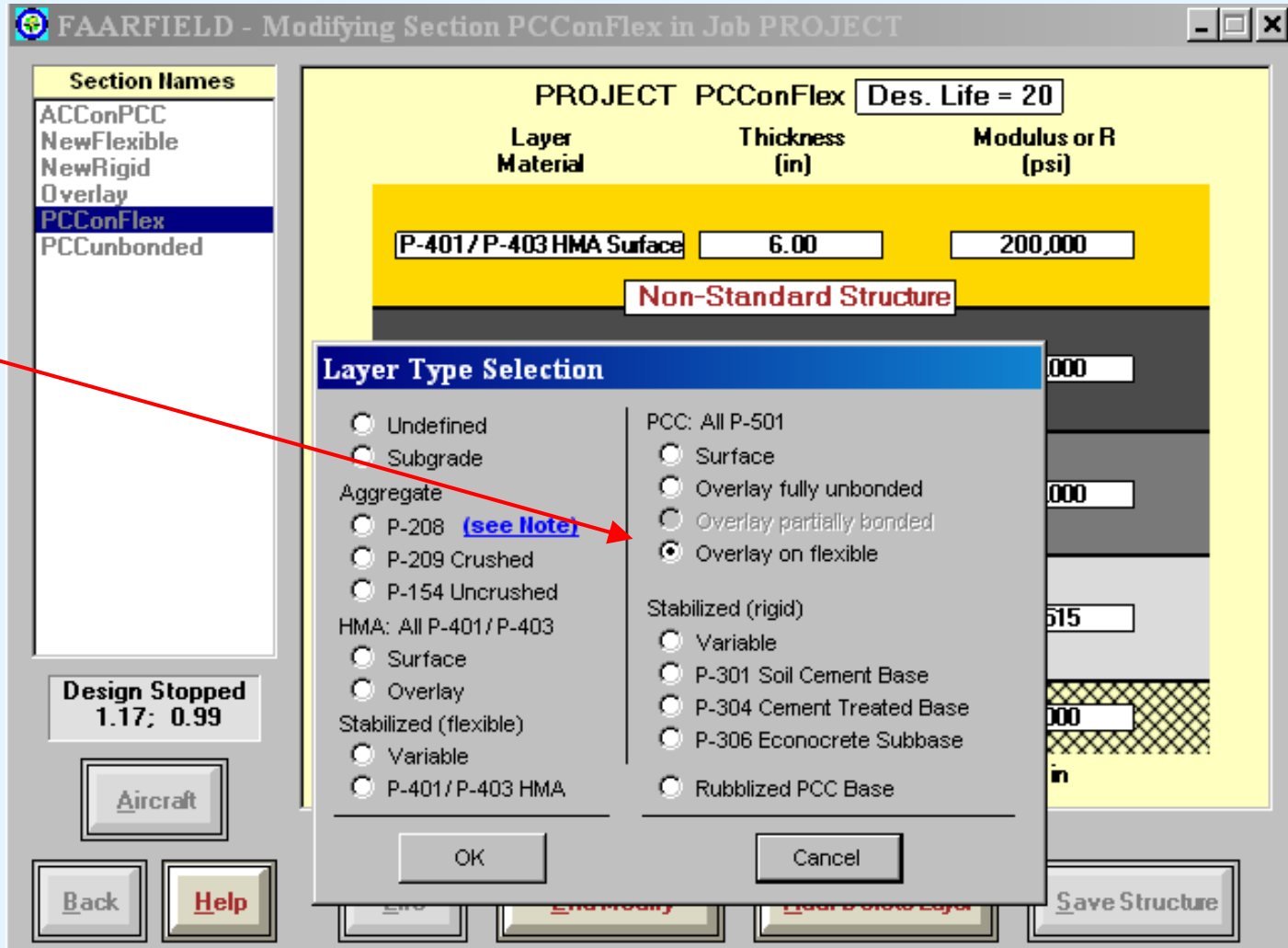
Click on the New layer to change it to a PCC overlay



