

ICAO AERODROME PAVEMENT WORKSHOP

Design Examples Using FAARFIELD 2.1

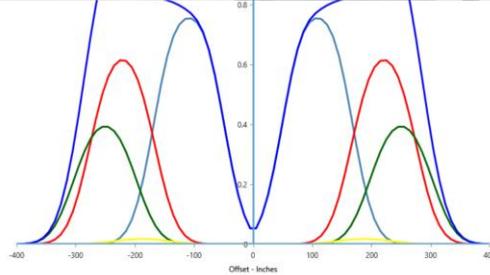
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Dakar, Senegal

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Date: 24 October 2024



**Federal Aviation
Administration**



FAARFIELD 2.1

Flexible Pavement Design Example

Flexible Pavement Design Example

A flexible pavement is being designed for a new runway at a commercial airport in Washington, D.C. Based on the information obtained from the Airport Master Plan, the new runway is expected to handle the traffic mix presented in Table 1. Eight soil borings were performed for this project, the results of which are presented in Table 2.

Table 1. Aircraft traffic mix for flexible pavement design example.

Aircraft	Departure Weight, kg	Arrival Weight, kg	Annual Departures
S-30	13,608	10,206	8000
Fokker F-100	44,452	34,019	6500
B737-300	62,822	52,163	5000
B767-300 ER	158,757	131,541	3200
A380-800	544,310	462,664	400
B777-300	263,083	237,682	1500

Table 2. Soil boring results for flexible pavement design example.

Boring No.	UCSC Soil Type	Moisture Content, %	Optimal MC, %	Dry unit weight, kN/m ³	Water Table Depth, m	CBR, %
B-1	SC	12.2	10.4	20.26	3	10.6
B-2	SC	14.4	12.2	19.57	3	7.2
B-3	SC	16.5	9.6	20.80	2.5	8.4
B-4	CL	15.8	13.5	18.88	2.0	6.3
B-5	CL	17.0	14.5	19.24	2.4	4.8
B-6	CL	16.2	13.8	18.96	1.7	5.9
B-7	CL	16.8	12.6	19.48	1.4	4.2
B-8	CL	14.2	12.8	20.14	1.8	6.4
Average:						
Std. Deviation:						

Flexible Pavement Design Example

- 1. What do the soil boring results tell us about the in situ soil properties? What subgrade support value do you recommend for design?**
- 2. What type and thickness of base/subbase materials do you recommend? Are positive drainage features required?**
- 3. Should the pavement be designed for aircraft arrival or departure weights? What is the required flexible pavement thickness for the runway? What is the most demanding aircraft?**
- 4. Perform a sensitivity analysis on the following variables:**
 - Average annual departures of most demanding aircraft (+/- 10 percent of departures).
 - Departure weight of the most demanding aircraft (+/- 10 percent of weight).
 - Subgrade modulus (+/- 10 percent of modulus).

Flexible Pavement Design Example

- 1. What do the soil boring results tell us about the in-situ soil properties? What subgrade support value do you recommend for design?**
- 2. What type and thickness of base/subbase materials do you recommend? Are positive drainage features required?**
- 3. Should the pavement be designed for aircraft arrival or departure weights? What is the required flexible pavement thickness for the runway? What is the most demanding aircraft?**

Boring No.	UCSC Soil Type	Moisture Content, %	Optimal MC, %	Dry unit weight, kN/m ³	Water Table Depth, m	CBR, %
B-1	SC	12.2	10.4	20.26	3	10.6
B-2	SC	14.4	12.2	19.57	3	7.2
B-3	SC	16.5	9.6	20.80	2.5	8.4
B-4	CL	15.8	13.5	18.88	2.0	6.3
B-5	CL	17.0	14.5	19.24	2.4	4.8
B-6	CL	16.2	13.8	18.96	1.7	5.9
B-7	CL	16.8	12.6	19.48	1.4	4.2
B-8	CL	14.2	12.8	20.14	1.8	6.4
Average:		15.4	12.4	19.66	2.3	6.7
Std. Deviation:		1.7	1.7	0.68	0.6	2.0

Starting Screen – No Job Files Created

The screenshot displays the FAAIRFIELD 2.1.1 (Build 12/21/2023) software interface. The main window is titled "Structure" and contains the following elements:

- Job Information:** Job Name: "New Job 1", Thickness Design: "Thickness Design", Run button, Status, Gear, Structure tabs.
- Structure Name:** "New Structure 1", Include in Summary Report (checked), Add To Batch button.
- Pavement Layers:** Pavement Type dropdown menu.
- Table:** A table with columns: Material, Thickness (mm), E (MPa). The table is currently empty.
- Buttons:** "Select As The Design Layer" and "Delete Selected Layer".
- Design Life:** Design Life (Years): "20". Text: "The standard design life for pavement structure is 20 years (1 to 50 allowed)."
- Results:** Calculated Life (Years): [input field], Total thickness to the top of the subgrade (mm): [input field].
- Copy Structure to Clipboard** button.
- Traffic Section:** Stored Aircraft Mix dropdown, Save Aircraft Mix to File, Clear All Aircraft from List, Remove Selected Aircraft from Structure, Delete Aircraft Mix File.
- Table:** A table with columns: Airplane Name, Gross Taxi Weight (kg), Annual Departures, Annual Growth (%), Total Departures, CDF Contributions, CDF Max for Airplane, P/C Ratio, Tire Pressure (kPa), Percent GW on Gear, Tire Contact Width (mm), Tire Contact Length (mm), Tire Contact Area (mm²). The table is currently empty.

The Explorer panel on the left shows a tree view with "New Job 1" expanded, containing "Job Information", "Design Options", "Summary Report", "Structures", and "New Structure 1". Under "New Structure 1", there are "Structure Report", "CDF Graph", "PCR Report", "PCR Graph", and "Airport Master Record".



Creating/Naming a Job File

Click "New Job"

Enter Job Name

Enter Section Name

FAARFIELD 2.1.1 (Build 12/21/2023)

explorer Structure Notes

New Job 1

Job Information

Design Options

Summary Report

Structures

New Structure 1

Structure Report

CDF Graph

PCR Report

PCR Graph

Airport Master Record

Structure

Job Name: New Job 1 Thickness Design Run Status Gear Structure

Structure Name: New Structure 1 Include in Summary Report Add To Batch

Pavement Layers

Pavement Type:

Material	Thickness (mm)	E (MPa)
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Select As The Design Layer Delete Selected Layer

Design Life (Years): 20

The standard design life for pavement structure is 20 years (1 to 50 allowed).

Results

Calculated Life (Years): Total thickness to the top of the subgrade (mm): 0

Copy Structure to Clipboard

Traffic

Stored Aircraft Mix Save Aircraft Mix to File Clear All Aircraft from List Remove Selected Aircraft from Structure Delete Aircraft Mix File

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm ²)
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Explorer Aircraft Material Notes User Information



Federal Aviation
Administration

Selecting Structure

Structure

Job Name: New Job 1 Thickness Design Run

Structure Name: New Structure 1 Include in Summary Report Add To Batch

Pavement Type: New Flexible

Material	Thickness (in.)	E (psi)	CBR
P-401/P-403 HMA Surface	4.0	200,000	
P-401/P-403 HMA Stabilized	5.0	400,000	
--> P-209 Crushed Aggregate	10.0	75,000	
Subgrade		15,000	10

Design Life (Years): 20

The standard design life for pavement structure is 20 years (1 to 50 allowed).

Results

Calculated Life (Years): Total thickness to the top of the subgrade (in.): 19.0

Traffic

Airplane Name	Gross Taxi Weight (lbs)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (psi)	Percent GW on Gear	Tire Contact Width (in.)	Tire Contact Length (in.)	Tire Contact Area (in. ²)
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Select "Thickness Design"

Select Pavement Type as "New Flexible"

Default pavement structure details in table

Default pavement Design Life

Default pavement structure for "New Flexible"

Design Options

Click "Design Options"

Select Option for "HMA CDF"

"Automatic Flexible Base Design"

"Output File"

"Units"

Structure: Summary Report

Job Name: New Job 1 Thickness Design Run Status Gear Structure

Structure Name: New Structure 1 Include in Summary Report Add To Batch

Pavement Type: New Flexible

Material	Thickness (mm)	E (MPa)	CBR
P-401/P-403 HMA Surface	102	1,370.95	
P-401/P-403 HMA Stabilized	127	1,370.95	
P-209 Crushed Aggregate	254	517.11	
Subgrade			10

Design Life (Years): 20
The standard design life for pavement structure is 20 years (1 to 50 allowed).
Results
Calculated Life (Years):
Total thickness to the top of the subgrade (mm): 483

Design Options

Calculate HMA CDF: No

Reduced Cross Section: No

Automatic flexible base design: Yes

Slab Stress Overlay: No

Output file: No

Units: Metric

Allow Flexible Computation for Thick Overlays on PCC: Yes

Compute ACR for All Subgrade Categories: No

Show Advanced Options

Set as Program Default Reset Default to Initial

Show/Hide Pavement Image

Change Pavement Graphics

User Defined Aircraft Directory:
C:\Users\David Bril\Documents (My FAARFIELD)\User Defined Aircraft
Change Aircraft Directory

Design Options Notes User Information

Traffic

Stored Aircraft Mix Save Aircraft Mix to File Clear All Aircraft from List Remove Selected Aircraft from Structure Delete Aircraft Mix File

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm²)
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Set Units to "Metric"

Materials Library – Layer Types

The screenshot displays the FAARFIELD 2.1.1 software interface. On the left, the 'Material' tab is selected in the 'Explorer' pane, showing a tree view of material categories: General, User Defined, Subgrade, Aggregate, P-154 Uncrushed Aggregate, P-208 Crushed Aggregate, P-209 Crushed Aggregate, P-211 Lime Rock, P-219 Recycled Concrete Aggregate, P-401/P-403 HMA, P-401/P-403 HMA Surface, P-401/P-403 HMA Overlay, P-501 PCC, P-501 PCC Surface, P-501 PCC Overlay (unbonded), P-501 PCC Overlay on Flexible, Stabilized, P-301 Soil Cement Base, P-304 Cement Treated Base, P-306 Lean Concrete, and P-401/P-403 HMA Stabilized Variable (flexible) and Variable (rigid). An arrow points to the 'Material' tab in the Explorer pane with the text 'Click "Materials" tab to open materials library'. The main window shows the 'Structure Summary Report' for 'New Job 1'. The 'Structure Name' is 'New Structure 1'. The 'Pavement Type' is 'New Flexible'. A table lists the pavement layers:

Material	Thickness (mm)	E (MPa)	CBR
P-401/P-403 HMA Surface	102	1,378.95	
P-401/P-403 HMA Stabilized	127	2,757.90	
P-209 Crushed Aggregate	254	517.11	
Subgrade			103.42

The 'Design Life (Years)' is 20. The 'Standard design life for pavement structure is 20 years (1 to 50 allowed)'. The 'Calculated Life (Years)' is blank, and the 'Total thickness to the top of the subgrade (mm)' is 483. The 'Traffic' section shows 'Stored Aircraft Mix' and a table with columns: Airplane Name, Gross Taxi Weight (kg), Annual Departures, Annual Growth (%), Total Departures, CDF Contributions, CDF Max for Airplane, P/C Ratio, Tire Pressure (kPa), Percent GW on Gear, Tire Contact Width (mm), Tire Contact Length (mm), and Tire Contact Area (mm²). The 'Design Options' pane on the right includes settings for 'Calculate HMA CDF', 'Reduced Cross Section', 'Automatic flexible base design', 'Slab Stress Displayed', 'Output file', 'Units', 'Allow Flexible Computation for Thick Overlays on PCC', 'Compute ACR for All Subgrade Categories', 'Set as Program Default', 'Reset Default to Initial', 'Show/Hide Pavement Image', 'Change Pavement Graphics', and 'User Defined Aircraft Directory'.

Click "Materials" tab to open materials library

Aircraft Library

The screenshot displays the FAARFIELD 2.1.1 software interface. On the left, the 'Aircraft' tab is selected in the Explorer, and the 'FAARFIELD Aircraft Library' is expanded, showing a list of aircraft models from SWL-2 to S-60. An arrow points from the text 'Click "Aircraft" tab to open aircraft library' to the 'Aircraft' tab in the Explorer. The main window shows the 'Structure: Summary Report' for 'New Job 1'. The 'Pavement Layers' table is as follows:

Material	Thickness (mm)	E (MPa)	CBR
P-401/P-403 HMA Surface	102	1,378.95	
P-401/P-403 HMA Stabilized	127	2,757.90	
P-209 Crushed Aggregate	254	517.11	
Subgrade	103.42		10

The 'Design Life (Years):' is set to 20. The 'Standard design life for pavement structure is 20 years (1 to 50 allowed)'. The 'Results' section shows 'Calculated Life (Years):' and 'Total thickness to the top of the subgrade (mm): 483'. The 'Traffic' section includes a table for 'Stored Aircraft Mix' with columns for Airplane Name, Gross Taxi Weight (kg), Annual Departures, Annual Growth (%), Total Departures, CDF Contributions, CDF Max for Airplane, P/C Ratio, Tire Pressure (kPa), Percent GW on Gear, Tire Contact Width (mm), Tire Contact Length (mm), and Tire Contact Area (mm²).

