U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: Standardized Method of Reporting Airport Pavement Strength - PCR

Date: 4/29/2022
Initiated By: AAS-110

AC No: 150/5335-5D
Change:

1 **Purpose.**

This advisory circular (AC) provides guidance for the reporting of runway, taxiway and apron pavement strength in accordance with standardized International Civil Aviation Organization (ICAO) methods.

2 **Cancellation.**

This AC cancels AC 150/5335-5C, *Standardized Method of Reporting Airport Pavement Strength – PCN,* dated August 14, 2014.

3 **Applicability.**

This AC does not constitute a regulation, and is not legally binding in its own right. It will not be relied upon as a separate basis by the FAA for affirmative enforcement action or other administrative penalty. Conformity with this AC is voluntary, and nonconformity will not affect rights and obligations under existing statutes and regulations, except for the projects described in subparagraphs 2 and 3 below:

1. The standards and processes contained in this AC are specifications the FAA considers essential for the reporting of pavement strength.
2. Use of these standards and guidelines is mandatory for projects funded under Federal grant assistance programs, including the Airport Improvement Program (AIP). See Grant Assurances #11 and #34.
3. This AC is mandatory, as required by regulation, for projects funded by the Passenger Facility Charge program. See PFC Assurance #9.

Note: This AC provides one, but not the only, acceptable means of meeting the requirements of 14 CFR Part 139, *Certification of Airports*.

4 **Effective Date.**

1. The FAA recommends the guidelines and specifications in this AC for reporting airport pavement strength using the standardized Aircraft Classification Rating-

Pavement Classification Rating (ACR-PCR) method for all paved runways, taxiways, and aprons at all airports.

2. The FAA requires all public use paved runways providing air carrier service at all 14 CFR Part 139 certificated airports be assigned gross weight and PCR data by November 28, 2025. (14 CFR §§ 139.339)
3. Airports that have received either AIP funds or have been approved for PFC collection will update the Airport Master Record (AMR) data elements, within the Airport Data and Information Portal (ADIP), associated with Gross Weight and Pavement Classification Rating developed following procedures in this AC in conjunction with implementation/update of Airport Pavement Management Program.

5 Principal Changes.

The AC includes the following principal changes:

1. Updates the Effective Date paragraph.
2. Updates the AC to incorporate the changes to pavement strength reporting as adopted in Amendment 15 to ICAO Annex 14.

6 Related Reading Material.

The publications listed in Appendix F provide further information on the development and use of the ACR-PCR method.

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CHAPTER 1. Introduction

1.1 Background.

The United States is a contracting state of the International Civil Aviation Organization (ICAO) and, under 49 USC §40105(b), will act consistently with the obligations of the United States Government under an international agreement. Amendment 15 to Annex 14 to the Convention of International Civil Aviation, Aerodromes, requires member states to publish information on the strengths of all public use airport pavements in its own Aeronautical Information Publication. The FAA implements this by having public use airports report pavement strength information in accordance with ICAO standards on the Airport Master Record (AMR). The AMR is currently updated in the Airport Data and Information Portal (ADIP). This information is published to the National Airspace System Resources (NASR) database and in the Chart Supplements (formerly known as Airport/Facility Directory).

1.2 Development of a Standardized Method.

In 2009, ICAO established a Study Group to investigate updating the international method of reporting pavement strengths. The study group developed, and ICAO adopted with Amendment 15 to Annex 14, the Aircraft Classification Rating - Pavement Classification Rating (ACR-PCR) method. Using this method, it is possible to express the effect of an individual aircraft on different pavements with a single unique number, the Aircraft Classification Rating (ACR). ACR varies according to aircraft weight and configuration (e.g. tire pressure, gear geometry, etc.), pavement type, and subgrade strength. Conversely, the load-carrying capacity of a pavement can be expressed by a single unique number, Pavement Classification Rating (PCR), without specifying a particular aircraft or detailed information about the pavement structure.

1.2.1 Definition of ACR.

ACR is a number that expresses the relative effect of an aircraft at a given configuration on a pavement structure for a specified standard subgrade strength.

1.2.2 Definition of PCR.

PCR is a number that expresses the load-carrying capacity of a pavement for unrestricted operations (see paragraph 4.1).

1.2.3 System Methodology.

The ACR-PCR system is structured so a pavement with a particular PCR value can support an aircraft that has an ACR value equal to or less than the pavement's PCR value. This is possible because ACR and PCR values are computed using the same technical basis.

1.3 Application.

The use of the standardized method of reporting pavement strength applies only to pavements at public use airports with bearing strengths of 12,500 pounds (5,700 kg) or greater. The method of reporting pavement strength for pavements of less than 12,500 pounds (5,700 kg) is to only report the gross weight and gear configuration of the aircraft that can be accommodated.

1.4 Limitations of the ACR-PCR System.

The ACR-PCR system is only intended as a method that airport operators can use to evaluate acceptable operations of aircraft. It is not intended as a pavement design or pavement evaluation procedure, nor does it restrict the methodology used to design or evaluate a pavement structure.

There is no mathematical correlation between the previous ICAO pavement strength reporting ACN-PCN and the new ICAO ACR-PCR system.

CHAPTER 2. Determination of Aircraft Classification Rating

2.1 Determination of the ACR.

The aircraft manufacturer provides the official computation of an ACR value. Computation of the ACR requires detailed information on the operational characteristics of the aircraft, such as maximum aft center of gravity, maximum ramp weight, wheel spacing, and tire pressure.

2.2 Subgrade Category.

The ACR-PCR method adopts four standard levels of subgrade strength for rigid and flexible pavements. These standard categories are used to represent a range of subgrade conditions as shown in Table 2-1.

Table 2-1. Standard Subgrade Conditions for ACR Calculation

Subgrade Strength Category	Subgrade Support E (Elastic Modulus) psi (MPa)	Represents E (Elastic Modulus) psi (MPa)	Code Designation
High	29008 (200)	E ≥ 21,756 (≥150)	A
Medium	17405 (120)	E ≥14,504 <21,756 (≥100 <150)	B
Low	11603 (80)	E≥8,702 <14,504 (≥60 <100)	C
Ultra Low	7252 (50)	E < 8,702 (< 60)	D

2.3 Operational Frequency.

Operational frequency is defined in terms of coverages that represent a full-load application on a point in the pavement Aircraft seldom travel in a perfectly straight path or along the exact same path. The path is modeled by a statistically normal distribution to account for aircraft wander. It may take several trips or passes along the pavement for a specific point on the pavement to receive a full-load application from the aircraft. It is easy to observe the number of passes an aircraft may make on a given pavement, but the number of coverages must be mathematically derived based upon an established pass-to-coverage ratio for each aircraft.

2.4 Rigid and Flexible ACR.

For rigid and flexible pavements, the aircraft landing gear support requirements are determined by the layer elastic method for each subgrade support category.

2.5 ACR Calculation.

Using the parameters defined for each type of pavement section, a mathematically derived single wheel load is calculated to define the landing gear/pavement interaction. The derived single wheel load implies equal stress to the pavement structure and eliminates the need to specify pavement thickness for comparative purposes. This is achieved by equating the thickness derived for a given aircraft landing gear to the thickness derived for a single wheel load at a standard tire pressure of 218 psi (1.5 MPa). The ACR is defined as two times the derived single wheel load (expressed in hundreds of kilograms).

2.6 Variables Involved in Determination of ACR Values.

Because aircraft can be operated at various weight and center of gravity combinations, ICAO adopted standard operating conditions for determining ACR values. Aircraft manufacturers publish maximum weight and center of gravity information in their Airplane Characteristics for Airport Planning (ACAP) manuals. The ACR is determined at the weight and center of gravity combination that creates the maximum ACR value. Tire pressures are assumed to be those recommended by the manufacturer for the noted conditions.

2.6.1 To standardize the ACR calculation for flexible pavement the derived single wheel load is calculated at a constant pressure of 218 psi (1.50 Mpa) relative to a total thickness t computed for 36,500 passes of the aircraft.

2.6.2 To standardize the ACR calculation for rigid pavements, a standard stress is stipulated as σ = 399 psi (2.75 Mpa). Note the working stress used for the design has no relationship to the standard stress used for pavement strength reporting.

CHAPTER 3. Determination of ACR-PCR Values

3.1 Mathematical Models.

The sole mathematical model used in the ACR-PCR method is Layered Elastic Analysis (LEA). The LEA model assumes that the pavement structure, whether flexible or rigid, can be represented by homogeneous, elastic, isotropic layers arranged as a stack. Each layer *i,* in the system is characterized by an elastic modulus E_i, Poisson's ratio v_i, and uniform layer thickness t_i. Layers are assumed to be of infinite horizontal extent, and the bottom, or subgrade, layer is assumed to extend vertically to infinity (i.e., the subgrade is modeled as an elastic half-space). Due to the linear elastic nature of the model, individual wheel loads can be summed to obtain the combined stress and strain responses for a complex, multiple-wheel aircraft gear load. The use of the LEA model permits correlation to world-wide pavement design methods.

3.2 ICAO-ACR 1.3 and FAARFIELD 2.0.

To facilitate the use of the ACR-PCR system, the FAA developed a software application, ICAO-ACR 1.3, that calculates ACR values using the procedures and conditions specified by ICAO and can be used to determine PCR values following the procedures in this AC. The application is included within FAARFIELD 2.0 the FAA pavement design program. The PCR module will continue to be supported in future FAARFIELD versions. Ensure the current version of FAARFIELD is used to calculate PCR values.

These public domain programs ICAO-ACR and FAARFIELD are available at: https://www.faa.gov/airports/engineering/design_software/

3.3 FAARFIELD 2.0.

3.3.1 Internal Aircraft Library.

FAARFIELD 2.0 contains an internal library of aircraft covering most large commercial and U.S. military aircraft currently in operation. The internal library is based on aircraft information provided directly by aircraft manufacturers or obtained from Aircraft ACAP Manuals. The default characteristics of aircraft in the internal library represent the ICAO standard conditions for calculation of ACR. These characteristics include center of gravity at the maximum aft position for each aircraft. Changes to characteristics of internal library aircraft are not permanent unless the internal library aircraft is added to an external library.

3.4 External Aircraft Library.

3.4.1 FAARFIELD 2.0 allows for an external aircraft library where characteristics of the aircraft can be changed and additional aircraft added as desired. Functions permit users to modify the characteristics of an aircraft and save the modified aircraft in the external library. There are no safeguards in the FAARFIELD 2.0 program to assure that aircraft parameters in the external library are feasible or appropriate. The user is responsible for assuring all data is correct.

3.4.2 When saving an aircraft from the internal library to the external library, the FAARFIELD 2.0 program will calculate the tire contact area based upon the gross load, maximum aft center of gravity, and tire pressure. This value is recorded in the external library and is used for calculating the pass-to-coverage (P/C) ratio in the pavement thickness mode. Since the tire contact area is constant, the P/C ratio is also constant in the pavement thickness mode. This fixed P/C ratio is used for converting passes to coverages for pavement thickness determination and equivalent aircraft operations.

3.5 How ACRs are Determined.

Appendix 2 of the ICAO Aerodrome Design Manual, Part 3, Pavements, Third Edition, provides procedures for determining the Aircraft Classification Rating (ACR). FAA developed ICAO-ACR 1.3 to calculate ACRs in accordance with the ICAO standards. ICAO-ACR 1.3 is used internally by FAARFIELD 2.0 to calculate ACR's.

3.5.1 ACR Rigid Pavements.

The rigid pavement ACR procedure relates the derived single wheel load at a constant tire pressure of 218 psi (1.50 MPa) to a reference concrete slab thickness *t*. It takes into account the four subgrade categories detailed in paragraph 2.2 and uses a standard concrete stress of 399 psi (2.75 MPa). Note that, because a standard concrete stress is used, no information concerning either pavement flexural strength or number of coverages is needed for rigid ACR computation.

The following steps are used to determine the rigid ACR of an aircraft:

3.5.1.1 Reference Pavement Structure.

Using the pavement requirement data published by the manufacturer, obtain the reference thickness *t* for the given aircraft mass, *E*-value of the subgrade, and standard concrete stress for reporting, i.e., 399 psi (2.75 MPa). Use the cross-section shown in Table 3-1 for the LEA model for all four subgrade categories.

Table 3-1. Reference Pavement Structure for Rigid ACR

Layer Description	Designation	Thickness, in (mm)	E, psi (MPa)	ν
Surface course (PCC)	Layer 1	variable	4,000,000 (27 579)	0.15
Base course (crushed aggregate)	Layer 2	7.9 (200)	72,519 (500)	0.35
Subgrade	Layer 3	infinite	Paragraph 2.2, Table 2.1	0.40

The minimum allowable thickness of Layer 1 in the LEA model is 2 in (50.8 mm). LEA computations further assume that the horizontal interface between Layer 1 and Layer 2 is not bonded (full slip), and that the horizontal interface between Layer 2 and Layer 3 is full bond.

Within the LEA model, stress σ is the maximum horizontal stress computed on the bottom of Layer 1 (the cement concrete layer).

3.5.1.2 **Evaluation Gear.**

The ACR value is computed for a single truck in the main landing gear assembly (i.e., for 2 wheels in a dual, or D assembly, 4 wheels in a dual-tandem, or 2D assembly, etc.). For more complex landing gear types with more than 2 trucks (i.e., having a designation in FAA Order 5300.7, *Standard Naming Convention for Aircraft Landing Gear Configurations*, consisting of more than two characters), the individual truck in the main gear assembly with the largest rigid ACR determines the rigid ACR for the aircraft. All trucks are evaluated at the mass and c.g. that produces the highest total main gear loading on the pavement.

3.5.1.3 **Stress Evaluation Points.**

The number of LEA evaluation points is equal to the number of wheels in the evaluation gear. The evaluation points are located at the bottom of Layer 1, below the center point of each wheel. The thickness t of Layer 1 is adjusted until the maximum stress evaluated over all evaluation points is equal to 399 psi (2.75 MPa). The resulting t is the reference thickness for ACR.

3.5.1.4 **DSWL Calculation.**

Using the above reference thickness and the same LEA model as shown in Table 3-1, calculate a Derived Single Wheel Load (DSWL) for the selected subgrade. Maintaining a constant tire pressure of 218 psi (1.50 MPa), adjust the single wheel load magnitude until the maximum horizontal stress at the bottom of Layer 1 is equal to 399 psi (2.75 MPa). For evaluation of stresses under the single wheel load, use one evaluation point located at the bottom of Layer 1, directly below the center of the wheel.

3.5.1.5 **Modified DSWL Calculation for Lightweight Aircraft.**

For some lightweight aircraft, the required reference thickness t is less than the minimum allowable thickness. Use the following modified steps to compute DSWL when the theoretical thickness of Layer 1 that makes the maximum stress equal to 399 psi (2.75 MPa) is less than 2 in (50.8 mm).

1. Determine the value of stress (less than 399 psi (2.75 MPa)) corresponding to the minimum allowable concrete thickness 2 in (50.8 mm).

2. Calculate DSWL for the selected subgrade using the minimum concrete thickness of 2 in (50.8mm) of the reference structure. Maintaining a constant tire pressure of 218 psi (1.50 MPa), the single wheel load magnitude is adjusted until the maximum horizontal stress at the bottom of Layer 1 is equal to the stress value determined using the minimum thickness.

3.5.1.6 **ACR Calculation.**

The aircraft classification rating, at the selected mass and subgrade category, is two times the derived single wheel load in 100 kg. The numerical value of ACR may be rounded to the nearest multiple of ten for reporting.

3.5.2 Flexible Pavements.

The flexible pavement ACR procedure relates the derived single wheel load at a constant tire pressure of 218 psi (1.50 MPa) to a reference total thickness *t* computed for 36,500 passes of the aircraft. It takes into account the four subgrade categories.

3.5.2.1 **Reference Pavement Structures.**

The ACR-PCR system must cover a wide range of aircraft weighing from a few to several hundreds of tons. Reference structures have been chosen to produce appropriate thicknesses for the standard subgrade categories for the range of aircraft weights used. Determining the reference structures for the flexible ACR computation consists in defining the materials and constitutive properties of the several layers. All layers are defined by: Elastic modulus *E*, Poisson's ratio ν, and (except for the design layer) thickness. LEA computations assume that all horizontal interfaces between layers are fully bonded. The following tables define the reference structures to be used in calculating flexible ACR.

Table 3-2a. Reference Structure for Flexible ACR (Aircraft fitted with 2 or fewer wheels on all legs of the main landing gear)

Layer Description	Thickness, in (mm)	*E*, psi (MPa)	*ν*
Surface course (asphalt)	3 (76)	200,000 (1379)	0.35
Base course (crushed aggregate)	Variable	Paragraph 3.5.2.2	0.35
Subgrade	infinite	Paragraph 2.2 Table 2.1	0.35

Table 3-2b. Reference Structure for Flexible ACR (Aircraft fitted with more than 2 wheels on any leg of the main landing gear)

Layer Description	Thickness, in(mm)	*E*, psi (MPa)	*v*
Surface course (asphalt)	5 (127)	200,000(1379)	0.35
Base course (crushed aggregate)	variable	Paragraph 3.5.2.2	0.35
Subgrade	infinite	Paragraph 2.2 Table 2.1	0.35

In the LEA model, the minimum allowable thickness of the variable (base course) layer is 1 in (25.4 mm). Because of the intentionally limited number of reference structures, computed layer thicknesses may not be realistic at the extremes of the aircraft weight range. However, this does not invalidate the ACR concept, in which *t* is a relative indicator rather than the basis for a practical design.

3.5.2.2 **Base Layer Modulus.**

All flexible reference pavement structures include a variable thickness layer above the subgrade, representing a crushed aggregate base layer. The modulus of the variable thickness layer is not fixed in the ACR procedure, but is a function of the thickness and of the subgrade modulus. Within the LEA model, the base layer is subdivided into smaller sub-layers and a modulus value is then assigned to each sub-layer using a recursive procedure as explained below. Modulus values are assigned to the sub-layers following the procedure in the FAA computer program FAARFIELD (version 2.0), for Item P-209 (crushed aggregate). The steps in the procedure are as follows:

Step 1. Determine the number of sub-layers *N*. If the base layer thickness t_B is less than 15 in (381 mm), then $N = 1$ and sub-layering is not required. If t_B is greater than or equal to 15 in (381 mm), the number of sub-layers is:

$$N = \text{int}\left(\frac{t_B}{254} + 0.5\right)$$

where t_B is in mm, and the int. function returns the integer part of the argument (i.e., rounds down to the next whole number).

Step 2. Determine the thickness of each sub-layer. If $N = 1$, then the sublayer thickness is equal to the base layer thickness t_B. If $N >$ 1, then the thickness of the bottom N - 1 sub-layer is 10 in (254 mm), and the thickness of the top sub-layer is $t_B - (N-1) \times 10$ in (254 mm). Note that, in general, the *N* sublayers do not have equal thickness. For example, if the thickness of the base layer is 26 in (660 mm), then from step 1, the number of sub-layers is 3. The bottom 2 sub-layers are each 10 in (254 mm), while the top sub-layer is 6 in (152 mm) (26 in (660 mm) – 2 × 10 in (254 mm)).

Step 3. Assign a modulus value E to each sub-layer. Modulus values increase from bottom to top, reflecting the effect of increasing confinement of the aggregate material. Modulus values are given by the following equation:

$$E_n = E_{n-1} \times \{1 + [\log_{10}(t_n) - \log_{10}(25.4)]$$
$$\times (c - d[\log_{10}(E_{n-1}) + \log_{10}(145.037)])\}$$

Where:

E_n = the modulus of the current sub-layer in psi (MPa);

E_{n-1} = the modulus of the sub-layer immediately below the current sub-layer; or the modulus of the subgrade layer when the current sub-layer is the bottom sub-layer;

t_n = the thickness of the current sub-layer in inches (mm);

c = 10.52 (constant)

d = 2.0 (constant).

The above equation is applied recursively beginning with the bottom sub-layer.

Step 4. The modulus assignment procedure in Step 3 must be modified for the top two sub-layers whenever t_B is between 5 in (127 mm) and 10 in (254 mm) greater than an integer multiple of 10 in (254 mm). This modification ensures that the modulus of all sub-layers is a continuous function of the layer thickness, with no gaps. If $N > 1$ and t_B exceeds an integer multiple of 10 in (254 mm) by more than 5 in (127 mm), but less than 10 in (254 mm), then:

1. The top sub-layer (sub-layer N) is between 5 in (127mm) and 10 in (254 mm) thick, and all sub-layers below it (sub-layers 1 to N-1) are 10 in (254 mm) thick.
2. Using the equation in Step 3, compute the modulus E that would be obtained for sub-layer N for an assumed top sub-layer thickness tn equal to10 in (254 mm).
3. Compute the modulus of sub-layer N-1 (i.e., the sub-layer immediately below the top sub-layer) using the equation in Step 3, but substituting t_n = 20 in (508 mm) – t_N, where t_N is the actual thickness of the top sub-layer in mm.

Compute the modulus of sub-layer N by linear interpolation between E_{N-1} (the modulus of sub-layer N-1) and E_{254}:

$$E_N = E_{N-1} + (2t_N - 254) \times \frac{E_{254} - E_{N-1}}{254}$$

3.5.2.3 **Evaluation Gear.**

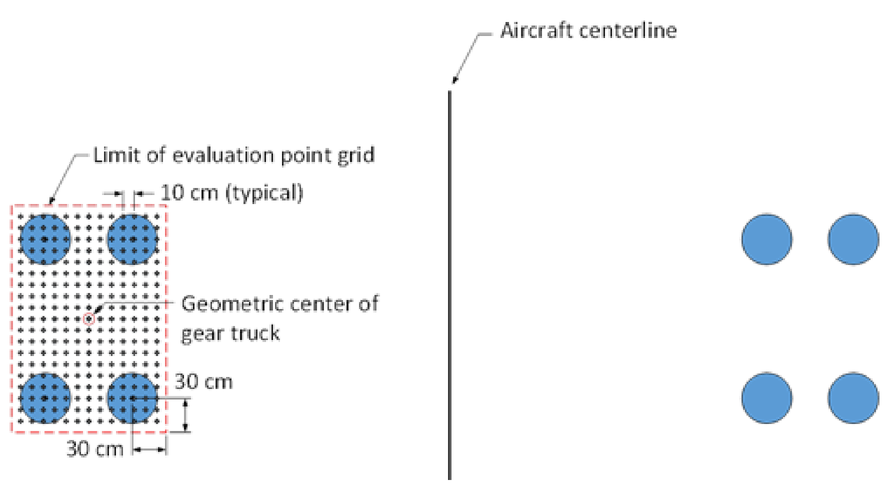
The ACR value is computed using all wheels in the main landing gear (wheels in the nose landing gear are not included). Main landing gears are evaluated at the mass and c.g. that produces the highest total main gear loading on the pavement.

3.5.2.4 **Strain Evaluation Points.**

Within the LEA model, strain ε is the maximum vertical strain computed on the top surface of the subgrade (lowest) layer. In the ICAO-ACR computer program, strains are computed at specific evaluation points based on the geometry of the evaluation gear. Evaluation points are placed directly below the center point of each wheel, and at the points defined by a regular rectangular grid spaced at 10-cm intervals, and oriented parallel to the principal axes of the gear.

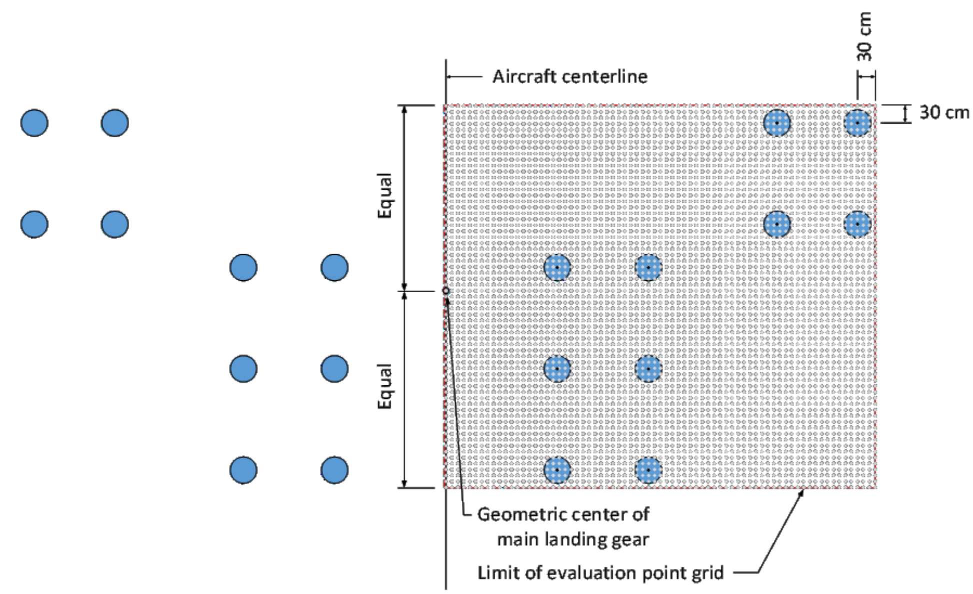
1. For simple main landing gears consisting of two trucks (i.e., for 2 wheels in a dual, or D assembly, 4 wheels in a dual-tandem, or 2D assembly, etc.) the grid origin is set at the geometric center of one truck. The limits of the grid extend 30 cm beyond the maximum wheel coordinates on all sides of the truck (Figure 3-1).

Figure 3-1. Grid Definition for Simple Main Landing Gear Arrangement



2. For more complex gear types with more than two trucks comprising the main landing gear assembly (i.e., all aircraft whose gear designation consists of more than two characters in FAA Order 5300.7, *Standard Naming Convention for Aircraft Landing Gear Configurations*), the origin of the grid is at the geometric center of the entire landing gear assembly. The limits of the grid extend 11.8 in (30 cm) beyond the maximum wheel coordinates on all sides (Figure 3-2). For the purpose of computing the geometric center coordinates, all included wheels should be weighted equally, regardless of different wheel loads or tire pressures.

Figure 3-2. Grid Definition for Complex Aircraft Main Landing Gear



Strain ε is the maximum of the strains computed for all evaluation points.

ICAO-ACR automatically detects symmetries within the evaluation point grid to reduce the number of required computations. In the case of B787-9, only one half of the evaluation point grid may actually be computed due to the transverse symmetry.

