

ICAO AERODROME PAVEMENT WORKSHOP

FAARFIELD 2.1 for PCR

Presented to: ICAO Aerodrome Pavement Workshop
Bangkok, Thailand

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Date: 9 February 2024



**Federal Aviation
Administration**

FAARFIELD 2.1 PCR Mode

- **Flexible Pavement PCR Example**
- **Understanding PCR Reports and Charts**
- **Rigid Pavement PCR Example**





Flexible Pavement PCR Example

FAARFIELD 2.0 PCR Example

- **Airport B**
 - Medium-hub airport in the U.S.
 - Runway 10R-28L is a flexible runway constructed in 2013.
- **Design Section:**
 - 5 in. (127 mm) HMA surface (P-401)
 - 11 in. (279 mm) HMA base (P-401)
 - 12 in. (305 mm) crushed aggregate subbase (P-209)
 - 12 in. (305 mm) cement-stabilized subgrade (P-301)
- **Existing subgrade soils were of poor quality and potentially contaminated.**
 - Cement-stabilized soil layer was added to provide a higher CBR while minimizing disturbance of the existing subgrade.
 - Assumed CBR 7 at the top of the cement-stabilized subgrade.
- **Airport reported PCN 77/F/C/W/T using COMFAA 3.0.**



10L/28R 10R/28L			
Runway Data		Obstruction Data	
Runway Identification	10R/28L	FAR 77 Category	PIR/PIR
Length	10,114	Displaced Threshold	/
Width	150	Controlling Obstruction	/
Surface Type-Condition	ASPH-E	Obstruction Marked/Lighted	/
Surface Treatment	CRVD	Height Above Runway End	/
Gross Weight (In Thousands)		Distance From Runway End	/
Single Wheel (S)	120.0	Centerline Offset & Direction	/
Dual Wheel (D)	250.0	Obstruction Clearance Slope	50/50
2 Dual Wheels in Tandem (2D)	424.0	Close-In Obstruction	N/N
2 Dual Wheels in Tandem / 2 Dual Wheels in Double Tandem (2D/2D2)			
Pavement Classification Number (PCN)	77 /F/C/W/T		

FAARFIELD 2.0 PCR - Data

Airport B - Runway 10R-28L



Traffic				
Stored Aircraft Mix	Airport B 10R-28L		Save Aircraft Mix to File	
Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures
B767-300(UDA)	143,789	365	0	7,300
B757-200	116,100	1,360	0	27,200
B737-900	85,366	1,360	0	27,200
B737-800	79,242	4,380	0	87,600
MD-83	73,016	365	0	7,300
B737-400	68,266	365	0	7,300
B737-300	63,503	17,885	0	357,700
B737-500	60,781	2,920	0	58,400
B717-200 HGW	55,338	3,531	0	706,200
CRJ900	38,329	6,570	0	131,400
CRJ700	34,019	18,615	0	372,300
ERJ-145 ER	21,999	32,405	0	648,100
S-10	3,969	550	0	11,000
S-3	1,043	600	0	12,000
D-30	13,608	6,525	0	130,500
S-10	4,536	15,225	0	304,500
D-50	22,680	40,400	0	808,000



One-Step PCR Procedure

- For PCR following design, the evaluation structure and traffic mix are already entered in FAARFIELD.
- No equivalent thickness calculation needed.
- In PCR mode, FAARFIELD automatically switches to standard CG and tire pressure conditions for ACR evaluation.
- FAARFIELD automatically determines the subgrade category from subgrade data.
- FAARFIELD automatically determines the critical aircraft from the traffic list.



FAARFIELD 2.0 PCR Example

One-Step Procedure

Structure

Job Name: PCR Comparisons 2 PCR Run Status Gear Structure

Structure Name: Airport B RWY 10R-28L ☒ Include in Summary Report Add To Batch

Pavement Layers

Pavement Type: New Flexible

Material	Thickness (mm)	E (MPa)
P-401/P-403 HMA Surface	127	1,378.95
P-401/P-403 HMA Stabilized	279	2,757.90
P-209 Crushed Aggregate	305	265.96
Subgrade		72.41

Select As The Design Layer Delete Selected Layer

Design Life (Years): 20 P/TC Ratio: 1

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): 711

Traffic

Stored Aircraft Mix: Airport B 10R-28L 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 Cor Area (m)
B767-300(UDA)	143,789	365	0	7,300	0	0	0	1210.88	0	332	531	138,286
B757-200	116,100	1,360	0	27,200	0	0	0	1261.74	0.95	292	467	107,174
B737-900	85,366	1,360	0	27,200	0	0	0	1515.22	0.95	323	517	131,218
B737-800	79,242	4,380	0	87,600	0	0	0	1406.53	0.95	323	517	131,218
MD-83	73,016	365	0	7,300	0	0	0	1344.48	0.95	317	508	126,509
B737-400	68,266	365	0	7,300	0	0	0	1275.53	0.95	315	504	124,651

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: No

Compute ACR for All Subgrade Categories: Yes

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 Brili\Documents\My FAARFIELD\User Defined Aircraft

Change Aircraft Directory

Design Options Notes User Information



FAARFIELD 2.0 PCR Example

$$\text{PCR} = 770/\text{F}/\text{C}/\text{X}/\text{T}$$

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

- Job Name:** PCR Comparisons 2
- Structure Name:** Airport B RWY 10R-28L
- Pavement Type:** New Flexible
- Pavement Layers:**

Material	Thickness (mm)	E (MPa)	CBR
P-401/P-403 HMA Surface	127	1,378.95	
P-401/P-403 HMA Stabilized	279	2,757.90	
P-209 Crushed Aggregate	305	266.01	
Subgrade		72.41	7

The 'Status' tab shows the following information:

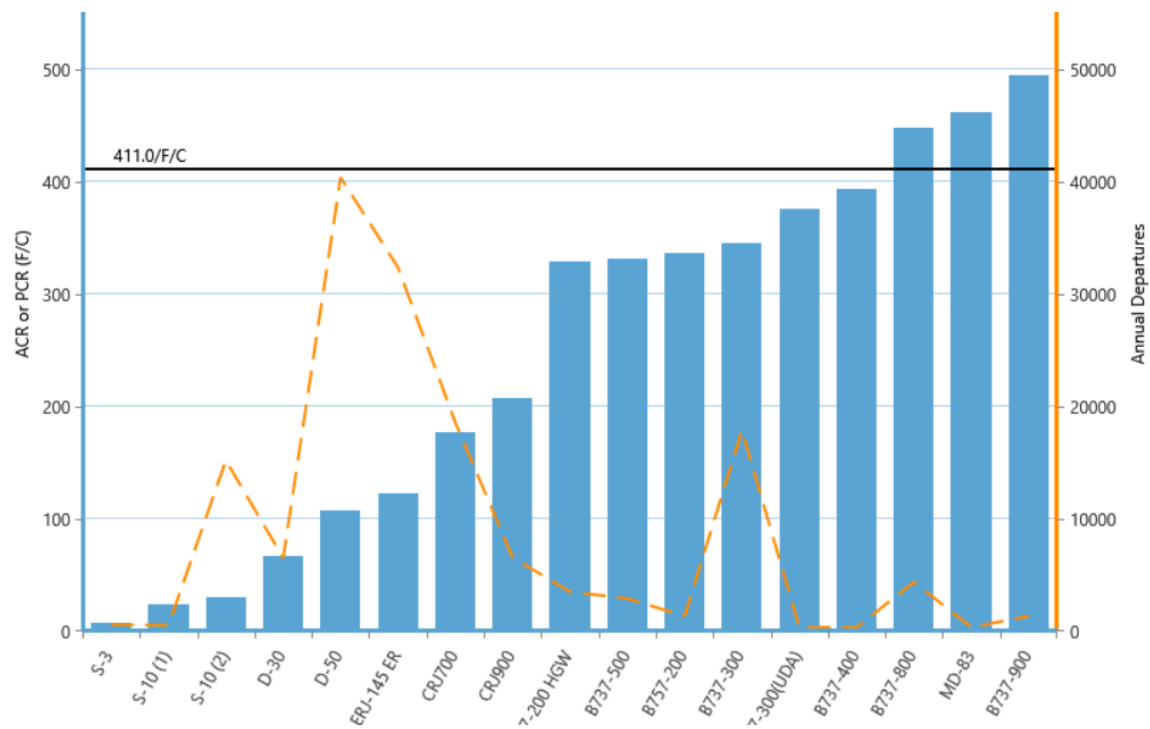
- Status:** PCR Calculation of Airport B RWY 10R-28L Completed
- Run Time:** 51 seconds
- PCR:** $770/\text{F}/\text{C}/\text{X}/\text{T}$