FAARFIELD – PCC Over Existing Flexible

Modify Overlay Selection

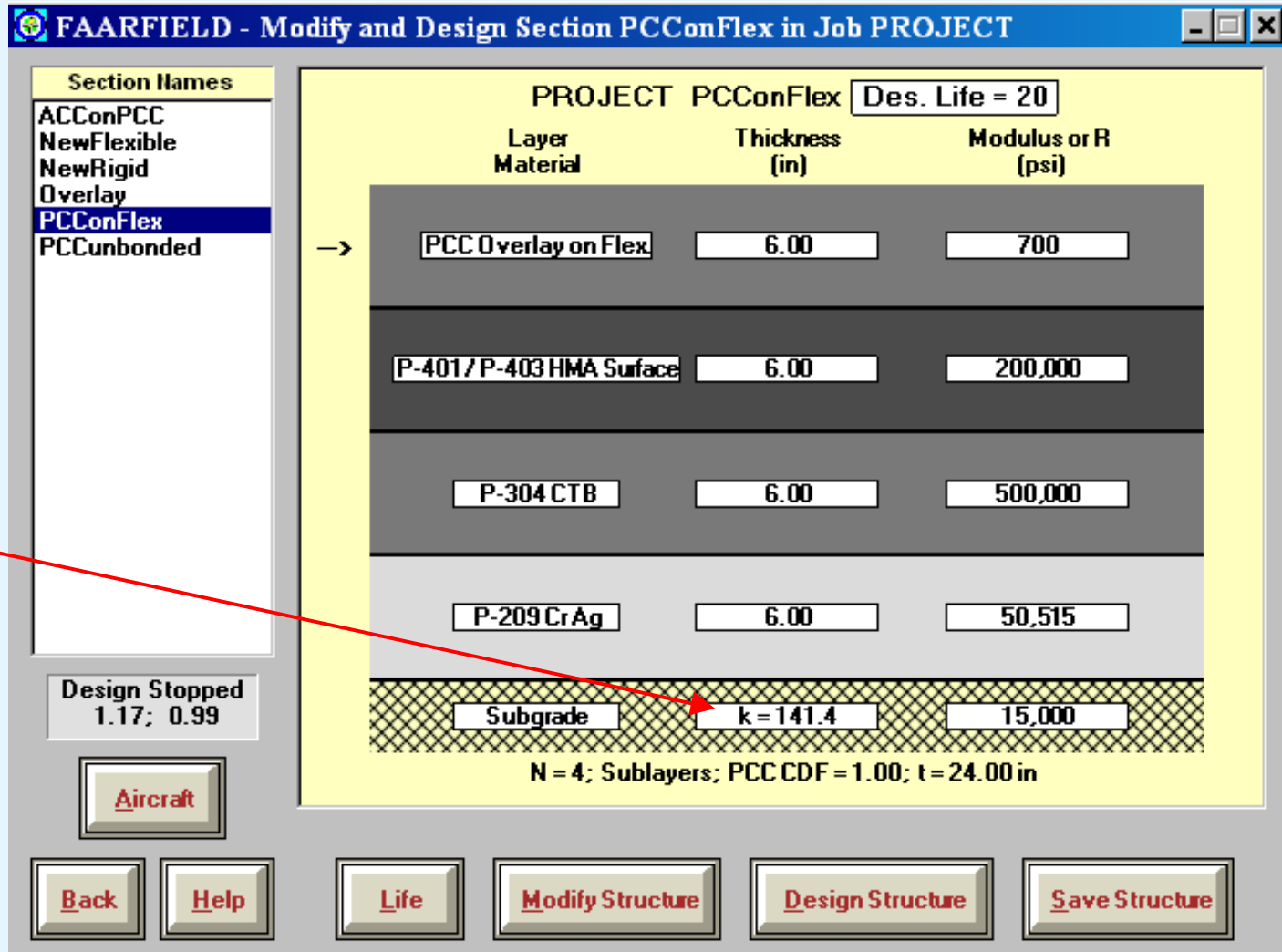
Select “Overlay on flexible”



FAARFIELD – PCC Over Existing Flexible

Modify Overlay Selection

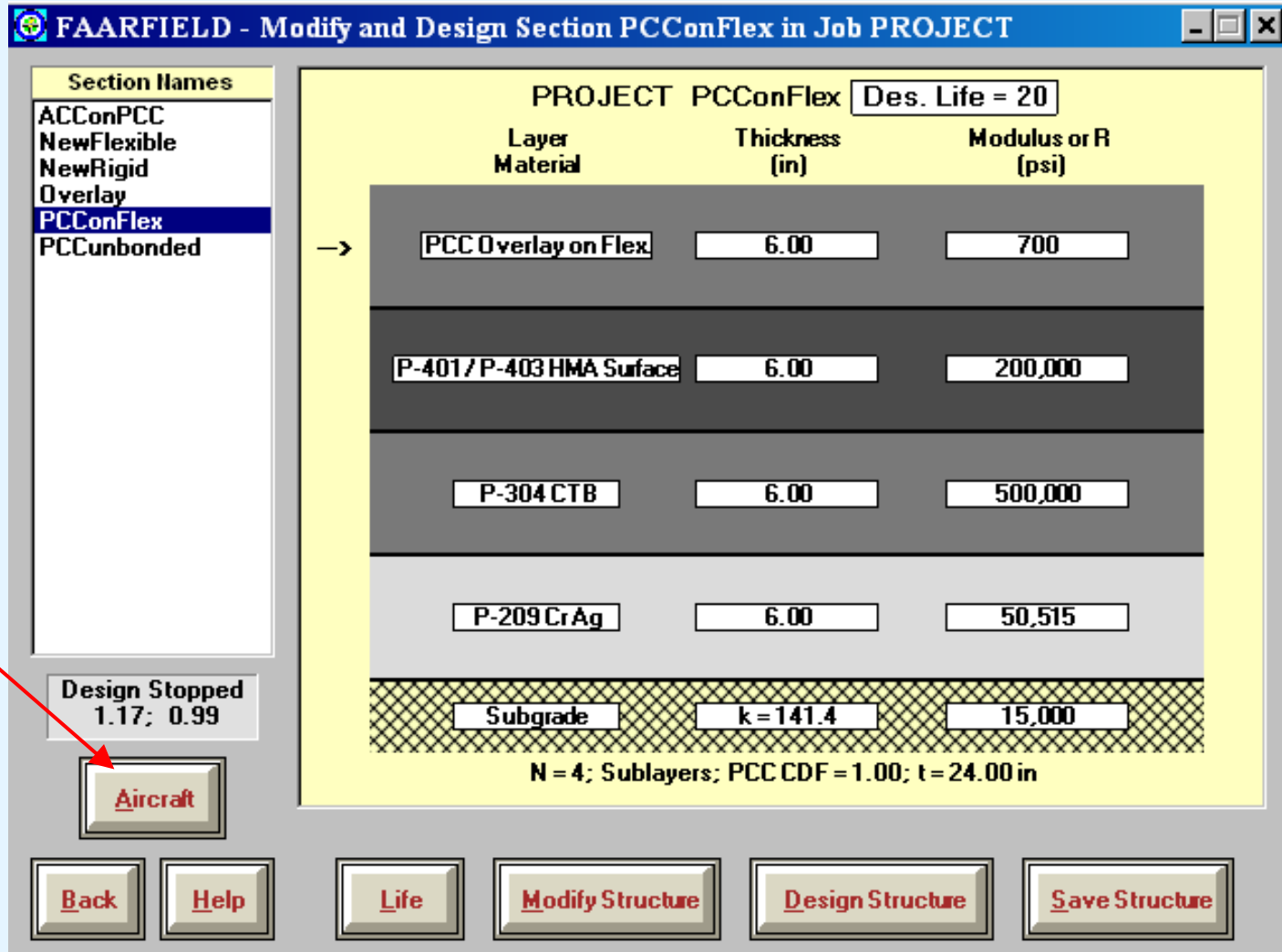
Note that the subgrade strength parameter has switch to k-value