Click "Aircraft" tab to open aircraft library

Aircraft Library –

Completely reorganized and updated for the FAARFIELD 2.0 release

FAARFIELD Aircraft Group	FAARFIELD Aircraft Group	FAARFIELD Aircraft Group					
Generic	Generic	Generic	Generic	Generic	Generic	Generic	Generic
Airbus	Airbus	Airbus	Airbus	Airbus	Airbus	Airbus	Airbus
Boeing	Boeing	Boeing	Boeing	Boeing	Boeing	Boeing	Boeing
McDonnell Douglas	McDonnell Douglas	McDonnell Douglas					
Other Large Jet	Other Large Jet	Other Large Jet					
Regional/Commuter	Regional/Commuter	Regional/Commuter	Regional/Commuter	Regional/Commuter	Regional/Commuter	Regional/Commuter	Regional/Commuter
General Aviation	General Aviation	General Aviation					
Military	Military	Military	Military	Military	Military	Military	Military
Non-Airplane Vehicles	Non-Airplane Vehicles	Non-Airplane Vehicles					
External Library	External Library	External Library					
FAARFIELD Aircraft Library	FAARFIELD Aircraft Library	FAARFIELD Aircraft Library					
SWL-2	A300-82	B707-320C	DC3	An-124	BAe 146-300/300QC/300QT	Beechcraft Baron 55	A400M LH
SWL-5	A300-82K	B717-200 HGW	DC8-63/73	An-225	BeechJet-400/400A	Beechcraft Bonanza F33A	A400M LN1
SWL-10	A300-B4/C4 Std Bogie	B727-100C Alternate	DC9-32	Bombardier CS100	Bombardier CL-604/605	Beechcraft King Air 300	A400M TLL1
SWL-50	A300-B4/C4 LGA Bogie	B727-200 Advanced Basic	DC9-51	COMAC C919	Cessna Citation II/Bravo C550	Beechcraft King Air 350	A400M TLL2
S-3	A300-600 Std Bogie	B727-200 Advanced Option	DC/MD-10-10/10F	COMAC C919 ER	Cessna Citation V	Beechcraft King Air B100	B-52
S-5	A300-600 LGA Bogie	B737-100	DC/MD-10-30/30F/40	Fokker-F-100	Cessna Citation VI/VII	Beechcraft King Air B200	C-5
S-10	A310-200	B737-200 Advanced QC	MD-11	Fokker-F-28-1000/2000	Cessna Citation X	Beechcraft King Air C90	C-17A
S-12.5	A310-300	B737-200	MD-83	F-28-3000/4000/6000	CRJ100/200	Cessna 172 Skyhawk	C-123
S-15	A318-100 std	B737-300	MD-90-30 ER	IL-62	CRJ100ER/200ER	Cessna 182 Skyline	C-130
S-20	A318-100 opt	B737-400		IL-76T	CRJ100LR/200LR	Cessna 206 Stationair	C-130-57
S-25	A319-100 std	B737-500		IL-86	CRJ700	Cessna 208B Grand Caravan	C-130-70
S-30	A319-100 opt	B737-600		L-100-20	CRJ900	Cessna 414/414A Chancellor	F-15C
S-30 HTP	A319neo	B737-700		L-1011	CRJ1000	Cessna C210 Centurion	F-16C
S-35 HTP	A320-200 std	B737-800		TU-134A	Dassault Falcon 50/50EX	Cessna C441 Conquest II	F/A-18C
S-40 HTP	A320-200 opt	B737-900		TU-154B	Dassault Falcon 900B/C	Cessna Citation M2 C525	KC-10
S-45	A320-200 WX000.Boeing	B737-900 ER					B-3C



Creating Aircraft Traffic Mix

The screenshot displays the FAARFIELD 2.1.1 software interface. On the left, the 'Aircraft' library is visible, listing various aircraft types such as 'Airbus', 'Boeing', and 'Bombardier'. The main window shows the 'Structure' design options, including 'Job Name', 'Structure Name', and 'Pavement Layers'. A graph displays the gear geometry for an airplane, with dimensions in millimeters. The 'Traffic' table at the bottom lists various aircraft types and their associated traffic data.

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CRF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm ²)
S-30	13,608	8,000	0	100,000	0	0	0	517.11	0.95	312	500	122,580
Fokker-F-100	44,452	6,500	0	130,000	0	0	0	1043.63	0.95	281	450	99,204
B737-300	62,822	5,000	0	100,000	0	0	0	1370.99	0.95	291	466	106,724
B767-300 ER	158,757	3,200	0	64,000	0	0	0	1168.60	0.95	355	568	158,205
A380-800 WW000	544,310	400	0	8,000	0	0	0	1455.74	0.38	372	596	174,171
A380-800 WW000 Belly	544,310	400	0	8,000	0	0	0	1455.74	0.57	372	596	174,171
B777-300	263,065	1,500	0	30,000	0	0	0	1236.75	0.95	354	566	157,264

- Select aircraft from the library by aircraft group and type.
- Double-click the aircraft name, or drag/drop into the traffic table.
- Once done, click “Save Aircraft Mix to File.” Give it a file name.
- Traffic files are stored in *My FAARFIELD/TrafficLibrary*

Highlight an aircraft to display gear geometry. (Gear geometry displays in window.)

Subgrade CBR

The screenshot displays the FAARFIELD 2.1.1 (Build 12/21/2023) interface. The main window shows a pavement structure design with the following layers:

Material	Thickness (mm)	E (MPa)	CBR
P-401/P-403 HMA Surface	102	1,379.95	
P-401/P-403 HMA Stabilized	127	2,757.90	
P-209 Crushed Aggregate	254	517.11	
Subgrade		48.61	4.7

The 'Layer Property' dialog box is open, showing the 'Materials Menu' with the following options:

- General:**
 - User Defined
 - Subgrade
- P-401/P-403 HMA:**
 - P-401/P-403 HMA Surface
 - P-401/P-403 HMA Overlay
- P-501 PCC:**
 - P-501 PCC Surface
 - P-501 PCC Overlay (Unbonded)
 - P-501 PCC Overlay on Flexible
- Aggregate:**
 - P-154 Uncrushed Aggregate
 - P-208 Crushed Aggregate
 - P-209 Crushed Aggregate
 - P-211 Lime Rock
 - P-219 Recycled Concrete Aggregate
- Stabilized:**
 - P-301 Soil Cement Base
 - P-304 Cement Treated Base
 - P-306 Lean Concrete
 - P-401/P-403 HMA Stabilized
 - Variable (flexible)
 - Variable (rigid)

Input fields in the dialog show: Update Thickness (in.) = 12.0, Update Modulus (psi) = 15,000, Update Concrete Flexural Strength R (psi) = [empty], Update CBR = 4.7, and Update Subgrade Reaction (pci) = 172.4.

A callout box on the left contains the following instructions:

- Enter Subgrade CBR
- Modulus is computed as $1500 \times \text{CBR}$ (psi)
- Enter data directly in the table, or click on a layer to bring up the layer property dialog box.

The bottom of the screen shows a 'Traffic' table with columns for Airplane Name, Gross Taxi Weight (kg), Annual Departures, Annual Growth (%), Total Departures, CDF Contributions, CDF Max for Airplane, P/C Ratio, Tire Pressure (kPa), Percent GW on Gear, Tire Contact Width (mm), Tire Contact Length (mm), and Tire Contact Area (mm²).



Performing Pavement Thickness Design

Click "Run" to start pavement thickness design

The screenshot displays the FAARFIELD 2.1.1 software interface for pavement thickness design. The main window is titled 'Structure Summary Report'. In the 'Structure' panel, the 'Run' button is highlighted with a callout box that says 'Click "Run" to start pavement thickness design'. The 'Pavement Layers' table is as follows:

Material	Thickness (mm)	E (MPa)	CBR
P-401/P-403 HMA Surface	102	1,378.95	
P-401/P-403 HMA Stabilized	127	2,757.90	
P-209 Crushed Aggregate	254	517.11	
Subgrade		48.61	4.7

The 'Design Options' panel on the right shows various settings, including 'Calculate HMA CDF: No', 'Reduced Cross Section: No', 'Automatic flexible base design: Yes', 'Slab Stress Displayed: No', 'Output file: No', 'Units: Metric', 'Allow Flexible Computation for Thick Overlays on FCC: Yes', and 'Compute ACR for All Subgrade Categories: No'. There are also buttons for 'Show Advanced Options', 'Set as Program Default', 'Reset Default to Initial', 'Show/Hide Pavement Image', and 'Change Pavement Graphics'.

The 'Traffic' table at the bottom provides data for various aircraft types:

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm ²)
S-30	13,608	8,000	0	160,000	0	0	0	517.11	0.95	312	500	122,580
Fokker-F-100	44,452	6,500	0	130,000	0	0	0	1043.63	0.95	281	450	99,204
B737-300	62,822	5,000	0	100,000	0	0	0	1370.99	0.95	291	466	106,724
B767-300 ER	158,757	3,200	0	64,000	0	0	0	1168.60	0.95	355	568	158,205
A380-800 WW000	544,310	400	0	8,000	0	0	0	1455.74	0.38	372	596	174,171
A380-800 WW000 Belly	544,310	400	0	8,000	0	0	0	1455.74	0.57	372	596	174,171
B777-300	263,083	1,500	0	30,000	0	0	0	1298.75	0.95	354	566	157,264



Federal Aviation Administration

Completed Pavement Thickness Design

P-209 Thickness was designed

P/C Ratio for each aircraft

CDF max. for aircraft

CDF contribution of each aircraft

Structure Summary Report

Job Name: New Job 1 | Thickness Design | Run | Status: Gear | Structure

Structure Name: New Structure 1 | Include in Summary Report | Add To Batch

Pavement Type: New Flexible

Material	Thickness (mm)	E (MPa)	CBR
P-401/P-403 HMA Surface	102	1,378.95	
P-401/P-403 HMA Stabilizer	127	2,757.90	
P-209 Crushed Aggregate	681	435.58	
Subgrade		48.61	4.7

Design Life (Years): 20

The standard design life for pavement structure is 20 years (1 to 50 allowed).

Results

Calculated Life (Years): | Total thickness to the top of the subgrade (mm): 909

Traffic

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm ²)
S-30	13,608	8,000	0	160,000	0	0	1.77	517.11	0.95	312	500	122,580
Fokker-F-100	44,452	6,500	0	130,000	0	0	1.33	1043.63	0.95	281	450	99,204
B737-300	62,822	5,000	0	100,000	0	0	1.26	1370.99	0.95	291	466	106,724
B767-300 ER	158,757	3,200	0	64,000	0.01	0.01	1.13	1168.60	0.95	355	568	158,205
A380-800 WW000	544,310	400	0	8,000	0.35	0.39	1.15	1455.74	0.38	372	596	174,171
A380-800 WW000 Belly	544,310	400	0	8,000	0.02	0.76	1.25	1455.74	0.57	372	596	174,171
B777-300 ER	263,083	1,500	0	30,000	0.62	0.62	1.19	1298.75	0.95	354	566	157,264

Design Options

Calculate HMA CDF: No

Reduced Cross Section: No

Automatic flexible base design: Yes

Slab Stress Displayed: No

Output file: No

Units: Metric

Allow Flexible Computation for Thick Overlays on FCC: Yes

Compute ACR for All Subgrade Categories: No

Show Advanced Options

Set as Program Default | Reset Default to Initial

Show/Hide Pavement Image

Change Pavement Graphics

User Defined Aircraft Directory: C:\Users\David Bril\Documents\My FAARFIELD\User Defined Aircraft

Change Aircraft Directory

Design Option | Notes | User Information

CDF Chart

FAARFIELD 2.1.1 (Build 12/21/2023)

File Edit View Structure Report Help

Structure: Summary Report

Job Name: New Job 1 Thickness Design Run

Structure Name: New Structure 1 Include in Summary Report Add To Batch

Pavement Layers: New Flexible

Material	Thickness (mm)	E (MPa)	CBR
P-401(P-403 HMA Surface	102	11,378.99	
P-401(P-403 HMA Stabilized	127	2,757.90	
P-209 Crushed Aggregate	681	435.58	
Subgrade		48.61	4.7

Design Life (Years): 20

The standard design life for pavement structure is 20 years (1 to 50 allowed).