A note box states: **Note – FAARFIELD automatically loads the correct tire pressure and %GW on main gear for PCR calculations. These may be different than thickness design values.**

The 'Aircraft' list shows the following data:

Aircraft	Tire Pressure (kPa)	Percent GW on Gear
B737-800	1210.88	0.922
MD-83	1261.74	0.912
B737-400	1515.22	0.936
	1406.53	0.936
	1344.48	0.948
	1275.53	0.938





Understanding PCR Reports and Charts

PCR Reports and Graphs

PCR Report
PCR Graph
Airport Master Record

FAARFIELD 2.1.1 (Build 12/21/2023)

Structure: PCR Report

Job Name: PCR Comparisons 2 PCR Run

Structure Name: Airport B RWY 10R-28L Include in Summary Report Add To Batch

Pavement Layers

Pavement Type: New Flexible

Material	Thickness (mm)	E (MPa)	CBR
P-401/P-403 HMA Surface	127	1,378.95	
P-401/P-403 HMA Stabilized	279	2,757.90	
P-209 Crushed Aggregate	305	266.01	
Subgrade		72.41	7

Select As The Design Layer Delete Selected Layer

Design Life (Years): 20 P/T Ratio: 1

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): 711

Traffic

Stored Aircraft Mix: Airport B 10R-28L 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)
B767-300(UDA)	143,789	365	0	7,300	0	0	1.28	1210.88	0.922	332	531	138,286
B757-200	116,100	1,360	0	27,200	0	0	1.3	1261.74	0.912	292	467	107,174
B737-900	85,366	1,360	0	27,200	0	0	1.28	1515.22	0.936	323	517	131,218
B737-800	79,242	4,380	0	87,600	0	0	1.28	1406.53	0.936	323	517	131,218
MD-83	73,016	365	0	7,300	0	0	1.35	1344.48	0.948	317	508	126,509
B737-400	68,266	365	0	7,300	0	0	1.33	1275.53	0.938	315	504	124,651

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: No

Compute ACR for All Subgrade Categories: Yes

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 Brill\Documents\My FAARFIELD\User Defined Aircraft Change Aircraft Directory

PCR Report

Summary Data

Results Table 1

Federal Aviation Administration FAARFIELD 2.1 PCR Report

FAARFIELD 2.1.1 (Build 12/21/2023)

Job Name: PCR Comparisons 2

Structure: Airport B RWY 10R-28L

This file name = PCR Results for New Flexible 2024-02-01 08:54:31

Evaluation pavement type is flexible and design program is FAARFIELD.

Structure name: Airport B RWY 10R-28L in job file: PCR Comparisons 2.JOB.xml

Units = Metric

Analysis Type: New Flexible

Subgrade Modulus = 72.41MPa (Subgrade Category is C)

Evaluation Pavement Thickness = 711 mm

Pass to Traffic Cycle (PtoTC) Ratio = 1.00

Maximum number of wheels per gear = 4

CUF = 0.000

At least one aircraft has 4 or more wheels per gear.

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight (kg)	Percent Gross Weight	Tire Pressure (MPa)	Annual Departure	20 Years Coverage
1	B767-300(UDA)	143,789	92.20	1,210.88	365	5,689
2	B757-200	116,100	91.20	1,261.74	1,360	20,870
3	B737-900	85,366	93.60	1,515.22	1,360	21,169
4	B737-800	79,242	93.60	1,406.53	4,380	68,176
5	MD-83	73,016	94.80	1,344.48	365	5,404
6	B737-400	68,266	93.80	1,275.53	365	5,498
7	B737-300	63,503	90.80	1,385.85	17,885	246,731
8	B737-500	60,781	92.20	1,337.58	2,920	43,563
9	B717-200 HGW	55,338	94.40	1,130.74	3,531	50,595
10	CRJ900	38,329	95.00	1,110.39	6,570	91,366
11	CRJ700	34,019	95.00	1,005.87	18,615	258,580
12	ERJ-145 ER	21,999	95.00	1,062.49	32,405	404,016
13	S-10	3,969	95.00	301.65	550	4,528
14	S-3	1,043	95.00	264.23	600	4,856
15	D-30	13,608	95.00	586.05	6,525	77,404
16	S-10	4,536	95.00	344.74	15,225	136,426
17	D-50	22,680	95.00	551.58	40,400	537,250

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. HGW (mm)	PCR/F/C
1	B737-900	1,360	118,791	807	771.9
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)	
1	B767-300(UDA)	143,789	92.2	1,210.88	
2	B757-200	116,100	91.2	1,261.74	
3	B737-900	85,366	93.6	1,515.22	
4	B737-800	79,242	93.6	1,406.53	
5	MD-83	73,016	94.8	1,344.48	
6	B737-400	68,266	93.8	1,275.53	
7	B737-300	63,503	90.8	1,385.85	
8	B737-500	60,781	92.2	1,337.58	
9	B717-200 HGW	55,338	94.4	1,130.74	
10	CRJ900	38,329	95	1,110.39	
11	CRJ700	34,019	95	1,005.87	
12	ERJ-145 ER	21,999	95	1,062.49	
13	S-10	3,969	95	301.65	
14	S-3	1,043	95	264.23	
15	D-30	13,608	95	586.05	
16	S-10	4,536	95	344.74	
17	D-50	22,680	95	551.58	

Results Table 2

Results Table 3



PCR Report

- **PCR report tables are similar to COMFAA results tables, but simpler.**
 - Results Table 1 – Input Traffic Data.
 - Results Table 2 displays PCR data for the critical (reference) aircraft only. PCR is defined as the ACR of the critical aircraft at the maximum allowable gross weight (MAGW).
 - Results Table 3 – ACR Data.
- **No cut-and-paste. The PCR graph is generated automatically.**

PCR Terminology

- **Critical aircraft:** Aircraft taken to represent the whole traffic mix in the PCR computation. *It is not necessarily the aircraft with the highest ACR.*
- **Critical aircraft total equivalent departures** = number of departures of the critical aircraft at the operating weight that results in the same CDF as the whole traffic mixture.
- **Maximum allowable gross weight (MAGW)** = gross weight of critical aircraft that results in $CDF = 1$ for the evaluation structure (at total equivalent departures).
- **PCR = ACR of critical aircraft computed at MAGW.**

Results Tables 1 and 2

FAARFIELD 2.1.1 (Build 12/21/2023)

Explorer: PCR Graph, Airport Master Record, Airport B RWY 10L-28R (No), Structure Report, CDF Graph, PCR Report, PCR Graph, Airport Master Record, Airport B RWY 10L-28R Exten, Structure Report, CDF Graph, PCR Report, PCR Graph, Airport Master Record, Airport B RWY 10R-28L, Structure Report, CDF Graph, PCR Report, PCR Graph, Airport Master Record, Airport C RWY 01-19, Structure Report, CDF Graph, PCR Report, PCR Graph, Airport Master Record, Airport F RWY 9-27, Structure Report

Structure: PCR Report

Save As PDF

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight (kg)	Percent Gross Weight	Tire Pressure (MPa)	Annual Departure	20 Years Coverage
1	B767-300(UDA)	143,789	92.20	1,210.88	365	5,689
2	B757-200	116,100	91.20	1,261.74	1,360	20,870
3	B737-900	85,366	93.60	1,515.22	1,360	21,169
4	B737-800	79,242	93.60	1,406.53	4,380	68,176
5	MD-83	73,016	94.80	1,344.48	365	5,404
6	B737-400	68,266	93.80	1,275.53	365	5,498
7	B737-300	63,503	90.80	1,385.85	17,885	266,731
8	B737-500	60,781	92.20	1,337.58	2,920	43,563
9	B717-200 HGW	55,338	94.40	1,130.74	3,531	50,595
10	CRJ900	38,329	95.00	1,110.39	6,570	91,366
11	CRJ700	34,019	95.00	1,005.87	18,615	258,580
12	ERJ-145 ER	21,999	95.00	1,062.49	32,405	404,016
13	S-10	3,969	95.00	301.65	550	4,928
14	S-3	1,043	95.00	264.23	600	4,856
15	D-30	13,608	95.00	586.05	6,525	77,404
16	S-10	4,536	95.00	344.74	15,225	136,426
17	D-50	22,680	95.00	551.58	40,400	537,250

