U.S. Department
of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Standardized Method of Reporting Airport Pavement Strength - PCN

Date: DRAFT
Initiated by: AAS-100

AC No: 150/5335-5C

1. PURPOSE OF THIS ADVISORY CIRCULAR.

a. This advisory circular (AC) provides guidance for using the standardized International Civil Aviation Organization (ICAO) method to report airport runway, taxiway, and apron pavement strength. ICAO requires member states to report aerodrome-related aeronautical data, including pavement strength. The standardized method, known as the Aircraft Classification Number – Pavement Classification Number (ACN-PCN) method, has been developed and adopted as an international standard and has facilitated the exchange of pavement strength rating information.

b. The AC provides guidance for use of the standardized method of reporting pavement strength which applies only to pavements 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) bearing strength remains unchanged.

c. The AC provides guidance for reporting changes to airport data that is generally published on Federal Aviation Administration (FAA) Form 5010, Airport Master Record. The data elements associated with Gross Weight (Data Elements 35 through 38) and Pavement Classification Number (Data Element 39) are affected.

2. EFFECTIVE DATE.

a. The FAA recommends the guidelines and specifications in this AC for reporting airport pavement strength using the standardized method for all paved runways, taxiways, and aprons at all airports.

b. The FAA requires all public-use paved runways at all Part 139 certificated Airports be assigned gross weight and PCN data.

c. Effective **one year** after the issue date of this AC, all public-use paved runways at primary airports serving air carrier aircraft will be assigned gross weight and PCN data. Effective **three years** after the issue date of this AC, all public use paved runways at nonprimary commercial service airports serving air carrier aircraft will be assigned gross weight and PCN data.

3. APPLICABILITY.

The FAA recommends the guidelines and specifications in this AC for reporting airport runway pavement strength using the standardized method. Use of this AC is mandatory for all public-use paved runways at primary airports serving air carrier aircraft and all public-use paved runways at nonprimary commercial service airports serving air carrier aircraft which an airport has or will receive projects funded with Federal grant monies through the Airport Improvement Program (AIP) or with revenue from the Passenger Facility Charge (PFC) Program. See Grant Assurance No. 34, “Policies, Standards, and Specifications,” and PFC Assurance No. 9, “Standards and Specifications.”

4. WHAT THIS AC CANCELS.

This AC cancels AC 150/5335-5B, Standardized Method of Reporting Airport Pavement Strength – PCN, dated August 26, 2011.

5. PRINCIPAL CHANGES.

Changes are marked by vertical bars in the margins. This AC includes the following major changes:

a. Updates the Effective Date paragraph above for public-use paved runways at nonprimary commercial service airports serving air carrier aircraft.

b. Updates the Applicability paragraph above to clarify that this AC applies to all runways that have or will receive AIP or PFC funding.

c. Clarifies in Chapter 3 that COMFAA calculates ACN using ICAO procedures but calculates PCN using the procedures in this AC.

d. Updates paragraph 4.2, Using Aircraft Method to Determine PCN.

e. Clarifies the subgrade support category requirement in paragraph 4.3, Technical Evaluation Method to Determine PCN.

f. Adds a note to Table A-1, Standard P/TC Ratio Summary.

g. Updates Appendix C and particularly Section 2.2, Technical Evaluation Examples for Flexible Pavements, and Section 2.4, Technical Evaluation Examples for Rigid Pavements, with easier to follow examples and to comply with the current version of COMFAA (updated in 2012) and the new COMFAA support spreadsheet (11/21/2012).

h. Updates Appendix D to conform to the current version of COMFAA.

i. Makes editorial corrections and clarifications throughout.

6. RELATED READING MATERIAL.

The publications listed in Appendix G provide further information on the development and use of the ACN-PCN method.