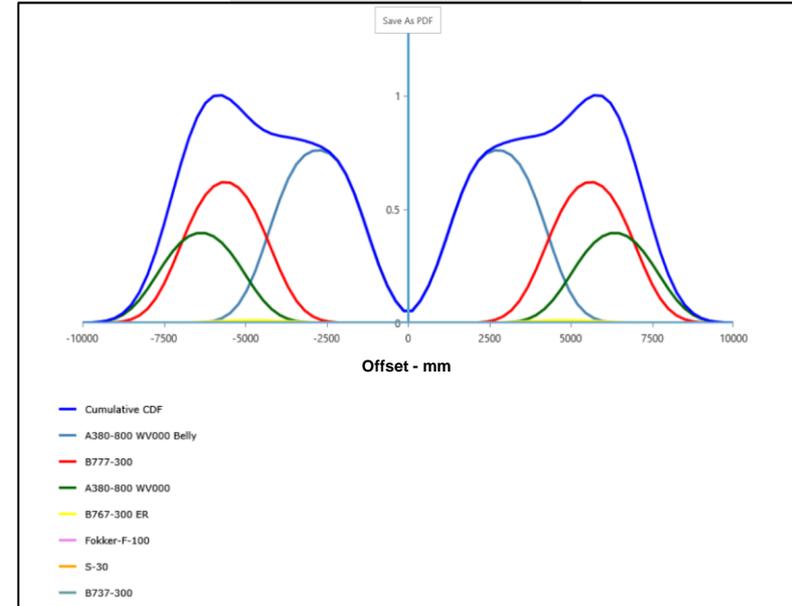
Results:

Calculated Life (Years): Total thickness to the top of the subgrade (mm): 909

Traffic:

Aircraft Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDP Contributions	CDP Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm ²)
S-30	13,608	8,000	0	160,000	0	0	1.77	517.11	0.95	312	500	122,580
Fokker-F-100	44,452	6,500	0	130,000	0	0	1.33	1043.63	0.95	281	450	99,204
B737-300	62,822	1,000	0	100,000	0	0	1.26	1370.99	0.95	291	466	106,724
B767-300 ER	158,757	3,200	0	64,000	0.01	1.13	1168.60	0.95	355	568	158,205	
A380-800 WV000	544,310	400	0	8,000	0.35	0.39	1.15	1455.74	0.38	372	596	174,171
A380-800 WV000 Belly	544,310	400	0	8,000	0.02	0.36	1.25	1455.74	0.57	372	596	174,171
B777-300	263,083	1,500	0	30,000	0.62	0.62	1.19	1298.75	0.95	354	566	157,254

Job Name: New Job 1
 Structure: New Structure 1
 Analysis Type: New Flexible
 Analysis Run Time: 2024-01-30 09:15:41
 Last Run: Thickness Design
 Design Life = 20.0 Years
 Total thickness to the top of the subgrade = 909mm



Structure Report

FAARFIELD 2.1.1 (Build 12/21/2023)

New Job | Open Job | New Structure | Save Job | Save As | Save All | Close Job | User Defined Aircraft | Create | Edit | Batch Run Selection | Select All | DeSelect All | PAVEAIR Access

Explorer: Structure Summary Report Structure Report CDF Graph

Save As PDF

Federal Aviation Administration FAARFIELD 2.1 Structure Report

FAARFIELD 2.1.1 (Build 12/21/2023)

Job Name: New Job 1
 Structure: New Structure 1
 Analysis Type: New Flexible
 Last Run: Thickness Design 2024-01-30 09:15:41
 Design Life = 20 Years
 Total thickness to the top of the subgrade = 909mm

Pavement Structure Information by Layer

No.	Type	Thickness (mm)	Modulus (MPa)	CBR	Poisson's Ratio	Strength R (MPa)
1	P-401/P-403 HMA Surface	102	1,378.95	0	0.35	0
2	P-401/P-403 HMA Stabilized	127	2,757.90	0	0.35	0
3	P-209 Crushed Aggregate	681	435.58	0	0.35	0
4	Subgrade	0	48.61	4.7	0.35	0

Airplane Information

No.	Name	Gross Wt. (kg)	Annual Departures	% Annual Growth
1	S-30	13,608	8,000	0
2	Fokker-F-100	44,452	6,500	0
3	B737-300	62,822	5,000	0
4	B767-300 ER	158,757	3,200	0

Design Options: Calculate HMA CDF: No, Reduced Cross Section: No, Automatic flexible base design: Yes, Slab Stress Displayed: No, Output file: No, Units: Metric, Allow Flexible Computation for Thick Overlays on PCC: Yes, Compute ACR for All Subgrade Categories: No

Show Advanced Options

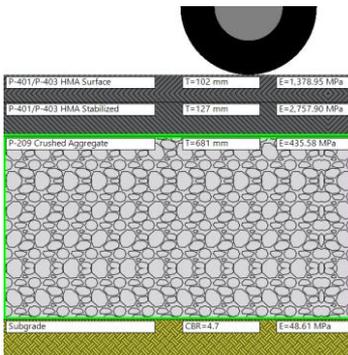
Set as Program Default | Reset Default to Initial

Show/Hide Pavement Image

Change Pavement Graphics

User Defined Aircraft Directory: C:\Users\David Bnll\Documents\My FAARFIELD\User Defined Aircraft | Change Aircraft Directory

Design Options | Notes | User Information




Federal Aviation Administration

Life/Compaction

The screenshot displays the FAARFIELD 2.1.1 software interface. The main window is titled 'Structure' and shows a design for 'New Job 1'. The 'Structure' tab is active, displaying a table of pavement layers and a cross-section diagram. The 'Design Options' panel on the right is also visible.

Structure Table:

Material	Thickness (mm)	E (MPa)	CBR
P-401/P-403 HMA Surface	102	1,378.95	
P-401/P-403 HMA Stabilized	127	2,757.90	
P-209 Crushed Aggregate	681	435.58	
Subgrade		48.61	4.7

Design Options:

- Calculate HMA CDF: No
- Reduced Cross Section: No
- Automatic flexible base design: Yes
- Slab Stress Displayed: No
- Output file: No
- Units: Metric
- Allow Flexible Computation for Thick Overlays on PCC: Yes
- Compute ACR for All Subgrade Categories: No
- Show Advanced Options: [Button]
- Set as Program Default: [Button]
- Reset Default to Initial: [Button]
- Show/Hide Pavement Image: [Button]
- Change Pavement Graphics: [Button]
- User Defined Aircraft Directory: C:\Users\David Bril\Documents (My FAARFIELD)\User Defined Aircraft [Button]

Traffic Table:

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm ²)
S-30	13,608	8,000	0	160,000	0	0	0	517.11	0.95	312	500	122,580
Fokker-F-100	44,452	6,500	0	130,000	0	0	0	1043.63	0.95	281	450	99,204
B737-300	62,822	5,000	0	100,000	0	0	0	1370.99	0.95	291	466	106,724
B767-300 ER	158,757	3,200	0	64,000	0	0	0	1168.60	0.95	355	568	158,205
A380-800 WW000	544,310	400	0	8,000	0	0	0	1455.74	0.38	372	596	174,171
A380-800 WW000 Belly	544,310	400	0	8,000	0	0	0	1455.74	0.57	372	596	174,171

Select "Life/Compaction"

Click "Run" to start Life and Compaction requirements

Life/Compaction

FAARFIELD 2.1.1 (Build 12/21/2023)

Structure Summary Report Structure Report CDF Graph

Job Name: New Job 1 Life/Compaction Run

Structure Name: New Structure 1 Include in Summary Report Add To Batch

Pavement Layers: New Flexible

Material	Thickness (mm)	E (MPa)	CBR
P-401/P-403 HMA Surface	102	12,000.00	
P-401/P-403 HMA Stabilized	127	2,757.90	
P-209 Crushed Aggregate	101	435.58	
Subgrade		48.61	4.7

Design Life (Years): 20

The standard design life for pavement structure is 20 years (1 to 50 allowed).

Results

Calculated Life (Years): 20.0 Total thickness to the top of the subgrade (mm): 909

Status Gear Structure

New Flexible Analysis of New Structure 1 Completed
 Run Time: 4 seconds
 Sub CDF = 1.00; Life = 20.0 yrs;
 HMA CDF = 0.03

Traffic

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm ²)
S-30	13,608	8,000	0	160,000	0	1.77	517.11	0.95	312	500	122,580	
Fokker-F-100	44,452	6,500	0	130,000	0	1.33	1043.63	0.95	281	450	99,204	
B737-300	62,822	5,000	0	100,000	0	1.26	1370.99	0.95	291	466	106,724	
B767-300 ER	158,757	3,200	0	64,000	0.01	1.13	1168.60	0.95	355	568	158,205	
A380-800 W/V000	544,310	400	0	8,000	0.35	0.39	1455.74	0.38	372	596	174,171	
A380-800 W/V000 Belly	544,310	400	0	8,000	0.02	0.76	1455.74	0.57	372	596	174,171	
B777-300	263,083	1,500	0	30,000	0.62	0.62	1298.75	0.95	354	566	157,264	

Pavement Life results

Compaction Requirements

Section Report

The screenshot displays the FAARFIELD 2.1.1 software interface. On the left, the Explorer pane shows a tree view with 'Structure Report' highlighted in a red box. The main window displays a 'Subgrade Compaction Requirements' report for 'NonCohesive Soil' and 'Cohesive Soil'. The report includes two tables with columns for 'Percent Maximum Dry Density (%)', 'Depth of compaction from pavement surface (mm)', 'Depth of compaction from top of subgrade (mm)', and 'Critical Airplane for Compaction'. Below the tables are 'Subgrade Compaction Notes' and a 'NOTE' section.

Subgrade Compaction Requirements

NonCohesive Soil

Percent Maximum Dry Density(%)	Depth of compaction from pavement surface (mm)	Depth of compaction from top of subgrade (mm)	Critical Airplane for Compaction
100	0 - 738	--	A380-800 WV000 Belly
95	738 - 2202	0 - 1293	A380-800 WV000 Belly
90	2202 - 4042	1293 - 3133	A380-800 WV000 Belly
85	4042 - 6075	3133 - 5166	A380-800 WV000 Belly

Cohesive Soil

Percent Maximum Dry Density(%)	Depth of compaction from pavement surface (mm)	Depth of compaction from top of subgrade (mm)	Critical Airplane for Compaction
95	0 - 706	--	A380-800 WV000 Belly
90	706 - 1540	0 - 630	A380-800 WV000 Belly
85	1540 - 2751	630 - 1842	A380-800 WV000 Belly
80	2751 - 3967	1842 - 3057	A380-800 WV000 Belly

Subgrade Compaction Notes:

1. Noncohesive soils, for the purpose of determining compaction control, are those with a plasticity index (PI) less than 3.
2. Tabulated values indicate depth ranges within which densities should equal or exceed the indicated percentage of the maximum dry density as specified in Item P-152.
3. Maximum dry density is determined using ASTM Method D 1557.
4. The subgrade in cut areas should have natural densities shown or should (a) be compacted from the surface to achieve the required densities, (b) be removed and replaced at the densities shown, or (c) when economics and grades permit, be covered with sufficient select or subbase material so that the uncompacted subgrade is at a depth where the in-place densities are satisfactory.
5. For swelling soils refer to AC 150/5320-6F paragraph 3.10.

NOTE:

User is responsible for checking frost protection requirements.

PCR

Select "PCR" in the function drop-down box.