FAARFIELD – PCC Over Existing Flexible

Confirm Airplanes in Traffic Model

Check to make sure you have the desired traffic for the overlay design



FAARFIELD – PCC Over Existing Flexible

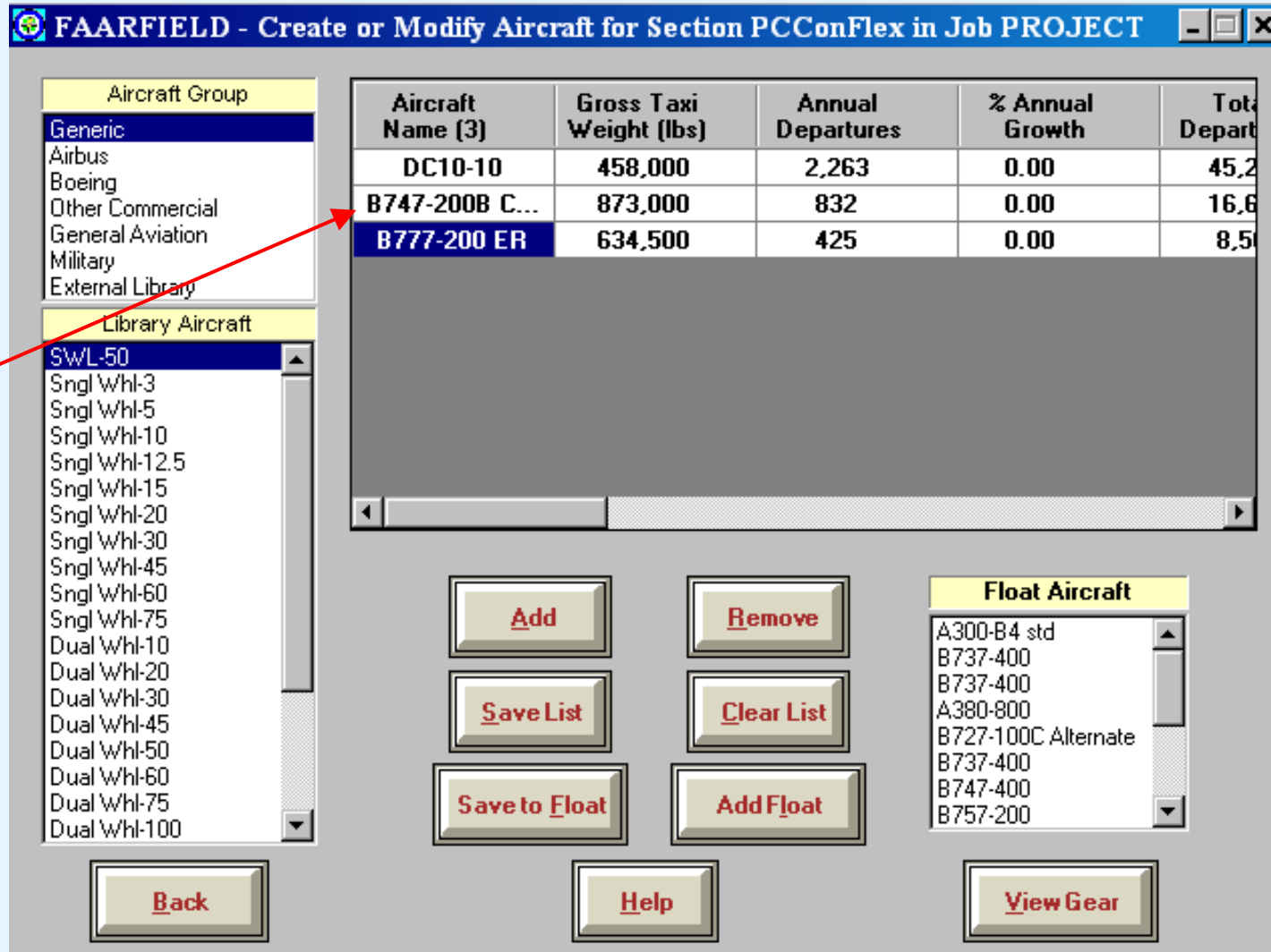
Traffic Mix for this PCC Overlay on Flexible Example