Results Table 2. PCR Value

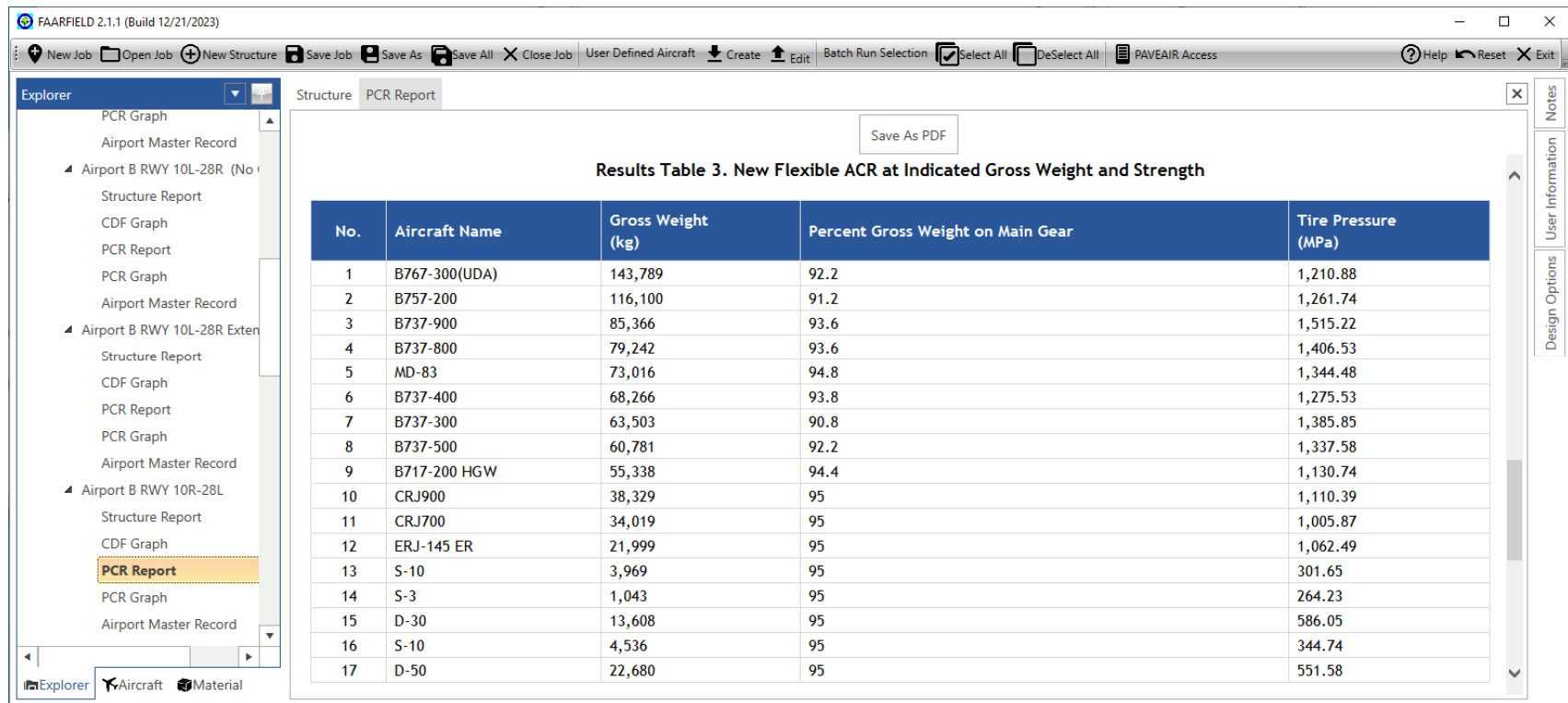
No.	Aircraft Name	Critical aircraft Total equiv. departures	Max allowable Gross Weight of critical aircraft (kg)	ACR Thick at max. (mm)	IGW	PCR/F/C
1	B737-900	1,360	118,791	807		771.9

Critical Aircraft

- Actual computed PCR = 771.9.
- Report PCR to nearest whole multiple of 10 (per ADM).
- Report PCR 770/F/C/X/T.

PCR/F/C
771.9

Results Table 3



FAARFIELD 2.1.1 (Build 12/21/2023)

Menu: 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:

- PCR Graph
- Airport Master Record
- Airport B RWY 10L-28R (No)
- Structure Report
- CDF Graph
- PCR Report
- PCR Graph
- Airport Master Record
- Airport B RWY 10L-28R Extension
- Structure Report
- CDF Graph
- PCR Report
- PCR Graph
- Airport Master Record
- Airport B RWY 10L-28L
- Structure Report
- CDF Graph
- PCR Report**
- PCR Graph
- Airport Master Record

Structure PCR Report

Save As PDF

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)
1	B767-300(UDA)	143,789	92.2	1,210.88
2	B757-200	116,100	91.2	1,261.74
3	B737-900	85,366	93.6	1,515.22
4	B737-800	79,242	93.6	1,406.53
5	MD-83	73,016	94.8	1,344.48
6	B737-400	68,266	93.8	1,275.53
7	B737-300	63,503	90.8	1,385.85
8	B737-500	60,781	92.2	1,337.58
9	B717-200 HGW	55,338	94.4	1,130.74
10	CRJ900	38,329	95	1,110.39
11	CRJ700	34,019	95	1,005.87
12	ERJ-145 ER	21,999	95	1,062.49
13	S-10	3,969	95	301.65
14	S-3	1,043	95	264.23
15	D-30	13,608	95	586.05
16	S-10	4,536	95	344.74
17	D-50	22,680	95	551.58