3.5.2.5 **Damage Model.**

The flexible ACR procedure relies on the subgrade failure criterion associated with the elementary damage law:

$$D_e(\varepsilon) = \frac{1}{C_e(\varepsilon)}$$

This elementary damage law is based on the notion of loading cycle (single-peak strain profile with maximum value ε), which cannot be applied to arrangements with axles in tandem producing complex strain profiles, possibly with multiple strain peaks and no return to zero-strain between peaks.

Therefore, the elementary damage law is extended to a continuous integral form:

$$D = \int_{x=-\infty}^{x=+\infty} < \frac{dD_e(x)}{dx} > dx$$

Where x refers to the longitudinal position along the landing gear and <y> to the positive part of y.

3.5.2.6 **DSWL Calculation.**

Using the pavement requirement data published by the manufacturer, calculate the reference thickness *t* for the given aircraft mass, E-value of the subgrade, and 36,500 passes of the aircraft. Use the appropriate reference pavement structure from paragraph 3.5.2.1 with evaluation points as described in paragraph 3.5.2.4. The thickness of the variable (design) layer is adjusted until the damage as computed from 3.5.2.5 is equal to 1.0. The resulting thickness t is the reference thickness for ACR.

Using the above reference thickness and the same LEA model as in paragraph 3.5.2.1, obtain a derived single wheel load for the selected subgrade. Maintaining the constant tire pressure of 218 psi (1.50 MPa), the single wheel load magnitude is adjusted until the damage is equal to 1.0 for 36,500 passes. For evaluation of strains under the single wheel load, use one evaluation point located at the top of the subgrade, directly below the center of the wheel.

3.5.2.7 **Modified DSWL Calculation for Lightweight Aircraft.**

For some lightweight aircraft, the required reference thickness *t* is less than the minimum allowable thickness. Use the following modified steps to compute DSWL when the theoretical thickness of the variable design layer that makes the damage equal to 1.0 for 36,500 aircraft passes is less than 1 inch (25.4 mm):

1. Determine the value of maximum vertical strain at the top of the subgrade corresponding to the minimum allowable variable design layer thickness 1 inch (25.4 mm).
2. Calculate DSWL for the selected subgrade using the minimum thickness of the reference structure. Maintaining the constant tire pressure of 218 psi (1.50 MPa), the single wheel load magnitude is adjusted until the maximum vertical strain at the top of the subgrade is equal to the value determined in paragraph 3.5.2.

3.5.3 ACR Calculation.

3.5.3.1 The aircraft classification rating, at the selected mass and subgrade category, is two times the DSWL in 100 kg. The numerical value of ACR may be rounded to the nearest multiple of ten for reporting.

3.5.3.2 Aircraft normally have their tires inflated to the pressure corresponding to the maximum gross mass without engine thrust, and maintain this pressure regardless of the variation in take-off masses. There are times, however, when operations at reduced masses, modified center of gravity and/or reduced tire pressures are productive and reduced ACRs need to be calculated. To calculate the ACR for these conditions, the adjusted tire inflation pressure should be entered in the ICAO-ACR dedicated input field.

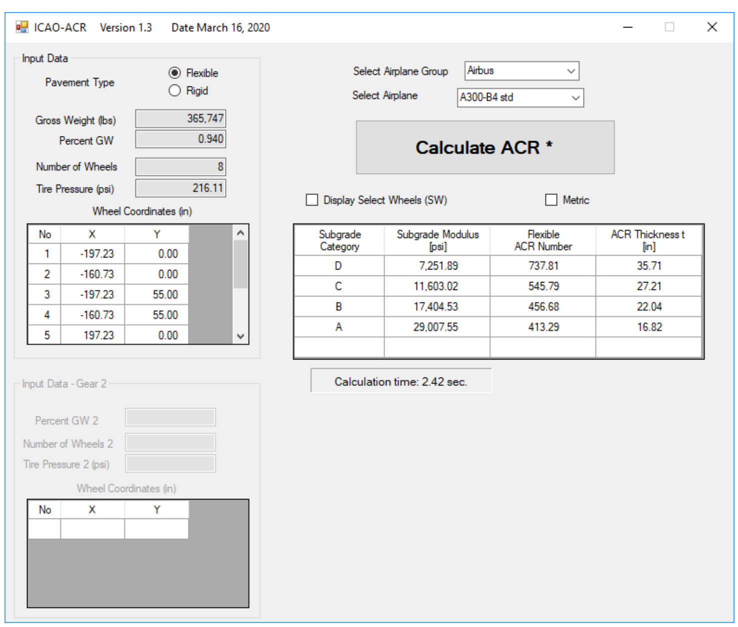
3.5.4 Using the ICAO-ACR Program to calculate ACR.

Using the ICAO-ACR program to calculate ACR values is visually interactive and intuitive, see Figure 3-3.

1. The user selects:
   a. Pavement Type, Flexible or Rigid.
   b. Airplane Group and Airplane (adjusting weight and percent GW if necessary.
2. Calculate ACR.

The program then calculates ACR values for the 4 subgrade categories.

Figure 3-3. Screen Shot ICAO-ACR



CHAPTER 4. Determination of PCR Numerical Value

4.1 PCR Concept.

The strength of a pavement is reported in terms of the load rating of the aircraft which the pavement can accept on an unrestricted basis. The term unrestricted operations in the definition of PCR does not mean unlimited operations. Unrestricted refers to the relationship of PCR to the aircraft ACR, and that it is permissible for an aircraft to operate without weight restriction when the PCR is greater than or equal to the ACR. The term unlimited operations does not take into account pavement life. The PCR to be reported is such that the pavement strength is sufficient for the current and future traffic analyzed, and should be re-evaluated if traffic changes significantly. A significant change in traffic would be indicated by the introduction of a new aircraft type or an increase in current aircraft traffic levels not accounted for in the original PCR analysis.

4.2 Determination of Numerical PCR Value.

Determination of the numerical PCR value for a particular pavement can be based upon one of two procedures: the "Using aircraft method" or the "Technical evaluation method". ICAO procedures permit member states to determine how PCR values will be determined. Either procedure may be used to determine a PCR, but the methodology used must be reported as part of the posted rating.

4.3 Using Aircraft Method to Determine PCR.

The Using Aircraft Method is a procedure where ACR values for all aircraft currently permitted to use the pavement facility are determined and the largest ACR value is reported as the PCR. This method is easy to apply and does not require detailed knowledge of the pavement structure. The subgrade support category is not a critical input when reporting PCR based on the Using Aircraft Method. The recommended subgrade support category when information is not available should be Category B. See Appendix B paragraph B.1 for an example of the Using Aircraft Method.

4.3.1 Assumptions of the Using Aircraft Method.

An underlying assumption with the Using Aircraft Method is that the pavement structure has the structural capacity to accommodate all aircraft in the traffic mix, and that each aircraft is capable of operating on the pavement structure without weight restriction. The methodology used to determine ACR/PCR does not consider the critical design aircraft used to determine airport dimensional requirements.

4.3.2 Inaccuracies of the Using Aircraft Method.

The accuracy of this method is dependent upon having records of past aircraft traffic. Significant over-estimation of the pavement capacity can result if an excessively damaging aircraft, which uses the pavement on a very infrequent basis, is used to determine the PCR. Likewise, significant under-estimation of the pavement capacity can lead to uneconomic use of the pavement by preventing acceptable traffic from operating. Although there are no minimum limits on frequency of operation before an aircraft is considered part of the normal traffic, the reporting agency must use a rational approach to avoid overstating or understating the pavement capacity. Use a consistent method based on a design period minimum frequency of 250 annual departures. Use of the Using Aircraft Method is discouraged on a long-term basis due to the concerns listed above.

4.4 Technical Evaluation Method to Determine PCR.

4.4.1 The strength of a pavement section will vary depending on the aircraft traffic composition and number of operations combined with type of pavement structure and subgrade support conditions. The technical evaluation method attempts to address these and other site-specific variables to determine reasonable pavement strength. In general terms, for a given pavement structure and given aircraft, the allowable number of operations (traffic) will decrease as the intensity of pavement loading increases (increase in aircraft weight). It is entirely possible that two pavement structures with different cross-sections will report similar strength. However, the permissible aircraft operations will be considerably different. This discrepancy must be acknowledged by the airport operator and may require operational limitations administered outside of the ACR-PCR system. All of the factors involved in determining a pavement rating are important, and it is for this reason that pavement ratings should not be viewed in absolute terms, but rather as estimations of a representative value. A successful pavement evaluation is one that assigns a pavement strength rating that considers the effects of all variables on the pavement.

4.4.2 The accuracy of a technical evaluation is better than that produced with the Using Aircraft procedure but requires additional information. Pavement evaluation may require a combination of on-site inspections, load-bearing tests, and engineering judgment. It is common to think of pavement strength rating in terms of ultimate strength or immediate failure criteria. However, pavements are rarely removed from service due to instantaneous structural failure. A decrease in the serviceability of a pavement is commonly attributed to increases in surface roughness or localized distress, such as rutting or cracking. Determination of the adequacy of a pavement structure must not only consider the magnitude of pavement loads but the impact of the accumulated effect of traffic over the intended life of the pavement. To determine a technical PCR requires information on: (1) aircraft traffic composition and frequency, (2) thickness, material type and strength of each layer of pavement structure and (3) elastic modulus of subgrade. For examples on technical evaluation to determine PCR see Appendix B paragraph B.2.

4.4.3 Recommended Procedure for Technical Evaluation (T) PCR.

The following recommended PCR procedure consists of the computation of an aircraft ACR. This paragraph explains the steps to convert the mix of using aircraft traffic to an equivalent critical, or reference aircraft at maximum allowable gross weight, which will then produce a CDF of 1.0 on the evaluated pavement. The ACR calculation follows the ACR procedure described in paragraph 3.5.

The PCR procedure considers the characteristics of the pavement structure and aircraft traffic forecast over the life period selected. The life period should reflect the design life for new pavements and the remaining life for in-service pavements. The PCR should be valid only for this usage period. A new evaluation is required after pavement rehabilitation or when traffic changes as compared to the initial traffic. It is assumed that generally in the US a PCR will be calculated in conjunction with a construction project or as part of a pavement management program. See AC 150/5320-6, *Airport Pavement Design and Evaluation,* for information on pavement design and AC 150/5380-7, *Airport Pavement Management Program,* for information on Pavement Management Programs.

The PCR procedure involves the following steps:

Step 1. Collect all relevant pavement data (layer thicknesses, elastic moduli and Poisson's ratio of all layers, using or projected aircraft traffic) using the best available data sources,

Step 2. Define the aircraft mix by aircraft type, number of departures (or operations consistent with pavement design practices), and aircraft weight that the evaluated pavement is expected to experience over its design or estimated remaining structural life,

Note: The FAA procedure assumes that the passes are distributed by a Gaussian (or normal) distribution function, with a standard deviation s = 30.54 inches (776 mm) independent of type of aircraft.

Step 3. Compute the ACRs for each aircraft in the aircraft mix at its operating weight and record the maximum ACR aircraft.

Note: ACR computations must follow the procedure in paragraph 3.5.

Step 4. Compute the maximum CDF of the aircraft mix and record the value,

Note: the CDF is computed with any damage/failure model consistent with the procedure used for pavement design.

Step 5. Select the aircraft with the highest contribution to the maximum CDF as the critical aircraft. This aircraft is designated AC(i), where *i* is an index value with an initial value 1. Remove all aircraft other than the current critical aircraft AC(i) from the traffic list.

Step 6. Adjust the annual departures of the critical aircraft until the maximum aircraft CDF is equal to the value recorded in (4). Record the equivalent annual departures of the critical aircraft,

Step 7. Adjust the critical aircraft weight to obtain a maximum CDF of 1.0 for the number of annual departures obtained at step (6).

This is the Maximum Allowable Gross Weight (MAGW) for the critical aircraft,

Step 8. Compute the ACR of the critical aircraft at its MAGW. The value obtained is designated as PCR(i).

Note: ACR computations must follow the procedure in paragraph 3.5.

Step 9. If AC(i) is the maximum ACR aircraft from step 3, then skip to step 13. If not continue to Step 10.

Step 10. Remove the current critical aircraft AC(i) from the traffic list and re-introduce the other aircraft not previously considered as critical aircraft. The new aircraft list, which does not contain any of the previous critical aircraft, is referred to as the reduced aircraft list. Increment the index value ($i = i+1$).

Step 11. Compute the maximum CDF of the reduced aircraft list and select the new critical aircraft AC(i),

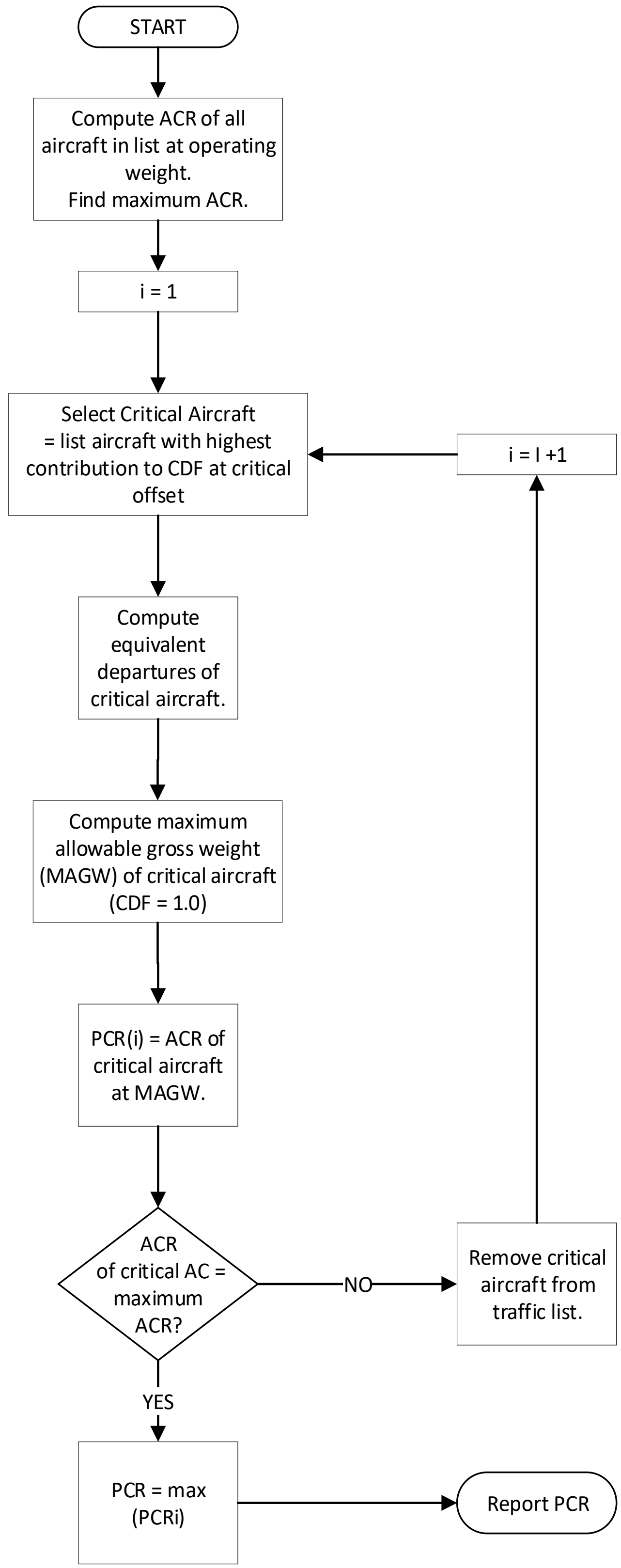
Step 12. Repeat steps 5-9 for AC(i). In step 6, use the same maximum CDF as computed for the initial aircraft mix to compute the equivalent annual departures for the reduced list.

Step 13. The PCR to be reported is the maximum value of all computed PCR(i). The critical aircraft is the aircraft associated with this maximum value of PCR(i).

A flowchart of the above procedure is shown in Figure 4-1. The purpose of steps 10-12 is to account for certain cases with a large number of annual departures of a short/medium-range aircraft (such as the B737) and a relatively small number of departures of a long-range aircraft (e.g., the B777). Without this step, the smaller aircraft would generally be identified as critical, with the result that the PCR would require unreasonable operating weight restrictions on larger aircraft (unreasonable because the design traffic already included the large aircraft). Note that if the initial critical aircraft is also the aircraft in the list with the maximum ACR at operating weight, then the procedure is completed in one iteration, with no subsequent reduction to the traffic list.

The above procedure returns a uniquely determined PCR numerical value based on the identified critical aircraft.

Figure 4-1. Flowchart of Recommended PCR Computation Procedure



4.4.4 Examples of PCR Calculation.

See Appendix B for examples of calculating and evaluating what PCR to report.

4.4.5 Limitations of the PCR.

The PCR value should not be used for pavement design or as a substitute for evaluation. Pavement design and evaluation are complex engineering problems that require detailed analyses. They cannot be reduced to a single number. The PCR rating system uses a continuous scale to compare pavement capacity where higher values represent pavements with larger load capacity.

4.5 Reporting the PCR.

The PCR system uses a coded format to maximize the amount of information contained in a minimum number of characters and to facilitate computerization. The PCR is reported as a five-part code where the following codes are ordered and separated by forward slashes: Numerical PCR value / Pavement type / Subgrade category / Allowable tire pressure / Method used to determine the PCR.

4.5.1 Numerical PCR Value.

The PCR numerical value indicates the load-carrying capacity of a pavement in terms of a standard single wheel load at a tire pressure of 218 psi (1.5 MPa). The PCR value should be reported in whole numbers, rounding off any fractional parts to the nearest whole number. For pavements of diverse strengths, the controlling PCR numerical value for the weakest segment of the pavement should normally be reported as the strength of the pavement. Engineering judgment may be required if the weakest segment is not in the most heavily used part of the runway, then another representative segment may be more appropriate to determine PCR.

4.5.2 Pavement Type.

For the purpose of reporting PCR values, pavement types are considered to function as either flexible or rigid structures. Table 4-1 lists the pavement codes for the purposes of reporting PCR.

Table 4-1. Pavement Codes for Reporting PCR

Pavement Type	Pavement Code
Flexible	F
Rigid	R

4.5.2.1 **Flexible Pavement.**

Flexible pavements support loads through bearing rather than flexural action. They comprise several layers of select materials designed to gradually distribute loads from the surface to the layers beneath. The design ensures that load transmitted to each successive layer does not exceed the layer's load-bearing capacity.

4.5.2.2 **Rigid Pavement.**

Rigid pavements employ a single structural layer, which is very stiff or rigid in nature, to support the pavement loads. The rigidity of the structural layer and resulting beam action enable rigid pavement to distribute loads over a large area of the subgrade. The load-carrying capacity of a rigid structure is highly dependent upon the strength of the structural layer, which relies on uniform support from the layers beneath.

4.5.2.3 **Composite Pavement.**

Various combinations of pavement types and stabilized layers can result in complex pavements that could be classified as between rigid or flexible. A pavement section may comprise multiple structural elements representative of both rigid and flexible pavements. Composite pavements are most often the result of pavement surface overlays applied at various stages in the life of the pavement structure. If a pavement is of composite construction, the pavement type should be reported as the type that most accurately reflects the structural behavior of the pavement. FAARFIELD will consider a rigid pavement overlaid with flexible to be a rigid pavement until the overlay thickness matches the rigid thickness. It is good practice to include a note stating that the pavement is of composite construction, and to note what the wearing surface is.

4.5.3 Subgrade Strength Category.

As discussed in paragraph 2.2, there are four standard subgrade strengths identified for calculating and reporting ACR or PCR values. Table 2-1 lists the values for rigid and flexible pavements.

4.5.4 Allowable Tire Pressure.

Table 4-2 lists the allowable tire pressure categories identified by the ACR-PCR system. The tire pressure codes apply equally to rigid or flexible pavement sections; however, the application of the allowable tire pressure differs substantially for rigid and flexible pavements.

Table 4-2. Tire Pressure Codes for Reporting PCR

Category	Code	Tire Pressure Range
Unlimited	W	No pressure limit
High	X	Pressure limited to 254 psi (1.75 MPa)
Medium	Y	Pressure limited to 181 psi (1.25 MPa)
Low	Z	Pressure limited to 73 psi (0.50 MPa)

4.5.4.1 **Tire Pressures on Rigid Pavements.**

Aircraft tire pressure will have little effect on pavements with cement concrete (concrete) surfaces. Rigid pavements are inherently strong enough to resist tire pressures higher than currently used by commercial aircraft and can usually be rated as code W.

4.5.4.2 **Tire Pressures on Flexible Pavements.**

Tire pressures may be restricted on asphaltic concrete (asphalt), depending on the quality of the asphalt mixture and climatic conditions. Tire pressure effects on an asphalt layer relate to the stability of the mix in resisting shearing or densification. A poorly constructed asphalt pavement can be subject to rutting due to consolidation under load. The principal concern in resisting tire pressure effects is with stability or shear resistance of lower quality mixtures. A properly prepared and placed mixture that conforms to FAA specification Item P-401 can withstand substantial tire pressure in excess of 218 psi (1.5 Mpa). Item P-401, Asphalt Mix Pavement, is provided in the current version of AC 150/5370-10, *Standards for Specifying Construction of Airports*. Mixtures utilizing lower quality materials and construction standards can show distress under tire pressures of 100 psi (0.7 MPa) or less. Although these effects are independent of the asphalt layer thickness, pavements with well-placed asphalt of 4 to 5 inches (10.2 to 12.7 cm) can generally be rated with code X or W, while thinner pavement of poorer quality asphalt should not be rated above code Y.

4.5.5 Method Used to Determine PCR.

The PCR system recognizes two pavement evaluation methods. If the evaluation represents the results of a technical study, the evaluation method should be coded T. If the evaluation is based on “Using Aircraft” experience, the evaluation method should be coded U. Technical evaluation implies that some form of technical study and computation were involved in the determination of the PCR. Using Aircraft evaluation means the PCR was determined by selecting the highest ACR among the aircraft currently using the facility and not causing pavement distress.

4.5.6 Example PCR Reporting.

An example of a PCR code is 800/R/B/W/T—with:

- 800 expressing the PCR numerical value,
- R for rigid pavement,
- B for medium strength subgrade,
- W for high allowable tire pressure, and
- T for a PCR value obtained by a technical evaluation.

4.5.7 Report PCR Values (See Appendix E).

Once a PCR value and the coded entries are determined, report the value in the Airport Master Record. Use the Airport Data and Information Portal (ADIP) to update the AMR. The PCR data will be disseminated by the Aeronautical Data Team through aeronautical publications such as the Chart Supplements and the Aeronautical Information Publication (AIP). An aircraft's ACR can then be compared with published PCR's to determine if pavement strength places any weight or tire pressure restrictions on the aircraft operating on that pavement.

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APPENDIX A. EQUIVALENT TRAFFIC

A.1 Equivalent Traffic.

A.1.1 A detailed method based on the cumulative damage factor (CDF) procedure allows the calculation of the combined effect of multiple aircraft in the traffic mix for an airport. This combined traffic is brought together into the equivalent traffic of a critical aircraft. This is necessary since the procedure used to calculate ACR allows only one aircraft at a time. By combining all of the aircraft in the traffic mix into an equivalent critical aircraft, calculation of a PCR that includes the effects of all traffic becomes possible. The methodology used to determine ACR/PCR does not consider the critical design aircraft used to determine airport dimensional requirements.

A.1.2 The assessment of equivalent traffic, as described in this section, is needed only in the process of determining PCR using the technical method and may be disregarded when the Using Aircraft Method is employed.

A.1.3 In order to arrive at a technically derived PCR, it is necessary to determine the maximum allowable gross weight of each aircraft in the traffic mixture, which will generate the known pavement structure. This in turn requires that the pavement cross-section and aircraft loading characteristics be examined in detail. Consequently, the information presented in this appendix appears at first to apply to pavement design rather than a PCR determination. However, with this knowledge in hand, an engineer will be able to arrive at a PCR that will have a solid technical foundation.

A.2 Equivalent Traffic Terminology.

In order to determine a PCR, based on the technical evaluation method, it is necessary to define common terms used in aircraft traffic and pavement loading. The terms arrival, departure, pass, coverage, load repetition, operation, and traffic cycle are often used interchangeably by different organizations when determining the effect of aircraft traffic operating on a pavement. It is important to determine which aircraft movements need be counted when considering pavement stress and how the various movement terms apply in relation to the pavement design and evaluation process. For the purposes of this document, they are differentiated as follows:

A.2.1 <u>Arrival (Landing) and Departure (Takeoff).</u>

Typically, aircraft arrive at an airport with a lower amount of fuel than is used at takeoff. As a consequence, the stress loading of the wheels on the runway pavement is less when landing than at takeoff due to the lower weight of the aircraft as a result from the fuel used during flight and the lift on the wings. This is true even at the touchdown impact in that there is still lift on the wings, which alleviates the dynamic vertical force. Because of this, the FAA pavement design procedure only considers departures and ignores the arrival traffic count. However, if the aircraft do not receive additional fuel at the airport, then the landing weight will be substantially the same as the takeoff weight (discounting the changes in passenger count and cargo), and the landing operation should be counted as a takeoff for pavement stress loading cycles. In this latter scenario, there are two equal load stresses on the pavement for each traffic count (departure), rather than just one. Regardless of the method of counting load stresses, a traffic cycle is defined as one takeoff and one landing of the same aircraft, subject to a further refinement of the definition in the following text.

A.2.2 Pass.

A pass is a one-time movement of the aircraft over the runway pavement. It could be an arrival, a departure, a taxi operation, or all three, depending on the loading magnitude and the location of the taxiways. Figure A-1 shows typical traffic patterns for runways having either parallel taxiways or central taxiways. A parallel taxiway requires that none or very little of the runway be used as part of the taxi movement. A central taxiway requires that a large portion of the runway be used during the taxi movement.