Aircraft Name	Gross Taxi Weight, lb	Annual Departures	Annual Growth, %
DC 10-10	458,000	2.263	0.0
B747-200B Combi	873,000	823	0.0
B777-200 ER	634.500	425	0.0

FAARFIELD – PCC Over Existing Flexible

Enter Traffic

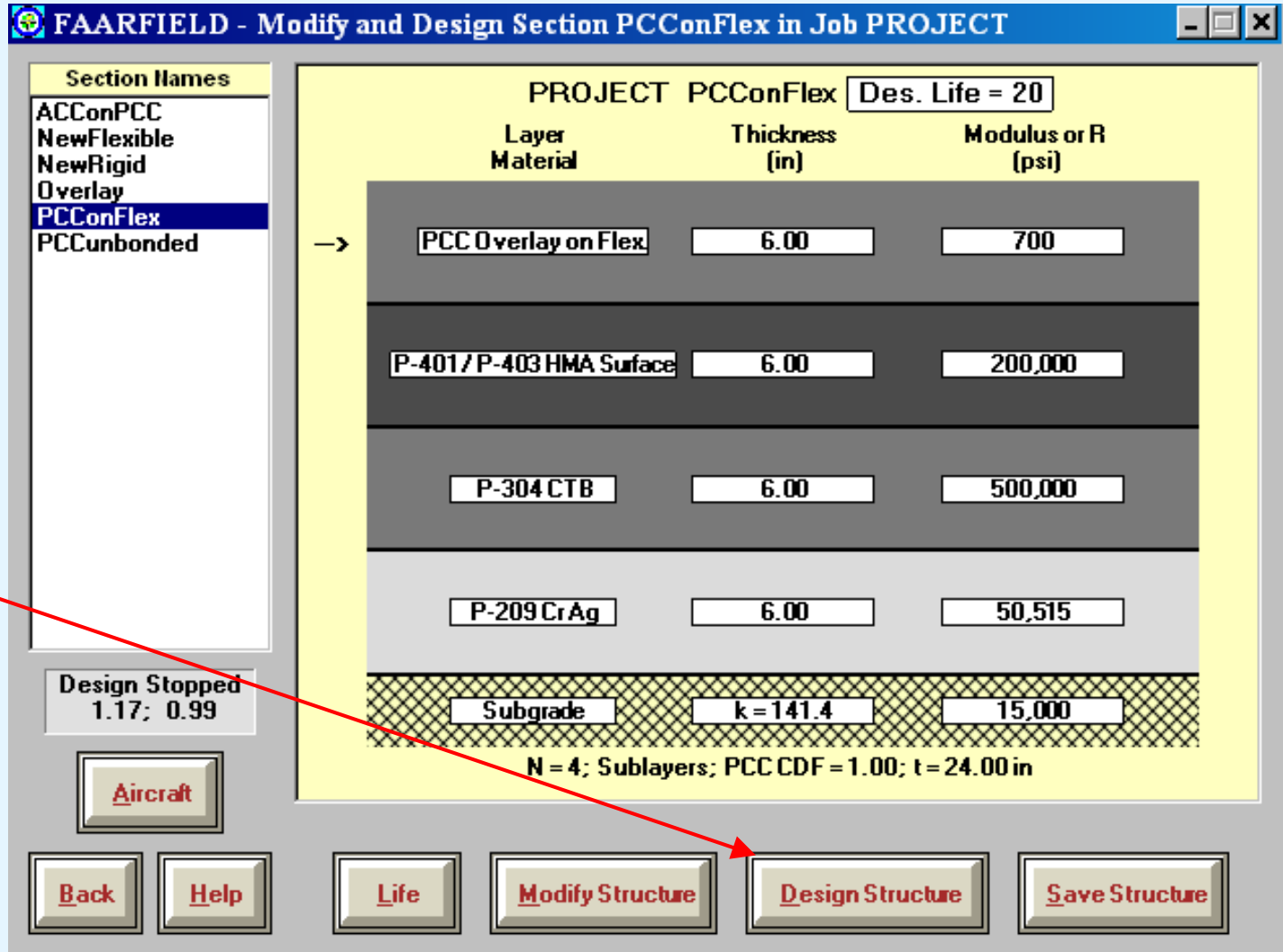
Input desired traffic



FAARFIELD – PCC Over Existing Flexible

Design Overlay Pavement Section

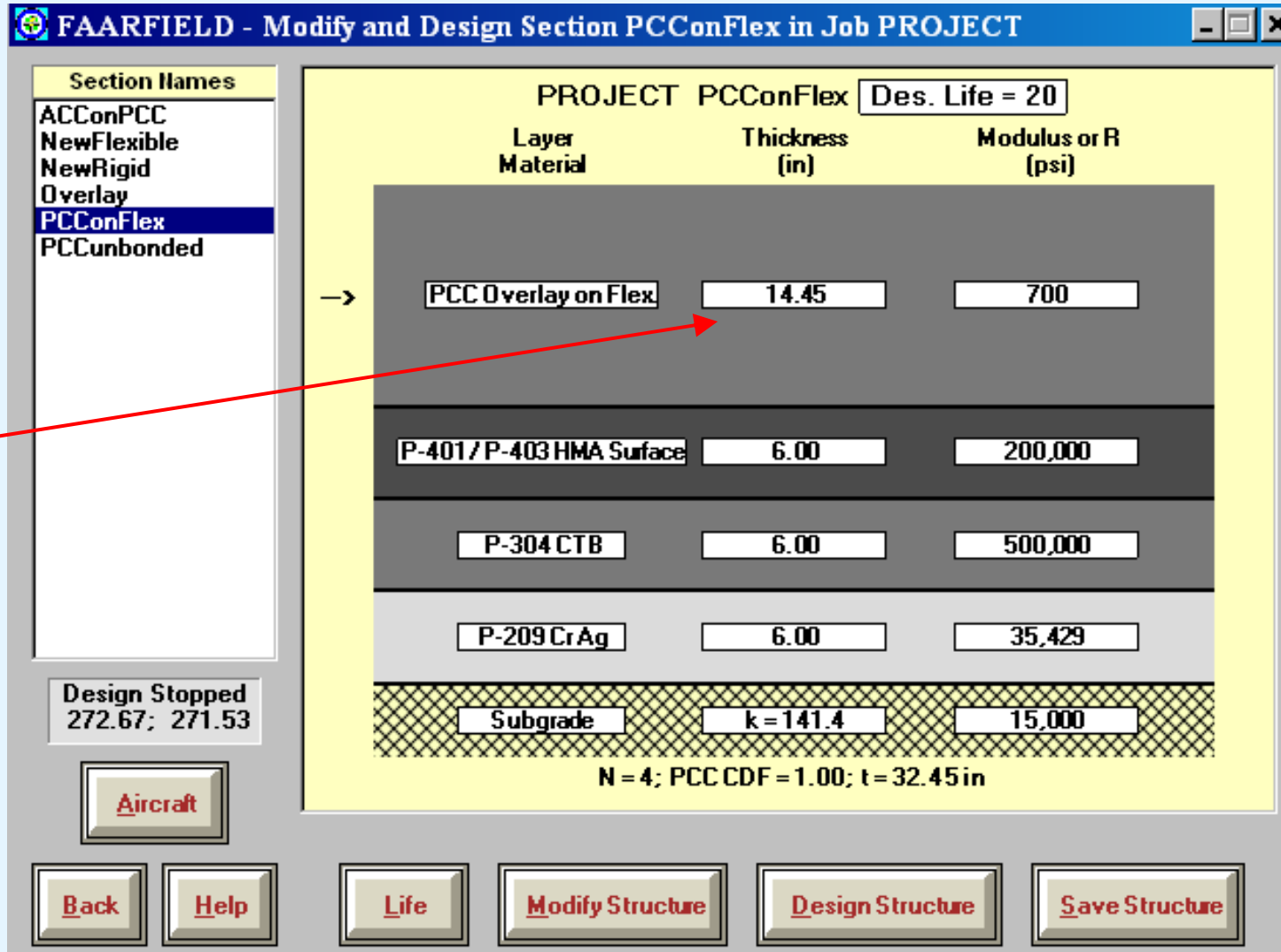
Select “Design Structure”