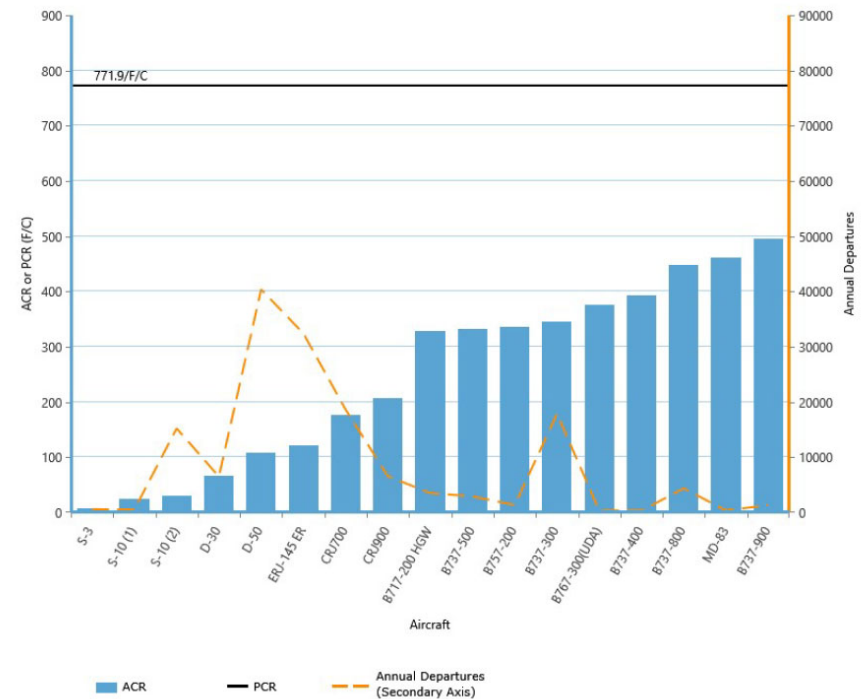
Explorer Aircraft Material

PCR Graph for Example

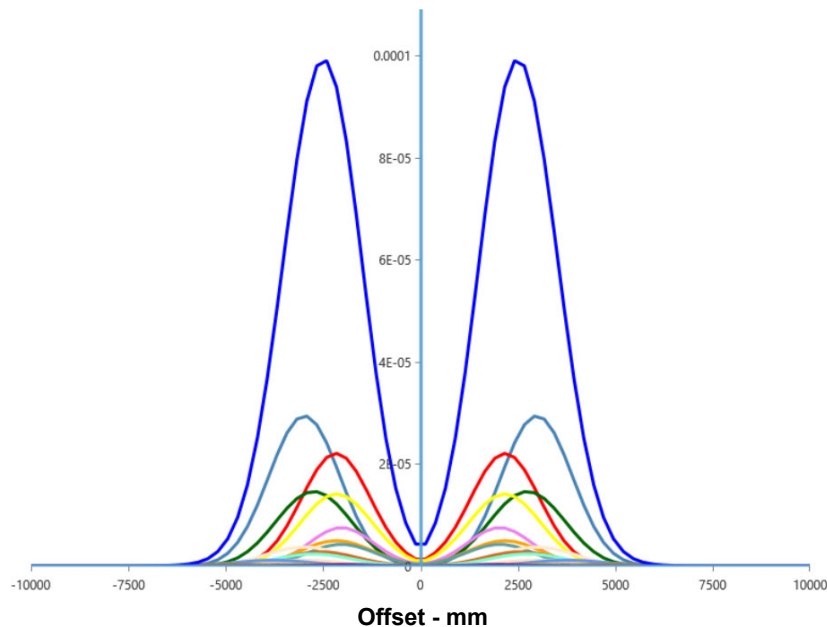
Critical aircraft: B737-900

No.	Aircraft Name	Aircraft ACR	Calculated PCR	Annual Departure
1	B737-900	495.4	771.9	1,360
2	MD-83	401.8	-	365
3	B737-800	447.9	-	4,380
4	B737-400	393.4	-	365
5	B767-300(UDA)	376	-	365
6	B737-300	345.6	-	17,885
7	B757-200	336.5	-	1,360
8	B737-500	331.6	-	2,920
9	B717-200 HGW	328.5	-	3,531
10	CRJ900	207.7	-	6,570
11	CRJ700	177.5	-	18,615
12	ERJ-145 ER	122.2	-	32,405
13	D-50	108	-	40,400
14	D-30	66.9	-	6,525
15	S-10	30.3	-	15,225
16	S-10	24.2	-	550
17	S-3	7.9	-	600

All design aircraft have ACR < PCR



CDF Graph



- **CDF for this example $\ll 1$**
 - Significant excess strength.
 - Consistent with no restrictions on using aircraft.
 - Aircraft generally bunched up around same offset.
- **Maximum CDF for PCR is usually less than CDF for design.**
 - Due to different gear characteristics used for PCR computation
 - For design, we assume 95% of gross weight on the main gear (conservative).
 - PCR assumes maximum ramp mass and actual corresponding aft c.g.

Airport Master Record (AMR) Data

Use the information on this page to populate fields 35-39 in Airport Master Record (U.S. only).

FAARFIELD 2.1.1 (Build 12/21/2023)

Save As PDF

Federal Aviation Administration FAARFIELD 2.1 Airport Master Record

FAARFIELD 2.1.1 (Build 12/21/2023)

RUNWAY DATA

Job Name: PCR Comparisons 2

Structure: Airport B RWY 10R-28L

Gross Weight (In THSDS)

35 S	120
36 D	250
37 2D	415
38 2D/2D2	998
39 PCR	770/F/C/X/T

What if we reduce the base thickness?

Reduce base thickness to 150 mm

Traffic mix the same

FAARFIELD 2.1.1 (Build 12/21/2023)

Structure CDF Graph PCR Report PCR Graph Airport Master Record

Job Name: PCR Comparisons 2 PCR Run Status Gear Structure

Structure Name: Airport B RWY 10R-28L Include in Summary Report Add To Batch

Pavement Layers

Pavement Type: New Flexible

Material	Thickness (mm)	E (MPa)	CBR
P-401/P-403 HMA Surface	127	1,378.95	
P-401/P-403 HMA Stabilized	150	2,757.90	
P-209 Crushed Aggregate	305	266.01	
Subgrade		72.41	7

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

Life (Years): Total thickness to the top of the subgrade (mm): 582

P/C Ratio: 1

Traffic

Stored Aircraft Mix: Airport B 10R-28L 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)
B767-300(UDA)	143,789	365	0	7,300	0	0	1.28	1210.88	0.922	332	531	138,286
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B737-800	79,242	4,380	0	87,600	0	0	1.28	1406.53	0.936	323	517	131,218
MD-83	73,016	365	0	7,300	0	0	1.35	1344.48	0.948	317	508	126,509
B737-400	68,266	365	0	7,300	0	0	1.33	1275.53	0.938	315	504	124,651

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: No

Compute ACR for All Subgrade Categories: No

Show Advanced Options

Set as Program Default Reset Default to Initial

Show/Hide Pavement Image

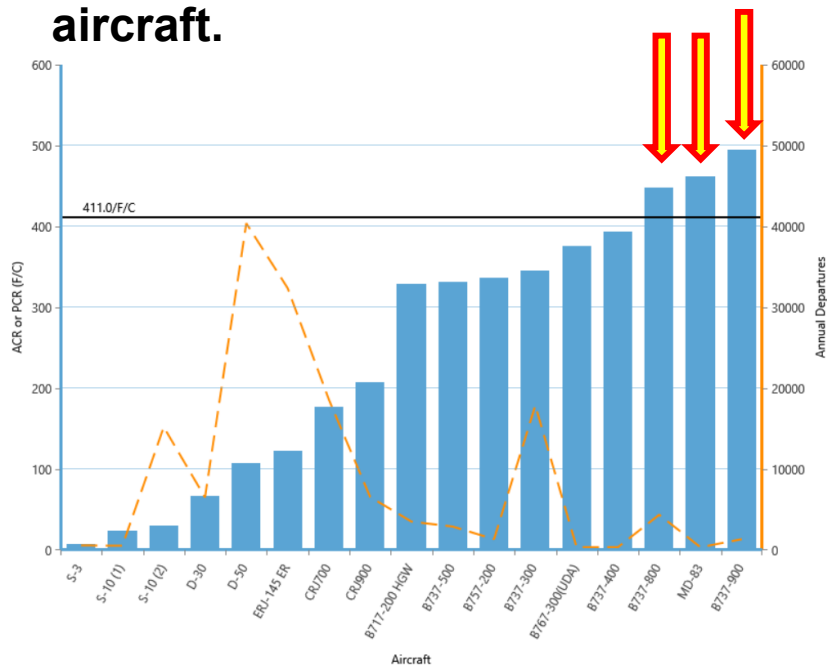
Change Pavement Graphics

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

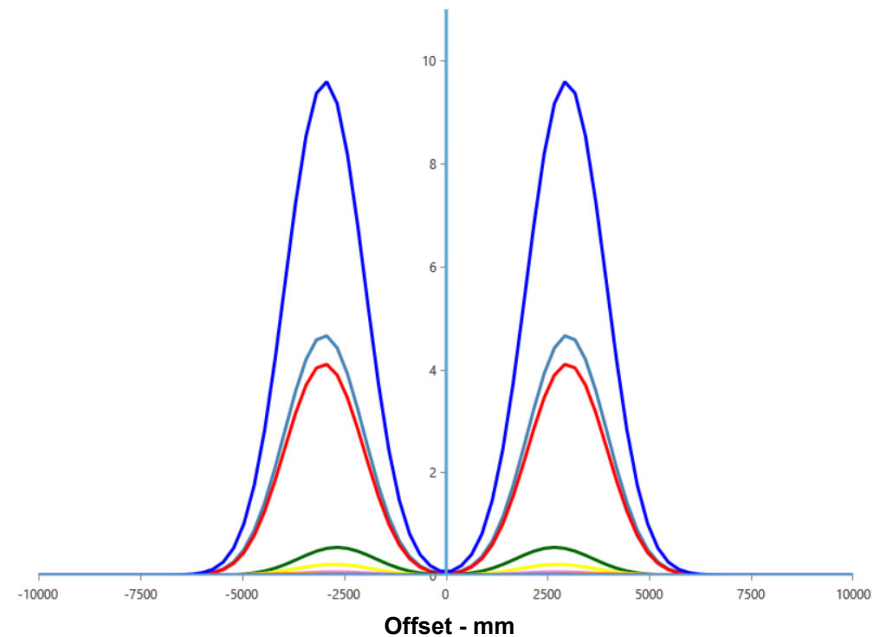
Change Aircraft Directory

PCR for Reduced Based Thickness

- PCR 410/F/C/X/T
- Requires exclusion or operating weight restrictions on 3 mix aircraft.