Click "Run" to execute PCR Computations

The screenshot shows the FAARFIELD 2.1 software interface. The main window is titled "Structure" and displays the "Structure Report" for "New Job 1". The "Job Name" is "New Job 1" and the "Structure Name" is "New Structure 1". The "Function" is set to "PCR". The "Run" button is highlighted with a red box and an arrow pointing to it. The "Pavement Layers" section shows a table with the following data:

Material	Thickness (mm)	E (MPa)	CBR
P-401/P-403 HMA Surface	102	1,376.95	
P-401/P-403 HMA Stabilized	127	2,757.90	
P-209 Crushed Aggregate	681	435.58	
Subgrade	48.61	4.7	

The "Design Life (Years)" is set to 20, and the "P/C Ratio" is 1. The "Results" section shows "Calculated Life (Years): 20.0" and "Total thickness to the top of the subgrade (mm): 909". The "Traffic" section shows a table with the following data:

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm ²)	ACR Thi (D)
S-30	13,608	8,000	0	160,000	0	0	0	517.11	0.95	312	500	122,580	0
Fokker-F-100	44,452	6,500	0	130,000	0	0	0	1043.63	0.95	281	450	99,204	0
B737-300	62,822	5,000	0	100,000	0	0	0	1370.99	0.95	291	466	106,724	0
B767-300 ER	158,757	3,200	0	64,000	0	0	0	1168.60	0.95	355	568	198,205	0
A380-800 WV000	544,310	400	0	8,000	0	0	0	1455.74	0.38	372	596	174,171	0
A380-800 WV000 Belly	544,310	400	0	8,000	0	0	0	1455.74	0.57	372	596	174,171	0

PCR

Results of PCR computations

The screenshot displays the FAARFIELD 2.1.1 software interface. The main window shows the 'Structure' tab with the following details:

- Job Name: New Job 1
- Structure Name: New Structure 1
- Pavement Type: New Flexible
- Materials and Properties Table:

Material	Thickness (mm)	E (MPa)	CBR
P-401/P-403 HMA Surface	102	1,378.95	
P-401/P-403 HMA Stabilized	127	2,757.90	
P-209 Crushed Aggregate	681	435.58	
Subgrade		48.61	4.7

Design Life (Years): 20
P/C Ratio: 1
Calculated Life (Years): []
Total thickness to the top of the subgrade (mm): 909

Traffic table:

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm ²)	ACR Thi (D)
S-30	13,608	8,000	0	160,000	0	0	3.7	517.11	0.95	312	500	122,580	427
Fokker-F-100	44,452	6,500	0	130,000	0	0	2.07	1043.63	0.956	281	450	99,204	643
B737-300	62,822	5,000	0	100,000	0	0	2.18	1370.99	0.908	291	466	106,724	699
B767-300 ER	158,757	3,200	0	64,000	0	0	1.13	1168.60	0.904	355	568	198,205	805
A380-800 WW000	544,310	400	0	8,000	0.36	0.4	1.19	1455.74	0.39	372	596	174,171	960
A380-800 WW000 Belly	544,310	400	0	8,000	0.02	0.76	0.88	1455.74	0.57	372	596	174,171	0

PCR Calculation of New Structure 1 Completed
Run Time: 12 seconds
PCR = 850/F/D/X/T



PCR Report

FAARFIELD 2.1.1 (Build 12/21/2023)

Structure Summary Report Structure Report CDF Graph PCR Report

Save As PDF

Maximum number of wheels per gear = 6
 CDF = 0.980
 At least one aircraft has 4 or more wheels per gear.

PCR Report

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight (kg)	Percent Gross Weight	Tire Pressure (MPa)	Annual Departure	20 Years Coverage
1	S-30	13,608	95.00	517.11	8,000	43,206
2	Fokker-F-100	44,452	95.60	1,043.63	6,500	62,737
3	B737-300	62,822	90.80	1,370.99	5,000	45,957
4	B767-300 ER	158,757	92.40	1,168.60	3,200	56,882
5	A380-800 WV000	544,310	38.00	1,455.74	400	6,721
6	A380-800 WV000 Belly	544,310	57.00	1,455.74	400	9,115
7	B777-300	263,083	94.80	1,298.75	1,500	35,719

Results Table 2. PCR Value

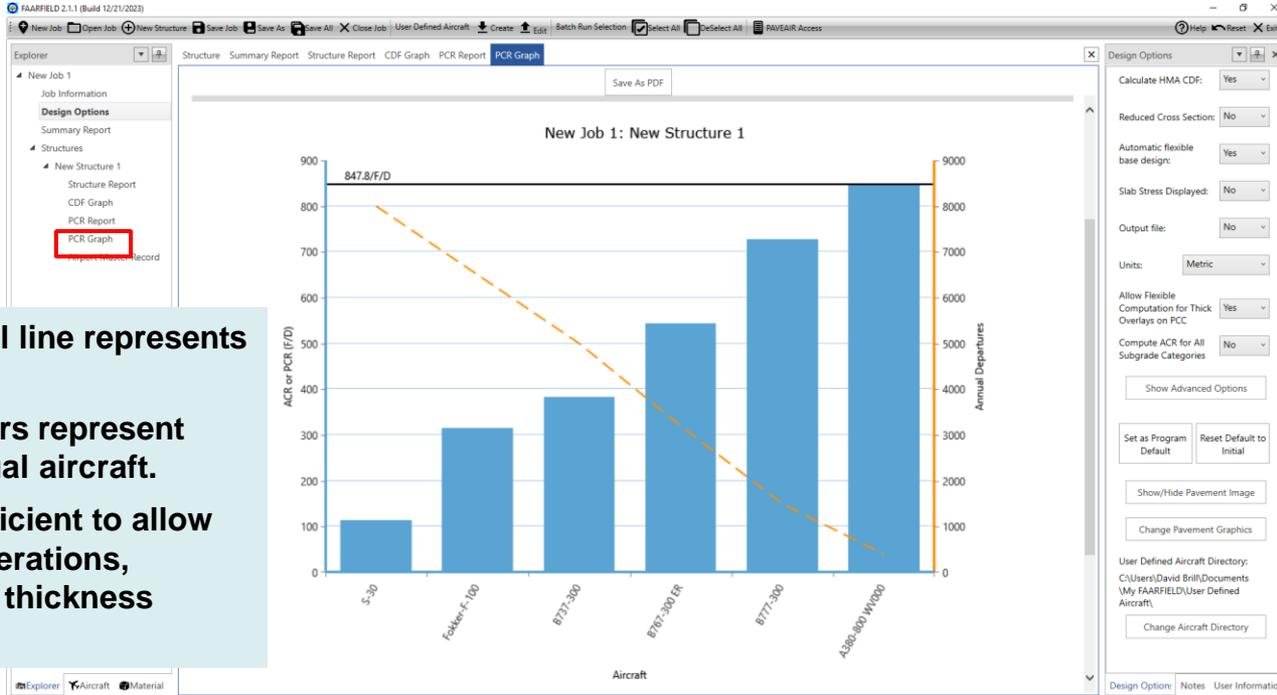
No.	Aircraft Name	Critical aircraft Total equiv. departures	Max allowable Gross Weight of critical aircraft (kg)	ACR Thick at max. MGW (mm)	PCR/F/D
1	A380-800 WV000	518	544,954	961	847.8

Results Table 3. New Flexible ACR at Indicated Gross Weight and Strength

No.	Aircraft Name	Gross Weight (kg)	Percent Gross Weight on Main Gear	Tire Pressure (MPa)	ACR Thick (mm) (D)	ACR/F/D
1	S-30	13,608	95	517.11	427	113.9
2	Fokker-F-100	44,452	95.6	1,043.63	643	314.6
3	B737-300	62,822	90.8	1,370.99	699	382.9
4	B767-300 ER	158,757	92.4	1,168.60	805	543.8
5	A380-800 WV000	544,310	95	1,455.74	960	845.7
6	B777-300	263,083	94.8	1,298.75	902	727.2



PCR Graph



- Black horizontal line represents PCR.
- Blue vertical bars represent ACR of individual aircraft.
- PCR is just sufficient to allow unrestricted operations, consistent with thickness design.



Airport Master Record

FAARFIELD 2.1.1 (Build 12/21/2023)

Explorer

- New Job 1
 - Job Information
 - Design Options
 - Summary Report
 - Structures
 - New Structure 1
 - Structure Report
 - CDF Graph
 - PCR Report
 - PCR Graph
 - Airport Master Record**

Federal Aviation Administration FAARFIELD 2.1 Airport Master Record

FAARFIELD 2.1.1 (Build 12/21/2023)

RUNWAY DATA

Job Name: New Job 1

Structure: New Structure 1

Gross Weight (In THSDS)

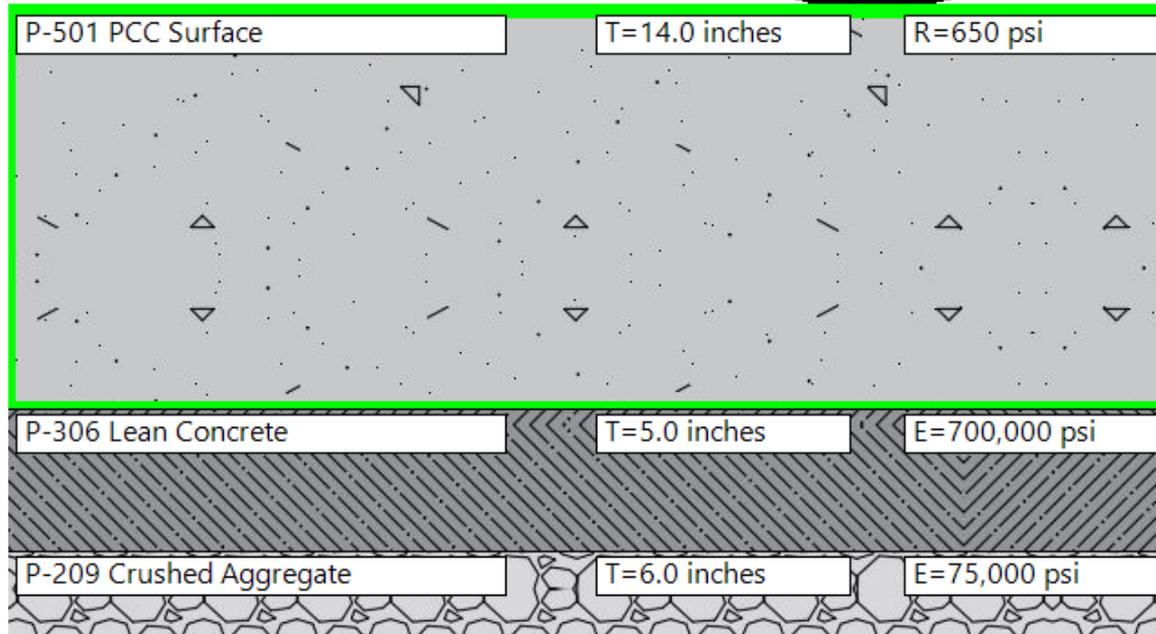
35 S	120
36 D	250
37 2D	352
38 2D/2D2	864
39 PCR	850/F/D/X/T

base design: [dropdown]
Slab Stress Displayed: No [dropdown]
Output file: No [dropdown]
Units: Metric [dropdown]
Allow Flexible Computation for Thick Overlays on PCC: Yes [dropdown]
Compute ACR for All Subgrade Categories: No [dropdown]
Show Advanced Options [button]
Set as Program Default [button] Reset Default to Initial [button]
Show/Hide Pavement Image [button]
Change Pavement Graphics [button]
User Defined Aircraft Directory: C:\Users\David Brill\Documents (My FAARFIELD)\User Defined Aircraft [button]
Change Aircraft Directory [button]
Design Option: Notes User Information

U.S. airports use this information to populate the Airport Master Record (AMR)

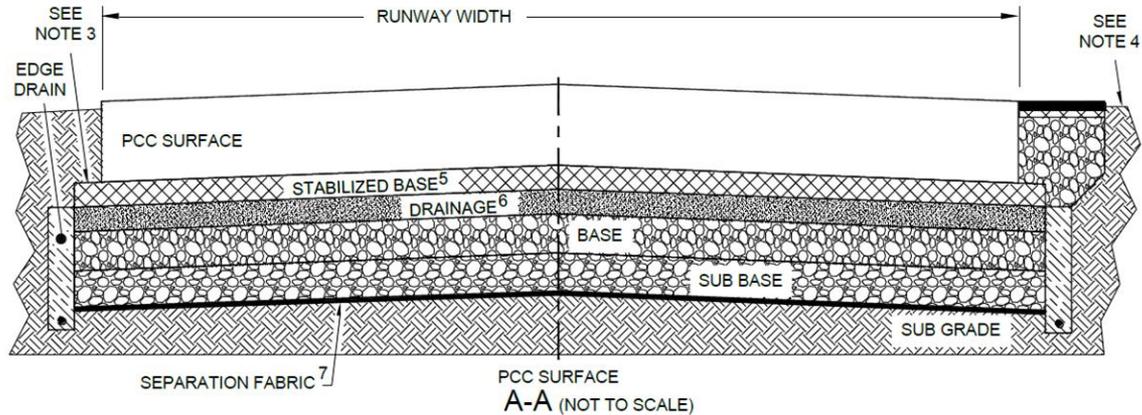


Federal Aviation
Administration



Rigid Pavement Design Example Using FAARFIELD 2.1

Typical Rigid Pavement



NOTES:

1. RUNWAY, TAXIWAY AND SHOULDER WIDTHS; TRANSVERSE SLOPES, ETC. PER AC 150/ 5300-13, AIRPORT DESIGN
2. SURFACE, BASE, PCC, ETC. THICKNESS PER AC 150/5320-6.
3. STABILIZED BASE, BASE AND SUBBASE MINIMUM 12 INCHES [30CM] UP TO 36 INCHES [90 CM] BEYOND FULL STRENGTH PAVEMENT.
4. CONSTRUCT A 1.5 INCH [4 CM] DROP BETWEEN PAVED AND UNPAVED SURFACES.
5. WHEN REQUIRED, SEE PARAGRAPH 3.5.
6. LOCATION AND NEED FOR DRAINAGE LAYER AS RECOMMENDED BY GEOTECHNICAL AND PAVEMENT ENGINEER.
7. WHEN RECOMMENDED BY GEOTECHNICAL AND PAVEMENT ENGINEER.