Figure A-1. Traffic Load Distribution Patterns

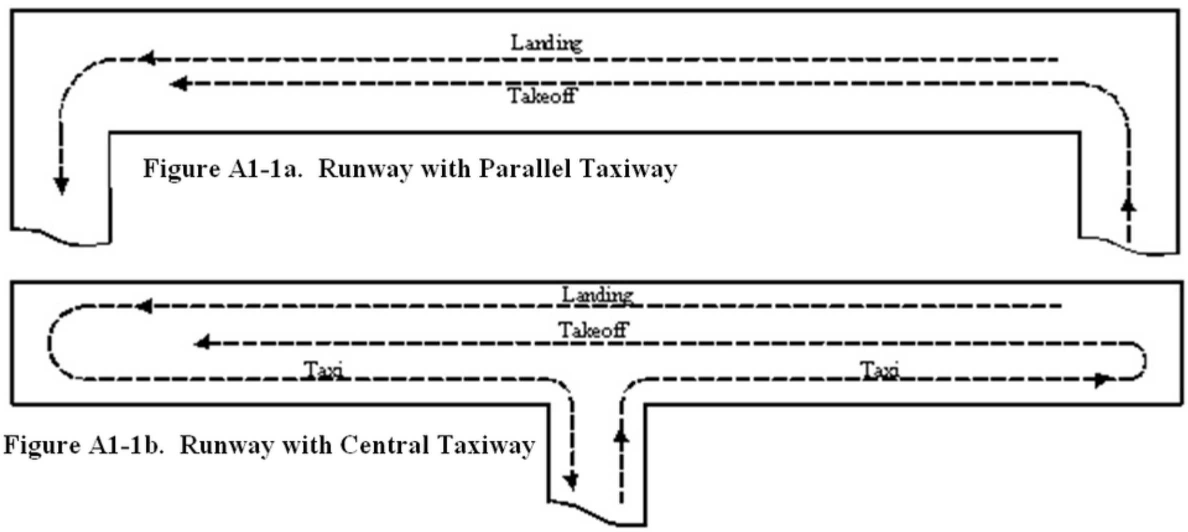


Figure A1-1a. Runway with Parallel Taxiway

Figure A1-1b. Runway with Central Taxiway

A.2.2.1 **Parallel Taxiway Scenario.**

In the case of the parallel taxiway, shown as Figure A1-1a in Figure A-1, two possible loading situations can occur. Both of these situations assume that the passenger count and cargo payload are approximately the same for the entire landing and takeoff cycle:

1. If the aircraft obtains fuel at the airport, then a traffic cycle consists of only one pass since the landing stress loading is considered at a reduced level, which is a fractional equivalence. For this condition only the takeoff pass is counted, and the ratio of passes to traffic cycles (P/TC) is 1.
2. If the aircraft does not obtain fuel at the airport, then both landing and takeoff passes should be counted, and a traffic cycle consists of two passes of equal load stress. In this case, the P/TC ratio is 2.

A.2.2.2 **Central Taxiway Scenario.**

For a central taxiway configuration, shown as Figure A1-1b in Figure A-1, there are also two possible loading situations that can occur. As was done for the parallel taxiway condition, both of these situations assume that the payload is approximately the same for the entire landing and takeoff cycle:

1. If the aircraft obtains fuel at the airport, then both the takeoff and taxi to takeoff passes should be counted since they result in a traffic cycle consisting of two passes at the maximum load stress. The landing pass can be ignored in this case. It is recognized that only part of the runway is used during some of these operations, but it is conservative to assume that the entire runway is covered each time a pass occurs. For this situation, the P/TC ratio is 2.
2. If the aircraft does not obtain fuel at the airport, then both the landing and takeoff passes should be counted, along with the taxi pass, and a traffic cycle consists of three passes at loads of equal magnitude. In this case, the P/TC ratio is 3.

A.2.2.3 A simplified, but less conservative, approach would be to use a P/TC ratio of 1 for all situations. Since a landing and a takeoff only apply full load to perhaps the end third of the runway (opposite ends for no shift in wind direction), this less conservative approach could be used to count one pass for both landing and takeoff. However, the FAA recommends conducting airport evaluations on the conservative side, which is to assume any one of the passes covers the entire runway.

A.2.2.4 Table A-1 summarizes the standard P/TC ratio discussion.

Table A-1. Standard P/TC Ratio Summary (see note)

Taxiway Serving the Runway	P/TC Fuel Obtained at the Airport (i.e. departure gross weight more than arrival gross weight.)	P/TC No Fuel Obtained at the Airport (i.e. departure gross weight same as arrival gross weight.)
Parallel	1	2
Central	2	3

Note: The standard P/TC ratios are whole numbers 1, 2, and 3. The range of values that can be entered in the software is 0.001 thru 10.0. This feature allows flexibility in those instances where a fraction of the total traffic may use different runways or other pavements. For example, a P/TC ratio of 0.5 multiplies the coverages of each aircraft by 0.5, which will increase the PCR of the pavement.

A.2.3 Coverage.

A.2.3.1 When an aircraft moves along a runway, it seldom travels in a perfectly straight line or over the exact same wheel path as before. It will wander on the runway with a statistically normal distribution. One coverage occurs when a unit area of the runway has been traversed by a wheel of the aircraft main gear. Due to wander, this unit area may not be covered by the wheel every time the aircraft is on the runway. The number of passes required to statistically cover the unit area one time on the pavement is expressed by the pass to coverage (P/C) ratio.

A.2.3.2 Although the terms coverage and P/C ratio have commonly been applied to both flexible and rigid pavements, the P/C ratio has a slightly different meaning when applied to flexible pavements as opposed to rigid pavements. This is due to the manner in which flexible and rigid pavements are considered to react to various types of gear configurations. For gear configurations with wheels in tandem, such as dual tandem (2D) and triple dual tandem (3D), the ratios are different for flexible and rigid pavements, and using the same term for both types of pavements may become confusing.

A.2.3.3 Aircraft passes can be determined (counted) by observation but coverages are used by the FAARFIELD program. The P/C ratio is necessary to convert passes to coverages for use in the program. This ratio is different for each aircraft because of the different number of wheels, main gear configurations, tire contact areas, and load on the gear. Fortunately, the P/C ratio for any aircraft is automatically determined by the FAARFIELD program and the user only need be concerned with passes.

A.2.4 Operation.

The meaning of this term is unclear when used in pavement design or evaluation. It could mean a departure at full load or a landing at minimal load. It is preferable to use the more precise terms of departure or landing.

APPENDIX B. PCR DETERMINATION EXAMPLES

B.1 The Using Aircraft Method.

B.1.1 The Using Aircraft Method for determining PCR is presented in the following steps. This procedure can be used when there is limited knowledge of the existing traffic and runway characteristics. It is also useful when engineering analysis is neither possible nor desired. Because the rating has not been determined rigorously, airport authorities should exercise more care when applying a Using Aircraft PCR than they would with a Technical PCR.

B.1.2 The basic procedure to arrive at a Using Aircraft PCR is:

1. Determine the ACR for each aircraft in the traffic mix currently using the pavement**.**
2. Assign the highest ACR value as the PCR.

B.1.3 The examples in paragraphs B.2 and B.3 show the steps needed to perform the ACR calculations using ICAO-ACR, and the results. For both flexible and rigid pavement surfaces, the detailed steps are as follows:

1. Assign the pavement surface type as code F or R.
2. From available records, determine the strength of the pavement subgrade. If the subgrade strength is not known use Medium.
3. Determine which aircraft has the highest ACR from the list of aircraft that regularly use the pavement, based on the surface type code assigned in Step 1 and the subgrade code in Step 2. ACR values may be determined from the ICAO-ACR program, or from ACR graphs found in the manufacturer's published ACAP manuals. Use the same subgrade code for each of the aircraft when determining the maximum ACR. Base ACRs on the highest operating weight of the aircraft at the airport if the data are available; otherwise, use an estimate or the published maximum allowable gross weight of the aircraft in question. Report the ACR from the aircraft with the highest ACR that regularly uses the pavement as the PCR for the pavement. '
4. **Note:** The FAA recommends that an aircraft be considered to "regularly use" an airport if they have 250 annual departures. Use engineering judgement for seasonal or occasional use aircraft.
5. The PCR is the highest ACR of all Using Aircraft, with appropriate tire pressure and evaluation codes added. The numerical value of the PCR may be adjusted up or down at the preference of the airport authority. Adjustments are not considered standard practice but reasons for adjustment may include local restrictions, allowances for certain aircraft, or pavement conditions.
6. The tire pressure code (W, X, Y, or Z) should represent the highest tire pressure of the aircraft fleet currently using the pavement. For flexible pavements, code X should be used if no higher tire pressure is evident from among the existing traffic.

It is commonly understood that concrete can tolerate substantially higher tire pressures, so the rigid pavement rating should normally be given as W.

7. The evaluation method for the Using Aircraft Method is reported as U.

B.2 Using Aircraft Example for Flexible Pavements.

B.2.1 The following example illustrates the Using Aircraft PCR process for flexible pavements:

B.2.2 An airport has a runway with the known traffic mix shown in Table B-1. The runway has a flexible (asphalt-surfaced) pavement with an estimated subgrade strength of CBR 9. Applying the conversion $E = 1500 \times \text{CBR}$ gives estimated $E = 13{,}500$ psi, which places it in subgrade category C.

Table B-1. Using Aircraft Traffic for a Flexible Pavement

No.	Aircraft Name	Gross Weight, lbs.	Annual Departures	Tire Pressure, psi
1	A300-B4 Std	365,747	1,500	216.1
2	A319-100 Std	141,978	1,200	172.6
4	B737-300	140,000	6,000	201.0
5	B747-400	877,000	1,000	200.0
6	B767-200 ER	396,000	2,000	190.0
7	B777-200 ER	657,000	1,000	205.0
8	DC8-63	330,000	3,000	194.0

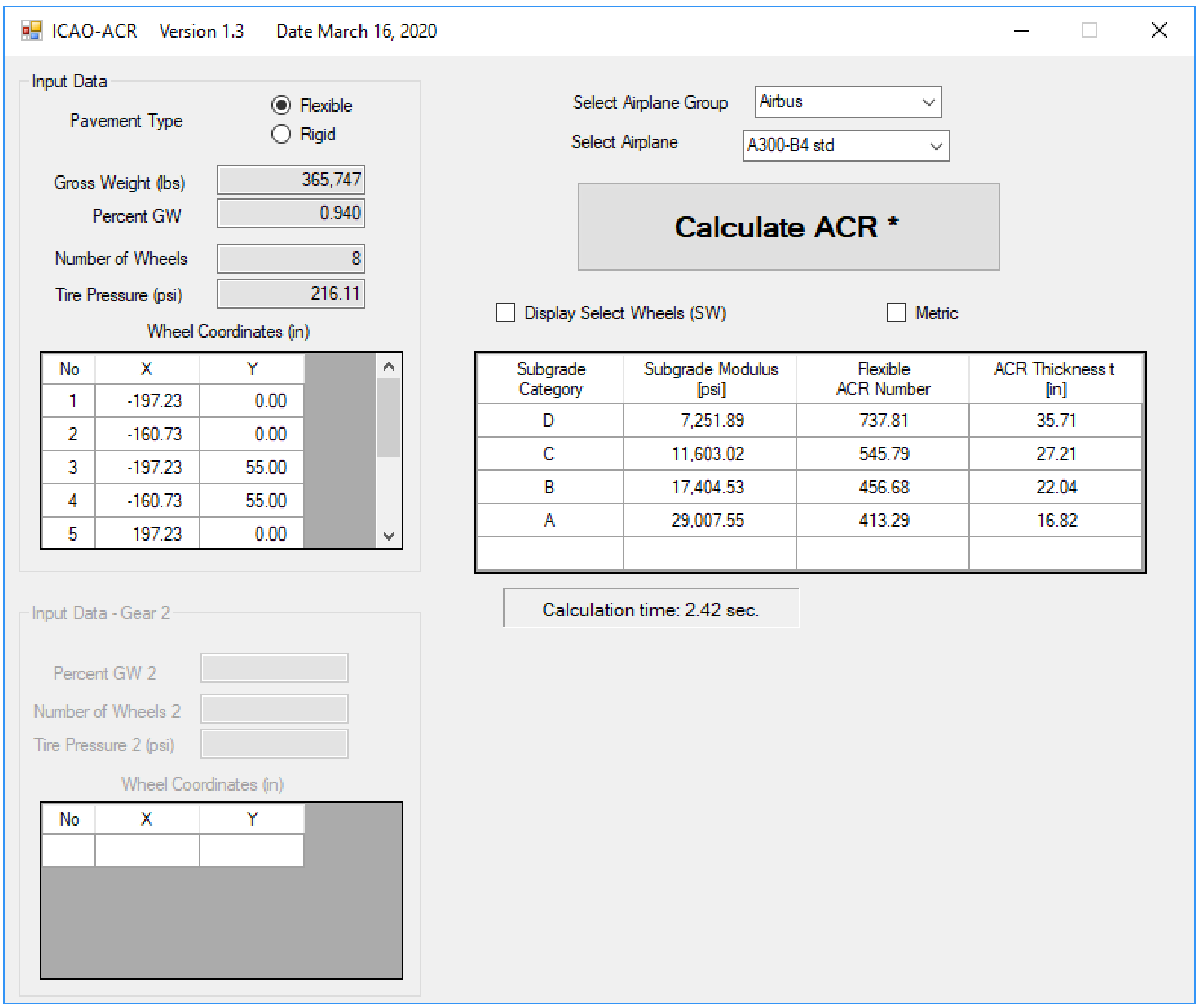
B.2.3 Determine flexible ACR values for each airplane listed in Table B-1 using ICAO-ACR. Figure B-1 shows a sample ICAO-ACR computation for the A300-B4, the first airplane on the list. For subgrade category C, the flexible ACR number is 545.79. Table B-2 lists computed ACR values for all the operating aircraft. Note that the number of annual departures is not required to determine ACR; however, check to ensure that the number of annual operations qualifies the aircraft as being in "regular use."

Table B-2. Flexible ACR Values for Using Aircraft in Table B-1

No.	Aircraft Name	ACR/F/C
1	A300-B4 Std	545.79
2	A319-100 Std	326.02

No.	Aircraft Name	ACR/F/C
4	B737-300	345.93
5	B747-400	606.91
6	B767-200 ER	507.86
7	B777-200 ER	585.58
8	DC8-63	523.07

Figure B-1. Sample ICAO-ACR Computation for A300-B4 Std (Flexible)



1. Since this is a flexible pavement, the pavement type code is F.
2. The subgrade strength category is Low, so the appropriate code is C.
3. The highest tire pressure of any aircraft in the traffic mix is 216.1 psi, so the tire pressure code is X.

4. From Table B-2, the critical aircraft is the B747-400, because it has the highest ACR of the group at the operational weights shown (607/F/B). Additionally, it has regular service.
5. Since there was minimal engineering analysis done in this example, and the rating was determined simply by examination of the current aircraft using the runway, the evaluation code is U.
6. Based on the results of the previous steps, the runway pavement should tentatively be rated as PCR 610/F/C/X/U, assuming that the pavement is performing satisfactorily under the current traffic.
7. If this pavement was a taxiway, the airport could rate this taxiway as the same PCR.

B.2.4 If the pavement shows obvious signs of distress, this rating should be adjusted downward by the airport authority. If the rating is lowered, then one or more of the aircraft will have ACRs that exceed the assigned rating. This may require the airport to restrict the allowable gross weight for those aircraft or consider pavement strengthening.

B.3 Using Aircraft Example for Rigid Pavements.

An airport has a runway with the known traffic mix shown in Table B-1. The runway has a rigid (concrete-surfaced) pavement. The subgrade soil has an estimated modulus E = 15,000 psi, which places it in subgrade category B.

B.3.1 Determine rigid ACR values for each airplane listed in Table B-1 using ICAO-ACR. Figure B-2 shows a sample ICAO-ACR computation for the A300-B4, the first airplane on the list. For subgrade category B, the rigid ACR number is 600.2. Table B-3 lists computed ACR values for all the operating aircraft. Note that the number of annual departures is not required to determine ACR; however, check to ensure that the number of annual operations qualifies the aircraft as being in “regular use.” Also note that no information on in-situ concrete strength or thickness is needed to perform the ACR computations.

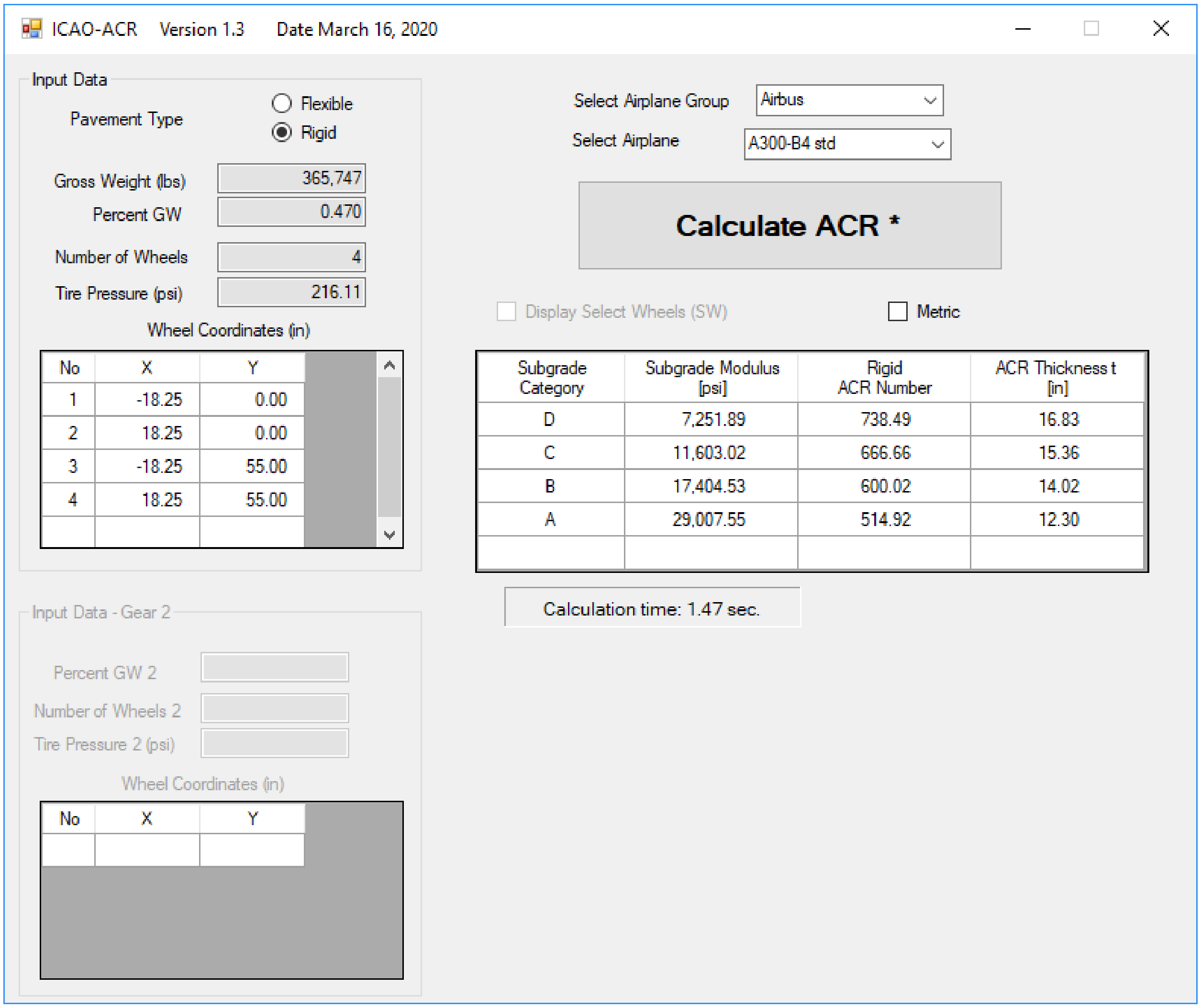
Table B-3. Rigid ACR Values for Using Aircraft in Table B-1

No.	Aircraft Name	ACR/R/B
1	A300-B4 Std	600.02
2	A319-100 Std	380.09
4	B737-300	403.48
5	B747-400	685.56
6	B767-200 ER	563.26
7	B777-200 ER	739.73
8	DC8-63	552.47

1. Since this is a rigid pavement, the pavement type code is R.
2. The subgrade strength category is Medium, so the appropriate code is B.
3. Concrete surfaces can tolerate high tire pressures, so use tire pressure code W for rigid pavement.
4. The B777-200 has the highest ACR of the group at the operational weights shown (740/R/B).
5. Since there was no engineering analysis done in this example, and the rating was determined simply by examination of the current aircraft using the runway, the evaluation code is U.
6. Based on these steps, the pavement should tentatively be rated as PCR 740/R/B/W/U in order to accommodate all of the current traffic.

B.3.2 If the pavement shows obvious signs of distress, this rating should be adjusted downward by the airport authority. If the rating is lowered, then one or more of the aircraft will have ACRs that exceed the assigned rating. This may require the airport to restrict the allowable gross weight for those aircraft or consideration of pavement strengthening. The rating could also be adjusted upward, depending on the performance of the pavement under the current traffic.

Figure B-2. Sample ICAO-ACR Computation for A300-B4 Std (Rigid)



B.4 The Technical Evaluation Method.

Use the Technical evaluation method of determining PCR when there is reliable knowledge of the existing traffic and pavement characteristics. Layer thickness and cross-sectional data, and accurate traffic counts, are needed to perform the evaluation. The following examples illustrate the use of the FAARFIELD 2.0 computer program to determine Technical PCR for flexible and rigid pavements.

B.5 Technical Evaluation for Flexible Pavements.

The following list summarizes the steps for using the technical evaluation method for flexible pavements:

1. Determine the type of aircraft and number of annual departures of each aircraft type that the pavement will experience over its life.

2. Determine the subgrade elastic modulus. The modulus may be determined from test data or converted from the CBR value using $E = 1{,}500 \times \text{CBR}$ (for E in psi).
3. Determine the pavement layer characteristics. In FAARFIELD, each layer above the subgrade is characterized by its thickness and elastic modulus E. For materials meeting an FAA specification, FAARFIELD will assign the E-value automatically, or allow the user to select it from an allowable range.
4. Determine the P/TC ratio for the pavement using the criteria in Appendix A.
5. Enter all information in FAARFIELD and run the PCR evaluation.

B.6 **Technical Evaluation Examples for Flexible Pavements.**

The following three examples demonstrate the technical evaluation method of determining a PCR for flexible pavements.

1. Example 1 is a pavement with excess strength relative to the using traffic volume (Total CDF < 1).
2. Example 2 has a thickness approximately equal to the structural requirement for the 20-year traffic (Total CDF ≈ 1).
3. Example 3 demonstrates how to report PCR when the pavement under consideration contains significant excess structural capacity relative to the forecast traffic (Total CDF << 1).

B.6.1 Flexible Pavement Example 1.

B.6.1.1 An airport has a flexible (asphalt-surfaced) runway pavement with a subgrade CBR of 8 and a total thickness of 32.0 inches. The structure is: 4-inch asphalt surface layer (Item P-401), 5 inches cement-treated stabilized base (Item P-304), 6-inch standard base layer (Item P-209) and 17 inches standard subbase layer (Item P-154). The traffic mix is the same as in the Using Aircraft example (Table B-1). It is assumed for the purposes of this example that the traffic level is constant over the 20-year time period. Additional fuel is generally obtained at the airport before departure, and the runway has a parallel taxiway (P/TC ratio = 1). The pavement was designed for a life of 20 years.

B.6.1.2 Enter the data in FAARFIELD. After opening FAARFIELD, select “PCR” from the drop-down function list at the top of the screen. Select the New Flexible pavement type from the drop-down Pavement Type list. Enter or modify the structure layers directly in the Pavement Layers table, or by clicking on the image of the pavement cross section. Using the aircraft library, enter the aircraft list from Table B-3, and modify the gross weights and annual departures as necessary. The default value of P/TC is 1, and does not need to be changed. Figure B-3 shows the FAARFIELD user screen with all data entered for this example.