Michael J. O'Donnell
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CHAPTER 1. INTRODUCTION

1.0 BACKGROUND.

The United States is a contracting state of the International Civil Aviation Organization (ICAO) and, under 47 USC §40105(b), shall act consistently with the obligations of the United States Government under an international agreement. Annex 14 to the Convention of International Civil Aviation, Aerodromes, contains a standard that requires member states to publish information on the strengths of all public airport pavements in its own Aeronautical Information Publication. The FAA reports pavement strength information to the National Airspace System Resources (NASR) database and publishes pavement strength information in the Airport Master Record (Form 5010) and the Airport/Facility Directory (AFD).

1.1 DEVELOPMENT OF A STANDARDIZED METHOD.

In 1977, ICAO established a Study Group to develop a single international method of reporting pavement strengths. The study group developed, and ICAO adopted, the Aircraft Classification Number - Pavement Classification Number (ACN-PCN) method. Using this method, it is possible to express the effect of an individual aircraft on different pavements with a single unique number that varies according to aircraft weight and configuration (e.g. tire pressure, gear geometry, etc.), pavement type, and subgrade strength. This number is the Aircraft Classification Number (ACN). Conversely, the load-carrying capacity of a pavement can be expressed by a single unique number, without specifying a particular aircraft or detailed information about the pavement structure. This number is the Pavement Classification Number (PCN).

a. Definition of ACN. ACN 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.

b. Definition of PCN. PCN is a number that expresses the load-carrying capacity of a pavement for unrestricted operations.

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

1.2 APPLICATION.

The use of the standardized method of reporting pavement strength applies only to pavements 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) bearing strength remains unchanged.

1.3 LIMITATIONS OF THE ACN-PCN SYSTEM.

The ACN-PCN system is only intended as a method of reporting relative pavement strength so airport operators can 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.

CHAPTER 2. DETERMINATION OF AIRCRAFT CLASSIFICATION NUMBER

2.0 DETERMINATION OF THE ACN.

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

2.1 SUBGRADE CATEGORY.

The ACN-PCN method adopts four standard levels of subgrade strength for rigid pavements and four levels of subgrade strength for flexible pavements. These standard support conditions are used to represent a range of subgrade conditions as shown in Tables 2-1 and 2-2.

Table 2-1. Standard Subgrade Support Conditions for Rigid Pavement ACN Calculation

Subgrade Strength Category	Subgrade Support k-Value pci (MN/m3)	Represents pci (MN/m3)	Code Designation
High	552.6 (150)	k > 442 (>120)	A
Medium	294.7 (80)	221<k<442 (60<k<120)	B
Low	147.4 (40)	92<k<221 (25<k<60)	C
Ultra Low	73.7 (20)	k<92 (<25)	D

Table 2-2. Standard Subgrade Support Conditions for Flexible Pavement ACN Calculation

Subgrade Strength Category	Subgrade Support CBR-Value	Represents	Code Designation
High	15	CBR > 13	A
Medium	10	8<CBR<13	B
Low	6	4<CBR<8	C
Ultra Low	3	CBR<4	D

2.2 OPERATIONAL FREQUENCY.

Operational frequency is defined in terms of coverages that represent a full-load application on a point in the pavement. Coverages must not be confused with other common terminology used to reference movement of aircraft. As an aircraft moves along a pavement section it seldom travels in a perfectly straight path or along the exact same path as before.

This movement is known as aircraft wander and is assumed to be modeled by a statistically normal distribution. As the aircraft moves along a taxiway or runway, it may take several trips or passes along the pavement for a specific point on the pavement to receive a full-load application. 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 the established pass-to-coverage ratio for each aircraft.

2.3 RIGID PAVEMENT ACN.

For rigid pavements, the aircraft landing gear flotation requirements are determined by the Westergaard solution for a loaded elastic plate on a Winkler foundation (interior load case), assuming a concrete working stress of 399 psi (2.75 MPa).

2.4 FLEXIBLE PAVEMENT ACN.

For flexible pavements, aircraft landing gear flotation requirements are determined by the California Bearing Ratio (CBR) method for each subgrade support category. The CBR method employs a Boussinesq solution for stresses and displacements in a homogeneous, isotropic elastic half-space.

2.5 ACN 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 181 psi (1.25 MPa). The ACN is defined as two times the derived single wheel load (expressed in thousands of kilograms).