Rigid Pavement Design in FAARFIELD

- **Considers only one mode of failure for rigid pavement, bottom-up cracking of the concrete slab.**
- **Cracking is controlled by limiting the horizontal stress at the bottom of the concrete slab.**
- **The rigid pavement design model does not explicitly consider failure of subbase and subgrade layers.**

Rigid Pavement Failure Model

- **FAARFIELD rigid failure model:**

$$DF = \left[\frac{F'_s b d}{(1-\alpha)(d-b) + F'_s b} \right] \times \log C + \left[\frac{(1-\alpha)(ad-bc) + bc}{(1-\alpha)(d-b) + F'_s b} \right]$$

where:

$$SCI = \alpha \times 100 \quad 0 \leq \alpha \leq 1$$

DF = design factor = R/σ

R = concrete flexural strength (ASTM C78)

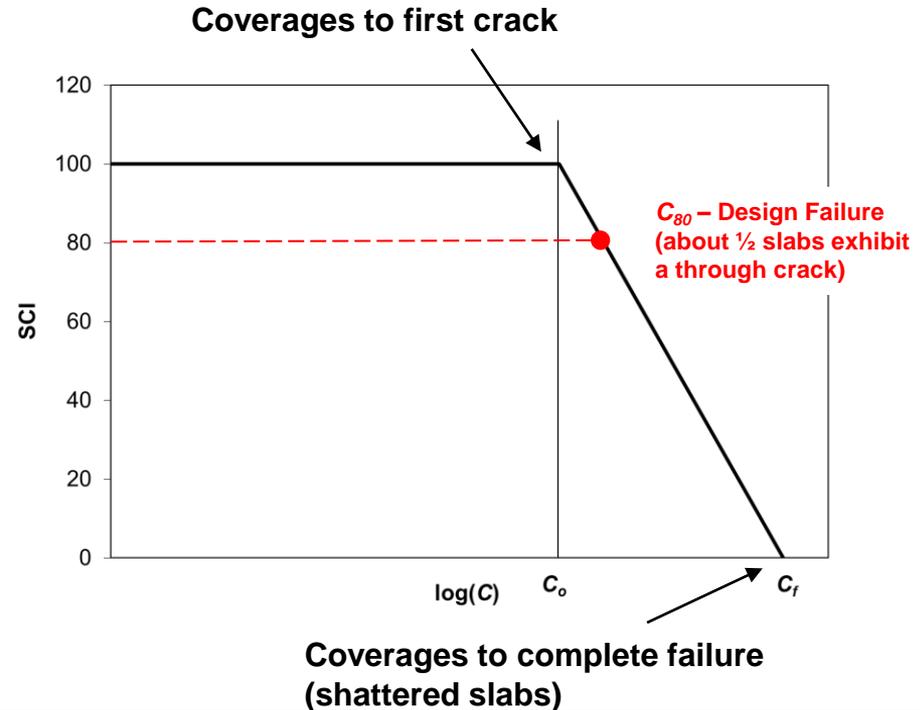
σ = max. computed tensile stress

C = coverages

F'_s = compensation factor for stabilized base

a, b, c, d = parameters determined by full-scale test

- **DF is linear in $\log(C)$.**



Concrete Flexural Strength

- **Design flexural strength between 600 and 750 psi (4.14 to 5.17 MPa) is recommended for most airfield applications.**
- **Avoid design flexural strengths higher than 750 psi (5.17 MPa), unless it can be shown that higher strength mixes are produced by normal methods using local materials, i.e., without relying on excessive cement contents or additives likely to negatively impact durability.**
- **The strength used in thickness design is different than the strength used for material acceptance in P-501.**
 - Design strength can be 5% higher than specified 28-day strength.

Subgrade Modulus

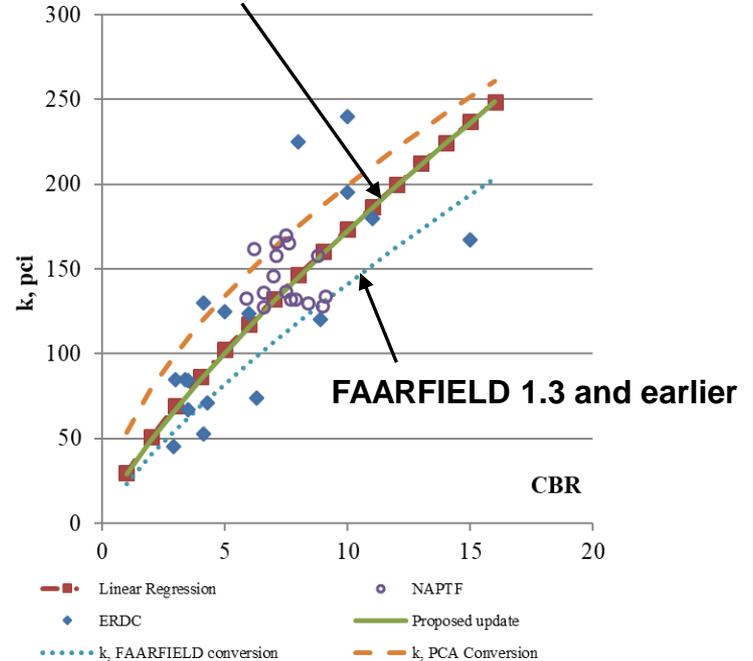
- FAARFIELD automatically converts k to E , and vice-versa.
- The conversion formula implemented in FAARFIELD 2.0 is:

$$k = 28.6926 \times \text{CBR}^{0.7788}$$

where: $\text{CBR} = E / 1500$
(E in psi, and k in psi/inch).

- Compared to the earlier formula:
 - Improved agreement with field correlations
 - less conservative when converting from CBR data.

FAARFIELD 2.0 conversion formula



Rigid Pavement Design Example

A rigid pavement is being designed for a new runway at a commercial airport in Dakar, Senegal. Based on the information obtained from the Airport Master Plan, the new runway is expected to handle the traffic mix presented in Table 1. Eight soil borings were performed for this project, the results of which are presented in Table 2. The specified 28-day strength (ASTM C78) is 4.27 MPa.

Table 1. Aircraft traffic mix for rigid pavement design example.

Aircraft	Departure Weight, kg	Arrival Weight, kg	Annual Departures
S-30	13,608	10,206	8000
Fokker F-100	44,452	34,019	6500
B737-300	62,822	52,163	5000
B767-300 ER	158,757	131,541	3200
A380-800	544,310	462,664	400
B777-300	263,083	237,682	1500

Same as flexible example!

Table 2. Soil boring results for rigid pavement design example.

Boring No.	UCSC Soil Type	Moisture Content, %	Optimal MC, %	Dry unit weight, kN/m ³	Water Table Depth, m	CBR, %
B-1	SC	12.2	10.4	20.26	3	10.6
B-2	SC	14.4	12.2	19.57	3	7.2
B-3	SC	16.5	9.6	20.80	2.5	8.4
B-4	CL	15.8	13.5	18.88	2.0	6.3
B-5	CL	17.0	14.5	19.24	2.4	4.8
B-6	CL	16.2	13.8	18.96	1.7	5.9
B-7	CL	16.8	12.6	19.48	1.4	4.2
B-8	CL	14.2	12.8	20.14	1.8	6.4
Average:						
Std. Deviation:						

Rigid Pavement Design Example

1. What do the soil boring results tell us about the in-situ soil properties? What subgrade support value do you recommend for design?

Mean CBR – 6.7 Standard Deviation – 2.04

Design CBR – 4.7 $E_{SG} \sim 47 \text{ MPa (5 CBR)}$

1. What type and thickness of base/subbase materials do you recommend? Are positive drainage features required?
2. What flexural strength of concrete would you use for the design?
 - AC 150/5320-6G allows 5 percent above specified 28-day strength for design.
 - Given 28-day strength = 4.27 MPa, the allowable design strength is $1.05 \times 4.27 = 4.48 \text{ MPa}$.
 - Use 4.48 MPa in the FAARFIELD design.
1. Should the pavement be designed for aircraft arrival or departure weights? What is the required flexible pavement thickness for the runway? What is the most demanding aircraft?

Boring No.	UCSC Soil Type	Moisture Content, %	Optimal MC, %	Dry unit weight, kN/m ³	Water Table Depth, m	CBR, %
B-1	SC	12.2	10.4	20.26	3	10.6
B-2	SC	14.4	12.2	19.57	3	7.2
B-3	SC	16.5	9.6	20.80	2.5	8.4
B-4	CL	15.8	13.5	18.88	2.0	6.3
B-5	CL	17.0	14.5	19.24	2.4	4.8
B-6	CL	16.2	13.8	18.96	1.7	5.9
B-7	CL	16.8	12.6	19.48	1.4	4.2
B-8	CL	14.2	12.8	20.14	1.8	6.4
Average:		15.4	12.4	19.66	2.3	6.7
Std. Deviation:		1.7	1.7	0.68	0.6	2.0

Creating/Naming a Structure

Click on "New Structure"

Enter Structure Name

The screenshot displays the FAARFIELD 2.1.1 software interface. The main window is titled 'Structure' and contains the following elements:

- Job Information:** Job Name: New Job 1, Thickness Design: Thickness Design, Run button, Status, Gear, Structure.
- Structure Name:** Rigid Example, Include in Summary Report (checked), Add To Batch.
- Pavement Layers:** Pavement Type: (empty), Design Life (Years): 20.
- Results:** The standard design life for pavement structure is 20 years (1 to 50 allowed). Calculated Life (Years): (empty), Total thickness to the top of the subgrade (mm): 0.
- Traffic:** Stored Aircraft Mix table with columns: Airplane Name, Gross Taxi Weight (kg), Annual Departures, Annual Growth (%), Total Departures, CDF Contributions, CDF Max for Airplane, P/C Ratio, Tire Pressure (kPa), Percent GW on Gear, Tire Contact Width (mm), Tire Contact Length (mm), Tire Contact Area (mm²).

Annotations with arrows point to the 'New Structure' button in the top toolbar and the 'Structure Name' input field.



Select Pavement Type

Select "Thickness Design"

Select Pavement Type as "New Rigid"

Default pavement structure details in table

Default pavement life (20 years)

Default pavement structure for "New Rigid" type

The screenshot shows the FAAIRFIELD 2.1.1 software interface. The main window is titled "Structure" and displays the "Design Options" for a "New Rigid" pavement structure. The "Pavement Layers" table is visible, showing the default structure for a "New Rigid" type. The "Design Life" is set to 20 years. The "Calculated Life (years)" is 0, and the "Total thickness to the top of the subgrade (mm)" is 635. The "Traffic" section shows a table of aircraft mix data.

Material	Thickness (mm)	E (MPa)	k (MN/m ³)	R (MPa)
P-501 PCC Surface	356	27,579.04		4.48
P-401/P-403 HMA Stabilized	127	2,757.90		
P-209 Crushed Aggregate	152			
Subgrade		103.42	46.8	

The cross-section diagram shows the following layers from top to bottom:

- P-501 PCC Surface: T=356 mm, R=4.48 MPa
- P-401/P-403 HMA Stabilized: T=127 mm, E=2,757.90 MPa
- P-209 Crushed Aggregate: T=152 mm, E=3,117.11 MPa
- Subgrade: k=46.8 MN/m³, E=103.42 MPa

The "Design Options" panel on the right includes the following settings:

- Calculate HMA CDF: Yes
- Reduced Cross Section: No
- Automatic flexible base design: Yes
- Slab Stress Displayed: No
- Output file: No
- Units: Metric
- Allow Flexible Computation for Thick Overlays on PCC: Yes
- Compute ACR for All Subgrade Categories: No
- Show Advanced Options: [Button]
- Set as Program Default: [Button]
- Reset Default to Initial: [Button]
- Show/Hide Pavement Image: [Button]
- Change Pavement Graphics: [Button]
- User Defined Aircraft Directory: C:\Users\David Brill\Documents\My FAIRFIELD\User Defined Aircraft
- Change Aircraft Directory: [Button]

Creating Aircraft Traffic Mix

Several ways to add aircraft to the traffic table:

- Pick aircraft from the library. Double click on the aircraft name or drag/drop.
- Select a stored aircraft mix from the drop-down.

Select an aircraft to display gear geometry.

Structure Panel:

Job Name: New Job 1 | Thickness Design | Run | Status: Gear | Structure

Structure Name: Rigid Example | Include in Summary Report | Add To Batch

Pavement Layers: New Rigid

Material	Thickness (mm)	E (MPa)	k (MN/m ³)	R (MPa)
P-501 PCC Surface	356	27,579.04		4.48
P-401/P-403 HMA Stabilized	127	2,757.90		
P-209 Crushed Aggregate	152	517.11		
Subgrade		103.42	46.8	

Design Life (Years): 20

The standard design life for pavement structure is 20 years (1 to 50 allowed).