- CDF > 1.0
- Consistent with need for weight restrictions.

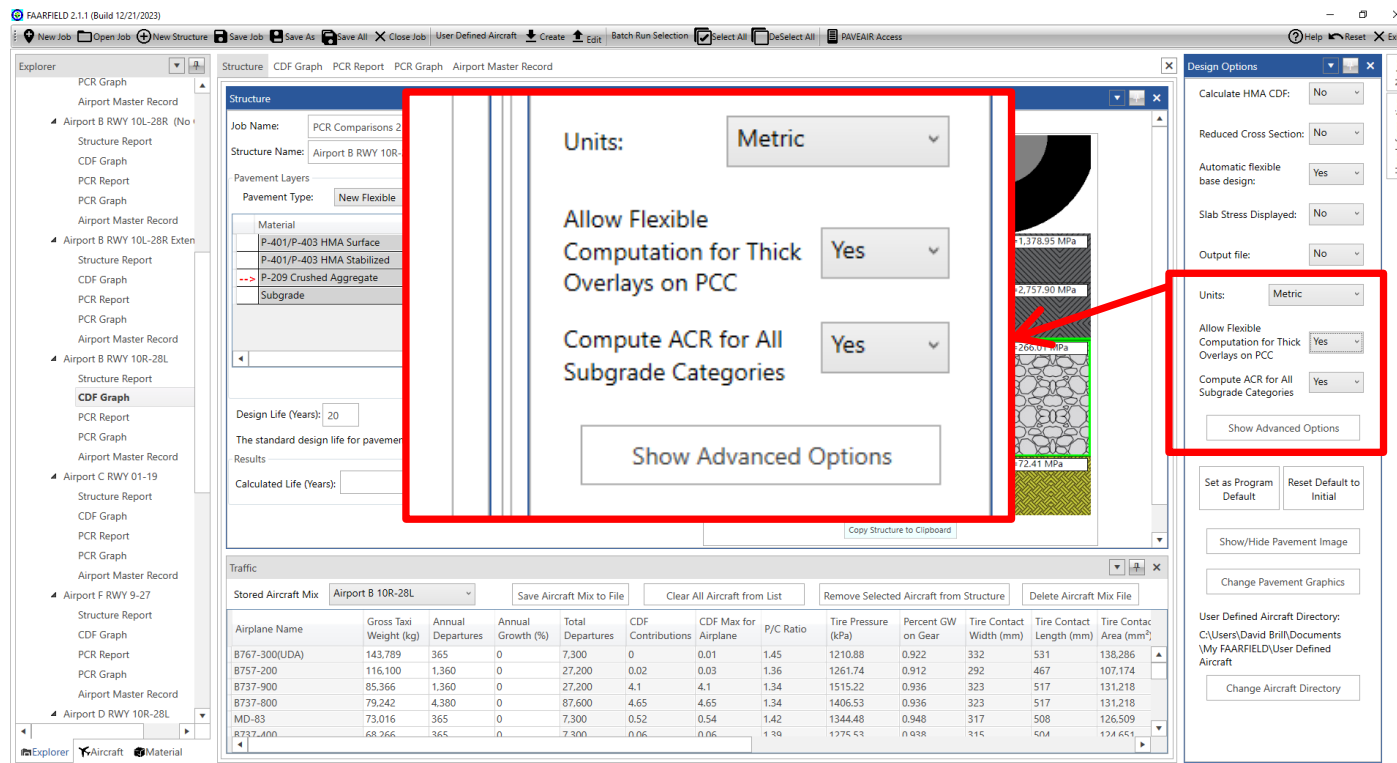


Use FAARFIELD to Compute ACR

- **By default, FAARFIELD computes ACR data for the subgrade strength category of the current pavement.**
- **Option to return ACR data for all subgrade categories.**
- **Convenient to compare ACR for various gear configurations.**



Use FAARFIELD to Compute ACR



Select PCR Mode / Hit Run

The screenshot displays the FAARFIELD 2.1.1 (Build 12/21/2023) software interface. The main window is titled 'Structure' and shows the 'PCR Comparisons 2' job. The 'Structure Name' is 'Airport B RWY 10R-28L'. The 'Pavement Layers' section lists the following layers:

Material	Thickness (mm)	E (MPa)	CBR
P-401/P-403 HMA Surface	127	1,378.95	
P-401/P-403 HMA Stabilized	150	2,757.90	
P-209 Crushed Aggregate	305	266.01	
Subgrade		72.41	7

The 'Design Life (Years)' is set to 20, and the 'P/TC Ratio' is 1. The 'Calculated Life (Years)' is blank, and the 'Total thickness to the top of the subgrade (mm)' is 582. The 'Traffic' section shows the 'Stored Aircraft Mix' for 'Airport B 10R-28L'.

The 'Run' button is highlighted with a red box, indicating the next step in the process.

PCR Complete

Scroll Traffic Table to the Right

The screenshot shows the FAARFIELD 2.1.1 (Build 12/21/2023) software interface. The main workspace displays the PCR calculation results for Airport B RWY 10R-28L. The 'Status' tab is selected, showing the completion message: 'PCR Calculation of Airport B RWY 10R-28L Completed Run Time: 52 seconds PCR = 410/F/C/X/T'. The 'Traffic' table is also visible, showing a list of aircraft 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).

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)
B767-300(UDA)	143,789	365	0	7,300	0	0.01	1.45	1210.88	0.922	332	531	138,286
B757-200	116,100	1,360	0	27,200	0.02	0.03	1.36	1261.74	0.912	292	467	107,174
B737-900	85,366	1,360	0	27,200	4.1	4.1	1.34	1515.22	0.936	323	517	131,218
B737-800	79,242	4,380	0	87,600	4.65	4.65	1.34	1406.53	0.936	323	517	131,218
MD-83	73,016	365	0	7,300	0.52	0.54	1.42	1344.48	0.948	317	508	126,509

Traffic Table

Now displays ACR values for all 4 subgrade categories.

The screenshot shows the FAARFIELD 2.1.1 software interface. The main window displays the 'Traffic' table, which is highlighted with a red box. The table lists aircraft types, their gross taxi weights, annual departures, and ACR values for four subgrade categories (A, B, C, D). A red arrow points to the ACR values in the table.

Airplane Name	Gross Taxi Weight (kg)	Annual Departures	ACR/F/A	ACR/F/B	ACR/F/C	ACR/F/D
B767-300(UDA)	143,789	365	320.4	342.6	376.0	464.8
B757-200	116,100	1,360	262.3	289.4	336.5	447.6
B737-900	85,366	1,360	417.8	453.9	495.4	562.9
B737-800	79,242	4,380	377.2	410.0	447.9	507.1
MD-83	73,016	365	360.5	409.1	461.6	529.6

The software interface also includes a 'Design Options' panel on the right, a 'Results' panel at the bottom, and a 'User Defined Aircraft Directory' section at the bottom right.

ICAO-ACR Version 1.4

- FAA developed program.
- Calculates standard ACR numbers for aircraft operating on flexible and rigid airport pavements.
- Core library can be linked directly to other programs to either compute ACR directly or use as part of a technical PCR evaluation.
- **New – Reads the FAARFIELD aircraft library directly.**
- Get technical information on how to link the library to a calling program from the ICAO-ACR download page:

<https://www.airporttech.tc.faa.gov/Products/Airport-Safety-Papers-Publications/Airport-Safety-Detail/icao-acr-14>

ICAO-ACR Version 1.4 Date 11/15/2023

Calculation Input Data

Pavement Type: ☒ Flexible ☐ Rigid

Gross Weight (lbs): 141978

Percent GW: 0.926

Number of Wheels: 4

Tire Pressure (psi): 172.6

Wheel Coordinates (in)

No	X	Y
1	-131.16	0.00
2	-167.66	0.00
3	167.66	0.00
4	131.16	0.00

Select Airplane Group: Airbus

Select Airplane: A318-100 std

Calculate ACR

☐ Display Select Wheels (SW) ☐ Metric

Subgrade Category	Subgrade Modulus [psi]	Flexible ACR Number	ACR Thickness t [in]
D	7,251.89	364.72	26.97
C	11,603.02	326.02	22.03
B	17,404.53	302.33	18.63
A	29,007.55	280.69	14.23

