

# ACR/PCR Overview

## *Aircraft Classification Rating/ Pavement Classification Rating*

Presented to: REDAC Subcommittee on Airports

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Date: March 4, 2020



Federal Aviation  
Administration



# What's Coming – Preview of the ACR-PCR System

- **Developed in cooperation with ICAO Aerodromes Pavement Expert Group (APEG).**
  - Designated ACR-PCR (Aircraft Classification Rating – Pavement Classification Rating) System
  - Participants included the major aircraft manufacturers, ACI World, FAA and DGAC-France.
- **Same concepts as current ACN-PCN method, but:**
  - Fully layered elastic-based.
  - Uses uniform standard subgrade categories for flexible and rigid.
  - NO alpha factor, layer equivalency factors, top-of-base  $k$ , etc.
- **FAA developed program ICAO-ACR.**
  - Visual Basic class library computes rigid & flexible ACRs.
  - Replacement for legacy ICAO ACN computer programs.
  - Open source library – supports linking to any PCN program.

# ACR-PCR Current Status

- **Proposed amendment to Annex 14 on ACR-PCR has gone through State review with no objections.**
- **After formal adoption by the ICAO Air Navigation Committee (ANC), there will be a four-year transition period from ACN-PCN to ACR-PCR:**
  - Effective date July 2020.
  - Full applicability November 2024.
  - During transition, both systems will remain available.
- **An updated ADM Part 3 with the new procedures will be posted in the near future.**
- **Training on ACR-PCR is planned.**

# ICAO-ACR Computer Program

- **Availability:**
  - Maintained by FAA.
  - Download free of charge:  
<https://www.airporttech.tc.faa.gov/Products/Airport-Pavement-Software-Programs>
- **Ability to link directly to other applications that:**
  - Compute ACR (e.g., for aircraft gear design).
  - Use the standard ACR computation to evaluate PCR.
- **Procedures for linking to ICAO-ACR will be given in an appendix to the ADM update.**

## ICAO-ACR version 1.25 GUI

ICAO-ACR Version 1.25 Date February 20, 2019

Input Data

Pavement Type ☒ Flexible ☐ Rigid

Gross Weight (lbs) 547,000

Percent GW 0.954

Number of Wheels 12

Tire Pressure (psi) 182.00

Wheel Coordinates (in)

No	X	Y
1	-243.50	-57.00
2	-188.50	-57.00
3	-243.50	0.00
4	-188.50	0.00
5	-243.50	57.00

Select Airplane Group Boeing

Select Airplane B777-200 Baseline

**Calculate ACR \***

☐ Display Select Wheels (SW) ☐ Metric

Subgrade Category	Subgrade Modulus [psi]	Flexible ACR Number	ACR Thickness t [in]
D	7,251.89	653.16	34.04
C	11,603.02	466.00	25.34
B	17,404.53	415.73	21.18
A	29,007.55	391.07	16.36

Calculation time: 2.66 sec.