Results:

Calculated Life (Years): Total thickness to the top of the subgrade (mm): 635

Traffic Panel:

Stored Aircraft Mix: BKK Example | Save Aircraft Mix to File | Clear All Aircraft from List | Remove Selected Aircraft from Structure | Delete Aircraft Mix File

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm ²)
S-30	13,608	8,000	0	160,000	0	0	0	517.11	0.95	312	500	122,580
Fokker-F-100	44,452	6,500	0	130,000	0	0	0	1043.63	0.95	281	450	99,204
B737-300	62,822	5,000	0	100,000	0	0	0	1370.99	0.95	291	466	106,724
B777-300 ER	158,757	3,200	0	64,000	0	0	0	1168.60	0.95	355	568	158,205
A380-800	544,310	400	0	8,000	0	0	0	1455.74	0.38	372	596	174,171
A380-800 WW009	544,310	400	0	8,000	0	0	0	1455.74	0.57	372	596	174,171
B777-300	263,083	1,500	0	30,000	0	0	0	1236.75	0.95	354	566	157,264



Modify Default Layer Properties

The screenshot displays the FAARFIELD 2.1.1 software interface. The main window shows the 'Structure' tab with a table of pavement layers. A callout box highlights the 'P-501 PCC Surface' layer, which has a thickness of 356 mm and a modulus of 27,579.04 MPa. A text box explains that the modulus value should be entered based on design CBR (47 MPa) and that FAARFIELD computes an equivalent k-value using the conversion formula.

Structure Properties:

- Job Name: New Job 1
- Thickness Design: Thickness Design
- Structure Name: Rigid Example
- Include in Summary Report:
- Pavement Type: New Rigid

Material	Thickness (mm)	E (MPa)	k (MN/m ³)
P-501 PCC Surface	356	27,579.04	
P-401/P-403 HMA Stabilized	127	2,757.90	
P-209 Crushed Aggregate	152	517.11	
Subgrade		47.00	25.3

Design Life: 20 years

Traffic: BKK Example

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm ²)
S-30	13,608	8,000	0	160,000	0	0	0	517.11	0.95	312	500	122,580
Fokker-F-100	44,452	6,500	0	130,000	0	0	0	1043.63	0.95	281	450	99,204
B737-300	62,822	5,000	0	100,000	0	0	0	1370.99	0.95	291	466	106,724
B747-300 ER	158,757	3,200	0	64,000	0	0	0	1168.60	0.95	355	568	150,295
A380-800 WW000	544,310	400	0	8,000	0	0	0	1455.74	0.38	372	596	174,171
A380-800 WW000 Belly	544,310	400	0	8,000	0	0	0	1455.74	0.57	372	596	174,171
B777-300	263,083	1,500	0	80,000	0	0	0	1286.75	0.95	354	566	157,264

- Enter the modulus value based on design CBR (47 MPa).
- FAARFIELD computes an equivalent k-value using the conversion formula.

Modify Default Layer Properties

The screenshot displays the FAARFIELD 2.1.1 software interface. The left sidebar shows the 'Structure' tree with 'Rigid Example' selected. The main window shows the 'Structure' properties for 'New Job 1', including 'Thickness Design' and 'Run' buttons. Below this is a table of pavement layers:

Material	Thickness (mm)	E (MPa)	k (MN/m ³)	R (MPa)
P-501 PCC Surface	356	27,579.04		4.48
P-306 Lean Concrete	127	4,826.33		
P-209 Crushed Aggregate	200	517.11		
Subgrade		47.00	25.3	

Below the table are fields for 'Design Life (Years): 20' and 'Total thickness to the top of the subgrade (mm): 683'. At the bottom, there is a 'Traffic' section with a table of aircraft mix data:

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	COF Contributions	COF Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm ²)
S-30	13,608	8,000	0	160,000	0	0	0	517.11	0.95	312	500	122,580
Fokker-F-100	44,452	6,500	0	130,000	0	0	0	1043.63	0.95	281	450	99,204
B737-300	62,822	5,000	0	100,000	0	0	0	1370.99	0.95	291	466	106,724
B747-300 ER	158,757	3,200	0	64,000	0	0	0	1168.60	0.95	355	568	158,205
A380-800 W/000	544,310	400	0	8,000	0	0	0	1455.74	0.38	372	596	174,171
A380-800 W/000 Belly	544,310	400	0	8,000	0	0	0	1455.74	0.57	372	596	174,171
B777-300	263,083	1,500	0	80,000	0	0	0	1238.75	0.95	354	566	157,264

On the right, a cross-section diagram shows the pavement layers with their respective properties:

- P-501 PCC Surface: T=356 mm, R=4.48 MPa
- P-306 Lean Concrete: T=127 mm, E=4,826.33 MPa
- P-209 Crushed Aggregate: T=200 mm, E=517.11 MPa
- Subgrade: k=25.3 MN/m³, E=47.00 MPa

A callout box points to the bottom layers with the text: "Select Base & Subbase type and thickness".

Modify Default Layer Properties

The screenshot displays the FAARFIELD 2.1.1 software interface. On the left, the Explorer pane shows the project structure. The main window is divided into several sections:

- Structure Properties:** Job Name: New Job 1, Thickness Design, Run button.
- Pavement Layers Table:**

Material	Thickness (mm)	E (MPa)	k (MN/m ³)	R (MPa)
P-501 PCC Surface	356	27,579.04		4.80
P-306 Lean Concrete	127	4,826.33		
P-209 Crushed Aggregate	200	517.11		
Subgrade		47.00	25.3	
- Design Life:** 20 years. Standard design life for pavement structure is 20 years (1 to 50 allowed).
- Results:** Calculated Life (years): [blank], Total thickness to the top of the subgrade (mm): 683.
- Traffic Table:**

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm ²)
S-30	13,608	8,000	0	160,000	0	0	0	517.11	0.95	312	500	122,580
Fokker-F-100	44,452	6,500	0	130,000	0	0	0	1043.63	0.95	281	450	99,204
B737-300	62,822	5,000	0	100,000	0	0	0	1370.99	0.95	291	466	106,724
B747-300 ER	158,757	3,200	0	64,000	0	0	0	1168.60	0.95	355	568	150,295
A380-800 WW000	544,310	400	0	8,000	0	0	0	1455.74	0.38	372	596	174,171
A380-800 WW000 Belly	544,310	400	0	8,000	0	0	0	1455.74	0.37	372	596	174,171
B777-300	263,083	1,500	0	80,000	0	0	0	1238.75	0.95	354	566	157,264
- Structure Cross-Section Diagram:** A vertical cross-section showing four layers:
 - P-501 PCC Surface:** T=356 mm, R=4.80 MPa
 - P-306 Lean Concrete:** T=127 mm, E=4,826.33 MPa
 - P-209 Crushed Aggregate:** T=200 mm, E=517.11 MPa
 - Subgrade:** k=25.3 MN/m³, E=47.00 MPa

Change flexural strength from default value to R =700 psi (as determined on a previous slide).

Run Pavement Thickness Design

FAAFIELD 2.1.1 (Build 12/21/2023)

Structure

Job Name: New Job 1 Thickness Design [Cancel] Status: Gear Structure

Structure Name: Rigid Example [Include in Summary Report] [Add To Batch] New Rigid of Rigid Example started.

Pavement Layers

Pavement Type: New Rigid

Material	Thickness (mm)	E (MPa)	k (MN/m ³)	R (MPa)
P-501 PCC Surface	356	27,579.04		4.80
P-306 Lean Concrete	127	4,826.33		
P-209 Crushed Aggregate	200	167.17		
Subgrade		47.00	25.3	

Design Life (Years): 20

The standard design life for pavement structure is 20 years (1 to 50 allowed).

Results

Calculated Life (Years): [] Total thickness to the top of the subgrade (mm): 683

Running Time: 00:01:05

Traffic

Stored Aircraft Mix: BKK Example [Save Aircraft Mix to File] [Clear All Aircraft from List] [Remove Selected Aircraft from Structure] [Delete Aircraft Mix File]

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm ²)
S-30	13,608	8,000	0	160,000	0	0	0	517.11	0.95	312	500	122,580
Fokker-F-100	44,452	6,500	0	130,000	0	0	0	1043.63	0.95	281	450	99,204
B737-300	62,822	5,000	0	100,000	0	0	0	1370.99	0.95	291	466	106,724
B767-300 ER	158,757	3,200	0	64,000	0	0	0	1168.80	0.95	355	568	158,205
A380-800 WV000	544,310	400	0	8,000	0	0	0	1455.74	0.38	372	596	174,171
A380-800 WV000 Belly	544,310	400	0	8,000	0	0	0	1455.74	0.57	372	596	174,171
B777-300	263,083	1,500	0	30,000	0	0	0	1298.75	0.95	354	566	157,264

Callout Box:

- Click "Run" to start pavement thickness design.
- While the design is running, the clock will advance.
- Rigid designs take longer than flexible designs. Be patient!

Completed Pavement Thickness Design

Structure

Material	Thickness (mm)	E (MPa)	k (MN/m ³)	R (MPa)
P-501 PCC Surface	436	27,579.04		4.48
P-306 Lean Concrete	127	4,826.33		
P-209 Crushed Aggregate	200	167.17		
Subgrade		47.00	25.3	

Traffic

Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)	Percent GW on Gear	Tire Contact Width (mm)	Tire Contact Length (mm)	Tire Contact Area (mm ²)
00	13,608	8,000	0	160,000	0	0	6.33	517.11	0.95	312	500	122,580
00	44,452	6,500	0	130,000	0	0	3.72	1043.63	0.95	281	450	99,204
00	62,822	5,000	0	100,000	0	0	3.8	1370.99	0.95	291	466	106,724
ER	158,757	3,200	0	64,000	0	0	3.65	1168.60	0.95	355	568	158,205

Structure Cross-Section: P-501 PCC Surface (436 mm) / P-306 Lean Concrete (T=127 mm, E=4,826.33 MPa) / P-209 Crushed Aggregate (200 mm) / Subgrade

P-501 PCC Surface Thickness was designed

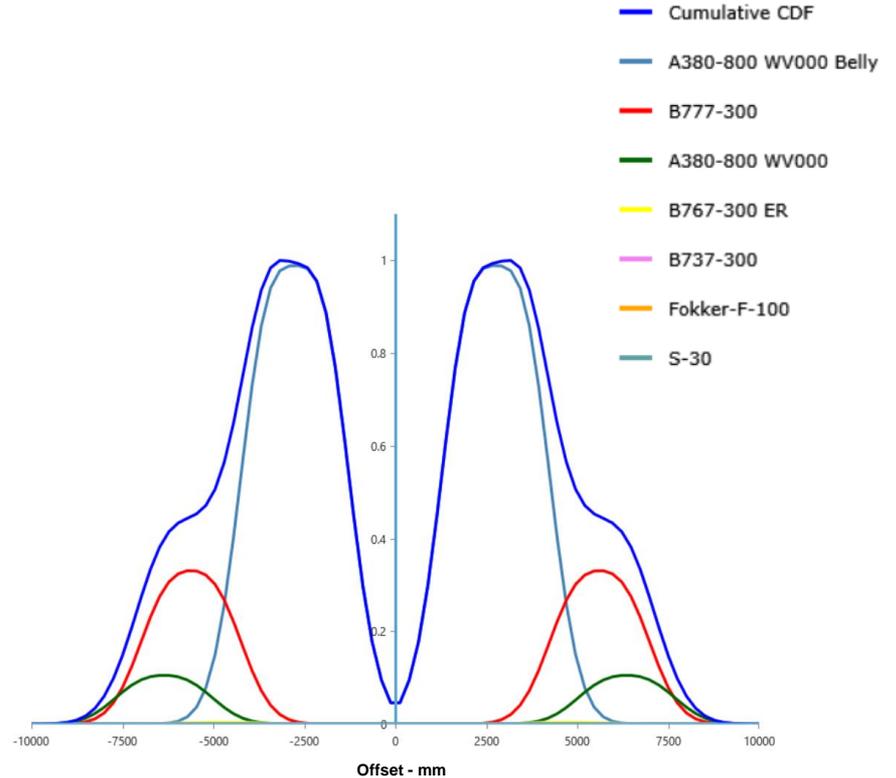
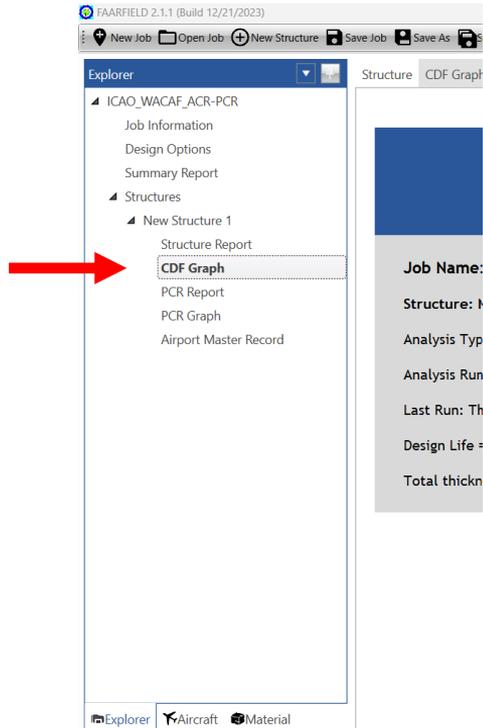
P/C Ratio for each aircraft

CDF max. for aircraft

CDF contribution of each aircraft

- Design thickness is 436 mm
- Round to the nearest 0.5 in or 1 cm.
- Specify as 44 cm.