Input Data - Belly Gear

Percent GW 2:

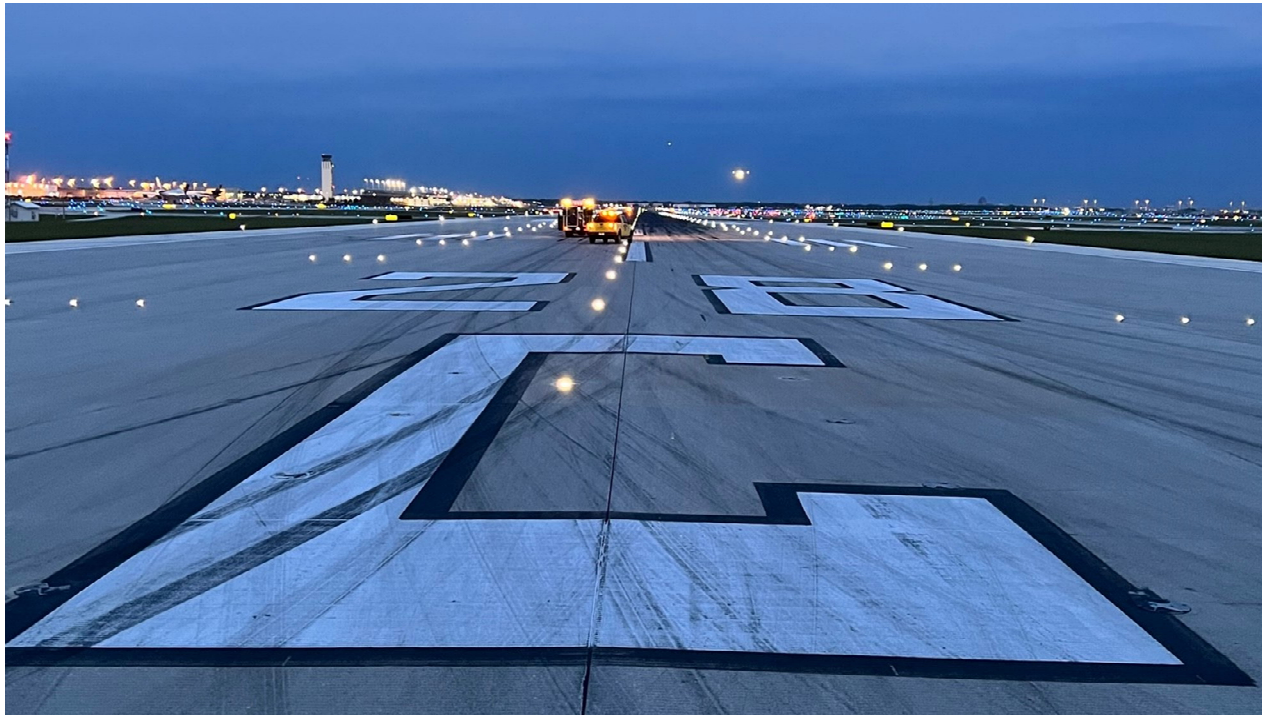
Number of Wheels 2:

Tire Pressure 2 (psi):

Wheel Coordinates (in)

No	X	Y





Rigid Pavement PCR Example

FAARFIELD 2.0 PCR Example

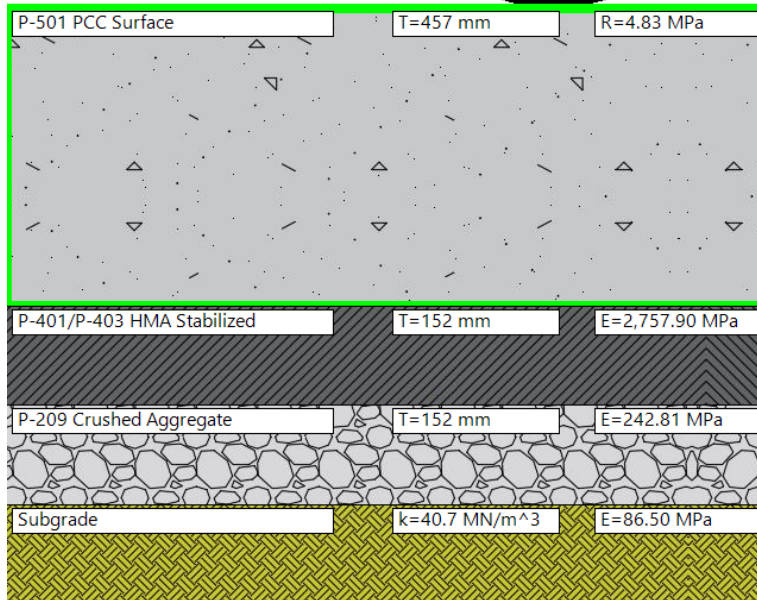
- **Airport E**
 - Large-hub airport in the U.S.
 - Runway 10C-28C is a rigid runway constructed in 2013.
- **Design Section:**
 - 18 in. (457 mm) PCC surface (P-501)
 - 6 in. (152 mm) HMA base (P-403)
 - 6 in. (152 mm) asphalt-treated permeable base (ATPB)
 - 12 in. (305 mm) stabilized subgrade over natural subgrade
- **For design purposes, ATPB is assumed equivalent to standard granular base course P-209.**
- **Subgrade stabilization provides estimated $k = 150$ pci at top of subgrade.**
- **Airport reported PCN 96/R/C/W/T using COMFAA 3.0 (Old ACN/PCN system).**



04L/22R	04R/22L	09C/27C	09L/27R	09R/27L	10C/28C	10L/28R	10R/28L	10X	H1
Runway Data					Obstruction Data				
Runway Identification					10C/28C	FAR 77 Category			PIR/PIR
Length					10,800	Displaced Threshold			/
Width					200	Controlling Obstruction			/
Surface Type-Condition					CONC-E	Obstruction Marked/Lighted			/
Surface Treatment					GRVD	Height Above Runway End			/
Gross Weight (In Thousands)						Distance From Runway End			/
Single Wheel (S)					75.0	Centerline Offset & Direction			/
Dual Wheel (D)					135.0	Obstruction Clearance Slope			50/50
2 Dual Wheels in Tandem (2D)					375.0	Close-In Obstruction			N/N
2 Dual Wheels in Tandem/ 2 Dual Wheels in Double Tandem (2D/2D2)					902.0				
Pavement Classification Number (PCN)					96	R/C/W/T			

FAARFIELD 2.0 PCR - Data

Airport E - Runway 10C-28C



Traffic				
Stored Aircraft Mix		Airport A		Save Aircraft Mix to File
Airplane Name	Gross Taxi Weight (kg)	Annual Departures	Annual Growth (%)	Total Departures
A330-200 WV020	212,735	81	0	1,620
A340-300 std	272,155	840	0	16,800
A340-300 std Belly	272,155	840	0	16,800
A380-800 WV000	405,511	424	0	8,480
A380-800 WV000 Belly	405,511	424	0	8,480
B747-400	395,986	2,722	0	54,440
B747-400 Belly	395,986	2,722	0	54,440
B767-300 ER/Freighter	185,519	3,454	0	69,080
B777-300	327,493	3,372	0	67,440
A300-600 Std Bogie	170,097	1,019	0	20,380
DC/MD-10-10/10F	207,746	71	0	1,420
MD-11	281,681	606	0	12,120
MD-11 Belly	281,681	606	0	12,120
B757-200	113,398	291	0	5,820
A320-200 std	68,039	24,656	0	493,120
B737-800	78,471	26,655	0	533,100
B727-200 Advanced Basic	78,018	1,346	0	26,920
D-50	20,412	28,229	0	564,580
S-30	10,206	3,808	0	76,160



One-Step PCR Procedure

- For PCR following design, the evaluation structure and traffic mix are already entered in FAARFIELD.
- No equivalent thickness calculation needed.
- In PCR mode, FAARFIELD automatically switches to standard CG and tire pressure conditions for ACR evaluation.
- FAARFIELD automatically determines the subgrade category from subgrade data.
- FAARFIELD automatically determines the critical aircraft from the traffic list.