Input Data - Gear 2

Percent GW 2

Number of Wheels 2

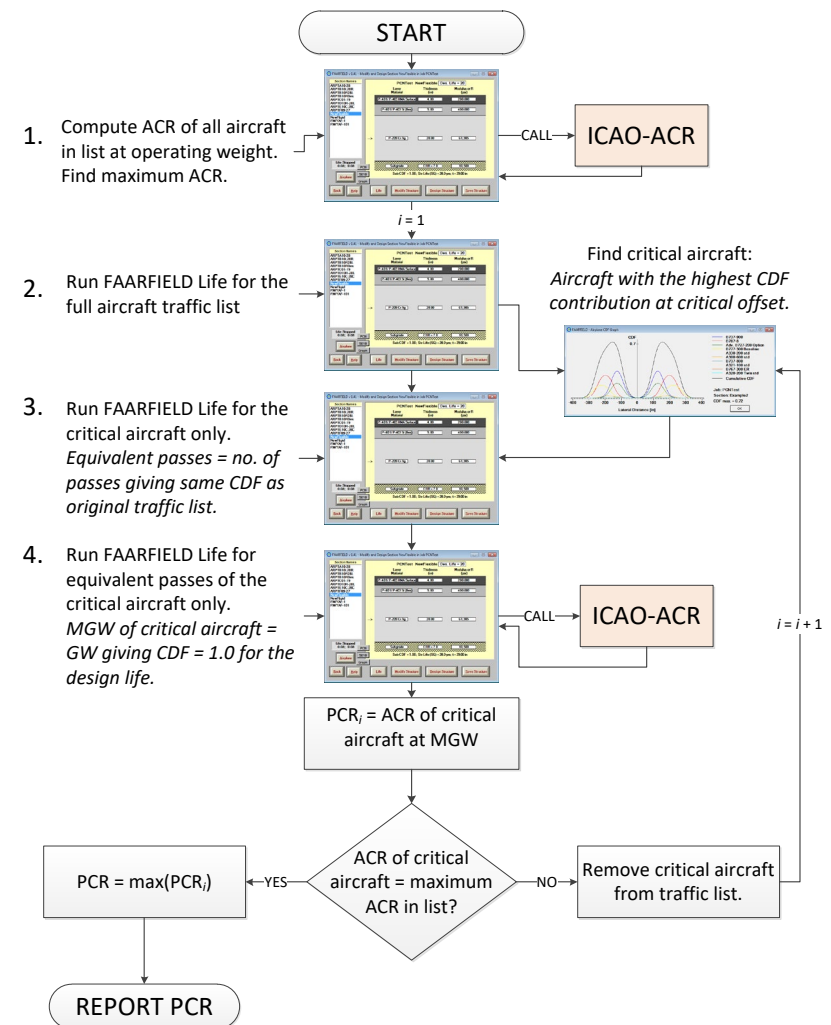
Tire Pressure 2 (psi)

Wheel Coordinates (in)

No	X	Y

# Flowchart of PCR Calculation

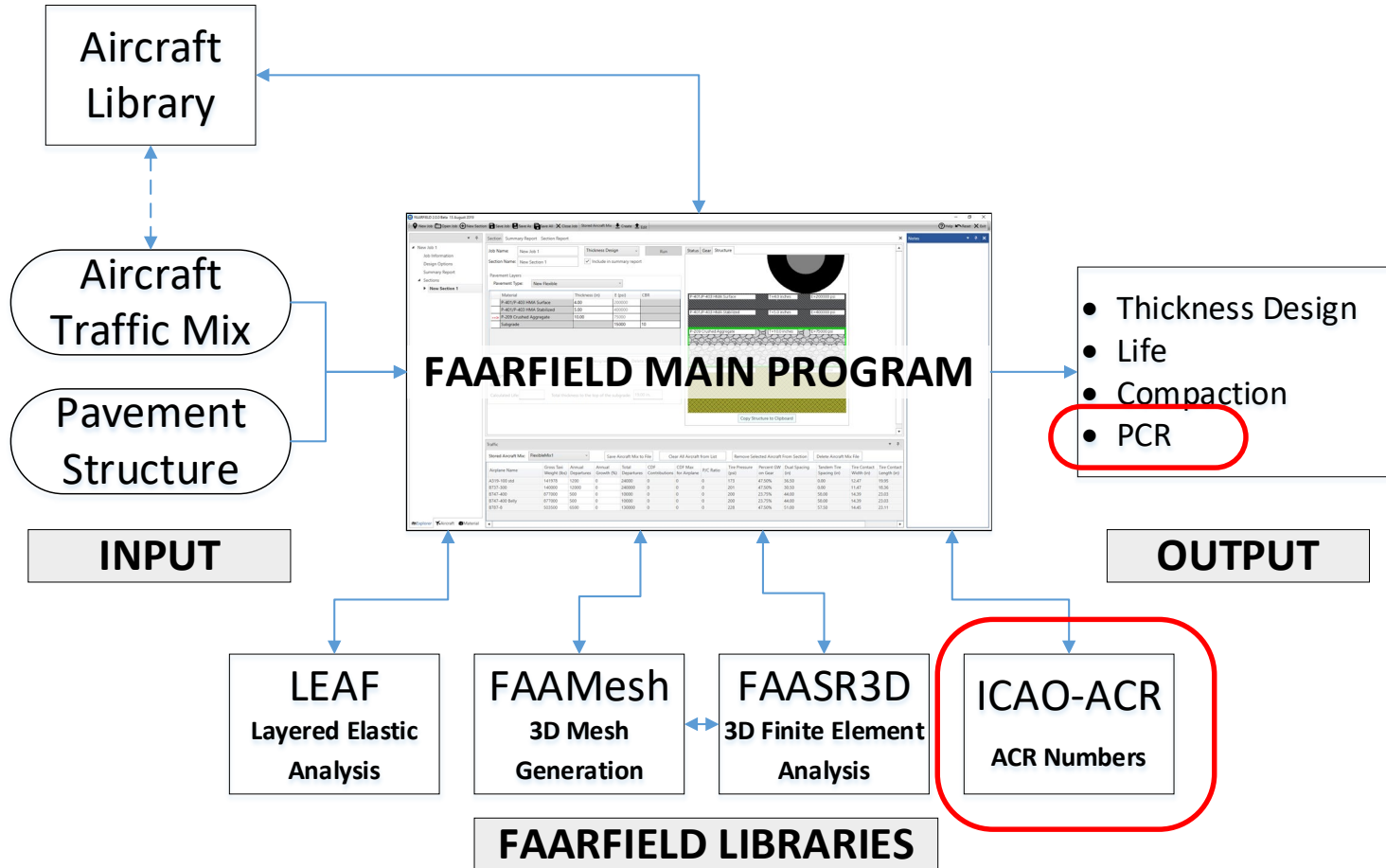
- **Directly uses FAARFIELD structure and traffic list.**
- **Planned replacement for COMFAA 3.0 & support spreadsheets.**
- **Method yields uniquely defined PCR.**
  - No more considering multiple potential PCRs for different critical aircraft.
- **Implemented in FAARFIELD 2.0**
  - Solves problem of computing PCR for mixed traffic (narrow bodies and LR aircraft) without unnecessary operating weight restrictions.
  - Seamlessly handles HMA overlays on flexible pavements.