Figure B-3. Screen Shot of FAARFIELD in PCR Mode with Data for Flexible Example 1

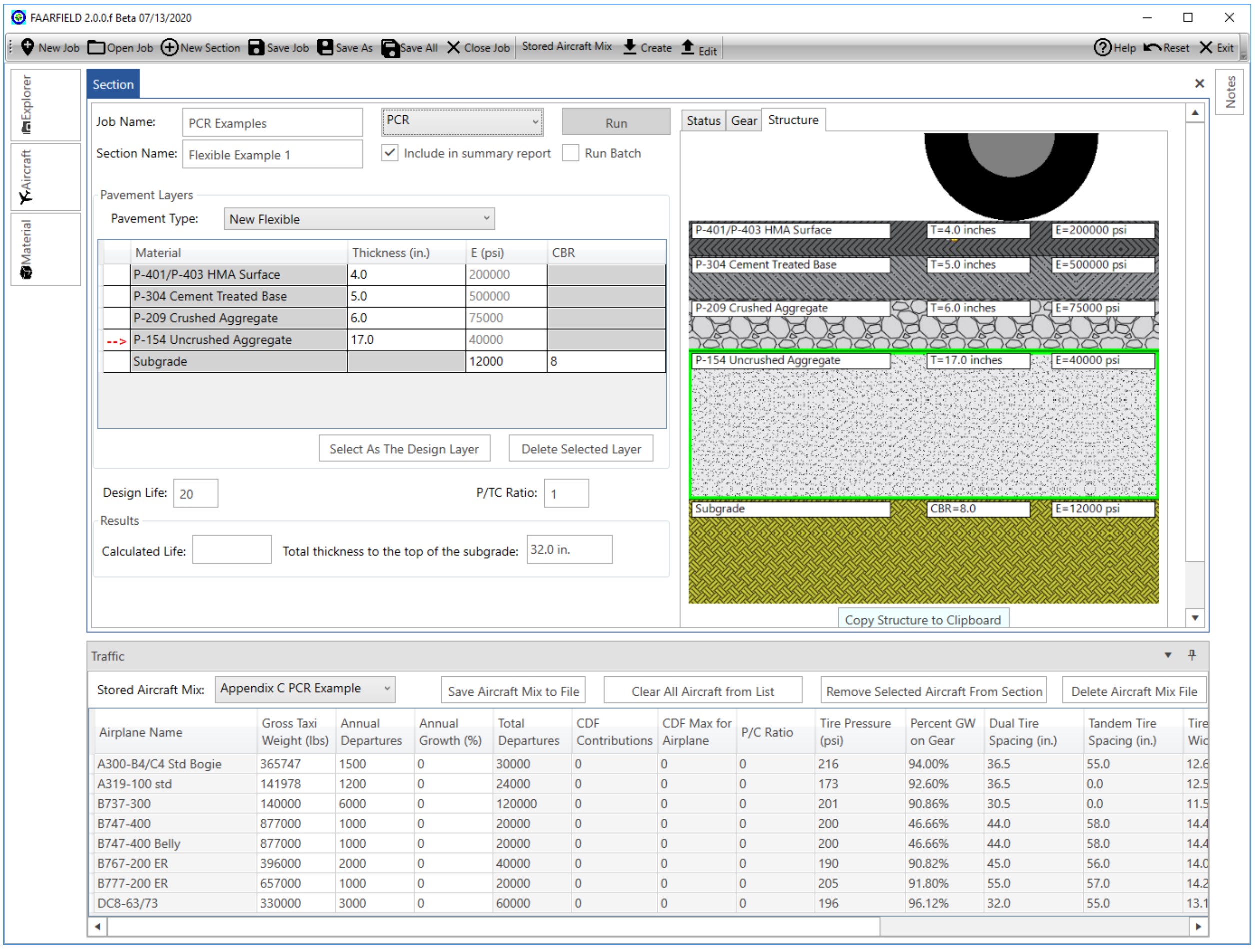


Figure B-4. FAARFIELD PCR Output – Flexible Example 1

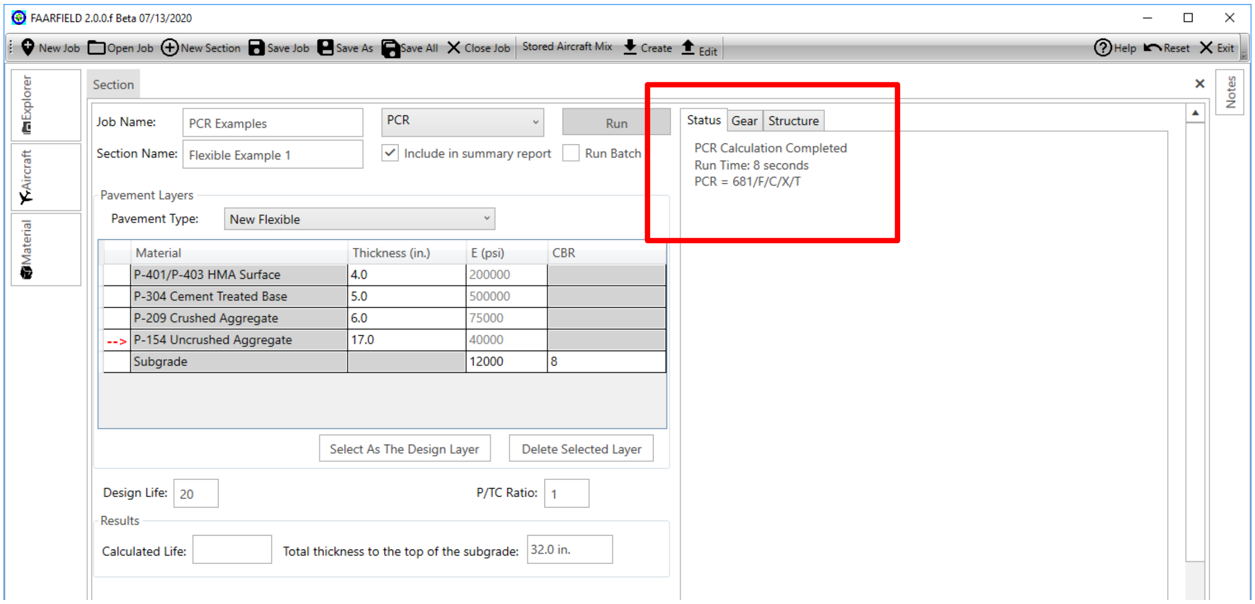


Figure B-5. FAARFIELD Traffic Table – Flexible Example 1

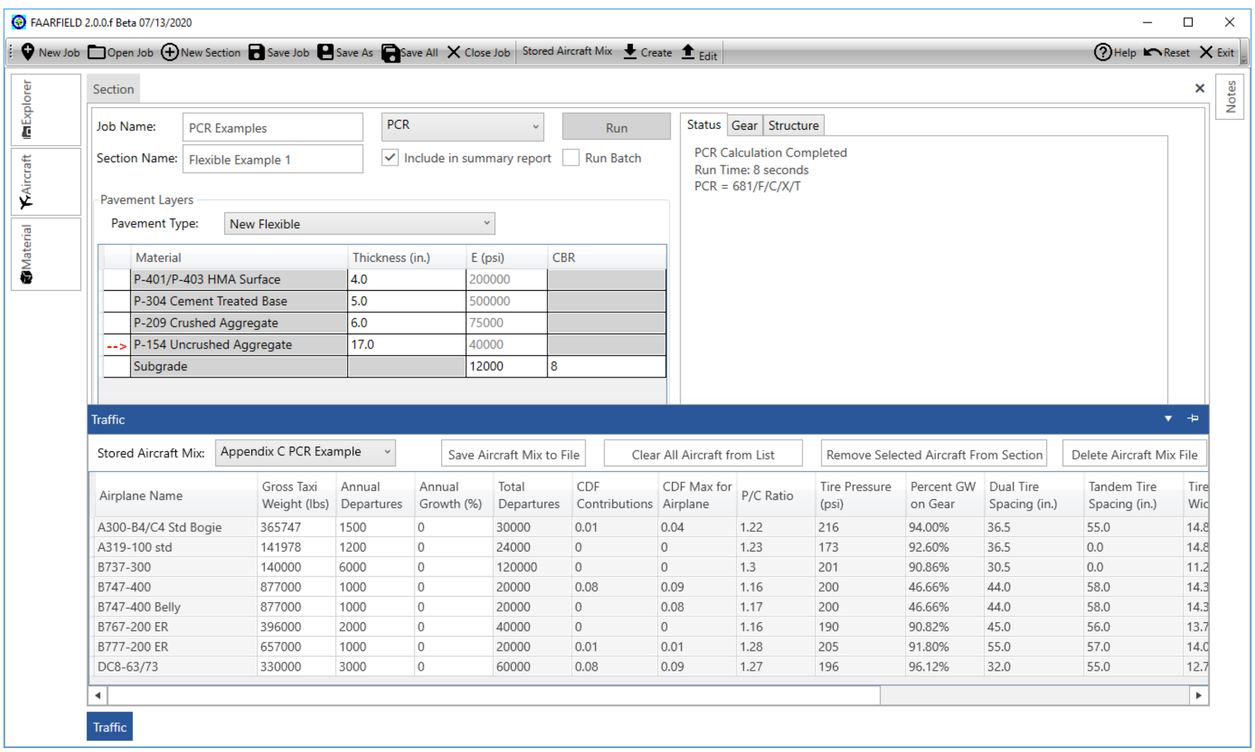
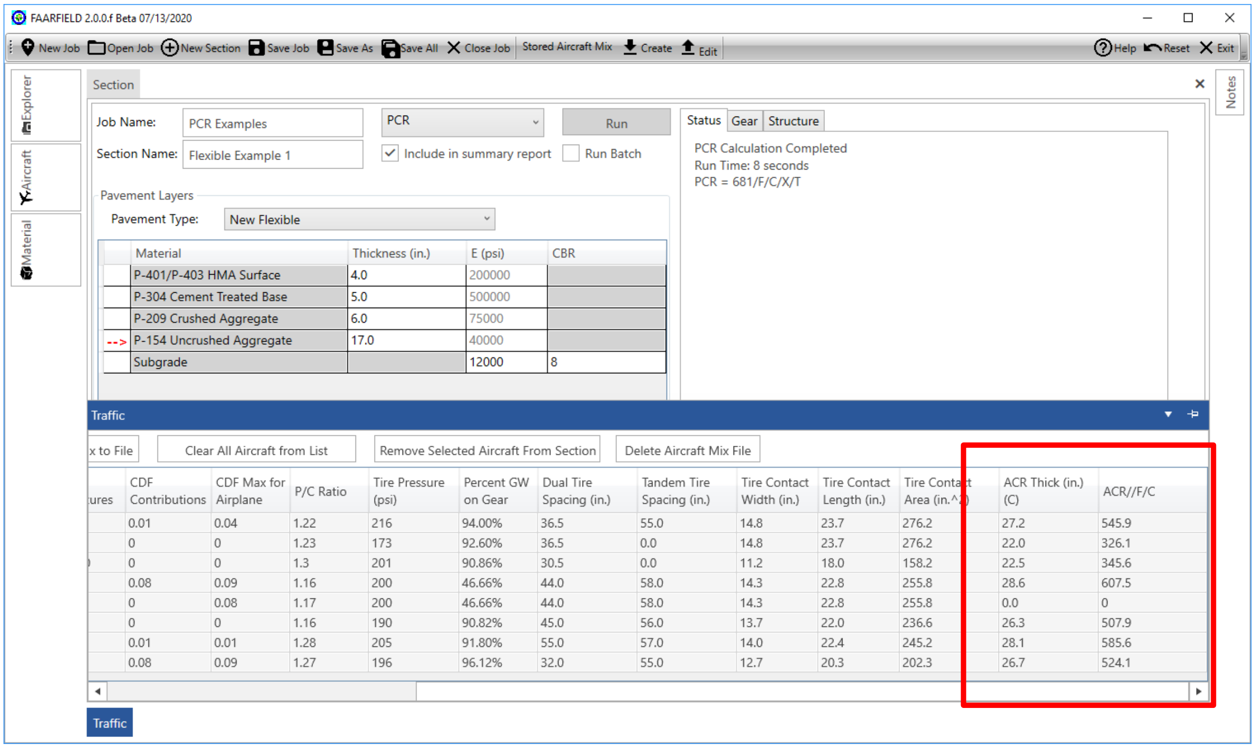


Figure B-6. FAARFIELD Traffic Table – Flexible Example 1 (ACR Values)



B.6.1.3 Click "Run." FAARFIELD will perform the PCR computations automatically. When the calculation is complete, the computed PCR value will appear in the "Status" screen at upper right (Figure B-4). For this example, the computed PCR is 681/F/C/X/T. Note that FAARFIELD automatically identifies the correct subgrade category based on the entered subgrade properties. FAARFIELD selects X as the default tire pressure category, but the user may choose to report a different category based on information about the surface asphalt mixture.

B.6.1.4 The Traffic table provides additional information about the PCR calculation (Figure B-5). Columns "CDF Contributions" and "CDF Max for Airplane" show the CDF contribution of each aircraft in the mix at the critical offset for the traffic mix, and for the individual aircraft, respectively. The total CDF for this example is 0.180. The total CDF for this example is less than 1.0, indicating that the flexible pavement has excess structural capacity for the using traffic. Note that the CDF values may differ from the values computed for the same traffic mix in Design mode. This is due to the different gear characteristics (percent of gross weight on the main gear and tire pressure) used for PCR calculations and design calculations.

B.6.1.5 Scrolling to the right of the FAARFIELD traffic table shows the computed ACR values of the Using Aircraft at their operating weights (Figure B-6). ACR thicknesses and flexible ACR values are displayed for each aircraft for the subgrade category of the pavement being evaluated. In this example, all ACRs are less than the computed PCR. Therefore, all aircraft can operate on the pavement without restriction.

B.6.1.6 From the explorer bar, select “PCR Graph.” FAARFIELD displays a bar graph showing visually the ACR values of the six most demanding aircraft in the list. The horizontal black bar represents the calculated PCR value. This graph shows that all ACR values are less than the PCR, hence all aircraft can operate with no restrictions. The PCR value appears in the table in the column associated with the critical aircraft. In this example, the critical aircraft for PCR calculations is the B747-400, which is also the aircraft with the highest ACR at operating weight.

B.6.1.7 From the explorer bar, select “PCR Report.” FAARFIELD displays details of the PCR computation, in the form of three tables:

1. Results Table 1 reports input traffic data for all using aircraft. Percent gross weight on the main gear and tire pressure values are those applicable to ACR calculations, and may differ from the values used for design.
2. Results Table 2 gives information on the critical aircraft: critical aircraft equivalent annual departures (which should be equal to or greater than the actual annual departures for that aircraft in Results Table 1); the computed MAGW of the critical aircraft (which will be greater than the operating gross weight if ACR < PCR); the ACR thickness for the critical aircraft at the MAGW, and the PCR, which is defined as the ACR of the critical aircraft at the MAGW.
3. Results Table 3 lists calculated ACR information for the Using Aircraft.

Clicking “Save as PDF” at the top of the screen saves a copy of the generated report (Figure B-8).

Figure B-7. FAARFIELD PCR Graph – Flexible Example 1

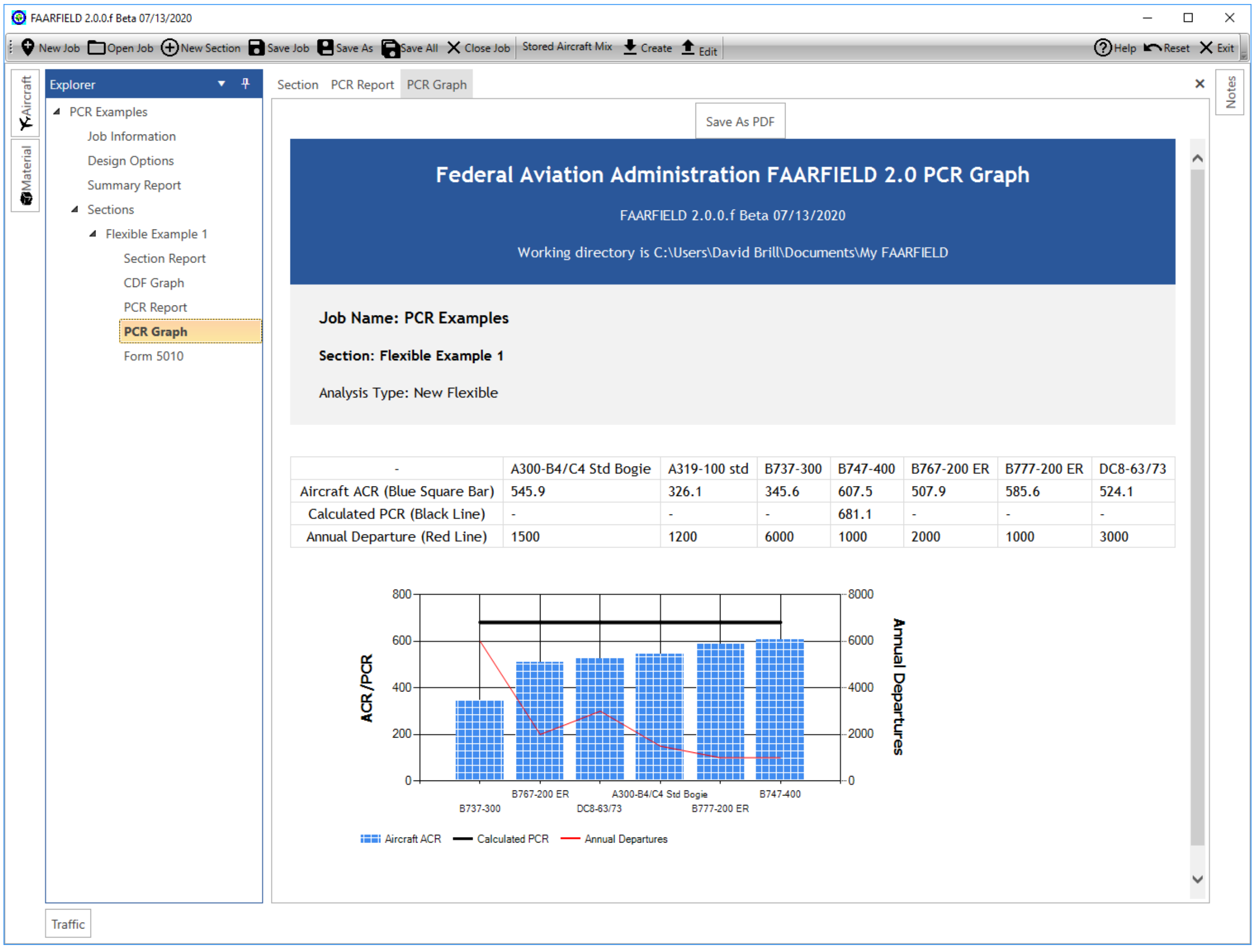


Figure B-8a. FAARFIELD PCR Report – Flexible Example 1

Federal Aviation Administration FAARFIELD 2.0 PCR Report

FAARFIELD 2.0.0.f Beta 07/13/2020

Working directory is C:\Users\David Brill\Documents\My FAARFIELD

Job Name: PCR Examples

Section: Flexible Example 1

This file name = PCR Results for Flexible 2020-07-15 11:34:46.txt

Evaluation pavement type is flexible and design program is FAARFIELD.

Section name: Flexible Example 1 in job file: C:\Users\David Brill\Documents\My FAARFIELD\PCR Examples.JOB.xml

Units = US Customary

Analysis Type: New Flexible

Subgrade Modulus =12000psi (Subgrade Category is C(11k))

Evaluation Pavement Thickness = 32.0 in.

Pass to Traffic Cycle (PtoTC) Ratio = 1.00

Maximum number of wheels per gear = 6

CDF = 0.180

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

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight lbs	Percent Gross Weight	Tire Pressure psi	Annual Departure	20 Years Coverage
1	A300-B4/C4 Std Bogie	365747	94.00	216.1	1500	24508
2	A319-100 std	141978	92.60	173.0	1200	19573
3	B737-300	140000	90.86	201.0	6000	92631
4	B747-400	877000	46.66	200.0	1000	17187
5	B747-400 Belly	877000	46.66	200.0	1000	17156
6	B767-200 ER	396000	90.82	190.0	2000	34480
7	B777-200 ER	657000	91.80	205.0	1000	15661
8	DC8-63/73	330000	96.12	196.0	3000	47172

Figure B-8b. FAARFIELD PCR Report – Flexible Example 1 (continued)

No.	Aircraft Name	Gross Weight lbs	Percent Gross Weight	Tire Pressure psi	Annual Departure	20 Years Coverage

Results Table 2. ACR Value

No.	Aircraft Name	Critical aircraft Total equiv. departures	Max allowable Gross Weight of critical aircraft	ACR Thick at max. MGW (in.)	PCR//F/C
1	B747-400	1790	947124	30.06	681.1

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

No.	Aircraft Name	Gross Weight lbs	Percent Gross Weight on Main Gear	Tire Pressure psi	ACR Thick (in.)(C)	ACR//F/C
1	A300-B4/C4 Std Bogie	365747	94.00	216.1	27.2	545.9
2	A319-100 std	141978	92.60	173.0	22	326.1
3	B737-300	140000	90.86	201.0	22.5	345.6
4	B747-400	877000	93.32	200.0	28.6	607.5
6	B767-200 ER	396000	90.82	190.0	26.3	507.9
7	B777-200 ER	657000	91.80	205.0	28.1	585.6
8	DC8-63/73	330000	96.12	196.0	26.7	524.1

B.6.2 Flexible Pavement Example 2.

B.6.2.1 The second example has the same traffic and subgrade CBR as Example 1, but with a reduced cross section that results in a total CDF approximately equal to 1. The structure is as shown in Figure B-9, and the other input data are as shown in Figure B-3. As in Flexible Example 1, the airport has a parallel taxiway configuration (Figure A1-1a) such that the P/TC ratio = 1. After running PCR, the PCR Graph and PCR Report are shown in Figures B-10 and B-11, respectively. For this example, the computed PCR is 617/F/C/X/T and the total CDF = 0.990. Figure B-10 shows that all operating aircraft have ACR < PCR. Hence, no weight restrictions are required on the operating fleet, which is consistent with CDF < 1.0. In general, CDF > 1.0 indicates that at least one aircraft in the fleet will have ACR > PCR.

Figure B-9. Flexible Pavement Structure for Flexible Example 2

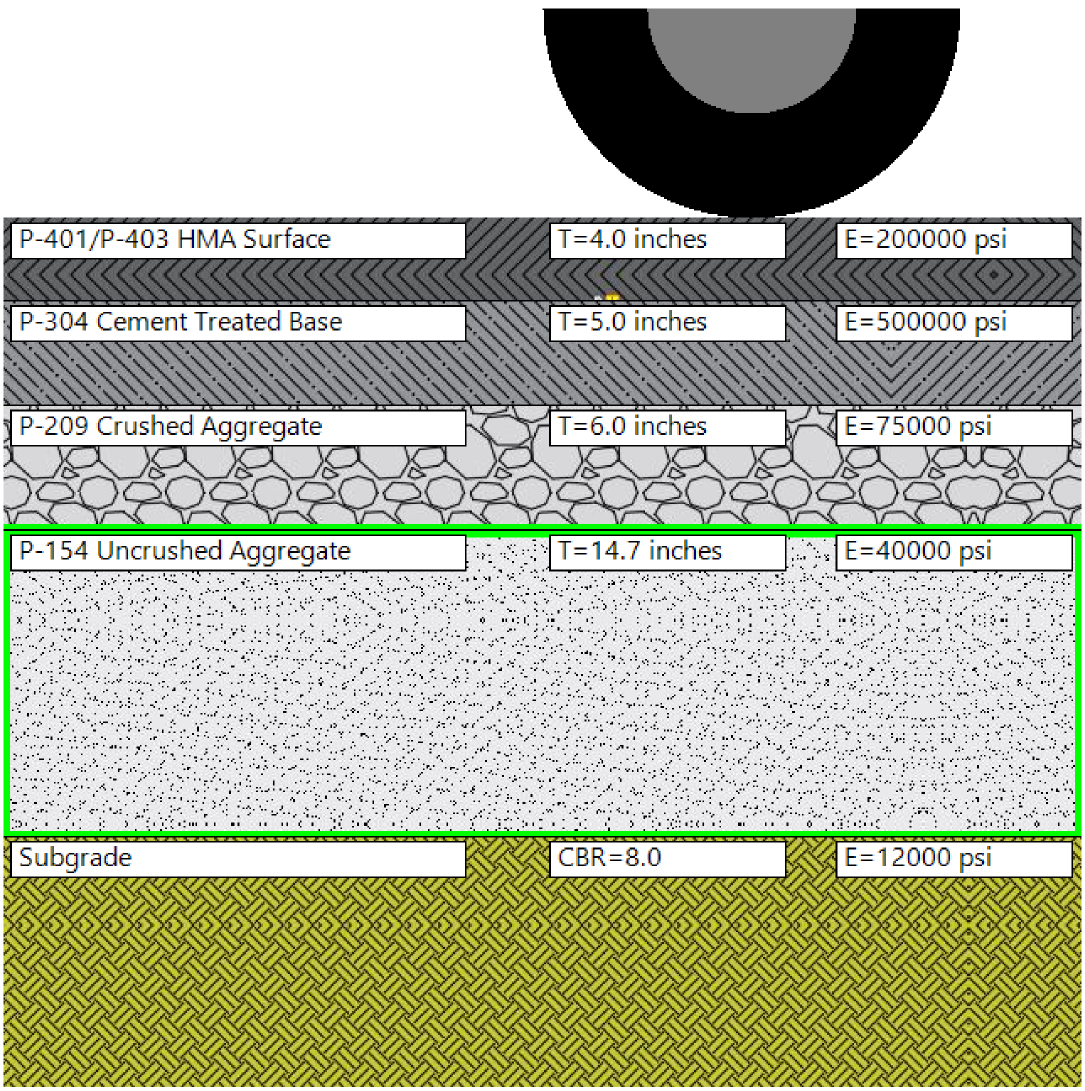


Figure B-10. PCR Graph for Flexible Example 2

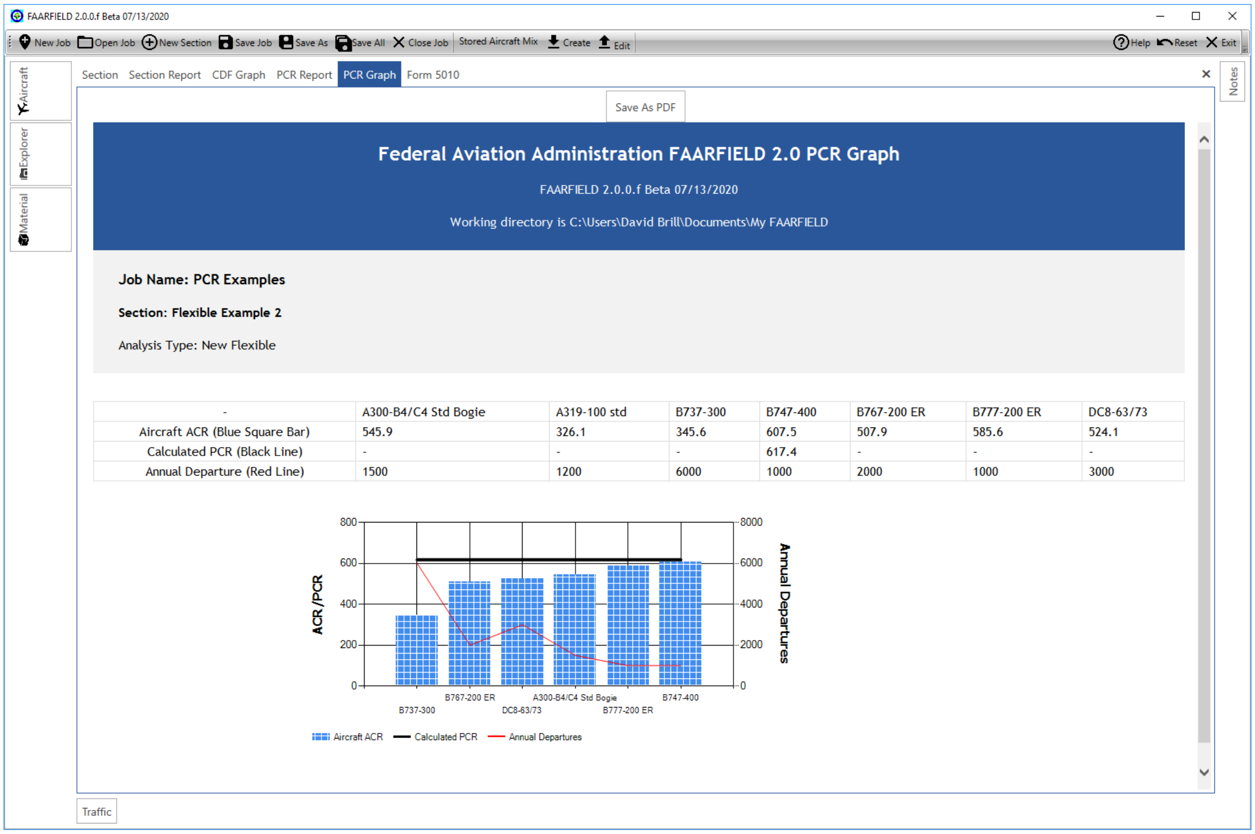


Figure B-11. FAARFIELD PCR Report – Flexible Example 2

Federal Aviation Administration FAARFIELD 2.0 PCR Report

FAARFIELD 2.0.0.f Beta 07/13/2020

Working directory is C:\Users\David Brill\Documents\My FAARFIELD

Job Name: PCR Examples

Section: Flexible Example 2

This file name = PCR Results for Flexible 2020-07-15 12:42:08.txt

Evaluation pavement type is flexible and design program is FAARFIELD.