FAARFIELD 2.0 PCR Example

One-Step Procedure

The screenshot shows the FAARFIELD 2.1.1 software interface. The 'Structure' window is active, displaying the 'PCR' tab. The 'Job Name' is 'PCR Comparisons 2' and the 'Structure Name' is 'Airport E RWY 10C-28C'. The 'Pavement Type' is 'New Rigid'. The 'Material' list shows: P-501 PCC Surface (457 mm), P-401/P-403 HMA Stabilized (152 mm), P-209 Crushed Aggregate (152 mm), and Subgrade (86 mm). The 'Design Life (Years)' is 20, and the 'P/TC Ratio' is 1. The 'Results' section shows 'Calculated Life (Years)' and 'Total thickness to the top of the subgrade (mm): 762'. A callout box with the text 'Select "PCR," then click "Run"' points to the 'PCR' dropdown menu and the 'Run' button. The 'Traffic' window is also visible, showing a table of aircraft 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)
A330-200 WV020	212,735	81	0	1,620	0	0	3.91	1448.33	0.948	374	598
A340-300 std	272,155	840	0	16,800	0	0	1.9	1401.06	0.7935	385	616
A340-300 std Belly	272,155	840	0	16,800	0	0	3.08	1074.60	0.1522	385	616
A380-800 WV000	405,511	424	0	8,480	0	0	4.5	1084.53	0.3805	316	506
A380-800 WV000 Belly	405,511	424	0	8,480	0	0	5	1084.53	0.57	316	506

FAARFIELD 2.0 PCR Example

$$\text{PCR} = 1140/R/C/W/T$$

The screenshot shows the FAARFIELD 2.1.1 (Build 12/21/2023) interface. The 'Structure' tab is active, displaying the 'PCR Calculation of Airport E RWY 10C-28C Completed' status. The 'Run Time' is 331 seconds, and the 'PCR' value is 1140/R/C/W/T. The 'Pavement Layers' section shows a list of materials with their thicknesses and properties. A callout box points to the 'PCR displays here: PCR 1140/R/C/W/T' text. Another callout box points to the 'Tire Pressure (kPa)' and 'Percent GW on Gear' table, which lists values for various aircraft types. A note box states: 'Note – FAARFIELD automatically loads the correct tire pressure and %GW on main gear for PCR calculations. These may be different than thickness design values.'

Note –
FAARFIELD automatically loads the correct tire pressure and %GW on main gear for PCR calculations. These may be different than thickness design values.

PCR displays here:
PCR 1140/R/C/W/T

Tire Pressure (kPa)	Percent GW on Gear
1448.33	0.948
1401.06	0.794
1074.60	0.152
1084.53	0.38
1084.53	0.57
1074.60	0.152

PCR Reports and Graphs

FAARFIELD 2.1.1 (Build 12/21/2023)

Structure CDF Graph PCR Report PCR Graph Airport Master Record

Job Name: PCR Comparisons 2 PCR Run

Structure Name: Airport E RWY 10C-28C Include in Summary Report Add To Batch

Pavement Layers

Material	Thickness (mm)	E (MPa)	k (MN/m ³)	R (MPa)
P-501 PCC Surface	457	27,579.04		4.83
P-401/P-403 HMA Stabilized	152	2,757.90		
P-209 Crushed Aggregate	152	242.86		
Subgrade		86.50	40.7	

Design Life (Years): 20 P/TC Ratio: 1

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): 762

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)
A330-200 WV020	212,735	81	0	1,620	0	0	1.98	1448.33	0.948	369	590
A340-300 std	272,155	840	0	16,800	0	0	1.88	1401.06	0.794	401	642
A340-300 std Belly	272,155	840	0	16,800	0	0	3.06	1074.60	0.152	222	356
A380-800 WV000	405,511	424	0	8,480	0	0	3.83	1084.53	0.38	372	596
A380-800 WV000 Belly	405,511	424	0	8,480	0	0	4.25	1084.53	0.57	372	596

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: Yes

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 Brill\Documents\My FAARFIELD\User Defined Aircraft

Change Aircraft Directory



PCR Report

Summary Data

Results Table 1

Federal Aviation Administration FAARFIELD 2.1 PCR Report

FAARFIELD 2.1.1 (Build 12/21/2023)

Job Name: PCR Comparisons 2

Structure: Airport E RWY 10C-28C

This file name = PCR Results for New Rigid 2024-02-01 11:08:01

Evaluation pavement type is rigid and design program is FAARFIELD.

Structure name: Airport E RWY 10C-28C in job file: PCR Comparisons 2 JOB.xml

Units = Metric

Analysis Type: New Rigid

Subgrade Modulus = 86.50MPa (Subgrade Category is C)

Evaluation Pavement Thickness = 762 mm

Pass to Traffic Cycle (PtoTC) Ratio = 1.00

Maximum number of wheels per gear = 6

CDF = 0.640

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight (kg)	Percent Gross Weight	Tire Pressure (MPa)	Annual Departure	20 Years Coverage
1	A330-200 WV020	212,735	94.80	1,448.33	81	818
2	A340-300 rtd	272,155	79.40	1,401.06	840	8,923
3	A340-300 rtd Belly	272,155	15.20	1,074.60	840	5,499
4	A380-800 WV000	405,511	38.00	1,084.53	424	2,217
5	A380-800 WV000 Belly	405,511	57.00	1,084.53	424	1,997
6	B747-400	395,986	46.60	1,372.66	2,722	15,562
7	B747-400 Belly	395,986	46.60	1,372.66	2,722	15,530
8	B767-300 ER/Freighter	185,519	92.40	1,365.60	3,454	18,689
9	B777-300	327,493	94.80	1,616.73	3,372	16,303
10	A300-600 Std Bogie	170,097	95.00	1,320.57	1,019	6,037
11	DC MD-10-10/10F	207,746	93.40	1,344.48	71	370
12	MD-11	281,681	77.60	1,393.40	606	3,293
13	MD-11 Belly	281,681	17.00	1,217.53	606	4,027
14	B757-200	113,398	91.20	1,232.17	291	1,456
15	A320-200 rtd	68,039	93.80	1,269.56	24,656	132,578
16	B737-800	78,471	93.60	1,392.84	26,655	149,876
17	B727-200 Advanced Basic	78,018	96.00	947.69	1,346	9,246
18	D-50	20,412	95.00	496.42	28,229	151,240
19	S-30	10,206	95.00	387.83	3,808	12,031

Results Table 2

Results Table 3

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/C
1	B777-300	3,398	333,825	511	1138.6

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) (C)	ACR/R/C
1	A330-200 WV020	212,735	94.8	1,448.33	399	693.7
2	A340-300 rtd	272,155	94.60001	1,401.06	417	759.9
3	A380-800 WV000	405,511	95	1,084.53	345	523.2
4	B747-400	395,986	93.2	1,372.66	417	761.7
5	B767-300 ER/Freighter	185,519	92.4	1,365.60	394	682.9
6	B777-300	327,493	94.8	1,616.73	503	1104
7	A300-600 Std Bogie	170,097	95	1,320.57	396	690.1
8	DC MD-10-10/10F	207,746	93.4	1,344.48	404	712.9
9	MD-11	281,681	94.60001	1,393.40	442	852.4
10	B757-200	113,398	91.2	1,232.17	302	405.2
11	A320-200 rtd	68,039	93.8	1,269.56	315	434.3
12	B737-800	78,471	93.6	1,392.84	348	532.3
13	B727-200 Advanced Basic	78,018	96	947.69	340	508
14	D-50	20,412	95	496.42	150	101.9
15	S-30	10,206	95	387.83	109	55.2



Review – PCR Report

- **Results Table 1 – Input Traffic Data.**
- **Results Table 2 displays PCR data for the critical (reference) aircraft only.**
 - PCR is defined as the ACR of the critical aircraft at the maximum allowable gross weight (MAGW).
 - Can report PCR to the nearest whole multiple of 10.
- **Results Table 3 – ACR Data.**



Results Tables 1 and 2

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 Structure CDF Graph PCR Report PCR Graph Airport Master Record