# FAARFIELD 2.0 PCR Implementation

- **Replacement for current FAARFIELD 1.42**
  - Release software with next update of AC 150/5320-6.
  - Currently in beta test.
  - **New:** Features support for ACR-PCR.
  - Will replace COMFAA as primary pavement strength reporting software in next update of AC 150/5335-5.
- **FAARFIELD PCR integration**
  - Shared aircraft library.
  - Use FAARFIELD pavement structure and aircraft list directly.
  - No support spreadsheets required.
  - Built-in 5010 report generation.
  - Much better compatibility with FAARFIELD thickness designs.

# FAARFIELD 2.0 PCR Integration



# FAARFIELD 2.0 PCR Example

## Completed Design:

**Pavement Layers**

Material	Thickness (in)	E (psi)	CBR
P-401/P-403 HMA Surface	4.0	200000	
P-401/P-403 HMA Stabilized	5.0	400000	
--> P-209 Crushed Aggregate	18.3	65665	
Subgrade		15000	10

**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	Dual Spacing (in)	Tandem Tire Spacing (in)	Tire Width (in)
A320-100	150796	600	0	12000	0	0	1.27	200	47.50%	36.5	0.0	11.9
A340-600 std	807333	1000	0	20000	0.8	0.8	1.36	234	35.98%	55.0	78.0	15.7
A340-600 std Belly	807333	1000	0	20000	0	0	1.31	222	23.04%	46.3	77.9	12.9
A380	1238998	300	0	6000	0	0	1.36	218	19.00%	53.1	66.9	14.7
A380 Belly	1238998	300	0	6000	0	0	1.49	218	28.50%	0.0	0.0	14.7
B737-800	174700	2000	0	40000	0	0	1.29	204	47.50%	34.0	0.0	12.7
B777-300 ER	777000	1000	0	20000	0.19	0.19	1.39	221	47.50%	55.0	57.6	14.9

**Design Options**

- Calculate HMA CDF: No
- Automatic flexible base design: Yes
- Output file: No
- Units: US Customary
- Allow Flexible Computation for Thick Overlays on PCC: Yes
- Set as Program Default: No
- Reset Default to Initial: No
- Show/Hide Pavement Image: No
- Change Pavement Graphics: No



# FAARFIELD 2.0 PCR Example

FAARFIELD 2.0.0 Beta 03 December 2019

New Job Open Job New Section Save Job Save As Save All Close Job Stored Aircraft Mix Create Edit Help Reset Exit

**Section**

Job Name: New Job 1 PCR Run Status Gear Structure

Section Name: New Section 1

Pavement Layers

Pavement Type: New Flexible

Material Thickness (in) E (psi) CBR

P-401/P-403 HMA Surface	4.0	200000	
P-401/P-403 HMA Stabilized	5.0	400000	
--> P-209 Crushed Aggregate	18.3	65665	
Subgrade		15000	10

Select As The Design Layer Delete Selected Layer

Design Life: 20 P/T Ratio: 1

Results

Calculated Life: Total thickness to the top of the subgrade: 27.30 in.