Section name: Flexible Example 2 in job file: C:\Users\David Brill\Documents\My FAARFIELD\PCR Examples.JOB.xml

Units = US Customary

Analysis Type: New Flexible

Subgrade Modulus =12000psi (Subgrade Category is C(11k))

Evaluation Pavement Thickness = 29.7 in.

Pass to Traffic Cycle (PtoTC) Ratio = 1.00

Maximum number of wheels per gear = 6

CDF = 0.990

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

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight lbs	Percent Gross Weight	Tire Pressure psi	Annual Departure	20 Years Coverage
1	A300-B4/C4 Std Bogie	365747	94.00	216.1	1500	24126
2	A319-100 std	141978	92.60	173.0	1200	19266
3	B737-300	140000	90.86	201.0	6000	90850
4	B747-400	877000	46.66	200.0	1000	16970
5	B747-400 Belly	877000	46.66	200.0	1000	16938
6	B767-200 ER	396000	90.82	190.0	2000	33248
7	B777-200 ER	657000	91.80	205.0	1000	14912
8	DC8-63/73	330000	96.12	196.0	3000	46328

Figure B-11. FAARFIELD PCR Report – Flexible Example 2 (continued)

No.	Aircraft Name	Gross Weight lbs	Percent Gross Weight	Tire Pressure psi	Annual Departure	20 Years Coverage

Results Table 2. ACR Value

No.	Aircraft Name	Critical aircraft Total equiv. departures	Max allowable Gross Weight of critical aircraft	ACR Thick at max. MGW (in.)	PCR//F/C
1	B747-400	1875	886680	28.76	617.4

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

No.	Aircraft Name	Gross Weight lbs	Percent Gross Weight on Main Gear	Tire Pressure psi	ACR Thick (in.)(C)	ACR//F/C
1	A300-B4/C4 Std Bogie	365747	94.00	216.1	27.2	545.9
2	A319-100 std	141978	92.60	173.0	22	326.1
3	B737-300	140000	90.86	201.0	22.5	345.6
4	B747-400	877000	93.32	200.0	28.6	607.5
6	B767-200 ER	396000	90.82	190.0	26.3	507.9
7	B777-200 ER	657000	91.80	205.0	28.1	585.6
8	DC8-63/73	330000	96.12	196.0	26.7	524.1

B.6.2.2 Assuming that the airport has a central taxiway configuration rather than parallel effectively doubles the number of coverages on the runway and reduces the PCR. In Figure B-12, the only change is that the P/TC ratio has been increased from 1 to 2, reflecting the central taxiway configuration in Fig. A1-1b. With this change, the computed PCR is now 589/F/C/X/T, and the total CDF is 1.52. Because the total CDF > 1.0, we expect that at least one of the listed aircraft has ACR > PCR. Figure B-13 shows that this is in fact the case, that the ACR of the B747-400 exceeds the PCR by approximately 3%. Following ICAO guidance that allows occasional overload operations by aircraft with ACR up to 10% above the reported PCR, operations of the B747-400 would still be allowed on this pavement, but the number of such operations at full weight would be limited to 5% of total operations on the taxiway. In addition, the taxiway pavement should be monitored for damage after each overload operation.

Figure B-12. FAARFIELD PCR Output – Flexible Example 2 (with P/TC = 2)

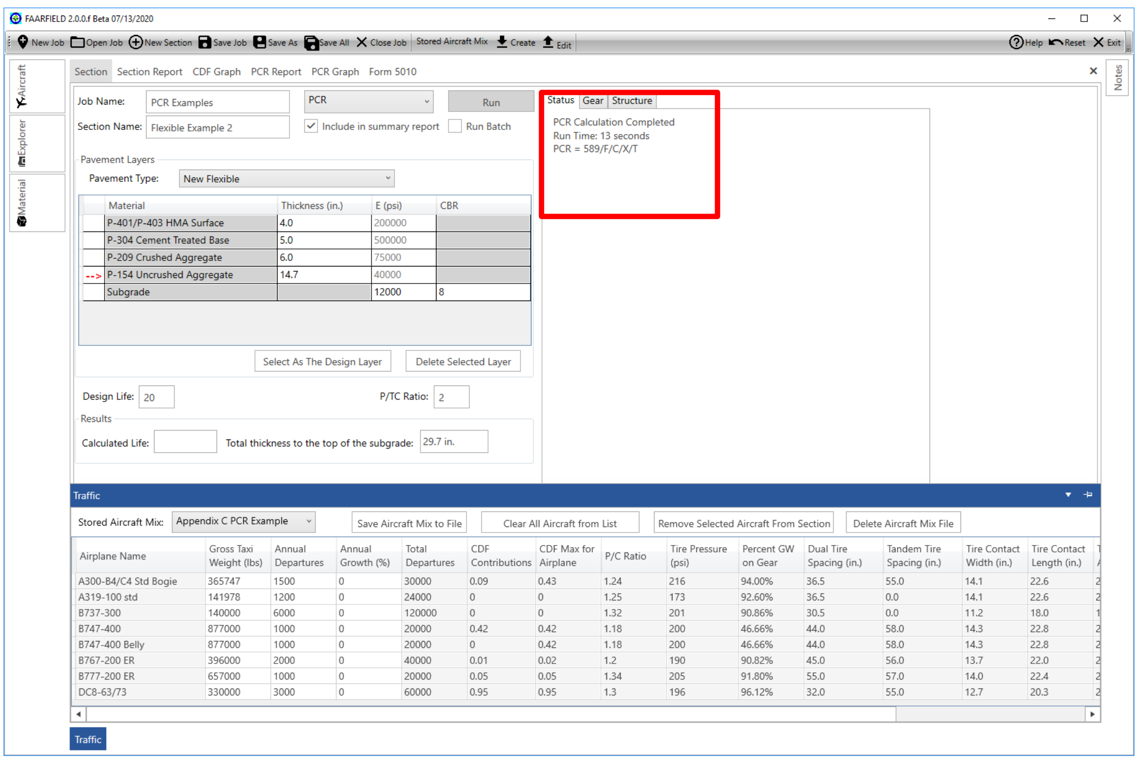
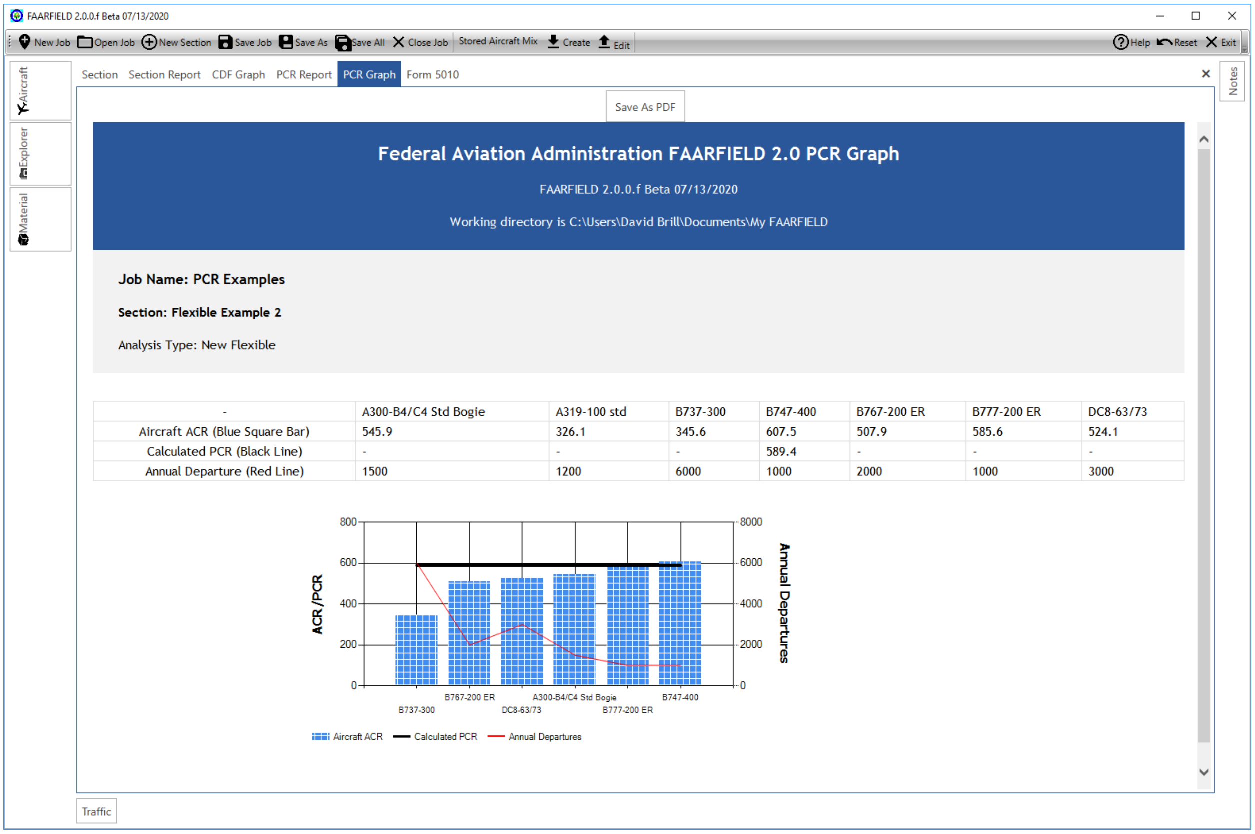


Figure B-13. FAARFIELD PCR Graph – Flexible Example 2 (with P/TC = 2)



B.6.3 Flexible Pavement Example 3.

B.6.3.1 An airport runway is located in a region subject to seasonal frost. To satisfy design requirements for frost protection, the frost-susceptible subgrade material has been removed and replaced to a depth below the frost line with additional P-154 subbase material, beyond what would be required by FAARFIELD for structural support. The as-built structure is: 4-inch asphalt surface layer (Item P-401), 5 inches asphalt stabilized base (Item P-403), 8 inch standard base layer (Item P-209) and 60 inches standard subbase layer (Item P-154), on CBR 4 subgrade. The traffic mix is the same as in the Using Aircraft example (Table B-1). It is assumed for the purposes of this example that the traffic level is constant over the 20-year time period. Additional fuel is generally obtained at the airport before departure, and the runway has a parallel taxiway (P/TC ratio = 1). The pavement was designed for a life of 20 years.

B.6.3.2 Enter the data in FAARFIELD. After opening FAARFIELD, select “PCR” from the drop-down function list at the top of the screen. Select the New Flexible pavement list from the drop-down Pavement Type list. Enter or modify the structure layers directly in the Pavement Layers table, or by clicking on the image of the pavement cross section. Using the aircraft library, enter the aircraft list from Table B-1 and modify the gross weights and annual departures as necessary. The default value of P/TC is 1 and does not need to be changed. Figure B-14 shows the FAARFIELD user screen with all data entered for this example.

B.6.3.3 Click “Run.” FAARFIED will perform the PCR computations automatically. When the calculation is complete, the computed PCR value will appear in the “Status” screen at upper right (Figure B-15). For this example, FAARFIELD computes PCR 1568/F/D/X/T. As shown in the PCR report (Fig. B-16), reported CDF = 0.000, which indicates that the structure is very strong relative to the requirements of the using traffic, and the actual computed CDF is negligible.

B.6.3.4 As there is no upper limit on the ACR-PCR scale, it would be acceptable to publish PCR 1568/F/D, which would have the effect of allowing unrestricted operations of all aircraft. However, such a number has no practical meaning, because no existing or planned aircraft yield ACR numbers in that range. A more conservative alternative would be to arbitrarily select a value 25% larger than the largest ACR of all using aircraft in the list and publish that value as the PCR. In this example, the largest ACR is for the B777-200ER (878/F/D), so publish PCR = 1098/F/D/X/T.

Figure B-14. Screen Shot of FAARFIELD in PCR Mode with Data for Flexible Example 3

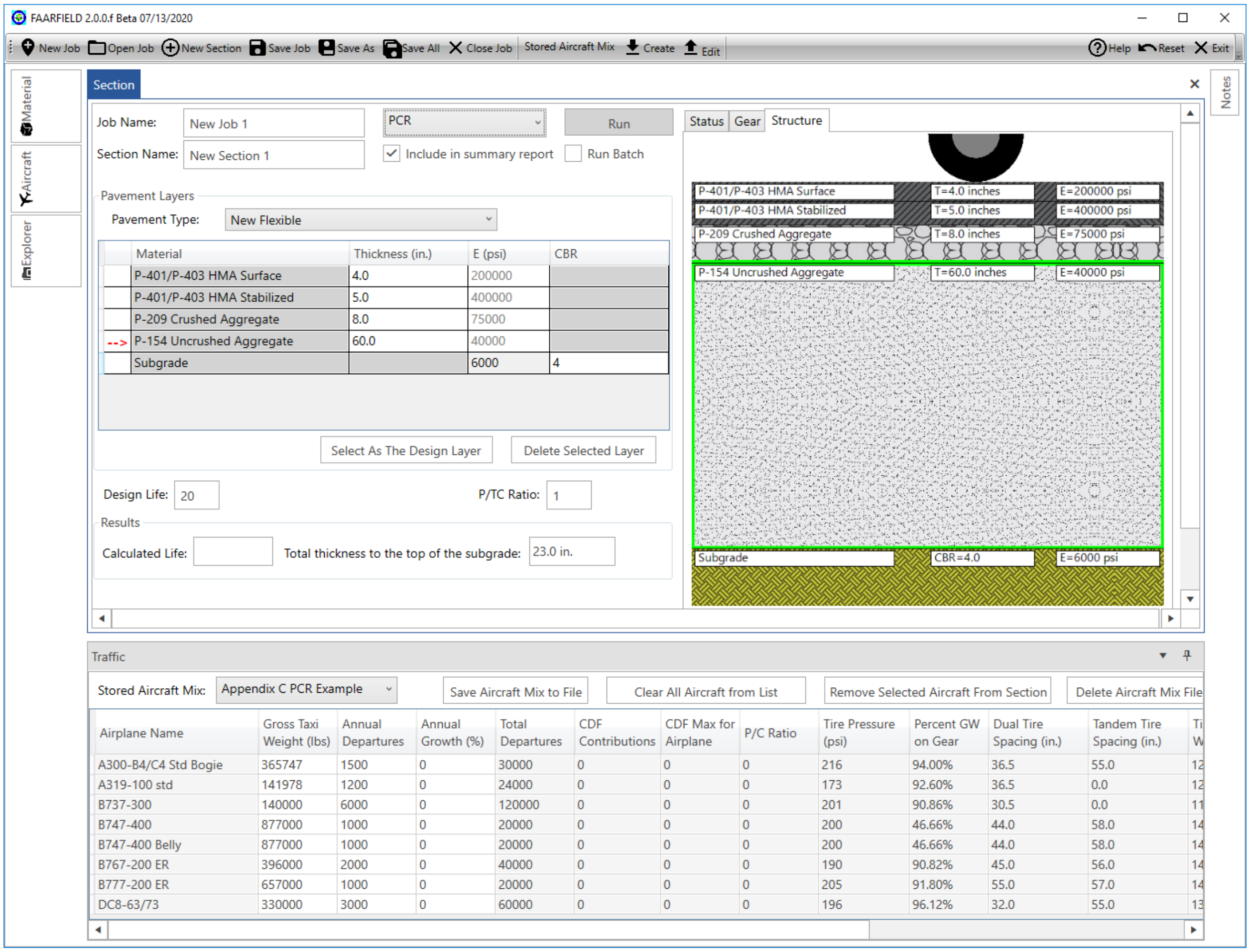


Figure B-15. FAARFIELD PCR Output – Flexible Example 3

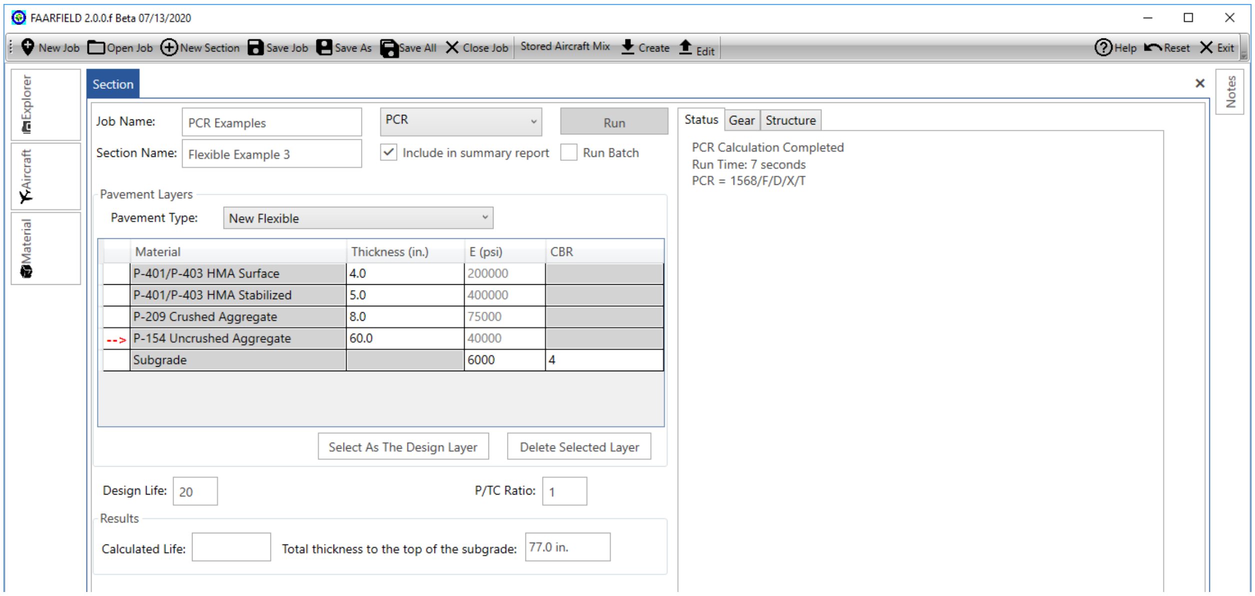


Figure B-16. FAARFIELD PCR Report – Flexible Example 3

Federal Aviation Administration FAARFIELD 2.0 PCR Report

FAARFIELD 2.0.0.f Beta 07/13/2020

Working directory is C:\Users\David Brill\Documents\My FAARFIELD

Job Name: PCR Examples

Section: Flexible Example 3

This file name = PCR Results for Flexible 2020-07-15 17:29:57.txt

Evaluation pavement type is flexible and design program is FAARFIELD.

Section name: Flexible Example 3 in job file: C:\Users\David Brill\Documents\My FAARFIELD\PCR Examples.JOB.xml

Units = US Customary

Analysis Type: New Flexible

Subgrade Modulus =6000psi (Subgrade Category is D(7k))

Evaluation Pavement Thickness = 77.0 in.

Pass to Traffic Cycle (PtoTC) Ratio = 1.00

Maximum number of wheels per gear = 6

CDF = 0.000

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

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight lbs	Percent Gross Weight	Tire Pressure psi	Annual Departure	20 Years Coverage
1	A300-B4/C4 Std Bogie	365747	94.00	216.1	1500	28846
2	A319-100 std	141978	92.60	173.0	1200	23068
3	B737-300	140000	90.86	201.0	6000	113729
4	B747-400	877000	46.66	200.0	1000	19454
5	B747-400 Belly	877000	46.66	200.0	1000	19531
6	B767-200 ER	396000	90.82	190.0	2000	38939
7	B777-200 ER	657000	91.80	205.0	1000	19651
8	DC8-63/73	330000	96.12	196.0	3000	57089

Figure B-16. FAARFIELD PCR Report – Flexible Example 3 (continued)

No.	Aircraft Name	Gross Weight lbs	Percent Gross Weight	Tire Pressure psi	Annual Departure	20 Years Coverage

Results Table 2. ACR Value

No.	Aircraft Name	Critical aircraft Total equiv. departures	Max allowable Gross Weight of critical aircraft	ACR Thick at max. MGW (in.)	PCR//F/D
1	B777-200 ER	1000	879098	48.96	1567.9

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

No.	Aircraft Name	Gross Weight lbs	Percent Gross Weight on Main Gear	Tire Pressure psi	ACR Thick (in.)(D)	ACR//F/D
1	A300-B4/C4 Std Bogie	365747	94.00	216.1	35.7	738.3
2	A319-100 std	141978	92.60	173.0	27	364.8
3	B737-300	140000	90.86	201.0	27.7	388.7
4	B747-400	877000	93.32	200.0	37.6	832.4
6	B767-200 ER	396000	90.82	190.0	34.3	664
7	B777-200 ER	657000	91.80	205.0	38.4	878.1
8	DC8-63/73	330000	96.12	196.0	35.1	709.9

B.7 **Technical Evaluation for Rigid Pavements.**

The following list summarizes the steps for using the technical evaluation method for rigid pavements:

1. Determine the type of aircraft and number of annual departures of each aircraft type that the pavement will experience over its life.
2. Determine the subgrade elastic modulus. The modulus may be determined from test data or converted from the CBR value using E = 1,500 × CBR (for E in psi).
3. Determine the concrete thickness and flexural strength. The flexural strength is an estimate of the concrete strength that would be obtained from a four-point beam break test following ASTM C 78. If current beam break test data are unavailable, the engineer should estimate the in-situ flexural strength from design records, correlations of flexural strength to split cylinder tensile strength, or correlations of flexural strength to in-situ concrete modulus E (e.g., from HWD tests).
4. Determine the other pavement layer characteristics. In FAARFIELD, each layer above the subgrade and below the concrete is characterized by its thickness and elastic modulus E. For materials meeting an FAA specification, FAARFIELD will assign the E-value automatically, or allow the user to select it from an allowable range.
5. Determine the P/TC ratio for the pavement using the criteria in Appendix A.
6. Enter all information in FAARFIELD and run the PCR evaluation.

B.8 **Technical Evaluation Examples for Rigid Pavements.**

The following three examples demonstrate the technical evaluation method of determining a PCR for flexible pavements.

1. Example 1 is under designed relative to the using traffic volume (Total CDF > 1). The computed PCR requires operating weight restrictions on the using traffic.
2. Example 2 has a thickness approximately equal to the structural requirement for the 20-year traffic (Total CDF ≈ 1).
3. Example 3 demonstrates how to report PCR when an existing pavement has a thin asphalt overlay, but is structurally a rigid pavement.

B.8.1 Rigid Pavement Example 1.

B.8.1.1 An airport has a rigid (concrete-surfaced) runway pavement. The in-situ flexural strength is 650 psi. The structure is: 16 inches concrete surface layer (Item P-501), 8 inches asphalt stabilized base (Item P-403), and 6 inches standard base layer (Item P-209) placed directly on a prepared subgrade. From HWD tests on the runway, the subgrade modulus is estimated at E = 7,800 psi. The traffic mix is the same as in the Using Aircraft example (Table B-1). It is assumed for the purposes of this example that the traffic level is constant over the 20-year time period. Additional fuel is generally obtained at the airport before departure, and the runway has a parallel taxiway (P/TC ratio = 1). The pavement was designed for a life of 20 years.

B.8.1.2 Enter the data in FAARFIELD. After opening FAARFIELD, select "PCR" from the drop-down function list at the top of the screen. Select the New Rigid pavement type from the drop-down Pavement Type list. Enter or modify the structure layers directly in the Pavement Layers table, or by clicking on the image of the pavement cross section. Using the aircraft library, enter the aircraft list from Table B-1, and modify the gross weights and annual departures as necessary. The default value of P/TC is 1 and does not need to be changed. Figure B-17 shows the FAARFIELD user screen with all data entered for this example.

B.8.1.3 Click "Run." FAARFIELD will perform the PCR computations automatically. When the calculation is complete, the computed PCR value will appear in the "Status" screen at upper right (Figure B-18). For this example, the computed PCR is 917/R/D/W/T. Note that FAARFIELD automatically identifies the correct subgrade category based on the entered subgrade properties. FAARFIELD selects 'W' as the default tire pressure category for rigid pavements, because it is assumed that concrete surfaces will tolerate high tire pressures.

B.8.1.4 The Traffic table provides additional information about the PCR calculation (Figure B-19). Columns "CDF Contributions" and "CDF Max for Airplane" show the CDF contribution of each aircraft in the mix at the critical offset for the traffic mix, and for the individual aircraft, respectively. The total CDF for this example is 4.84. Total CDF for this example is greater than 1.0, indicating that the rigid pavement has insufficient structural capacity for the using traffic. Note that the CDF values may differ from the values computed for the same traffic mix in Design mode. This is due to the different gear characteristics (percent of gross weight on the main gear and tire pressure) used for PCR calculations and design calculations.

B.8.1.5 Scrolling to the right of the FAARFIELD traffic table shows the computed ACR values of the Using Aircraft at their operating weights (Figure B-20). ACR thicknesses and rigid ACR values are displayed for each aircraft for the subgrade category of the pavement being evaluated. In this example, the computed ACR for the B777-200 ER (ACR 1040/R/D) exceeds the computed PCR. If the airport publishes the computed PCR, then operating weight restrictions on the B777-200 ER will be necessary. Possible alternatives to restricting the operating weight are (a) providing an overlay to increase the structural capacity of the runway; or (b) allowing occasional overload operations of the B777-200 ER on the runway, subject to the limitation that the number of such overload operations does not exceed 5 percent of total operations. The latter option is possible because the ACR of the B777-200ER at it maximum operating weight does not exceed the PCR by more than 10 percent.

B.8.1.6 From the explorer bar, select “PCR Graph.” FAARFIELD displays a bar graph showing visually the ACR values of the six most demanding aircraft in the list (Fig. B-21). The horizontal black bar represents the calculated PCR value. This graph shows that ACR values are less than the PCR, except for the aforementioned B777-200 ER. The PCR value appears in the table in the column associated with the critical aircraft. In this example, the critical aircraft for PCR calculations is also the B747-400.