CDF Chart



Rigid Pavement Example – Results

1. What do the soil boring results tell us about the in situ soil properties? What subgrade support value do you recommend for design?

Mean CBR = 6.7 Standard Deviation = 2.04 Design CBR = 4.7 $E_{SG} = 47 \text{ MPa}$

2. What type and thickness of base/subbase materials do you recommend? Are positive drainage features required?
3. What flexural strength of concrete would you use for the design?

AC 150/5320-6G allows 5 percent above specified 28-day strength for design.

Given 28-day strength = 4.27 MPa, the allowable design strength = $1.05 \times 4.27 = 4.48 \text{ MPa}$.

Use $R = 4.48 \text{ MPa}$ in the FAARFIELD design.

4. Should the pavement be designed for aircraft arrival or departure weights? What is the required PCC slab thickness for the runway? What is the most demanding aircraft?

For the given inputs, FAARFIELD 2.1 gives a slab thickness 44 cm.

The most demanding aircraft is the Airbus 380-800, for which the belly gear (6-wheels) contributes 98% of the CDF on the critical strip.

Structure Report

The screenshot displays the FAARFIELD 2.1.1 software interface. The Explorer pane on the left shows a tree view with 'Structure Report' selected under 'New Structure 1'. The main window displays the 'Structure Report' for 'ICAO_WACAF_ACR-PCR'. The report includes job information, structure details, analysis type, last run date, design life, and total thickness. A table titled 'Pavement Structure Information by Layer' provides details on four layers: P-501 PCC Surface, P-306 Lean Concrete, P-209 Crushed Aggregate, and Subgrade. The bottom of the window shows 'Aircraft Information'.

Federal Aviation Administration FAARFIELD 2.1 Structure Report
FAARFIELD 2.1.1 (Build 12/21/2023)

Job Name: ICAO_WACAF_ACR-PCR
Structure: New Structure 1
Analysis Type: New Rigid
Last Run: Thickness Design 2024-10-22 08:22:39
Design Life = 20 Years
Total thickness to the top of the subgrade = 763mm

Pavement Structure Information by Layer

No.	Type	Thickness (mm)	Modulus (MPa)	k (MN/m ³)	Poisson's Ratio	Strength R (MPa)
1	P-501 PCC Surface	436	27,579.04	0	0.15	4.48
2	P-306 Lean Concrete	127	4,826.33	0	0.2	0
3	P-209 Crushed Aggregate	200	167.17	0	0.35	0
4	Subgrade	0	47.00	25.3	0.4	0

Aircraft Information



PCR

FAARFIELD 2.1.1 (Build 12/21/2023)

New Job Open Job New Structure Save Job Save As Save All Close Job User Defined Aircraft Create Edit Batch Run Selection Select All DeSelect All PAVEAIR Access Help Reset Exit

Explorer

- ICAOWACAF_ACR-PCR
 - Job Information
 - Design Options
 - Summary Report
 - Structures
 - Flexible Example
 - Structure Report
 - CDF Graph
 - PCR Report
 - PCR Graph
 - Airport Master Record
 - Rigid Example**
 - Structure Report
 - CDF Graph
 - PCR Report
 - PCR Graph
 - Airport Master Record

Structure Structure Report CDF Graph PCR Report PCR Graph Airport Master Record

Structure

Job Name: ICAOWACAF_ACR-PCR **PCR** Run

Structure Name: Rigid Example Include in Summary Report Add To Batch

Pavement Layers

Pavement Type: New Rigid

Material	Thickness (mm)	E (MPa)	G (MN/m ²)	(M ₀)
P-501 PCC Surface	436	27,579.04		4.48
P-306 Lean Concrete	437	4,036.00		
P-209 Crushed Aggregate	100	15,000.00		
Subgrade		47.00	25.3	

Select As The Design Layer Delete Selected Layer

Traffic

Stored Aircraft Mix ICAOWACAF_ACR-PCR Workshop Save Aircraft Mix to File Clear All Aircraft from List Remove Selected

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)
S-30	13,608	8,000	0	160,000	0	0	0	517.11
Fokker-F-100	44,452	6,500	0	130,000	0	0	0	1043.63
B737-300	62,822	5,000	0	100,000	0	0	0	1370.99
B767-300 ER	158,757	3,200	0	64,000	0	0	0	1168.60

Notes User Information

4:55 PM 10/23/2024

Switch to "PCR"
and select "Run"

PCR

The screenshot displays the FAARFIELD 2.1.1 software interface. The main window shows the 'Structure' tab with the following details:

- Job Name: ICAO_WACAF_ACR-PCR
- Structure Name: Rigid Example
- Pavement Type: New Rigid
- Material: P-501 PCC Surface
- Thickness (mm): 436, 127, 200
- E (MPa): 27,579.04, 4,826.33, 167.17
- k: 47.00

Two callout boxes highlight key information:

- A red box at the top right contains: PCR Calculation of Rigid Example Co, Run Time: 190 seconds, PCR = 1100/R/D/W/T
- A larger red box on the right contains: Status Gear Structure, PCR Calculation of Rigid Example Co, Run Time: 190 seconds, PCR = 1100/R/D/W/T

A red arrow points from the larger callout box to the 'Structure' tab in the software interface.

At the bottom of the interface, a table shows the following data:

Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)
8,000	0	160,000	0	6.33	517.11	
5,500	0	130,000	0	0	3.71	1043.63
3,000	0	100,000	0	0	3.88	1370.99
2,200	0	64,000	0	0	3.7	1168.60

PCR = 1100

Rigid Pavement

Subgrade Class D

Unlimited Tire Pressure

Technical Evaluation



Federal Aviation
Administration

4:55 PM
10/23/2024

PCR

The screenshot displays the FAARFIELD 2.1.1 software interface. On the left, the Explorer pane shows a tree view under the project 'ICAO_WACAF_ACR-PCR'. The 'Rigid Example' folder is expanded, and the 'PCR Report' item is selected, indicated by a red arrow. The main window shows the report content, which includes the following information:

- Job Name:** ICAO_WACAF_ACR-PCR
- Structure:** Rigid Example
- File Name:** PCR Results for New Rigid 2024-10-23 16:55:01
- Evaluation:** Evaluation pavement type is rigid and design program is FAARFIELD.
- Structure Name:** Rigid Example in job file: ICAO_WACAF_ACR-PCR.JOB.xml
- Units:** Metric
- Analysis Type:** New Rigid
- Subgrade Modulus:** =47.00MPa (Subgrade Category is D)
- Evaluation Pavement Thickness:** = 763 mm
- Pass to Traffic Cycle (PtoTC) Ratio:** = 1.00
- Maximum number of wheels per gear:** = 6
- CDF:** = 1.000

The software title bar indicates 'FAARFIELD 2.1.1 (Build 12/21/2023)'. The bottom status bar shows the system time as 5:04 PM on 10/23/2024.



Rigid ACR-PCR: PCR Report

- Detailed results can be viewed from PCR Report

- Found in Navigation Pane

- PCR report includes:

1. Traffic Inputs
2. PCR Summary
3. ACR Summary

Results Table 2. PCR Value

No.	Aircraft Name	Critical aircraft Total equiv. departures	Max allowable Gross Weight of critical aircraft (kg)	ACR Thick at max. MGW (mm)	PCR/R/D
1	A380-800 WV000	403	544,310	522	1098.8

Results Table 3. New Rigid ACR at Indicated Gross Weight and Strength

No.	Aircraft Name	Gross Weight (kg)	Percent Gross Weight on Main Gear	Tire Pressure (MPa)	ACR Thick (mm) (D)	ACR/R/D
1	S-30	13,608	95	517.11	147	92.6
2	Fokker-F-100	44,452	95.6	1,043.63	279	315.4
3	B737-300	62,822	90.8	1,370.99	323	423.4
4	B767-300 ER	158,757	92.4	1,168.60	386	601.9
5	A380-800 WV000	544,310	95	1,455.74	523	1098.8
6	B777-300	263,083	94.8	1,298.75	470	893.9

Rigid ACR-PCR: PCR Report

ACR/PCR

Classification Rating

ACR Thickness

ACR Pavement Reference Thickness

MAGW

Aircraft Weight that Converts Total Equiv. Departures to CDF = 1.0

Total Equiv. Departures

Number of Departures for Critical Aircraft that provides same CDF as Aircraft Mix

No.	Aircraft Name	Critical aircraft Total equiv. departures	Max allowable Gross Weight of critical aircraft (kg)	ACR Thick at max. MGW (mm)	PCR/R/D
1	A380-800 WV000	403	544,310	522	1098.8

Rigid ACR-PCR: PCR Report

AC

**Parameters are for ACR-PCR
analysis only →**

**Should not be used during
pavement structural design**

Rigid ACR-PCR: PCR Report

- **Cumulative Damage Factor (CDF) is also reported in PCR Report summary**
- **CDF Conditions:**
 - **CDF \leq 1.0 \rightarrow ACR \leq PCR for all aircraft**
 - **CDF $>$ 1.0 \rightarrow Operating restrictions necessary**

Federal Aviation Administration FAARFIELD 2.1 PCR Report
FAARFIELD 2.1.1 (Build 12/21/2023)

Job Name: ICAO_WACAF_ACR-PCR
Structure: Rigid Example
This file name = PCR Results for New Rigid 2024-10-23 16:55:01
Evaluation pavement type is rigid and design program is FAARFIELD.
Structure name: Rigid Example in job file: ICAO_WACAF_ACR-PCR.JOB.xml
Units = Metric
Analysis Type: New Rigid
Subgrade Modulus =47.00MPa (Subgrade Category is D)
Evaluation Pavement Thickness = 763 mm
Pass to Traffic Cycle (PtoTC) Ratio = 1.00
Maximum number of wheels per gear = 6
CDF = 1.000

Rigid ACR-PCR: PCR Report

Federal Aviation Administration FAARFIELD 2.1 PCR Report

FAARFIELD 2.1.1 (Build 12/21/2023)

- Cumulative Damage Factor

(CDF) is also reported in

PCR

**CDF is not the same as CDF
obtained during structural
design**

- CDF

– CDF < 1.0

– **CDF > 1.0** → Operating
restrictions necessary

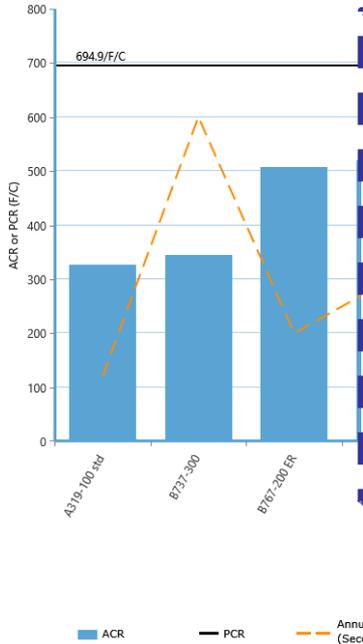
CDF = 1.000

1.000

Rigid ACR-PCR: PCR Report

ACR-PCR_Workshop_2024: FlexibleExample1

Results Table 2. PCR Value



Max. ACR ≤ PCR for all aircraft

No operating restrictions are necessary

Aircraft	ACR Thick at max. MGW (mm)	PCR/R/D
1	522	1098.8
2	147	92.6
3	279	315.4
4	323	423.4
5	386	601.9
6	523	1098.8
7	470	893.9



Overlay Design Example Using FAARFIELD 2.1

FAARFIELD Overlay Design

- **HMA Overlays on Flexible Pavement**
 - Same as designing a new flexible pavement, except the design layer is the HMA overlay.
- **PCC Overlays on Flexible Pavement**
 - Same principle as new rigid design.
- **HMA Overlays on Rigid Pavement**
- **PCC Overlays on Rigid Pavement**
 - More complex than new rigid pavement design.
 - Both slabs (base PCC and overlay) deteriorate with applied traffic. Stresses are computed for both slabs.
 - E-modulus of the base slab is a function of reduced SCI.

FAARFIELD Overlay Design – PCC on Rigid Overlays

- **Fully bonded overlays**
 - Treat as a new rigid pavement design.
 - Thickness of overlay slab is $h_{overlay} = h_{design} - h_{exist}$
- **Unbonded overlay**
 - Bond breaker or leveling course is used.
- **Partially bonded overlay**
 - Not a standard design in AC 150/5320-6F.
 - Default in FAARFIELD is off.
 - May be enabled from the Options window, but displays a “Non Standard Structure” message.