**In the drop-down list, select PCR.**

Design Options

Calculate HMA CDF: No

Automatic flexible base design: Yes

Set as Program Default Reset Default to Initial

Show/Hide Pavement Image

Change Pavement Graphics

Copy Structure to Clipboard

Traffic

Stored Aircraft Mix: FlexExampleMix Save Aircraft Mix to File Clear All Aircraft from List Remove Selected Aircraft From Section Delete Aircraft Mix File

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	Dual Spacing (in)	Tandem Tire Spacing (in)	Tire Width
A320-100	150796	600	0	12000	0	0	1.27	200	95.00%	36.5	0.0	11.9
A340-600 std	807333	1000	0	20000	0.8	0.8	1.36	234	71.96%	55.0	78.0	15.7
A340-600 std Belly	807333	1000	0	20000	0	0	1.31	222	23.04%	46.3	77.9	12.9
A380	1238998	300	0	6000	0	0	1.36	218	38.00%	53.1	66.9	14.7
A380 Belly	1238998	300	0	6000	0	0	1.49	218	57.00%	0.0	0.0	14.7
B737-800	174700	2000	0	40000	0	0	1.29	204	95.00%	34.0	0.0	12.7
B777-300 ER	777000	1000	0	20000	0.19	0.19	1.39	221	95.00%	55.0	57.6	14.9

# FAARFIELD 2.0 PCR Example

FAARFIELD 2.0.0 Beta 03 December 2019

New Job Open Job New Section Save Job Save As Save All Close Job Stored Aircraft Mix Create Edit Help Reset Exit

**Section**

Job Name: New Job 1 PCR Run Status Gear Structure

Section Name: New Section 1 ☒ Include in summary report

Pavement Layers

Pavement Type: New Flexible

Material	Thickness (in)	E (psi)	CBR
P-401/P-403 HMA Surface	4.0	200000	
P-401/P-403 HMA Stabilized	5.0	400000	
--> P-209 Crushed Aggregate	18.3	65665	
Subgrade		15000	10

Select As The Design Layer Delete Selected Layer

Design Life: 20 P/T Ratio: 1

Results

Calculated Life: Total thickness to the top of the subgrade: 27.30 in.

**Click "Run"**

Design Options

Calculate HMA CDF: No

Automatic flexible base design: Yes

Output file: No

Units: US Customary

Allow Flexible Computation for Thick Overlays on PCC: Yes

Set as Program Default Reset Default to Initial

Show/Hide Pavement Image

Change Pavement Graphics

Traffic

Stored Aircraft Mix: FlexExampleMix Save Aircraft Mix to File Clear All Aircraft from List Remove Selected Aircraft From Section Delete Aircraft Mix File

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	Dual Spacing (in)	Tandem Tire Spacing (in)	Tire Width (in)
A320-100	150796	600	0	12000	0	0	1.27	200	95.00%	36.5	0.0	11.9
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A380 Belly	1238998	300	0	6000	0	0	1.49	218	57.00%	0.0	0.0	14.7
B737-800	174700	2000	0	40000	0	0	1.29	204	95.00%	34.0	0.0	12.7
B777-300 ER	777000	1000	0	20000	0.19	0.19	1.39	221	95.00%	55.0	57.6	14.9

# FAARFIELD 2.0 PCR Example

The screenshot displays the FAARFIELD 2.0.0 Beta software interface. The 'Section' tab is active, showing job details for 'New Job 1' and 'New Section 1'. The 'Run' button is highlighted, and a status window indicates 'PCR Calculation Completed', 'Run Time: 7 seconds', and 'PCR = 704/F/B/X/T'. A red box highlights this status window, with an arrow pointing to a callout box that reads 'PCR displays here: PCR 704/F/B/X/T'. Below the status window, the 'Pavement Layers' section shows a table of materials and their properties. The 'Design Life' is set to 20, and the 'P/C Ratio' is 1. The 'Calculated Life' is blank, and the 'Total thickness to the top of the subgrade' is 27.30 in. The 'Traffic' section shows a table of aircraft data. A red box highlights the 'Tire Pressure (psi)' and 'Percent GW on Gear' columns, with an arrow pointing to a callout box that reads 'Tire pressure & Percent GW on Gear are correct for PCR'.