FAARFIELD – PCC Over Existing Flexible

Create Existing Pavement Section

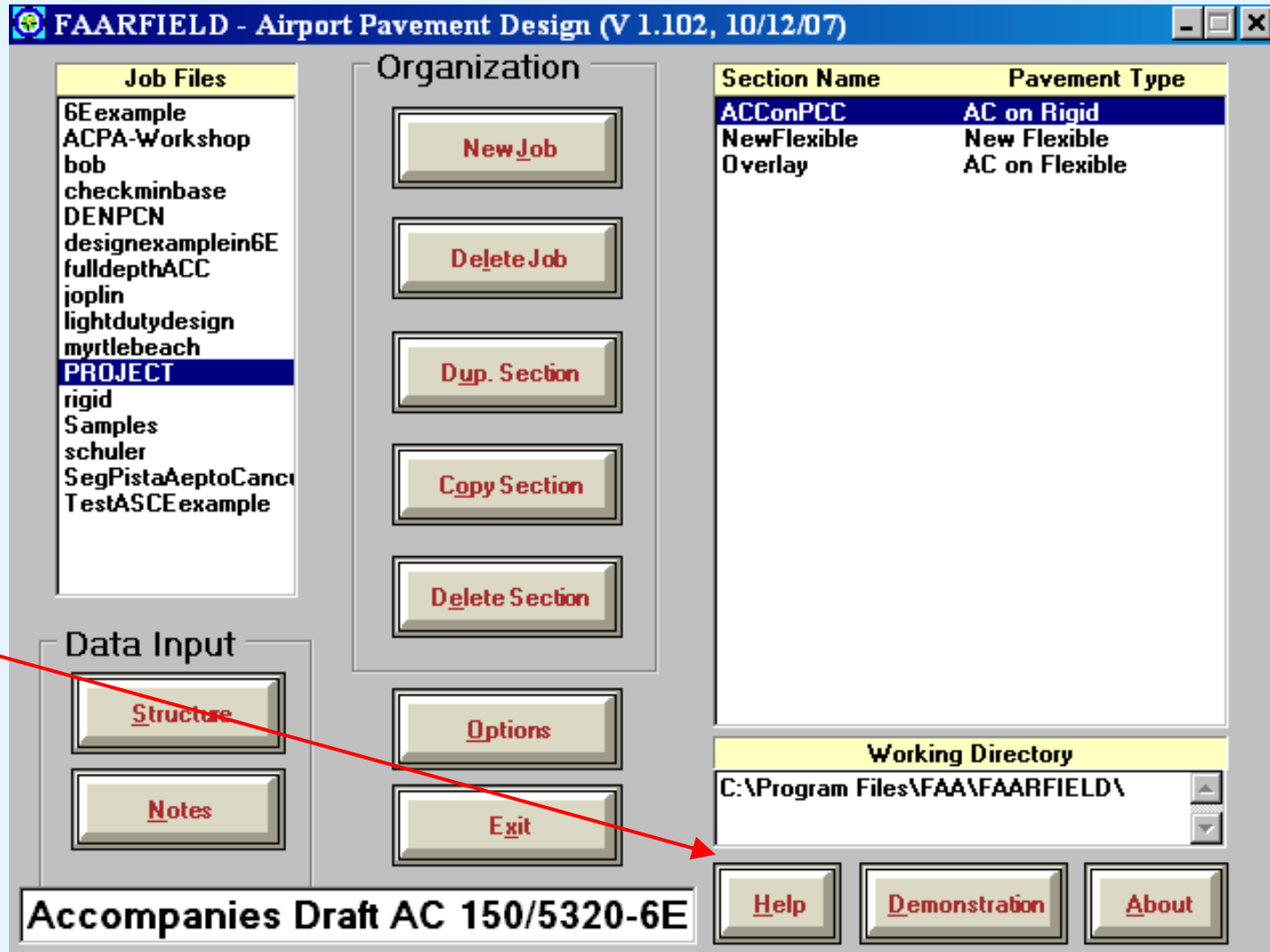
Final thickness of overlay = 14.5 inches



FAARFIELD - Help Manual

Interactive User's Manual / Help File

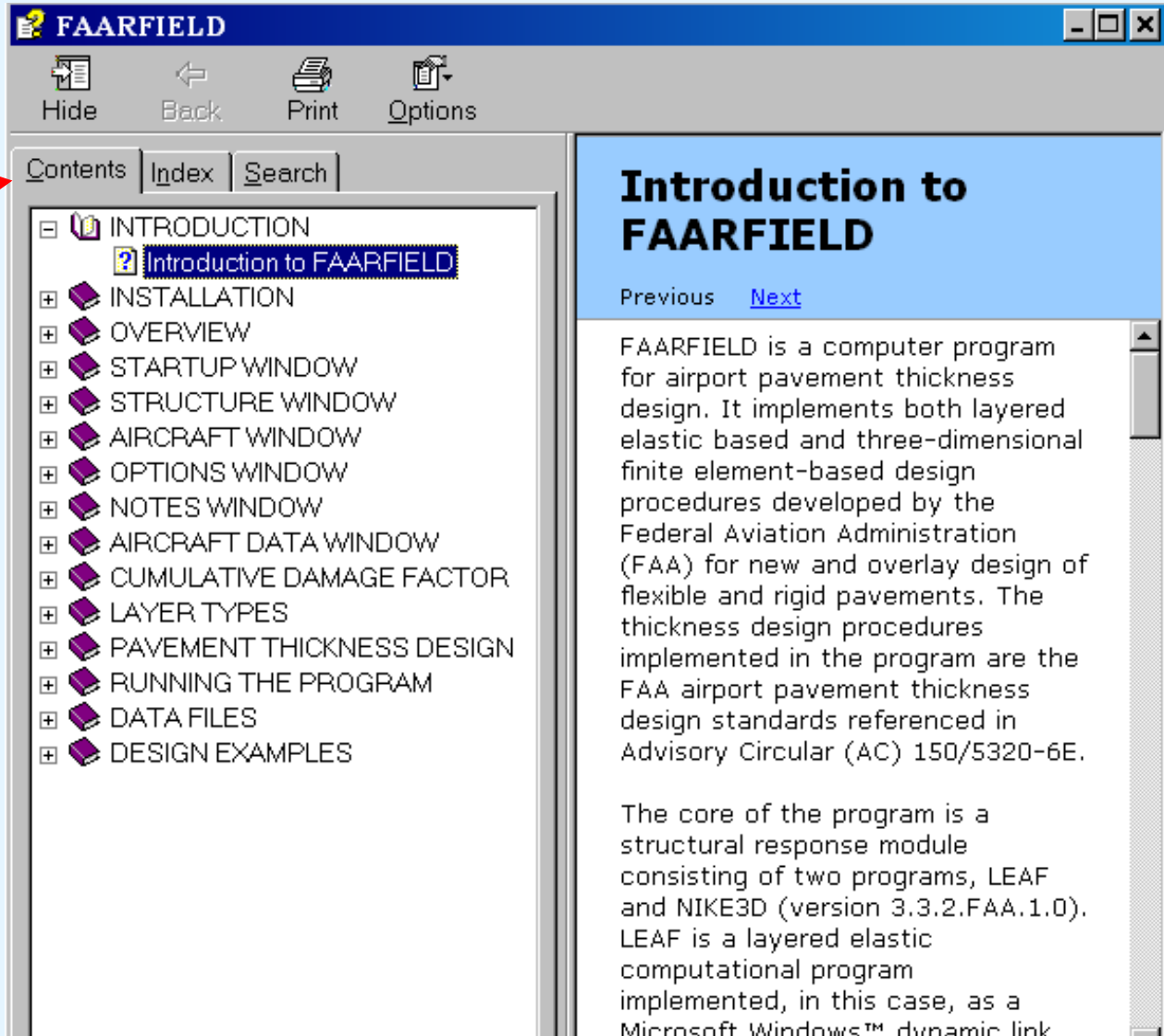
For assistance with the program click the Help key