B.8.1.7 From the explorer bar, select “PCR Report.” FAARFIELD displays details of the PCR computation, in the form of three tables:

1. Results Table 1 reports input traffic data for all Using Aircraft. Percent gross weight on the main gear and tire pressure values are those applicable to ACR calculations, and may differ from the values used for design.
2. Results Table 2 gives information on the critical aircraft: critical aircraft equivalent annual departures (which should be equal to or greater than the actual annual departures for that aircraft in Results Table 1); the computed MAGW of the critical aircraft (which will be greater than the operating gross weight if ACR < PCR); the ACR thickness for the critical aircraft at the MAGW, and the PCR, which is defined as the ACR of the critical aircraft at the MAGW.
3. Results Table 3 lists calculated ACR information for the Using Aircraft. If the CDF is greater than 1.0, at least one of the listed aircraft will have ACR > PCR.

B.8.1.8 Clicking “Save as PDF” at the top of the screen saves a copy of the generated report (Figure B-22).

Figure B-17. Screen Shot of FAARFIELD in PCR Mode with Data for Rigid Example 1

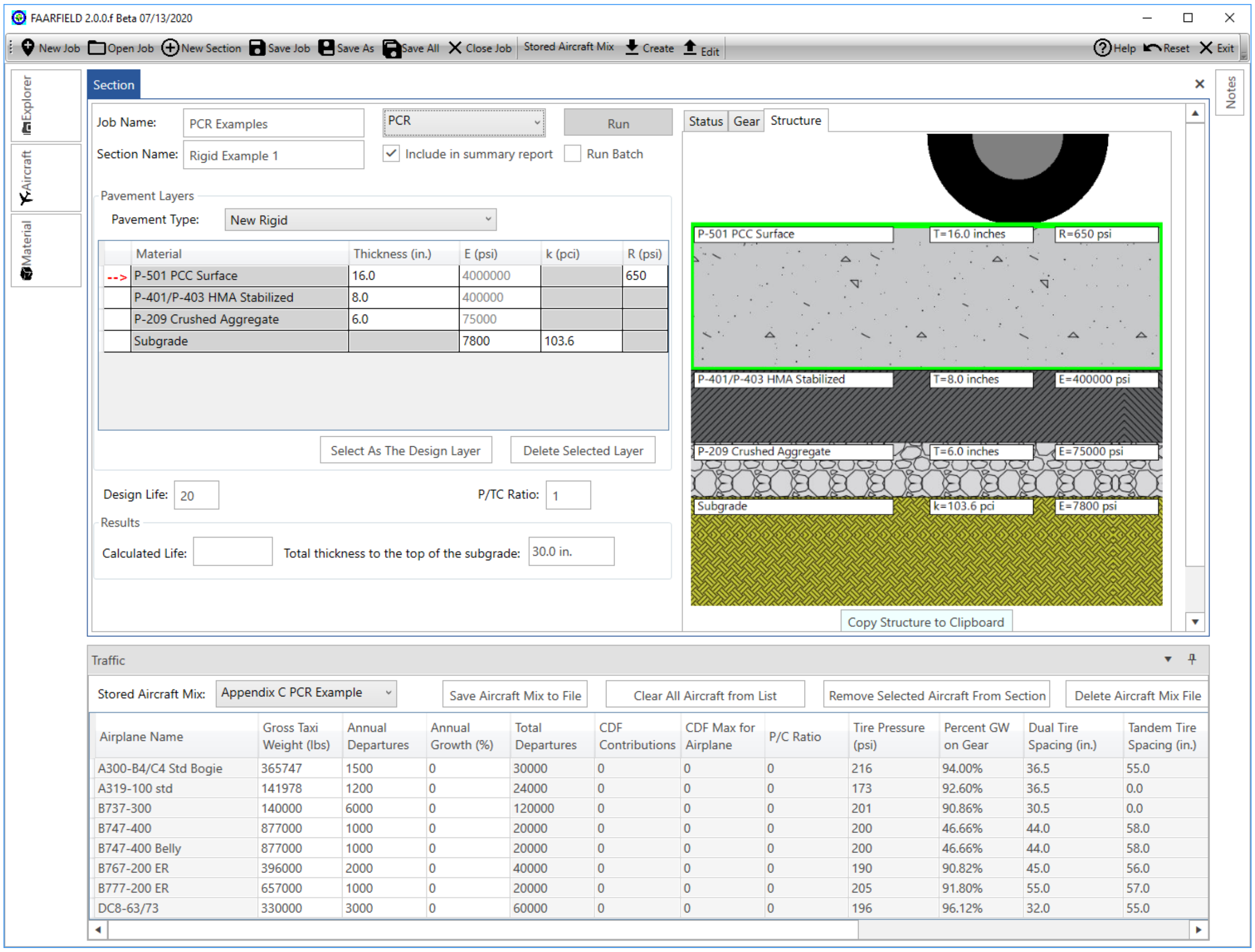


Figure B-18. FAARFIELD PCR Output – Rigid Example 1

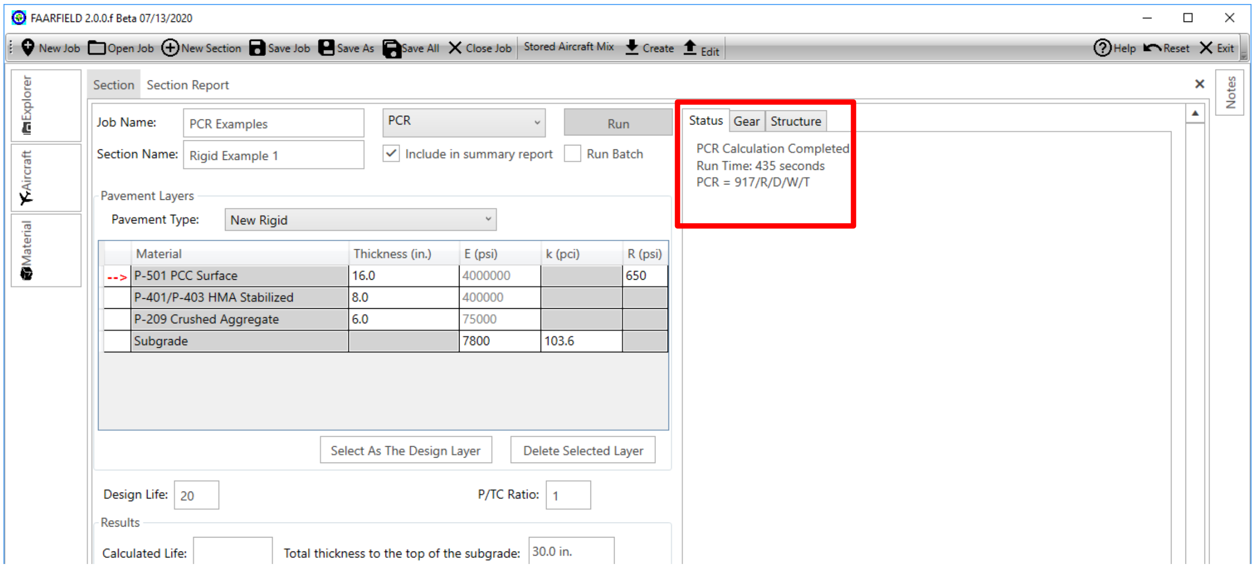


Figure B-19. FAARFIELD Traffic Table – Rigid Example 1

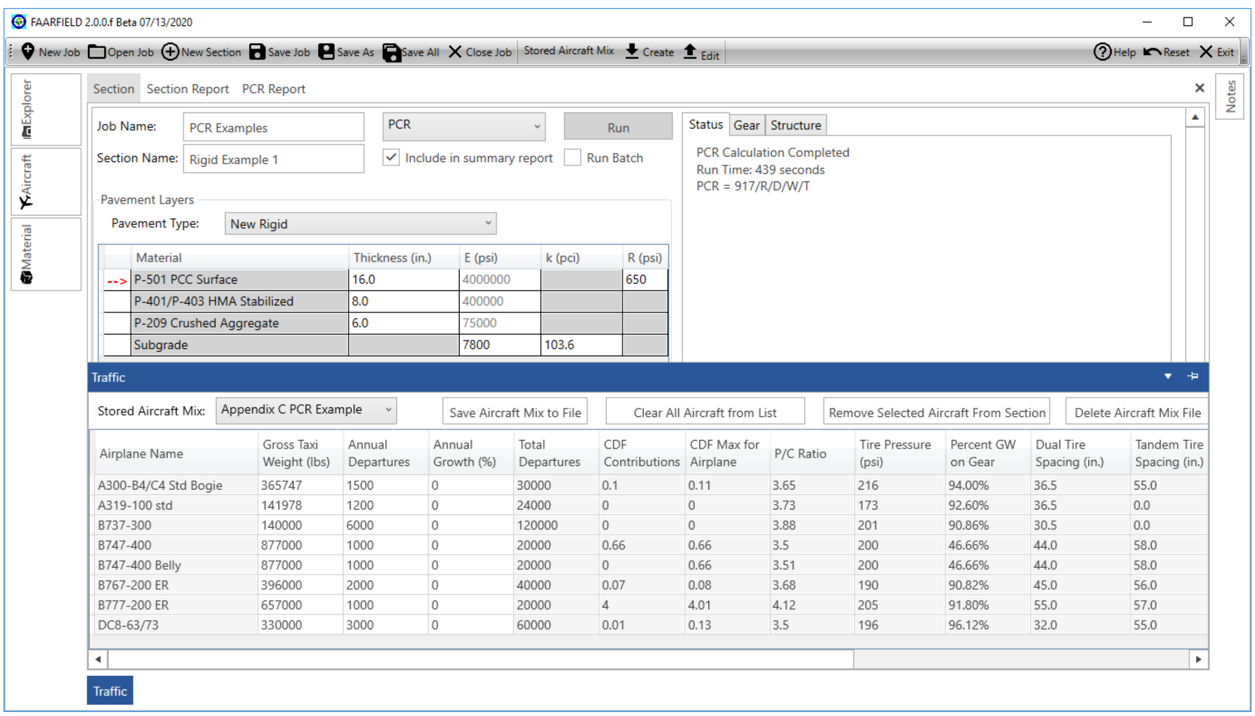
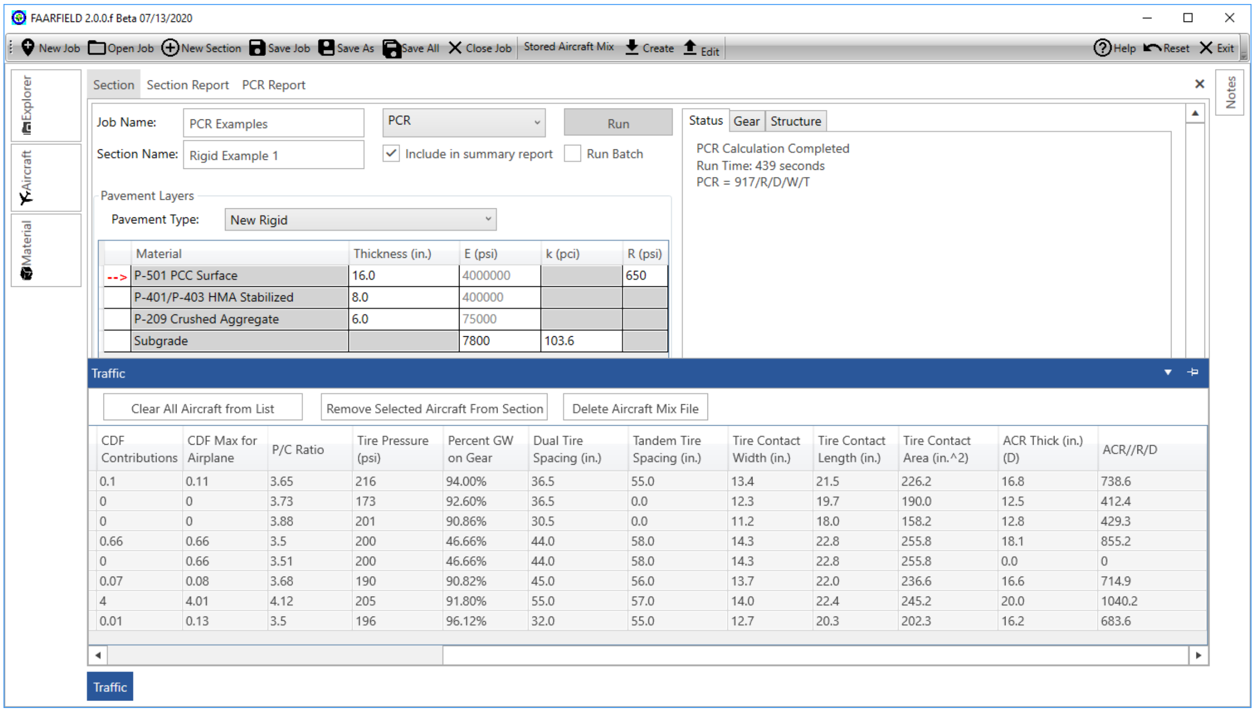


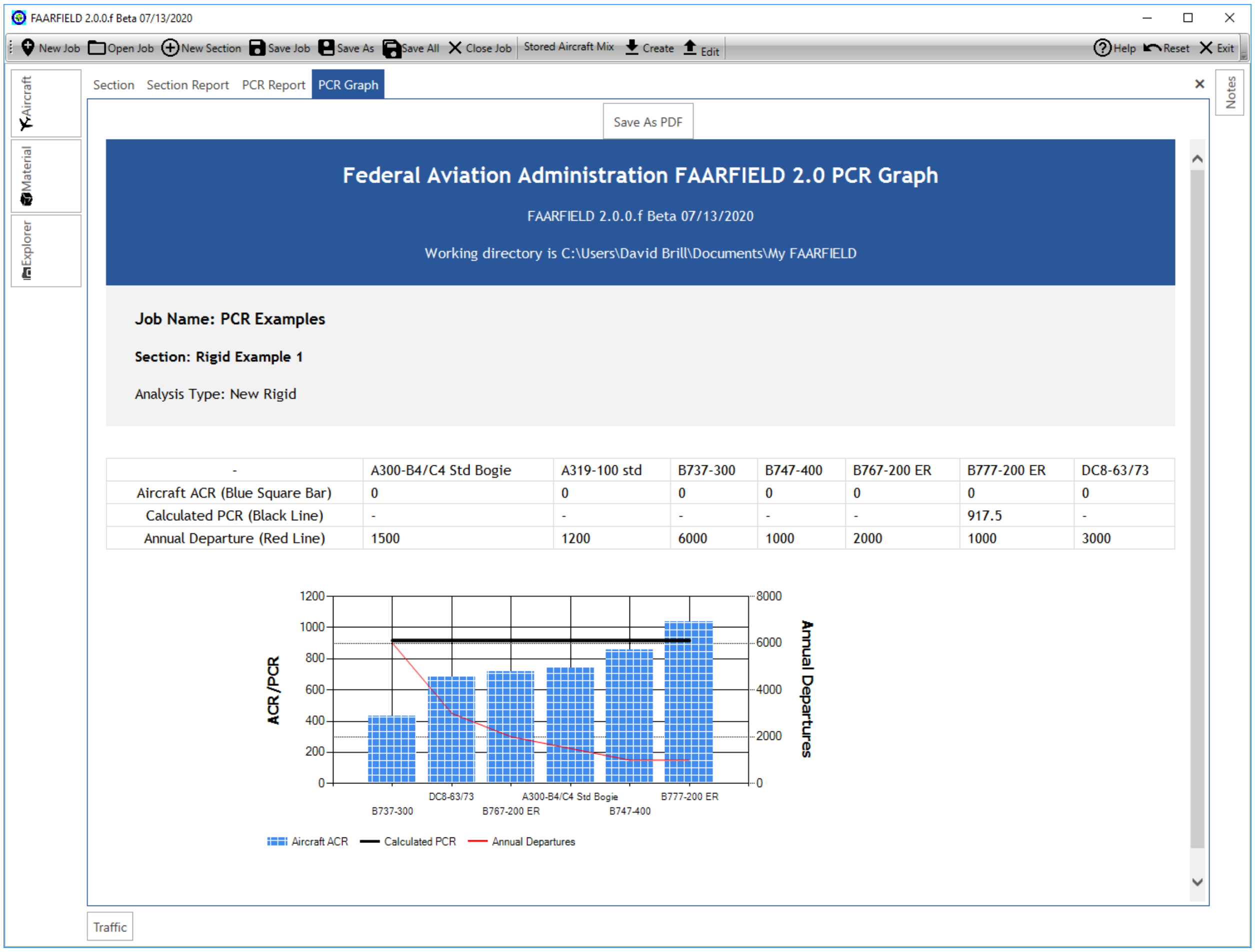
Figure B-20. FAARFIELD Traffic Table – Rigid Example 1 (ACR Values)



Material	Thickness (in.)	E (psi)	k (pci)	R (psi)
P-501 PCC Surface	16.0	4000000		650
P-401/P-403 HMA Stabilized	8.0	400000		
P-209 Crushed Aggregate	6.0	75000		
Subgrade		7800	103.6	

CDF Contributions	CDF Max for Airplane	P/C Ratio	Tire Pressure (psi)	Percent GW on Gear	Dual Tire Spacing (in.)	Tandem Tire Spacing (in.)	Tire Contact Width (in.)	Tire Contact Length (in.)	Tire Contact Area (in.^2)	ACR Thick (in.) (D)	ACR//R/D
0.1	0.11	3.65	216	94.00%	36.5	55.0	13.4	21.5	226.2	16.8	738.6
0	0	3.73	173	92.60%	36.5	0.0	12.3	19.7	190.0	12.5	412.4
0	0	3.88	201	90.86%	30.5	0.0	11.2	18.0	158.2	12.8	429.3
0.66	0.66	3.5	200	46.66%	44.0	58.0	14.3	22.8	255.8	18.1	855.2
0	0.66	3.51	200	46.66%	44.0	58.0	14.3	22.8	255.8	0.0	0
0.07	0.08	3.68	190	90.82%	45.0	56.0	13.7	22.0	236.6	16.6	714.9
4	4.01	4.12	205	91.80%	55.0	57.0	14.0	22.4	245.2	20.0	1040.2
0.01	0.13	3.5	196	96.12%	32.0	55.0	12.7	20.3	202.3	16.2	683.6

Figure B-21. FAARFIELD PCR Graph – Rigid Example 1



-	A300-B4/C4 Std Bogie	A319-100 std	B737-300	B747-400	B767-200 ER	B777-200 ER	DC8-63/73
Aircraft ACR (Blue Square Bar)	0	0	0	0	0	0	0
Calculated PCR (Black Line)	-	-	-	-	-	917.5	-
Annual Departure (Red Line)	1500	1200	6000	1000	2000	1000	3000

Figure B-22a. FAARFIELD PCR Report – Rigid Example 1

Federal Aviation Administration FAARFIELD 2.0 PCR Report

FAARFIELD 2.0.0.f Beta 07/13/2020

Working directory is C:\Users\David Brill\Documents\My FAARFIELD

Job Name: PCR Examples

Section: Rigid Example 1

This file name = PCR Results Rigid 2020-07-16 17:52:37.txt

Evaluation pavement type is rigid and design program is FAARFIELD.

Section name: Rigid Example 1 in job file: C:\Users\David Brill\Documents\My FAARFIELD\PCR Examples.JOB.xml

Units = US Customary

Analysis Type: New Rigid

Subgrade Modulus =7800psi (Subgrade Category is D(7k))

Evaluation Pavement Thickness = 30.0 in.

Pass to Traffic Cycle (PtoTC) Ratio = 1.00

Maximum number of wheels per gear = 6

CDF = 4.840

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight lbs	Percent Gross Weight	Tire Pressure psi	Annual Departure	20 Years Coverage
1	A300-B4/C4 Std Bogie	365747	94.00	216.1	1500	8225
2	A319-100 std	141978	92.60	173.0	1200	6435
3	B737-300	140000	90.86	201.0	6000	30892
4	B747-400	877000	46.66	200.0	1000	5717
5	B747-400 Belly	877000	46.66	200.0	1000	5705
6	B767-200 ER	396000	90.82	190.0	2000	10883
7	B777-200 ER	657000	91.80	205.0	1000	4853
8	DC8-63/73	330000	96.12	196.0	3000	17124

Figure B-22b. FAARFIELD PCR Report – Rigid Example 1 (continued)

Results Table 2. ACR Value

No.	Aircraft Name	Critical aircraft Total equiv. departures	Max allowable Gross Weight of critical aircraft	ACR Thick at max. MGW (in.)	PCR//R/D
1	B777-200 ER	1202	606255	18.77	917.5

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

No.	Aircraft Name	Gross Weight lbs	Percent Gross Weight on Main Gear	Tire Pressure psi	ACR Thick (in.)(D)	ACR//R/D
1	A300-B4/C4 Std Bogie	365747	94.00	216.1	16.8	738.6
2	A319-100 std	141978	92.60	173.0	12.5	412.4
3	B737-300	140000	90.86	201.0	12.8	429.3
4	B747-400	877000	93.32	200.0	18.1	855.2
6	B767-200 ER	396000	90.82	190.0	16.6	714.9
7	B777-200 ER	657000	91.80	205.0	20	1040.2
8	DC8-63/73	330000	96.12	196.0	16.2	683.6

B.8.2 Rigid Pavement Example 2.

B.8.2.1 The second example has the same traffic and rigid pavement structure as Example 1, but the estimated concrete strength is increased to 720 psi. The structure is as shown in Figure B-23, and the other input data are as shown in Figure B-17. As in Rigid Example 1, the airport has a parallel taxiway configuration (Figure A1-1a) such that the P/TC ratio = 1. After running PCR, the PCR Graph and PCR Report are shown in Figures B-24 and B-25, respectively. For this example, the computed PCR is 1089/R/D/W/T and the total CDF = 0.540. Following the practice of reporting PCR to the nearest even multiple of ten, publish PCR 1090/R/D/W/T. Figure B-10 shows that all operating aircraft have ACR < PCR. Hence, no weight restrictions are required on the operating fleet, which is consistent with CDF < 1.0. (In general, CDF > 1.0 indicates that at one aircraft in the fleet will have ACR > PCR.)

Figure B-23. Rigid Pavement Structure for Rigid Example 2

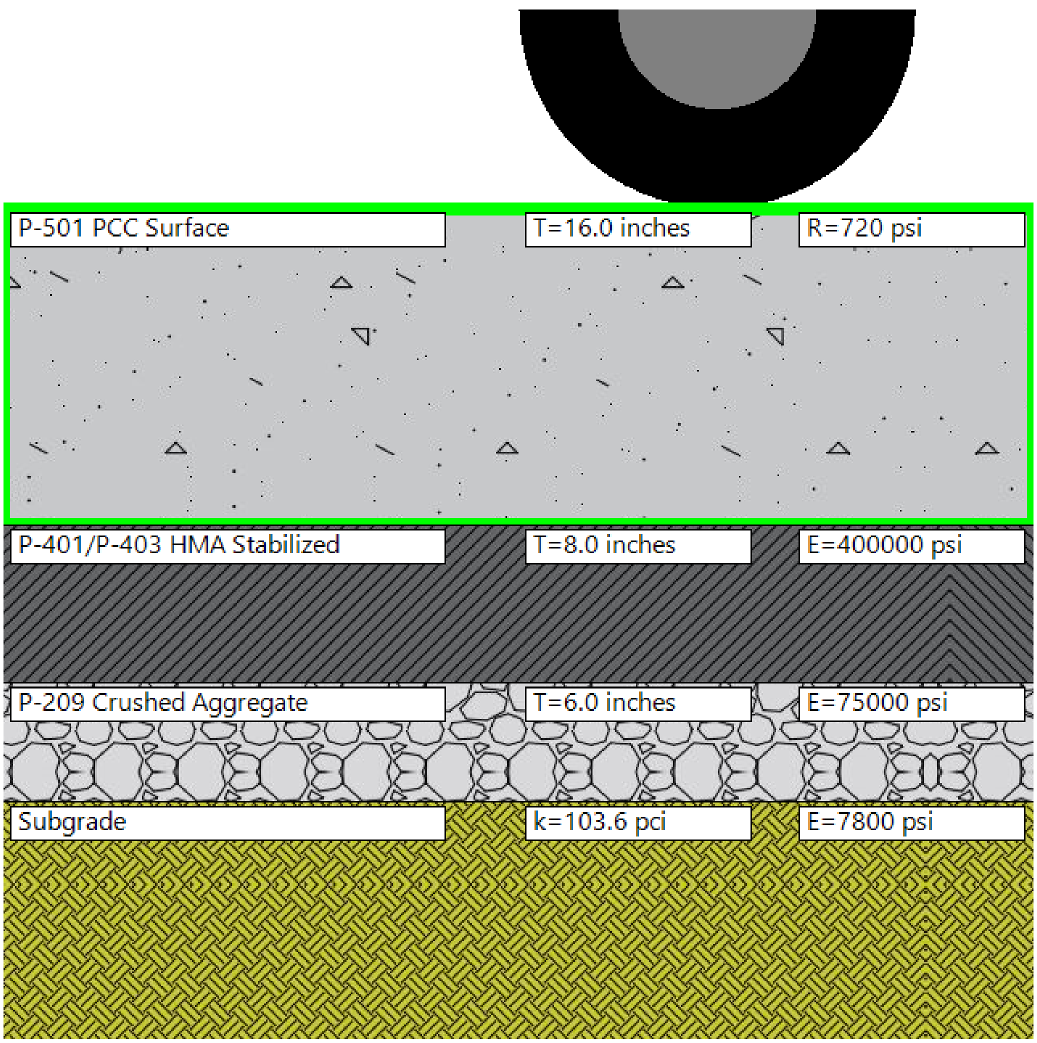
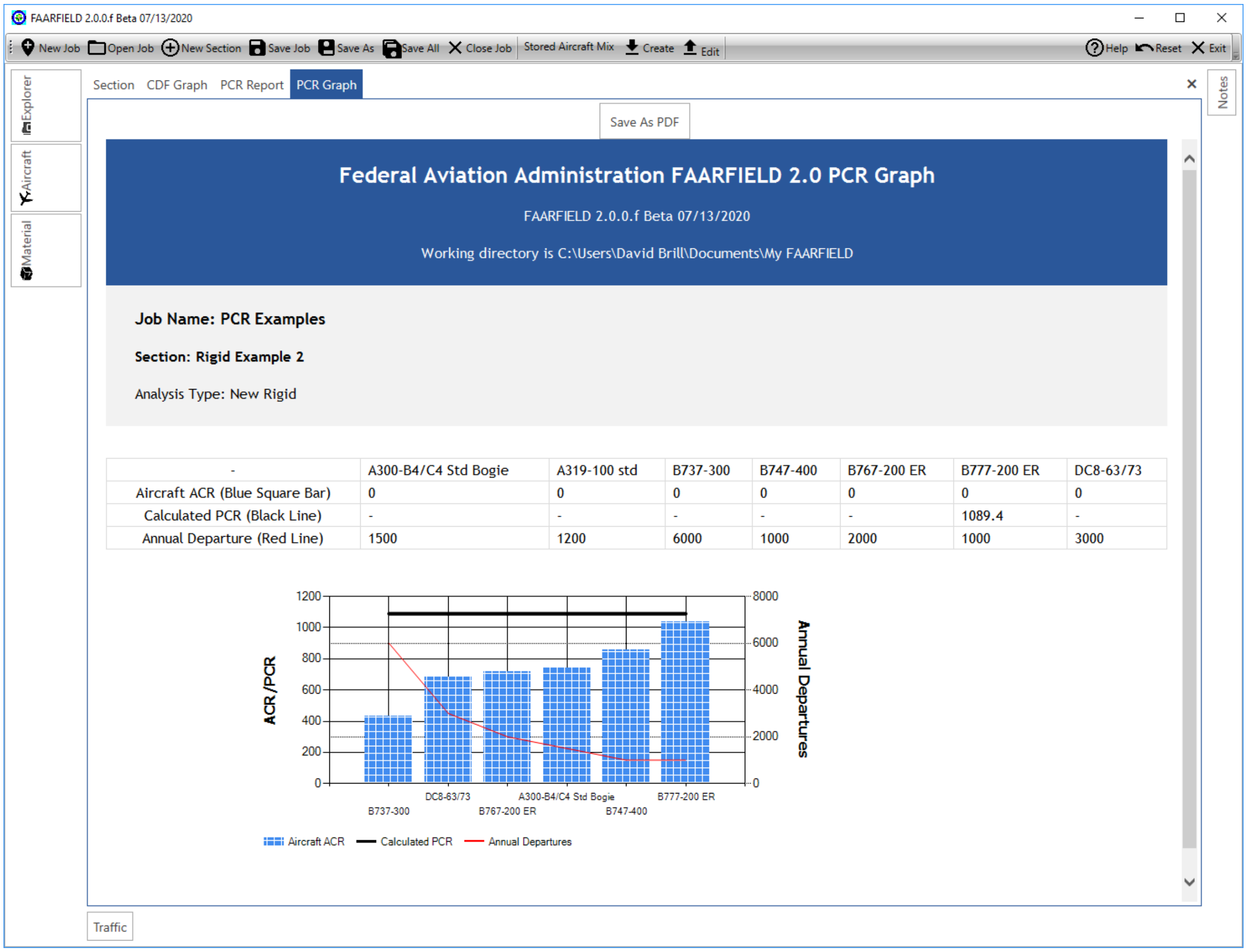


Figure B-24. FAARFIELD PCR Graph – Rigid Example 2



-	A300-B4/C4 Std Bogie	A319-100 std	B737-300	B747-400	B767-200 ER	B777-200 ER	DC8-63/73
Aircraft ACR (Blue Square Bar)	0	0	0	0	0	0	0
Calculated PCR (Black Line)	-	-	-	-	-	1089.4	-
Annual Departure (Red Line)	1500	1200	6000	1000	2000	1000	3000

Figure B-25. FAARFIELD PCR Report – Rigid Example 2

Federal Aviation Administration FAARFIELD 2.0 PCR Report

FAARFIELD 2.0.0.f Beta 07/13/2020

Working directory is C:\Users\David Brill\Documents\My FAARFIELD

Job Name: PCR Examples

Section: Rigid Example 2

This file name = PCR Results Rigid 2020-07-17 13:24:42.txt

Evaluation pavement type is rigid and design program is FAARFIELD.