FAARFIELD Overlay Design – HMA on Rigid Overlays

- **See AC 150/5320-6G, Paragraphs 4.7.5.5 & 4.7.5.6**
- **Current design procedure does not address reflection cracking.**
- **Default model assumes base concrete pavement continues to deteriorate under traffic, reaching a terminal SCI at end of life.**
- **Thick asphalt overlays on existing rigid pavements.**
 - Applies only when the overlay thickness exceeds the concrete thickness.
 - Can treat as a flexible design where the existing concrete acts as a high-quality base material.
 - Program performs both designs - reports the one that gives the thinner overlay.

FAARFIELD Overlay Design

Required Inputs

- **Existing rigid pavement condition is characterized by the Structural Condition Index (SCI).**
 - SCI derived from PCI as determined by ASTM D 5340, Airport Pavement Condition Index Surveys. AC 150/5320-6G, par. 4.7.5.3, gives guidance on SCI.
 - SCI is computed using only structural components from the PCI survey.
- **SCI = 80 is the FAA definition of structural failure. This is equivalent to 50% of the slabs in a section exhibiting a full-width structural crack)**
- **For existing pavements with structural damage (SCI < 100)**
 - The user inputs a value of SCI for the existing pavement.
 - The range of allowable values is SCI 67 – 100.
 - The Help file also gives approximate formulas for relating SCI to C_r and C_b factors in earlier FAA design methods.

FAARFIELD – PCC Unbonded Overlay Design Structural Condition Index (SCI)

Rigid Pavement Distress Types Used to Calculate 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

* Used only to describe a load-induced crack that extends only part of the way across a slab. The SCI does not include conventional shrinkage cracks due to curing or other non load-related problems.

Cumulative Damage Factor Used (CDFU)

**For existing pavements where SCI=100
(no structural distress):**

- **There is no visible distress contributing to reduction in SCI (no structural distress types). However, some pavement life has been consumed by the applied traffic.**
- **The amount of pavement life consumed before the onset of cracking is the percent CDF Used (%CDFU).**
- **Need to estimate a value of %CDFU.**
- **The Help file gives guidance on estimating %CDFU using the Life key.**

HMA on Rigid Overlay Example

- **HMA overlay will be placed on an existing PCC slab**
- **Assume the previous traffic mix.**
- **Existing PCC slab:**
 - Assume SCI = 67 for existing slab.
- **All other design inputs same as previous example.**

Create a New Structure

FAARFIELD 2.1.1 (Build 12/21/2023)

Job Information Structure Structure Report CDF Graph PCR Report PCR Graph Airport Master Record

Structure

Job Name: ICAO_WACAF_ACR-PCR PCR Run Status Gear Structure

Structure Name: Rigid Example Include in Summary Report Add To Batch

Pavement Layers

Pavement Type: New Rigid

Material	Thickness (mm)	E (MPa)	k (MN/m ³)	R (MPa)
P-501 PCC Surface	436	27,579.04		4.48
P-306 Lean Concrete	127	4,826.33		
P-209 Crushed Aggregate	200	167.17		
Subgrade		47.00	25.3	

PCR Calculation of Rigid Example Co
Run Time: 164 seconds
PCR = 1100/R/D/W/T

Design Options

Calculate HMA CDF: No

Reduced Cross Section: No

Automatic flexible base design: Yes

Slab Stress Displayed: No

Output file: No

Units: Metric

Allow Flexible Computation for Thick Overlays on PCC: Yes

Compute ACR for All Subgrade Categories: No

Show Advanced Options

Set as Program Default Reset Default to Initial

Show/Hide Pavement Image

Traffic

Stored Aircraft Mix ICAO_ACR-PCR Workshop Save Aircraft Mix to File Clear All Aircraft from List Remove Selected

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)
S-30	13,608	8,000	0	160,000	0	0	6.33	517.11
Fokker-F-100	44,452	6,500	0	130,000	0	0	3.71	1043.63
B737-300	62,822	5,000	0	100,000	0	0	3.88	1370.99
B767-300 ER	158,757	3,200	0	64,000	0	0	3.7	1168.60
A380-800 WW000	544,310	400	0	8,000	0	0.09	3.83	1455.74
A380-800 WW000 Belly	544,310	400	0	8,000	0.09	0.09	4.25	1455.74

Explorer

- ICAO_WACAF_ACR-PCR
 - Job Information
 - Design Options
 - Summary Report
 - Structures
 - Flexible Example
 - Rigid Example** (Copy, Delete, Paste)
 - Overlay Example
 - Overload

Copy/Paste "New Rigid" Section and rename structure.

Explorer Aircraft Material

7:14 PM 10/23/2024

Modify the Structure

(1) Click on the P-501 PCC Surface Layer

(2) On the Materials dialog box, select "P-401/P-403 HMA Overlay."

(3) Click "Add Layer Above."

The screenshot shows the 'Layer Property' dialog box with the following settings:

- Materials Menu:**
 - General: User Defined, Subgrade
 - P-401/P-403 HMA: P-401/P-403 HMA Surface, P-401/P-403 HMA Overlay
 - P-501 PCC: P-501 PCC Surface, P-501 PCC Overlay (Unbonded), P-501 PCC Overlay on Flexible
- Aggregate:**
 - P-154 Uncrushed Aggregate
 - P-208 Crushed Aggregate
 - P-209 Crushed Aggregate
 - P-211 Lime Rock
 - P-219 Recycled Concrete Aggregate
- Stabilized:**
 - P-301 Soil Cement Base
 - P-304 Cement Treated Base
 - P-306 Lean Concrete
 - P-401/P-403 HMA Stabilized
 - Variable (flexible)
 - Variable (rigid)
- Update Thickness (mm):** 410
- Update Modulus (MPa):** 1,378.95
- Update Concrete Flexural Strength R (MPa):** [Empty]
- Update CBR:** [Empty]
- Update Subgrade Reaction (MN/m³):** [Empty]

Buttons: Add Layer Below, Add Layer Above, OK, Delete Layer, Cancel

Modify the Structure

Note – Pavement type has been changed to “HMA Overlay on Rigid.”

SCI = 67

Material	Thickness (mm)	E (MPa)	k (MN/m ³)	R (MPa)
P-401/P-403 HMA Overlay	305	1,378.95		
P-501 PCC Surface	440	27,579.04		4.48
P-401/P-403 HMA Stabilized	127	2,757.90		
P-209 Crushed Aggregate	152	517.11		
Subgrade		47.00	25.3	

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)
S-30	13,608	8,000	0	160,000	0	0	0	517.11
Fokker-E-100	44,452	6,500	0	130,000	0	0	0	1043.63

Design Options

Design Options – Make sure “Allow Flexible Computation for Thick Overlays on PCC” is set to “Yes.”

The screenshot displays the FAARFIELD 2.1.1 software interface. The main window is titled "Structure" and shows the "Structure" tab selected. The "Structure" section includes fields for Job Name (ICAO_WACAF_ACR-PCR), Thickness Design (dropdown), and Structure Name (Overlay Example). The "Pavement Layers" section shows a table with the following data:

Material	Thickness (mm)	E (MPa)	k (MN/m ³)	R (MPa)
P-401/P-403 HMA Overlay	305	1,378.95		
P-501 PCC Surface	440	27,579.04		4.48
P-401/P-403 HMA Stabilized	127	2,757.90		
P-209 Crushed Aggregate	152	517.11		
Subgrade		47.00	25.3	

Below the table are buttons for "Select As The Design Layer" and "Delete Selected Layer". The "Design Life (Years)" is set to 20, "SC1" is 67, and "Percent CDFU" is 100. The "Traffic" section shows "Stored Aircraft Mix" as "ICAO_ACR-PCR Workshop" and a table with the following data:

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)
S-30	13,608	8,000	0	160,000	0	0	0	517.11
Fokker-E-100	44,452	6,500	0	130,000	0	0	0	1043.63

The "Design Options" panel on the right shows various settings, with "Allow Flexible Computation for Thick Overlays on PCC" set to "Yes".

Run Overlay Design

The screenshot displays the FAARFIELD 2.1.1 software interface. The main window is titled 'Structure' and shows the 'Run' button highlighted. A callout box with the text 'Click "Run"' points to this button. The interface includes a 'Job Information' section with fields for 'Job Name' (ICAO_WACAF_ACR-PCR) and 'Thickness Design'. Below this is a table of 'Pavement Layers' with columns for Material, Thickness (mm), E (MPa), k (MN/m³), and R (MPa). The 'Traffic' section at the bottom shows a table of aircraft data.

Material	Thickness (mm)	E (MPa)	k (MN/m ³)	R (MPa)
P-401/P-403 HMA Overlay	305	1,378.95		
P-501 PCC Surface	440	27,579.04		4.48
P-401/P-403 HMA Stabilized	127	2,757.90		
P-209 Crushed Aggregate	152	517.11		
Subgrade		47.00	25.3	

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)
S-30	13,608	8,000	0	160,000	0	0	0	517.11
Fokker-E-100	44,452	6,500	0	130,000	0	0	0	1043.63



Design Complete

The screenshot displays the FAARFIELD 2.1.1 software interface. The main window is titled "Structure" and shows the design parameters for a pavement structure. The "Pavement Layers" section is expanded, showing a table of layers. The top layer is "P-401/P-403 HMA Overlay" with a thickness of 81 mm. A callout box with a red border and text points to this layer, stating "Design thickness: 80 mm".

Material	Thickness (mm)	E (MPa)	R (MN/m ²)	R (MPa)
P-401/P-403 HMA Overlay	81	1,378.95		
P-501 PCC Surface	440	27,579.04		4.48
P-401/P-403 HMA Stabilized	127	2,757.90		
P-209 Crushed Aggregate	152	151.34		
Subgrade		47.00	25.3	

Below the table, the "Design Life (Years)" is set to 20, "SC1" is 67, and "Percent CDFU" is 100. The "Traffic" section shows the "Stored Aircraft Mix" as "ICAO_ACR-PCR Workshop".

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)
S-30	13,608	8,000	0	160,000	0	0	6.33	517.11
Fokker-F-100	44,452	6,500	0	130,000	0	0	7.71	1043.63

Run Overlay PCR Evaluation

The screenshot displays the FAARFIELD 2.1.1 software interface. The main window is titled 'Structure' and shows the 'Run' button highlighted in blue. A callout box with an arrow points to the 'Run' button, containing the text 'Click "Run"'. The interface includes a left-hand 'Explorer' pane, a central 'Structure' panel with a table of pavement layers, and a right-hand 'Design Options' panel. The 'Structure' panel shows a table with columns for Material, Thickness (mm), E (MPa), k (MN/m^3), and R (MPa). The 'Design Options' panel includes various settings such as 'Calculate HMA CDF', 'Reduced Cross Section', and 'Automatic flexible base design'.

Material	Thickness (mm)	E (MPa)	k (MN/m ³)	R (MPa)
--> P-401/P-403 HMA Overlay	100	1,378.95		
P-501 PCC Surface	356	27,579.04		4.48
P-401/P-403 HMA Stabilized	127	2,757.90		
P-209 Crushed Aggregate	152	151.34		
Subgrade		47.00	25.3	

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures	CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (kPa)
S-30	13,608	8,000	0	160,000	0	0	0	517.11
Fokker-F-100	44,452	6,500	0	130,000	0	0	0	1043.63
B737-200	63,822	5,000	0	100,000	0	0	0	1270.00

Run Overlay PCR Evaluation

The screenshot shows the FAARFIELD 2.1.1 software interface. The main window displays the 'Structure' tab for a job named 'ICAO_WACAF_ACR-PCR'. The structure name is 'Overlay Example'. The pavement type is 'HMA Overlay on Rigid'. A table lists the materials and their properties:

Material	Thickness (mm)	E (MPa)	k (MN/m ³)	R (MPa)
P-401/P-403 HMA Overlay	81	1,378.95		
	440	27,579.04		
	127	2,757.90		
	152	151.34		
	47.00	24		

Two red boxes highlight PCR calculation results:

- Top box: PCR Calculation of Overlay Example, Run Time: 333 seconds, PCR = 1100/R/D/W/T
- Bottom box: PCR Calculation of Overlay Example, Run Time: 734 seconds, PCR = 1100/R/D/W/T

A red arrow points from the bottom box to the 'Percent CDFU: 100' field in the design options panel.

Design Options panel includes:

- Calculate HMA CDF: No
- Reduced Cross Section: No
- Automatic flexible base design: Yes
- Slab Stress Displayed: No
- Output File: No

Bottom panel includes:

- Save Aircraft Mix to File
- Clear All Aircraft from List
- Remove Select
- Table with columns: Annual Departures, Annual Growth (%), Total Departures, CDF Contributions, CDF Max for Airplane, P/C Ratio, Tire Pressure (kPa)

PCR = 1100
Rigid Pavement
Subgrade Class D
Unlimited Tire Pressure
Technical Evaluation

PCR Calculation of Overlay Example
Run Time: 734 seconds
PCR = 1100/R/D/W/T

Thank You!

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