Save As PDF

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight (kg)	Percent Gross Weight	Tire Pressure (MPa)	Annual Departure	20 Years Coverage
1	A330-200 WV020	212,735	94.80	1,448.33	81	818
2	A340-300 std	272,155	79.40	1,401.06	840	8,923
3	A340-300 std Belly	272,155	15.20	1,074.60	840	5,499
4	A380-800 WV000	405,511	38.00	1,084.53	424	2,217
5	A380-800 WV000 Belly	405,511	57.00	1,084.53	424	1,997
6	B747-400	395,986	46.60	1,372.66	2,722	15,562
7	B747-400 Belly	395,986	46.60	1,372.66	2,722	15,530
8	B767-300 ER/Freighter	185,519	92.40	1,365.60	3,454	18,689
9	B777-300	327,493	94.80	1,616.73	3,372	16,303
10	A300-600 Std Bogle	170,097	95.00	1,320.57	1,019	6,037
11	DC/MD-10-10/10F	207,746	93.40	1,344.48	71	370
12	MD-11	281,681	77.60	1,393.40	606	3,293
13	MD-11 Belly	281,681	17.00	1,217.53	606	4,027
14	B757-200	113,398	91.20	1,232.17	291	1,456
15	A320-200 std	68,039	93.80	1,269.56	24,656	132,578
16	B737-800	78,471	93.60	1,392.84	26,655	149,876
17	B727-200 Advanced Basic	78,018	96.00	947.69	1,346	9,245
18	D-50	20,412	95.00	496.42	28,229	151,240
19	S-30	10,206	95.00	387.83	3,808	12,031

Critical Aircraft

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/C
9	B777-300	3,398	333,825	511	1138.6

Explorer Aircraft Material



Results Table 3

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 Structure CDF Graph PCR Report PCR Graph Airport Master Record

Airport Master Record
 Airport E RWY 10C-28C
 Structure Report
 CDF Graph
PCR Report
 PCR Graph
 Airport Master Record
 Airport G RWY 16L-34R
 Structure Report
 CDF Graph
 PCR Report
 PCR Graph
 Airport Master Record
 Airport I RWY 17L-35R
 Structure Report
 CDF Graph
 PCR Report
 PCR Graph

Save As PDF

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) (C)	ACR/R/C
1	A330-200 WV020	212,735	94.8	1,448.33	399	693.7
2	A340-300 std	272,155	94.60001	1,401.06	417	759.9
3	A380-800 WV000	405,511	95	1,084.53	345	523.2
4	B747-400	395,986	93.2	1,372.66	417	761.7
5	B767-300 ER/Freighter	185,519	92.4	1,365.60	394	682.9
6	B777-300	327,493	94.8	1,616.73	503	1104
7	A300-600 Std Bogie	170,097	95	1,320.57	396	690.1
8	DC/MD-10-10/10F	207,746	93.4	1,344.48	404	712.9
9	MD-11	281,681	94.60001	1,393.40	442	852.4
10	B757-200	113,398	91.2	1,232.17	302	405.2
11	A320-200 std	68,039	93.8	1,269.56	315	434.3
12	B737-800	78,471	93.6	1,392.84	348	532.3
13	B727-200 Advanced Basic	78,018	96	947.69	340	508
14	D-50	20,412	95	496.42	150	101.9
15	S-30	10,206	95	387.83	109	55.2

Explorer Aircraft Material

Notes
User Information
Design Options

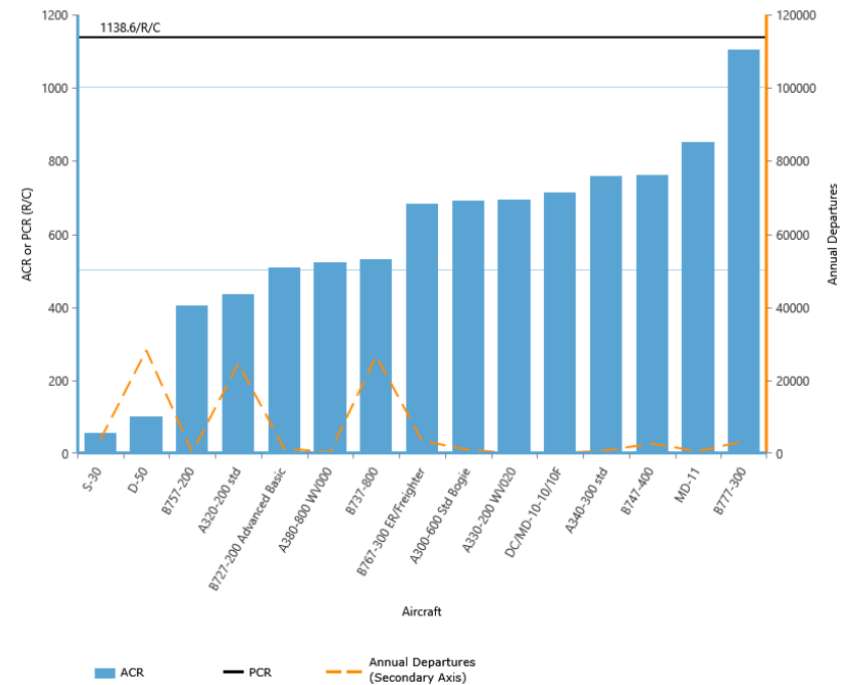


PCR Graph for Example

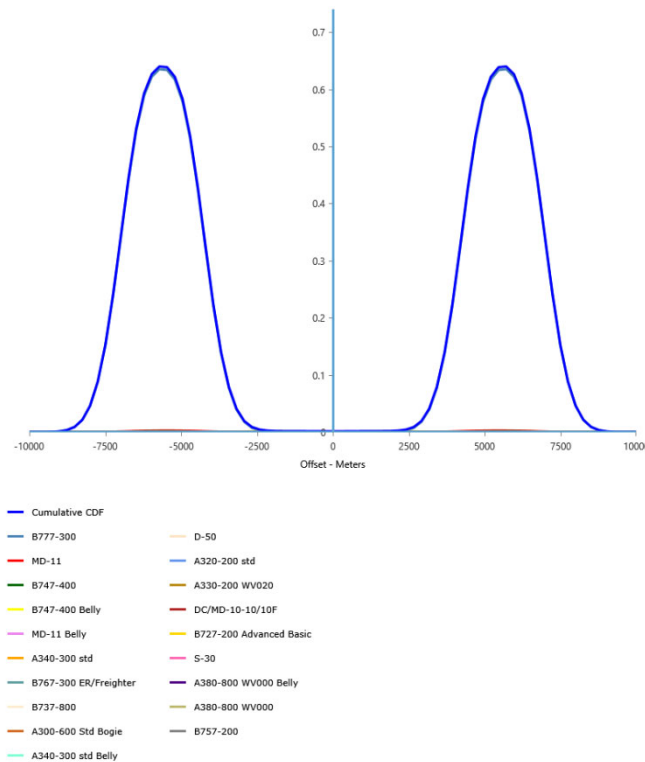
Critical aircraft: B777-300

No.	Aircraft Name	Aircraft ACR	Calculated PCR	Annual Departure
1	B777-300	1104	1138.6	3,372
2	MD-11	832.4	-	800
3	B747-400	761.7	-	2,722
4	A340-300 std	759.9	-	840
5	DC/MD-10-10/10F	712.9	-	71
6	A330-200 WV020	693.7	-	81
7	A300-600 Std Bogie	690.1	-	1,019
8	B767-300 ER/Freighter	682.9	-	3,454
9	B737-800	532.3	-	26,655
10	A380-800 WV000	523.2	-	424
11	B727-200 Advanced Basic	508	-	1,346
12	A320-200 std	434.3	-	24,656
13	B757-200	405.2	-	291
14	D-50	101.9	-	28,229

All design aircraft have ACR < PCR.
What does that mean?



CDF Graph



- **CDF for this example < 1**
 - Excess strength.
 - Consistent with no restrictions on using aircraft.
 - Maximum CDF is dominated by critical aircraft in this case.
- **Maximum CDF for PCR is usually less than CDF for design.**
 - Due to different gear characteristics used for PCR computation
 - For design, we assume 95% of gross weight on the main gear (conservative).
 - PCR assumes maximum ramp mass and actual corresponding aft c.g.

Rigid Pavement PCR Reminders

- Rigid pavement PCR is sensitive to concrete flexural strength (R).
- Subgrade strength categories have changed from ACN/PCN system.
 - Subgrade category is based on the E -modulus at top of subgrade. (No more estimation of top-of-base k .)
 - Subgrade category may be different from PCN.
- More examples: See FAA Report No. DOT/FAA/TC-23/57 (2023): *PCN–PCR Comparisons for Large- and Medium-Hub Airport Runways*



Questions?

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