**PCR Calculation Results:**

- PCR Calculation Completed
- Run Time: 7 seconds
- PCR = 704/F/B/X/T

**Pavement Layers:**

Material	Thickness (in)	E (psi)	CBR
P-401/P-403 HMA Surface	4.0	200000	
P-401/P-403 HMA Stabilized	5.0	400000	
--> P-209 Crushed Aggregate	18.3	65665	
Subgrade		15000	10

**Design Parameters:**

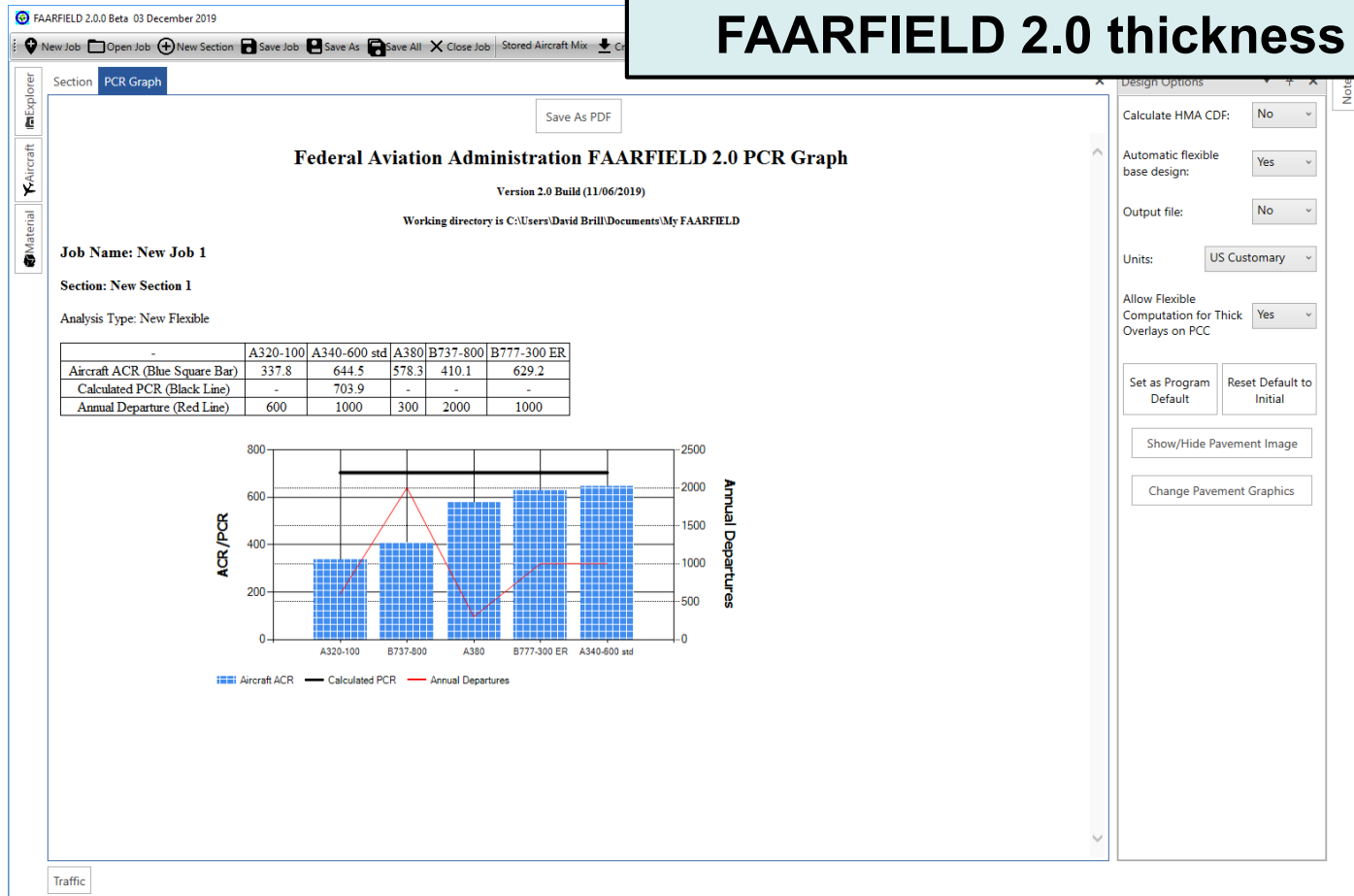
- Design Life: 20
- P/C Ratio: 1
- Calculated Life:
- Total thickness to the top of the subgrade: 27.30 in.