Section name: Rigid Example 2 in job file: C:\Users\David Brill\Documents\My FAARFIELD\PCR Examples.JOB.xml

Units = US Customary

Analysis Type: New Rigid

Subgrade Modulus =7800psi (Subgrade Category is D(7k))

Evaluation Pavement Thickness = 30.0 in.

Pass to Traffic Cycle (PtoTC) Ratio = 1.00

Maximum number of wheels per gear = 6

CDF = 0.540

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight lbs	Percent Gross Weight	Tire Pressure psi	Annual Departure	20 Years Coverage
1	A300-B4/C4 Std Bogie	365747	94.00	216.1	1500	8225
2	A319-100 std	141978	92.60	173.0	1200	6435
3	B737-300	140000	90.86	201.0	6000	30892
4	B747-400	877000	46.66	200.0	1000	5717
5	B747-400 Belly	877000	46.66	200.0	1000	5705
6	B767-200 ER	396000	90.82	190.0	2000	10883
7	B777-200 ER	657000	91.80	205.0	1000	4853
8	DC8-63/73	330000	96.12	196.0	3000	17124

Figure B-25. FAARFIELD PCR Report – Rigid Example 2 (continued)

Results Table 2. ACR Value

No.	Aircraft Name	Critical aircraft Total equiv. departures	Max allowable Gross Weight of critical aircraft	ACR Thick at max. MGW (in.)	PCR//R/D
1	B777-200 ER	1157	676972	20.46	1089.4

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

No.	Aircraft Name	Gross Weight lbs	Percent Gross Weight on Main Gear	Tire Pressure psi	ACR Thick (in.)(D)	ACR//R/D
1	A300-B4/C4 Std Bogie	365747	94.00	216.1	16.8	738.6
2	A319-100 std	141978	92.60	173.0	12.5	412.4
3	B737-300	140000	90.86	201.0	12.8	429.3
4	B747-400	877000	93.32	200.0	18.1	855.2
6	B767-200 ER	396000	90.82	190.0	16.6	714.9
7	B777-200 ER	657000	91.80	205.0	20	1040.2
8	DC8-63/73	330000	96.12	196.0	16.2	683.6

B.8.2.2 Assuming that the airport has a central taxiway configuration rather than parallel effectively doubles the number of coverages on the runway and reduces the PCR. In Figure B-26, the only change is that the P/TC ratio has been increased from 1 to 2, reflecting the central taxiway configuration in Fig. A1-1b. With this change, the computed PCR is now 1034/R/D/W/T, and the total CDF is 1.07. Following the practice of reporting PCR to the nearest even multiple of ten, publish PCR 1030/R/D/W/T. Because the total CDF > 1.0, we expect that at least one of the listed aircraft has ACR > PCR. Figure B-27 shows that this is in fact the case, that the ACR of the B747-400 (1040/R/D) now exceeds the published PCR just slightly (by less than 1%). Following ICAO guidance that allows occasional overload operations by aircraft with ACR up to 10% above the reported PCR, operations of the B747-400 would still be allowed on this pavement, but the number of such operations at full weight would be limited to 5% of total operations on the taxiway. In addition, the taxiway pavement should be monitored for damage after each overload operation.

Figure B-26. FAARFIELD PCR Output – Rigid Example 2 (P/TC = 2)

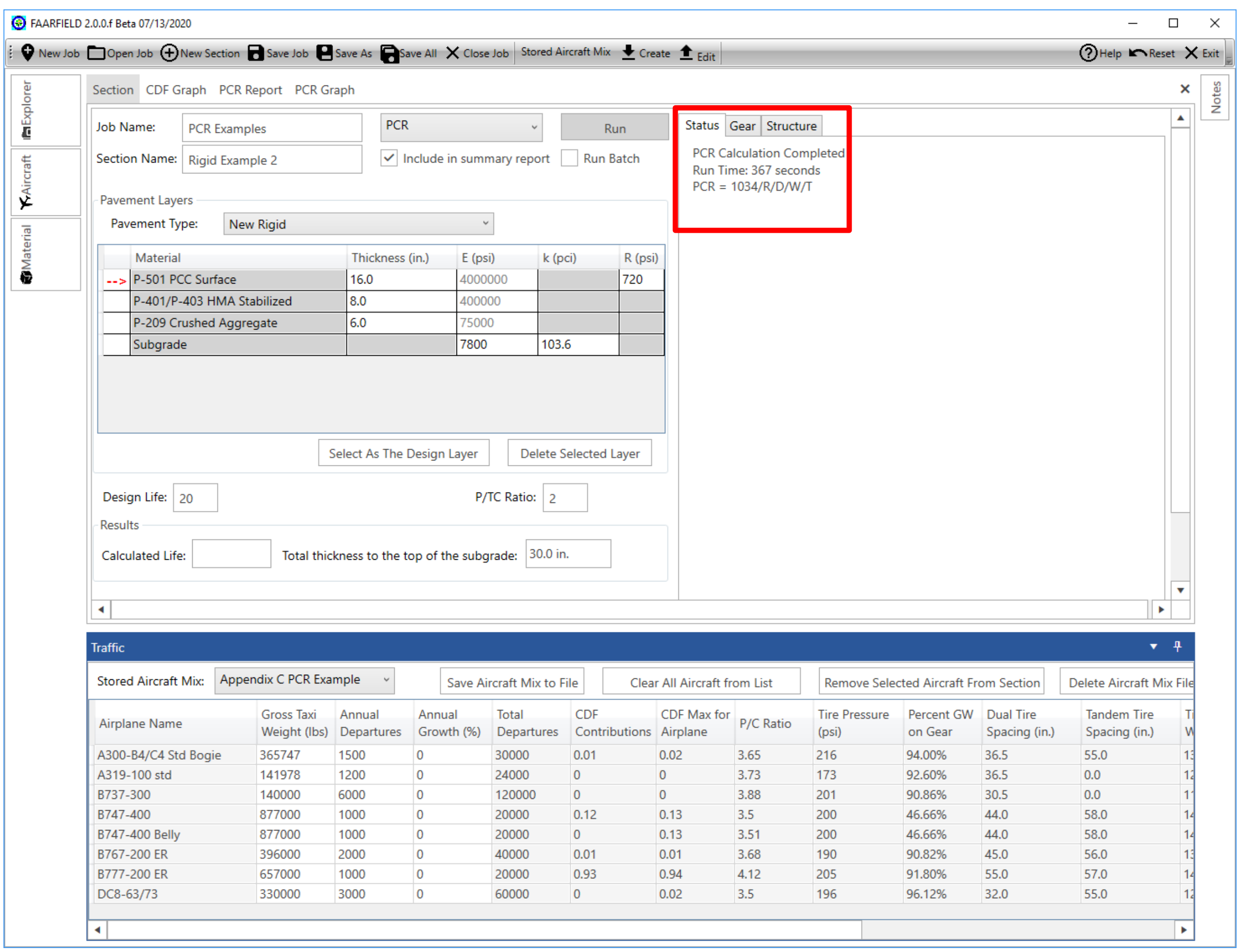
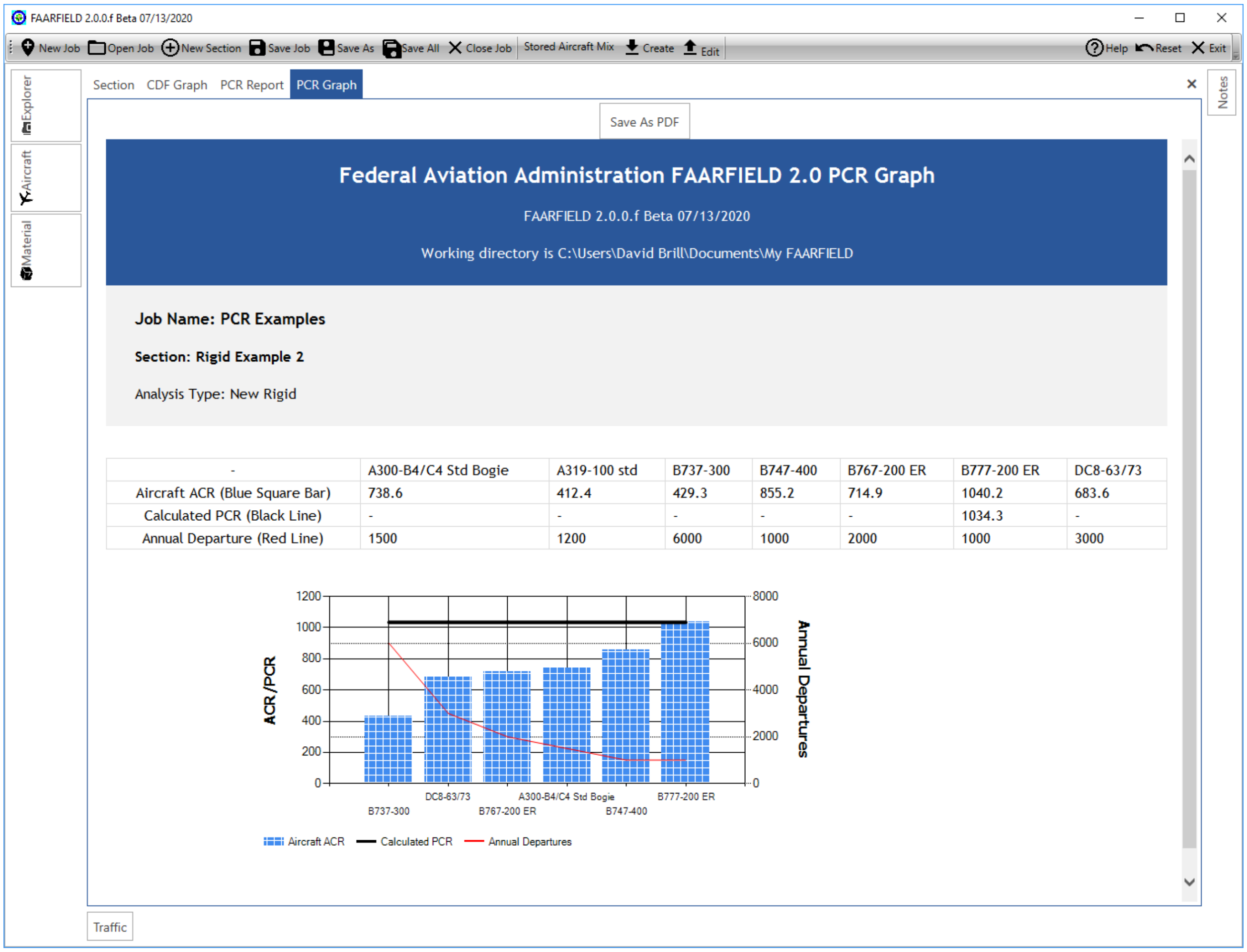


Figure B-27. FAARFIELD PCR Chart – Rigid Example 2 (P/TC = 2)



B.8.3 Rigid Pavement Example 3.

B.8.3.1 The third example has the same traffic as Examples 1 and 2, but in this case the existing concrete pavement has been overlaid at some point with a thin asphalt wearing surface. The ICAO ACR-PCR system does not include separate ratings for composite or overlay pavements. All pavements are assigned either “R” or “F” in the pavement type element of the PCR code. In general, the letter code should reflect the primary structural behavior of the pavement. In other words, if the pavement primarily resists loads through bending action in the panel, then the pavement should be given an R rating, Otherwise, use F. As illustrated in this example, FAARFIELD can help make this determination based on the entered pavement characteristics.

B.8.3.2 Assume the pavement structure as shown in Figure B-28. Enter the data in FAARFIELD. After opening FAARFIELD, select “PCR” from the drop-down function list at the top of the screen. Select the “HMA on Rigid” pavement type from the drop-down Pavement Type list. Enter or modify the structure layers directly in the Pavement Layers table, or by clicking on the image of the pavement cross section. By default, the concrete later is assigned a Structural Condition Index (SCI) value of 80 prior to overlay. Given the difficulty of determining the in-situ structural condition of the concrete layer in an overlay structure, it is generally sufficient to retain the default value of SCI when determining PCR. However, the engineer should ensure that the value of flexural strength R is representative of the actual in-situ flexural strength, as concrete flexural strength has a significant effect on PCR. Using the aircraft library, enter the aircraft list from Table B-1, and modify the gross weights and annual departures as necessary. The default value of P/TC is 1 and does not need to be changed.

B.8.3.3 Click “Run.” FAARFIELD will perform the PCR computations automatically. When the calculation is complete, the computed PCR value will appear in the “Status” screen at upper right (Figure B-29). For this example, the computed PCR is 774/R/B/W/T. Despite the fact that the pavement has an asphalt overlay, FAARFIELD reports rigid PCR because the primary resistance to load comes from the 16-inch PCC slab. Note that FAARFIELD automatically identifies the correct subgrade category based on the entered subgrade properties. FAARFIELD selects W as the default tire pressure category for rigid pavements. However, in this case it may be necessary to report a lower tire pressure category depending on the quality of the asphalt surface later. Following the practice of reporting PCR to the nearest even multiple of ten, and after determining that the surface asphalt can tolerate tire pressures up to 254 psi, publish PCR 770/R/B/X/T.

Figure B-28. Rigid Pavement Structure with Thin Asphalt Overlay for Rigid Example 3

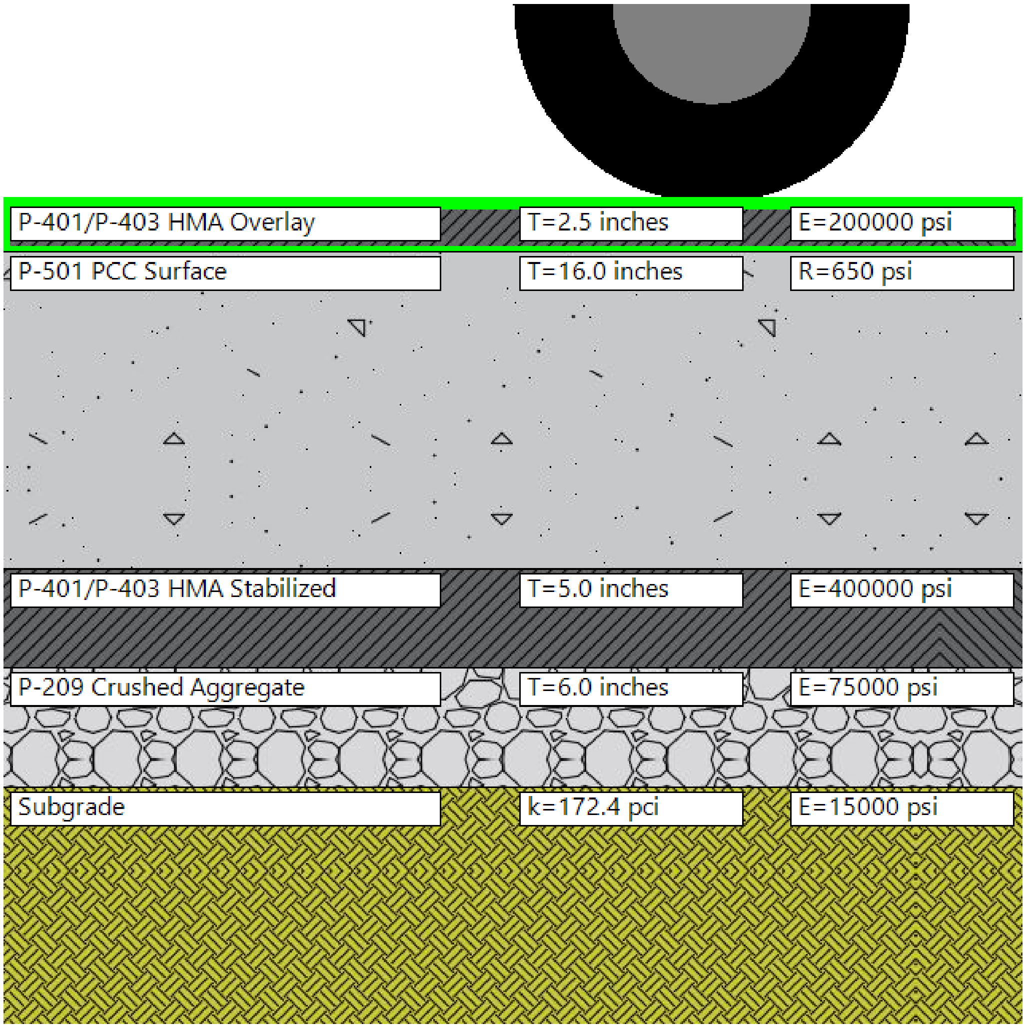
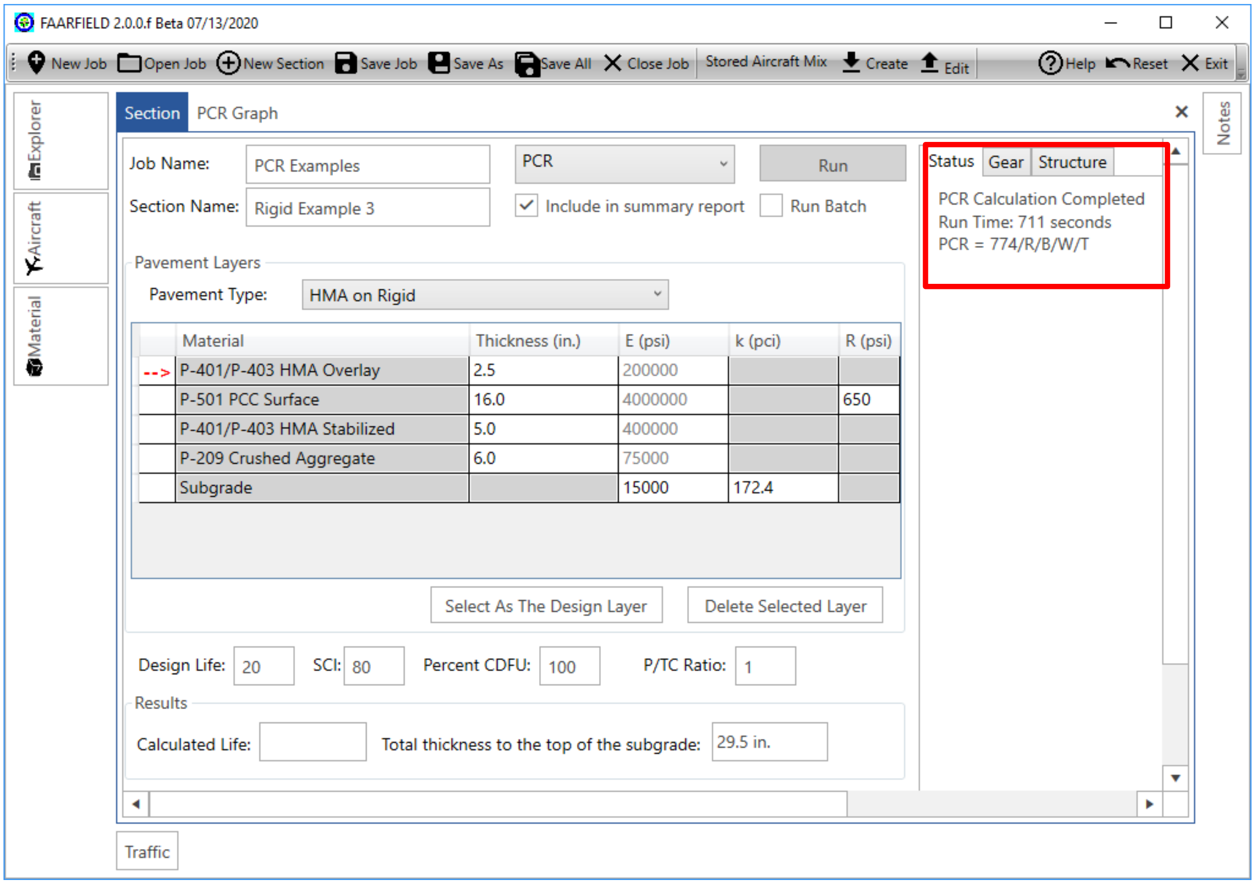


Figure B-29. FAARFIELD PCR Output – Rigid Example 3



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APPENDIX C. PAVEMENT OVERLOAD EVALUATION BY THE ACR-PCR SYSTEM

C.1 ICAO Pavement Overload Evaluation Guidance.

C.1.1 In the life of a pavement, it is possible that either the current or the future traffic will load the pavement in such a manner that the assigned pavement rating is exceeded. ICAO provides a simplified method to account for minor pavement overloading in which the overloading may be adjusted by applying a fixed percentage to the existing PCR.

C.1.2 The ICAO procedure for overload operations is based on minor or limited traffic having ACRs that exceed the reported PCR. Loads that are larger than the defined PCR will shorten the pavement design life, while smaller loads will use up the life at a reduced rate. With the exception of massive overloading, pavements do not suddenly or catastrophically fail. As a result, occasional minor overloading is acceptable with only limited loss of pavement life expectancy and relatively small acceleration of pavement deterioration.

C.1.3 The following guidelines are recommended when evaluating overloads:

1. For flexible or rigid pavements, occasional traffic by aircraft with an ACR not exceeding 10 percent above the reported PCR should not adversely affect the pavement. For example, a pavement with PCR=600 can support some limited traffic of aircraft with ACR=660.
2. The annual number of overload traffic should not exceed approximately 5 percent of the total annual aircraft traffic. There is no exact guidance for choosing a number of operations that represents 5 percent.
3. Overloads should not normally be permitted on pavements already exhibiting signs of structural distress, during periods of thaw following frost penetration, or when the strength of the pavement or its subgrade could be weakened by water.
4. When overload operations are conducted, the airport owner should regularly inspect the pavement condition. Periodically the airport owner should review the criteria for overload operations. Excessive repetition of overloads can cause a significant reduction in pavement life or accelerate when a pavement will require a major rehabilitation.

C.1.4 These criteria provide a consistent, repeatable process the airport owner can use to monitor the impact of these overload operations on the pavement in terms of pavement life reduction or increased maintenance requirements. This discusses methods for making overload allowances for both flexible and rigid pavements that will clearly indicate these effects and will give the authority the ability to determine the impact both economically and in terms of pavement life.

C.2 Overload Guidance.

C.2.1 The overload evaluation guidance in this appendix applies primarily to flexible and rigid pavements that have PCR values that were established by the technical method. Pavements that have ratings determined by the Using Aircraft Method can use the overload guidelines provided very frequent pavement inspection procedures are followed.

C.2.2 The adjustments for pavement overloads start with the assumption that some of the aircraft in the traffic mix have ACRs that exceed the PCR. If a technical analysis was performed, then most of the necessary data already exists to perform an examination of overloading.