FAARFIELD - Help Manual

Interactive User's Manual / Help File

Search by Contents/chapters, Index, or word search

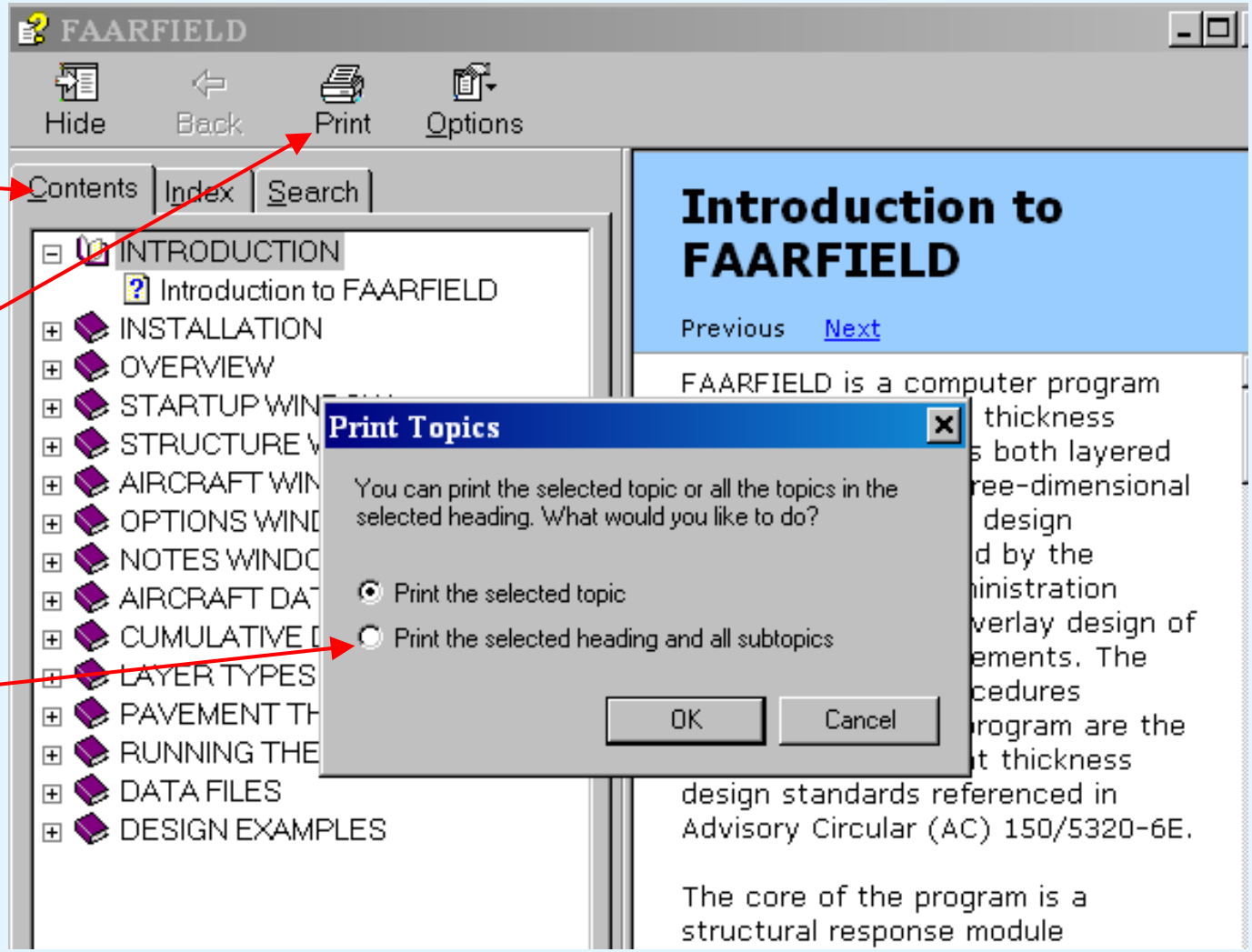


FAARFIELD - Help Manual

Print Help Manuals

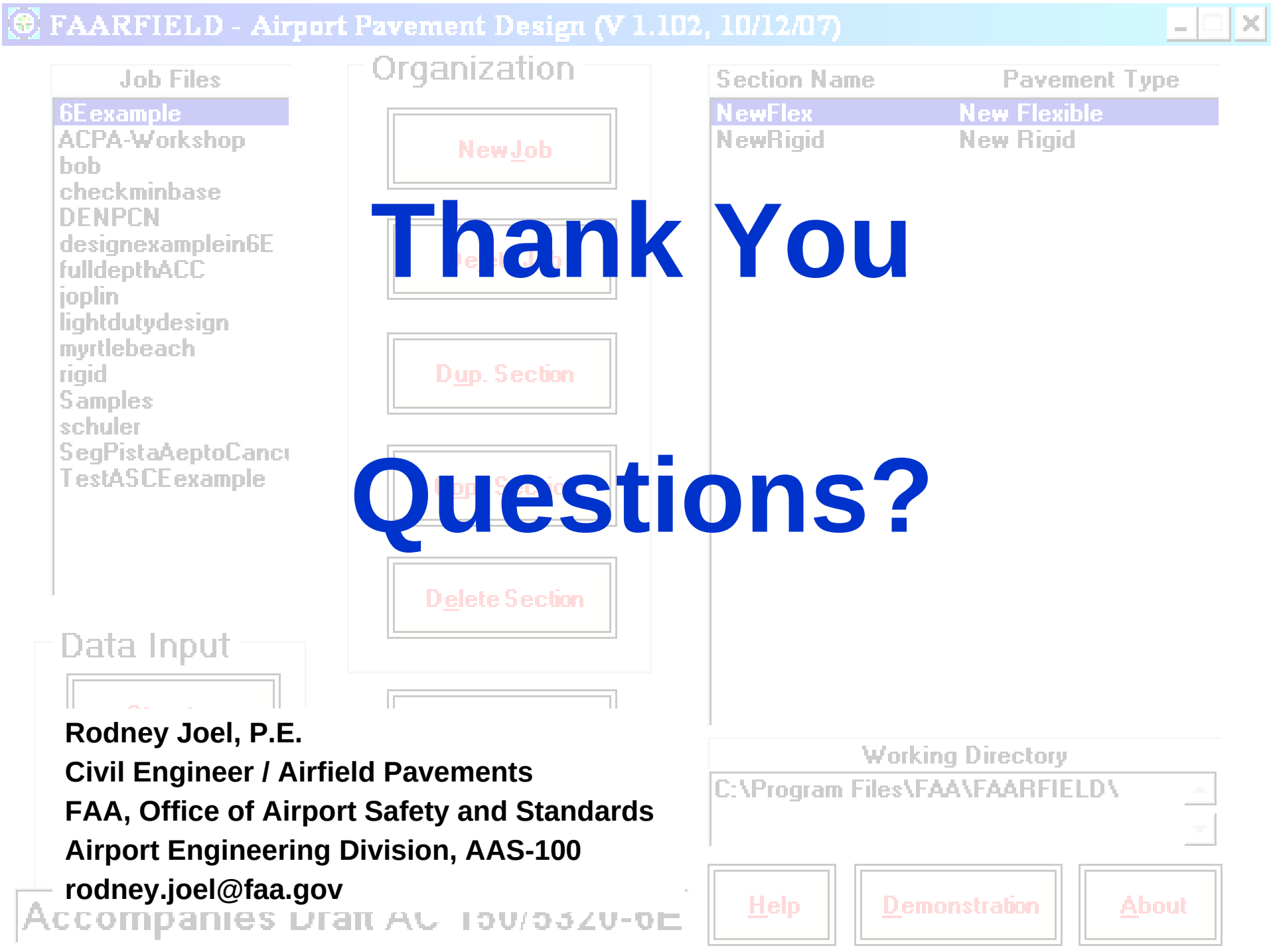
To print the manual move to the “Contents” tab and click Print

Select “Print the selected heading and all subtopic” Do this for each heading



Software Available at:

http://www.faa.gov/airports_airtraffic/airports/construction/design_software/


FAARFIELD - Airport Pavement Design (V 1.102, 10/12/07)
Job Files
6Eexample
ACPA-Workshop
bob
checkminbase
DENPCN
designexamplein6E
fulldepthACC
joplin
lightdutydesign
myrtlebeach
rigid
Samples
schuler
SegPistaAeptoCanc
TestASCEexample
Organization
New Job
Dup. Section
Delete Section
Section Name
Pavement Type
NewFlex
New Flexible
NewRigid
New Rigid
Data Input
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