**Traffic Data Table:**

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	Wheel Spacing (in)	Tandem Tire Spacing (in)	Tire Width (in)
A320-100	150796	600	0	12000	1	1	1.37	200	94.00%	3.5	0.0	15.5
A340-600 std	807333	1000	0	20000	0	0.31	1.24	234	64.42%	5.0	78.0	15.1
A340-600 std Belly	807333	1000	0	20000	0	0.01	1.26	222	29.10%	4.3	77.9	14.5
A380	1238998	300	0	6000	0	0	1.36	218	38.05%	5.1	66.9	14.7
A380 Belly	1238998	300	0	6000	0	0	1.49	218	57.08%	0.0	0.0	14.7
B737-800	174700	2000	0	40000	0	0	1.29	204	93.56%	3.0	0.0	12.6
B777-300 ER	777000	1000	0	20000	0.1	0.1	1.39	221	92.46%	5.0	57.6	14.7

# PCR Graph

- Critical aircraft is A340-600.
- All using aircraft ACR are  $<$  PCR.
- PCR is consistent with FAARFIELD 2.0 thickness design.



# Thank you!

**<http://www.airporttech.tc.faa.gov/>**  
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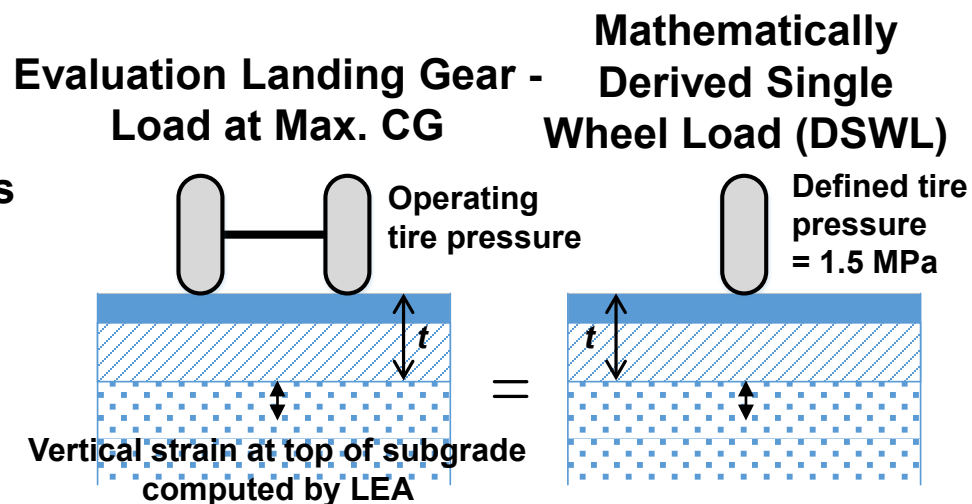
**ARA:**  
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# ACR Methodology – Principles

## Similar to ACN, except:

- All structures are layered elastic (rigid and flexible).
- Retains 4 standard subgrade categories, but defined by modulus ( $E$ ) not CBR or  $k$ .
- Flexible ACR considers all wheels in the main landing gear.
- Standard tire pressure increased to 1.5 MPa.
- Standard coverages increased to 36,500 for flexible ACR.
- DSWL expressed in 100's (not 1000's) of kg.
- *For most aircraft, ACR numerical values are approximately 10X higher than equivalent ACN.*



The ACR numerical value is defined as two times the DSWL (expressed in hundreds of kilograms)



# ACR-PCR Subgrade Categories

Category	A	B	C	D
Strength	High	Medium	Low	Ultra-Low
<i>E</i> Value, MPa	200	120	80	50
Range, MPa	$E \geq 150$	$150 > E \geq 100$	$100 > E \geq 60$	$60 > E$

- **Categories are defined by *E*, not CBR or *k*.**
- **Same categories for rigid and flexible pavements.**
- **All values defined at top of subgrade.**