C.2.3 The recommended PCR is not adequate for the traffic mix when the Total CDF>1. Airports have three options when evaluating what pavement strength rating to publish:

1. Let the PCR remain as derived from the technical evaluation method, but retain local knowledge that there are some aircraft in the traffic mix that can be allowed to operate with ACRs that exceed the published PCR or at a reduced weight to not exceed the PCR.
2. Provide for an increased PCR by adding an overlay or by reconstruction to accommodate aircraft with higher ACRs.
3. Adjust the PCR upward to that of the aircraft with the highest ACR but recognize the need to expect possible severe maintenance. This will result in earlier and increased costs for reconstruction or overlay projects. This is in essence changing the PCR rating to a using rating, and potentially reducing the remaining pavement life.

APPENDIX D. REPORTING CHANGES TO CERTAIN AIRPORT RUNWAY DATA ELEMENTS

This Advisory Circular affects the following airport runway data.

D.1 Allowable Gross Weight.

Aircraft weight data are reported using this AC based upon the PCR calculated for the pavement being evaluated.

D.1.1 Source of Data.

Runway weight bearing capacity data may be input by the airport owner or State Aviation Agency. Information is submitted electronically to the FAA Air Traffic Aeronautical Information Services for publication in FAA Flight Information manuals using the Airport Master Record (AMR). Airport Sponsors may update the AMR data elements in the Airport Data and Information Portal (ADIP). Currently this data base accepts gross aircraft weight data for single wheel landing gear (S), dual wheel landing gear (D), dual tandem landing gear (2D) and multiple dual-tandem landing gear (2D/2D2). All other gear types may be reported only with the PCR. The PCR reported must contain all five elements, e.g. 573/F/C/W/T.

D.1.2 Reporting Allowable Gross Weight.

The allowable gross aircraft weight for each gear configuration that may utilize the subject runway is published in the Airport Master Record. In addition, a PCR number should also be published for each Runway at the airport. Note the PCR “number” to report is the entire PCR string of five elements: PCR number, pavement type, subgrade category, tire pressure, and method of calculation. The FAARFIELD computer program calculates PCR based maximum gross weights for reporting Runway Weight Bearing Capacity Data as part of the PCR calculation procedure. Alternatively, or if only the PCR is known, a list of PCR-based maximum gross weights for reporting Runway Weight Bearing Capacity Data has been developed and is contained in Appendix E of this AC. Local experience can be considered to report a lower weight, but higher weights are not recommended.

D.2 Pavement Classification Rating (PCR).

D.2.1 Source of Data.

The source for Pavement Classification Rating (PCR) data is the airport operator. FAA Part 139 airport certification safety inspectors and State non-Part 139 airport inspectors are instructed to request PCR data from the airport manager as part of the manager interview before an airport inspection or as soon as practical from airport sponsors requesting Part 139 certification.

D.2.2 Reporting PCR.

For purposes of airport runway data elements generally published in the Airport Master Record (AMR), the PCR is a number that expresses the load-carrying capacity of a pavement based on all aircraft traffic that regularly operates on the pavement.

D.3 Assigning Aircraft Gross Weight Data.

D.3.1 Tables D-1 and D-2 summarize the process used to assign allowable aircraft gross weight. Tables D-1 and D-2 shows the flexible and rigid ACRs used to assign allowable aircraft gross weight. Allowable gross weight is based on the aircraft gear configuration as issued in FAA Order 5300.7, *Standard Naming Convention for Aircraft Landing Gear Configurations*, coupled with tire pressure and wheel spacing ranges. The ACR for these standard aircraft results in a recommended maximum gross weight for Runway Weight Bearing Capacity.

D.3.2 The data in Tables D-1 and D-2 were used to develop a list of maximum gross weights for Runway Weight Bearing Capacity Data. These lists (Appendix E) correlate known PCR values for flexible and rigid pavement to maximum allowable gross weights for the four gear types: S, D, 2D, and 2D/2D2.

D.3.3 The aircraft listed in Tables E-1, E-2, E-3 and E-4 represent generic gear types and typical ranges of weights and tire pressures. There will be cases where the gross weight of an operating aircraft exceeds the allowable gross weight for the relevant gear category as determined from Tables D-1 and D-2, although the operating ACR is less than the reported PCR determined using the procedures in Chapter 4 and in the examples in Appendix B. The values in the tables are not as accurate as the gross weights associated with the ACR assigned by the aircraft manufacturer. The reported PCR is the basis for data in the tables, and the airport manager should rely on the reported PCR, rather than the gross weight data in Tables E-1, E-2, E-3 and E-4 when the ACR of the departing or landing aircraft is known.

D.3.4 Enter the appropriate table for the subgrade category and read down to the PCR number. Then read across to find the allowable weight values, which are listed in thousands of pounds. Note that, regardless of PCR, the following gross weight values are considered the maximum allowable for each gear category:

Gear Type	Gross Weight (Thousands of Pounds)
S	120
D	250
2D	550
2D/2D2	1220

The first example, shown in the table, is for a flexible pavement that supports single (S), dual (D), and dual tandem (2D) gear aircraft. The airport can report a PCR of 300 with subgrade category B support. Refer to Table E-2 for subgrade category B. At the intersection of the PCR value with the gear types S, D, and 2D, find 79 kips (79,000 pounds) is the maximum allowable gross weight for S aircraft, 127 kips (127,000 pounds) is the maximum allowable gross weight for D aircraft, and 215 kips (215,000 pounds) is the maximum allowable gross weight for 2D aircraft. Local experience can be considered to use a lower weight, but higher weights are not recommended. The field for 2D/2D2 does not contain a value, therefore gross aircraft weight data for 2D/2D2 (Field 38 in the AMR) should be left blank.

D.3.5 The second example in the table is for a pavement that supports aircraft with single and dual wheel gear configurations. The pavement has a PCR of 430/R/B/W/T. The gross weights at the intersection of the PCR value for a B category subgrade with each gear type is between PCR values 400 and 450. Straight line interpolation between values is recommended. Single wheel gross weight is 108 kips (108,000 pounds). Dual wheel gross weight is 179 kips (179,000 pounds). Local experience can be considered to use lower weights, but higher weights are not recommended.

D.3.6 The procedures used to create Tables D-1 and D-2 have been implemented in FAARFIELD 2.0 and are automatically executed when PCR computation is run. In a given case there may be minor inconsistencies between the values in Tables E-1, E-2, E-3 and E-4 and those output by FAARFIELD. In case of a discrepancy, the FAARFIELD values should take precedence.

Table D-1. Flexible ACR Data Used to Establish Allowable Gross Weight

No.	Aircraft Name	Gross Weight, lbs.	% GW on Main Gear	Tire Pressure, psi	Flexible ACR			
					A	B	C	D
1	S-7.5std	7,500	95.00	52.5	18.9	20.4	22.8	26.6
2	S-15std	15,000	95.00	60.0	29.9	41.9	49.6	54.9
3	S-30std	30,000	95.00	75.0	70.2	95.0	105.9	113.8
4	S-45std	45,000	95.00	90.0	125.9	153.9	166.4	175.2
5	S-60std	60,000	95.00	105.0	188.2	216.8	229.6	238.5
6	S-75std	75,000	95.00	120.0	255.2	282.6	294.7	303.0
7	S-90std	90,000	95.00	135.0	325.4	350.3	361.1	368.5
8	S-105std	105,000	95.00	150.0	398.0	419.4	428.3	434.9
9	S-120std	120,000	95.00	165.0	472.3	489.5	496.4	502.2
10	D-37.5	37,500	95.00	65.0	34.7	57.6	71.5	88.2
11	D-50	50,000	95.00	80.0	63.0	89.2	108.0	131.9
12	D-75	75,000	95.00	110.0	128.4	160.5	189.4	230.9
13	D-100	100,000	95.00	140.0	197.4	231.4	272.1	320.9
14	D-125	125,000	95.00	150.0	252.9	294.9	340.7	395.7
15	D-150	150,000	95.00	160.0	307.0	346.9	396.8	455.6
16	D-175	175,000	95.00	180.0	375.2	419	471.3	539.6
17	D-200	200,000	95.00	200.0	442.9	491.7	544.3	622.3
18	D-225	225,000	95.00	220.0	511.7	562.0	616.3	701.5
19	D-250	250,000	95.00	240.0	580.9	630.0	690.9	778.6
20	2D-100	100,000	95.00	120.0	89.2	106.7	124.4	158.0
21	2D-150	150,000	95.00	140.0	153.6	187.6	232.1	301.0
22	2D-200	200,000	95.00	160.0	223.3	277.9	355.7	447.6
23	2D-250	250,000	95.00	170.0	284.7	353.5	454.8	577.5
24	2D-300	300,000	95.00	190.0	346.6	425.9	549.7	708.6
25	2D-350	350,000	95.00	190.0	412.1	509.5	655.7	843.6
26	2D-400	400,000	95.00	200.0	478.0	588.9	759.1	975.3
27	2D-450	450,000	95.00	210.0	533.3	635.7	802.4	1061.7

No.	Aircraft Name	Gross Weight, lbs.	% GW on Main Gear	Tire Pressure, psi	Flexible ACR			
					A	B	C	D
28	2D-500	500,000	95.00	220.0	588.0	678.2	833.0	1118.4
29	2D-550	550,000	95.00	230.0	641.0	706.5	844.3	1118.2
30	2D/2D2-40	640,000	95.00	210.0	351.5	368.6	401.6	490.5
31	2D/2D2-50	800,000	95.00	220.0	449.3	480.8	550.4	727.7
32	2D/2D2-60	960,000	95.00	230.0	553.4	610.1	721.9	1028.9
33	2D/2D2-70	1,120,000	95.00	240.0	663.9	758.3	935.2	1395.2
34	3D-40	480,000	95.00	210.0	355.7	367.02	395.9	509.0
35	3D-50	600,000	95.00	220.0	451.8	474.8	541.5	785.3
36	3D-60	720,000	95.00	230.0	553.1	596.3	729.5	1130.1
37	3D-70	840,000	95.00	240.0	659.4	783.7	979.8	1537.0
38	2D/3D2-40	800,000	95.00	210.0	349.3	356.0	371.5	421.8
39	2D/3D2-50	1,000,000	95.00	220.0	442.5	455.0	487.6	599.4
40	2D/3D2-60	1,200,000	95.00	230.0	539.4	561.1	619.6	847.7
41	2D/3D2-70	1,400,000	95.00	240.0	639.9	677.6	772.9	1187.0

Table D-2. Rigid ACR Data Used to Establish Allowable Gross Weight

No.	Aircraft Name	Gross Weight, lbs.	% GW on Main Gear	Tire Pressure, psi	Rigid ACR			
					A	B	C	D
1	S-7.5std	7,500	95.00	52.5	12.7	13.6	14.4	16.6
2	S-15std	15,000	95.00	60.0	28.4	33.6	37.1	40.4
3	S-30std	30,000	95.00	75.0	74.6	82.6	87.7	92.6
4	S-45std	45,000	95.00	90.0	128.7	138.3	144.4	150.3
5	S-60std	60,000	95.00	105.0	189.0	199.3	205.9	212.0
6	S-75std	75,000	95.00	120.0	254.0	264.3	270.8	277.3
7	S-90std	90,000	95.00	135.0	323.0	332.6	338.8	344.8
8	S-105std	105,000	95.00	150.0	394.8	403.4	409.0	414.7
9	S-120std	120,000	95.00	165.0	469.3	476.5	481.2	485.7
10	D-37.5	37,500	95.00	65.0	57.0	69.5	78.2	86.8
11	D-50	50,000	95.00	80.0	96.4	110.9	120.6	130.2
12	D-75	75,000	95.00	110.0	185.5	201.9	212.7	223.3
13	D-100	100,000	95.00	140.0	276.6	294.1	305.5	317.0
14	D-125	125,000	95.00	150.0	351.6	372.0	385.8	399.8
15	D-150	150,000	95.00	160.0	420.3	444.0	460.0	476.3
16	D-175	175,000	95.00	180.0	509.0	533.7	550.5	567.8
17	D-200	200,000	95.00	200.0	598.4	623.9	640.9	659.4
18	D-225	225,000	95.00	220.0	688.3	713.8	731.6	750.7
19	D-250	250,000	95.00	240.0	785.8	811.4	829.2	848.4
20	2D-100	100,000	95.00	120.0	98.4	110.7	126.0	147.6
21	2D-150	150,000	95.00	140.0	177.6	210.8	240.9	274.3
22	2D-200	200,000	95.00	160.0	274.9	325.9	365.7	407.8
23	2D-250	250,000	95.00	170.0	361.6	426.7	475.6	526.7
24	2D-300	300,000	95.00	190.0	449.7	527.5	585.4	645.7
25	2D-350	350,000	95.00	190.0	547.0	637.3	703.1	771.3
26	2D-400	400,000	95.00	200.0	641.6	744.0	817.9	894.7
27	2D-450	450,000	95.00	210.0	711.0	823.9	906.6	993.1

No.	Aircraft Name	Gross Weight, lbs.	% GW on Main Gear	Tire Pressure, psi	Rigid ACR			
					A	B	C	D
28	2D-500	500,000	95.00	220.0	767.6	889.5	981.2	1077.5
29	2D-550	550,000	95.00	230.0	803.9	930.8	1030.3	1137.4
30	2D/2D2-40	640,000	95.00	210.0	379.0	437.3	490.7	553.8
31	2D/2D2-50	800,000	95.00	220.0	524.6	610.9	681.8	760.9
32	2D/2D2-60	960,000	95.00	230.0	692.8	804.3	890.0	982.4
33	2D/2D2-70	1,120,000	95.00	240.0	880.3	1013.5	1112.3	1215.4

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APPENDIX E. MAXIMUM AIRCRAFT GROSS WEIGHT TABLES FOR AIRPORT MASTER RECORD REPORTING BASED ON PCR DETERMINATION

Table E-1. Subgrade Category A

PCR(A)	Allowable GW (1000's of lbs.) for FLEXIBLE PCR				Allowable GW (1000's of lbs.) for RIGID PCR			
	S	D	2D	2D/2D2	S	D	2D	2D/2D2
20	-	-	-	-	11	-	-	-
30	15	-	-	-	16	-	-	-
40	19	40	-	-	19	-	-	-
50	22	44	-	-	22	-	-	-
60	26	49	-	-	25	38	-	-
70	30	53	-	-	29	42	-	-
80	33	56	-	-	31	45	-	-
90	35	60	101	-	34	48	-	-
100	38	64	108	-	37	51	101	-
110	41	68	116	-	40	54	107	-
120	43	72	124	-	43	57	114	-
130	46	76	132	-	45	59	120	-
140	48	79	139	-	48	62	126	-
150	51	83	147	-	50	65	133	-
160	53	86	155	-	53	68	139	-
170	56	90	162	-	55	71	145	-
180	58	94	169	-	58	73	151	-
190	60	97	176	-	60	76	156	-
200	63	101	183	-	63	79	162	-
220	67	110	198	-	67	84	172	-
250	74	124	222	-	74	93	187	-
280	80	138	246	-	81	101	203	-
300	85	147	262	-	85	108	214	-
350	95	166	303	-	96	124	243	-

PCR(A)	Allowable GW (1000's of lbs.) for FLEXIBLE PCR				Allowable GW (1000's of lbs.) for RIGID PCR			
	S	D	2D	2D/2D2	S	D	2D	2D/2D2
400	105	184	341	719	106	143	271	663
450	115	203	379	801	116	158	300	718
470	120	210	394	832	120	164	310	740
500	120	221	420	878	120	172	325	773
550	120	239	465	955	120	186	352	824
580	120	250	493	999	120	195	367	853
600	120	250	511	1027	120	200	378	871
650	120	250	550	1100	120	214	406	919
700	120	250	550	1120	120	228	442	966
750	120	250	550	1120	120	241	484	1009
780	120	250	550	1120	120	248	517	1034
800	120	250	550	1120	120	250	545	1051
850	120	250	550	1120	120	250	550	1094
880	120	250	550	1120	120	250	550	1120

Table E-2. Subgrade Category B

PCR(B)	Allowable GW (1000's of lbs.) for FLEXIBLE PCR				Allowable GW (1000's of lbs.) for RIGID PCR			
	S	D	2D	2D/2D2	S	D	2D	2D/2D2
20	-	-	-	-	10	-	-	-
30	11	-	-	-	14	-	-	-
40	14	-	-	-	17	-	-	-
50	17	-	-	-	20	-	-	-
60	20	38	-	-	23	-	-	-
70	23	42	-	-	26	38	-	-
80	26	46	-	-	29	41	-	-
90	29	50	-	-	32	44	-	-
100	31	54	-	-	35	47	-	-
110	34	57	102	-	37	50	100	-
120	36	61	108	-	40	53	105	-
130	39	64	114	-	43	55	110	-
140	41	68	120	-	45	58	115	-
150	44	71	127	-	48	61	120	-
160	46	75	132	-	50	63	125	-
170	49	78	139	-	53	66	130	-
180	51	82	145	-	55	69	135	-
190	54	85	151	-	57	72	140	-
200	56	89	157	-	60	74	145	-
220	61	96	168	-	65	80	154	-
250	68	107	185	-	72	88	167	-
280	74	119	201	-	78	96	180	-
300	79	127	215	-	83	102	189	-
350	90	151	248	-	94	118	212	-
400	101	168	282	685	104	135	237	-
450	112	186	314	756	115	152	262	652
470	116	193	326	785	119	157	271	670

PCR(B)	Allowable GW (1000's of lbs.) for FLEXIBLE PCR				Allowable GW (1000's of lbs.) for RIGID PCR			
	S	**D**	**2D**	**2D/2D2**	**S**	**D**	**2D**	**2D/2D2**
490	120	199	338	811	120	163	281	689
500	120	203	344	824	120	166	286	698
550	120	221	375	886	120	180	310	744
580	120	232	394	923	120	188	324	772
600	120	239	412	948	120	193	333	790
630	120	250	444	981	120	202	347	816
650	120	250	467	1003	120	207	356	832
670	120	250	490	1025	120	213	365	849
700	120	250	539	1057	120	221	379	874
750	120	250	550	1111	120	234	404	915
800	120	250	550	1120	120	247	435	956
810	120	250	550	1120	120	250	441	964
850	120	250	550	1120	120	250	470	995
900	120	250	550	1120	120	250	513	1033
930	120	250	550	1120	120	250	549	1056
950	120	250	550	1120	120	250	550	1071
1000	120	250	550	1120	120	250	550	1110
1010	120	250	550	1120	120	250	550	1117

Table E-3. Subgrade Category C

PCR(C)	Allowable GW (1000's of lbs.) for FLEXIBLE PCR				Allowable GW (1000's of lbs.) For RIGID PCR			
	S	D	2D	2D/2D2	S	D	2D	2D/2D2
20	-	-	-	-	9	-	-	-
30	10	-	-	-	13	-	-	-
40	12	-	-	-	16	-	-	-
50	15	-	-	-	19	-	-	-
60	18	-	-	-	22	-	-	-
70	20	-	-	-	25	-	-	-
80	23	40	-	-	28	38	-	-
90	26	44	-	-	31	41	-	-
100	28	47	-	-	33	44	-	-
110	31	51	-	-	36	47	-	-
120	33	54	-	-	39	50	-	-
130	36	57	103	-	41	53	102	-
140	38	60	107	-	44	55	106	-
150	41	63	112	-	46	58	110	-
160	43	66	117	-	49	61	115	-
170	46	69	121	-	51	63	119	-
180	48	72	126	-	54	66	123	-
190	51	75	130	-	56	69	128	-
200	53	78	135	-	59	72	132	-
220	58	84	144	-	63	77	141	-
250	65	93	157	-	70	85	154	-
280	72	103	169	-	77	93	166	-
300	77	110	177	-	81	99	174	-
350	87	129	198	-	92	114	194	-
400	99	151	222	638	103	130	216	-
450	110	168	248	692	114	147	238	-
470	114	175	258	714	118	153	247	-

PCR(C)	Allowable GW (1000's of lbs.) for FLEXIBLE PCR				Allowable GW (1000's of lbs.) For RIGID PCR			
	S	**D**	**2D**	**2D/2D2**	**S**	**D**	**2D**	**2D/2D2**
480	116	178	263	724	120	156	252	-
490	119	181	269	735	120	158	257	639
500	120	184	274	746	120	161	261	648
550	120	202	300	800	120	175	284	690
580	120	212	314	828	120	183	298	715
600	120	219	324	846	120	189	306	732
630	120	230	338	874	120	197	319	757
650	120	236	347	893	120	203	327	773
670	120	243	357	912	120	208	336	790
690	120	250	367	930	120	214	344	806
700	120	250	371	940	120	216	349	814
750	120	250	396	981	120	230	370	852
800	120	250	447	1019	120	243	392	891
830	120	250	495	1041	120	250	407	914
840	120	250	531	1049	120	250	412	922
850	120	250	550	1056	120	250	418	929
900	120	250	550	1094	120	250	446	967
930	120	250	550	1116	120	250	466	989
950	120	250	550	1120	120	250	479	1003
1000	120	250	550	1120	120	250	519	1039
1030	120	250	550	1120	120	250	550	1061
1050	120	250	550	1120	120	250	550	1075
1100	120	250	550	1120	120	250	550	1111
1110	120	250	550	1120	120	250	550	1118

Table E-4. Subgrade Category D

PCR(D)	Allowable GW (1000's of lbs.) for FLEXIBLE PCR				Allowable GW (1000's of lbs.) for RIGID PCR			
	S	D	2D	2D/2D2	S	D	2D	2D/2D2
20	-	-	-	-	9	-		
30	8	-	-	-	12	-		
40	11	-	-	-	15	-		
50	14	-	-	-	18	-		
60	16	-	-	-	21	-		
70	19	-	-	-	24	-		
80	21	-	-	-	26	-		
90	24	38	-	-	29	38		
100	26	41	-	-	32	41		
110	29	44	-	-	35	44		
120	32	47	-	-	37	47		
130	34	49	-	-	40	50		
140	36	52	-	-	42	53		
150	39	55	-	-	45	55	101	
160	41	57	101	-	47	58	105	
170	44	60	104	-	50	61	109	
180	46	62	108	-	52	63	113	
190	49	65	111	-	55	66	117	
200	51	67	115	-	57	69	121	
220	56	72	122	-	62	74	129	
250	63	80	132	-	69	82	140	
280	70	89	143	-	76	90	152	
300	74	94	150	-	80	95	160	
350	86	110	167	-	91	110	178	
400	97	127	184	-	102	125	197	
450	108	148	201	-	112	141	218	
470	113	154	209	-	117	148	226	

PCR(D)	Allowable GW (1000's of lbs.) for FLEXIBLE PCR				Allowable GW (1000's of lbs.) for RIGID PCR			
	S	**D**	**2D**	**2D/2D2**	**S**	**D**	**2D**	**2D/2D2**
490	117	160	216	640	120	154	235	
500	120	163	220	646	120	156	239	
550	120	178	239	680	120	170	260	637
580	120	187	251	700	120	178	272	660
600	120	193	259	714	120	184	281	676
630	120	202	270	734	120	192	293	699
650	120	209	278	748	120	197	302	714
670	120	215	285	761	120	203	310	730
690	120	221	293	775	120	208	318	745
700	120	225	297	781	120	211	322	753
750	120	241	315	812	120	225	342	792
770	120	247	323	822	120	230	349	807
800	120	250	334	838	120	238	362	828
830	120	250	345	854	120	245	374	850
840	120	250	349	860	120	248	378	857
850	120	250	352	865	120	250	382	864
900	120	250	371	892	120	250	403	900
930	120	250	382	907	120	250	418	922
950	120	250	390	918	120	250	428	937
1000	120	250	414	945	120	250	454	972
1050	120	250	443	969	120	250	484	1006
1100	120	250	483	991	120	250	519	1041
1120	120	250	500	1000	120	250	535	1054
1150	120	250	550	1012	120	250	550	1075
1200	120	250	550	1034	120	250	550	1109
1250	120	250	550	1057	120	250	550	1120
1300	120	250	550	1078	120	250	550	1120
1350	120	250	550	1100	120	250	550	1120

PCR(D)	Allowable GW (1000's of lbs.) for FLEXIBLE PCR				Allowable GW (1000's of lbs.) for RIGID PCR			
	S	D	2D	2D/2D2	S	D	2D	2D/2D2
1390	120	250	550	1118	120	250	550	1120

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APPENDIX F. RELATED READING MATERIAL

The following publications were used during the development of this AC:

1. AC 150/5320-6, *Airport Pavement Design and Evaluation*. The FAA makes this publication available for free on the FAA website at https://www.faa.gov.
2. ICAO Bulletin, *Official Magazine of International Civil Aviation*, Airport Technology, Volume 35, No. 1, Montreal, Quebec, Canada H3A 2R2, January 1980.

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APPENDIX G. ACRONYMS AND ABBREVIATIONS

2D	Dual tandem landing gear
2D/2D	Multiple dual-tandem landing gear
AC	Advisory Circular
ACAP	Airplane Characteristics for Airport Planning
ACR	Aircraft Classification Rating
ADIP	Airport Data and Information Portal
AIP	Airport Improvement Program
AMR	Airport Master Record
ASTM	ASTM International
CBR	California Bearing Ratio
CDF	Cumulative Damage Factor
CFR	Code of Federal Regulations
D	Dual wheel landing gear
DSWL	Derived Single Wheel Load
E	Elastic modulus
FAA	Federal Aviation Administration
FAARFIELD	FAA Rigid and Flexible Iterative Elastic Layer Design
HMA	Hot Mix Asphalt
HWD	Heavy Weight Deflectometer
ICAO	International Civil Aviation Organization
LEA	Layered Elastic Analysis
MAGW	Maximum Allowable Gross Weight
NASR	National Airspace Systems Resource
P/TC	Passes to Traffic Cycles
PCC	Portland Cement Concrete (also Hydraulic Cement Concrete or Cement Concrete)
PCR	Pavement Classification Rating
PFC	Passenger Facility Charge
S	Single wheel landing gear
SCI	Structural Condition Index

Advisory Circular Feedback

If you find an error in this AC, have recommendations for improving it, or have suggestions for new items/subjects to be added, you may let us know by (1) mailing this form to Manager, Airport Engineering Division, Federal Aviation Administration ATTN: AAS-100, 800 Independence Avenue SW, Washington DC 20591 or (2) faxing it to the attention of the Office of Airport Safety and Standards at (202) 267-5383.

Subject: AC 150/5335-5D Date: ______________________

Please check all appropriate line items:

☐ An error (procedural or typographical) has been noted in paragraph ___________ on page ______________.

☐ Recommend paragraph _______________ on page _______________ be changed as follows:

____
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☐ In a future change to this AC, please cover the following subject:
(Briefly describe what you want added.)

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☐ Other comments:

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☐ I would like to discuss the above. Please contact me at (phone number, email address).

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