2.6 VARIABLES INVOLVED IN DETERMINATION OF ACN VALUES.

Because aircraft can be operated at various weight and center of gravity combinations, ICAO adopted standard operating conditions for determining ACN values. The ACN is to be determined at the weight and center of gravity combination that creates the maximum ACN value. Tire pressures are assumed to be those recommended by the manufacturer for the noted conditions. Aircraft manufacturers publish maximum weight and center of gravity information in their Aircraft Characteristics for Airport Planning (ACAP) manuals. To standardize the ACN calculation and to remove operational frequency from the relative rating scale, the ACN-PCN method specifies that ACN values be determined at a frequency of 10,000 coverages.

CHAPTER 3. DETERMINATION OF ACN-PCN VALUES USING COMFAA

3.0 AVAILABILITY OF COMFAA SOFTWARE APPLICATION.

To facilitate the use of the ACN-PCN system, the FAA developed a software application that calculates ACN values using the procedures and conditions specified by ICAO and can be used to determine PCN values following the procedures in this AC. The software is called COMFAA and may be downloaded along with its source code and supporting documentation from the FAA website.[1] The program is useful for determining an ACN value under various conditions; however, official ACN values are provided by the aircraft manufacturer.

3.1 ORIGIN OF THE COMFAA PROGRAM.

Appendix B of the ICAO Aerodrome Design Manual, Part 3, Pavements, provides procedures for determining the Aircraft Classification Number (ACN). The appendix provides program code for two FORTRAN software applications capable of calculating the ACN for various aircraft on rigid and flexible pavement systems. The computer program listings in Appendix B of the ICAO manual were optically scanned and the FORTRAN code translated into Visual Basic 6.0 for incorporation into COMFAA.

3.2 COMFAA PROGRAM.

The COMFAA software is a general purpose program that operates in two computational modes: ACN Computation Mode and Pavement Thickness Mode.

a. ACN Computation Mode.

- Calculates the ACN number for aircraft on flexible pavements.
- Calculates the ACN number for aircraft on rigid pavements.
- Calculates flexible pavement thickness based on the ICAO procedure (CBR method) for default values of CBR (15, 10, 6, and 3).
- Calculates rigid pavement slab thickness based on the ICAO procedures (Portland Cement Association method, interior load case) for default values of k (552.6, 294.7, 147.4, and 73.7 lb/in^3 [150, 80, 40, and 20 MN/m^3]).

Note: Thickness calculation in the ACN mode is for specific conditions identified by ICAO for determination of ACN and not intended to be used to design a new pavement. For flexible pavements, a standard tire pressure of 181 psi (1.25 MPa) and 10,000 coverages is specified. For rigid pavements, an allowable stress level of 399 psi is identified by ICAO. The thickness calculated in ACN mode has meaning for determining allowable pavement loading only for the specific conditions identified by ICAO. (Appendix C has more details.)

[1] See http://www.faa.gov/airports/engineering/design_software/. This software is in the public domain.

b. Pavement Thickness Mode (see Note).

- Calculates total flexible pavement thickness based on the FAA CBR method specified in AC 150/5320-6[2], Airport Pavement Design and Evaluation, for CBR values and coverage levels specified by the user.

- Calculates rigid pavement slab thickness based on the FAA Westergaard method (edge load analysis) specified in AC 150/5320-6 for k values and coverage levels specified by the user.

Note: The pavement thickness requirements associated with the ACN-PCN procedures are based upon historical procedures identified in previous versions of AC 150/5320-6. The FAA has replaced these procedures for pavement design with new procedures.

3.3 INTERNAL AIRCRAFT LIBRARY.

COMFAA 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 ACAP Manuals. The default characteristics of aircraft in the internal library represent the ICAO standard conditions for calculation of ACN. These characteristics include center of gravity at the maximum aft position for each aircraft in the ACN mode. 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.

COMFAA 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 COMFAA program to assure that aircraft parameters in the external library are feasible or appropriate. The user is responsible for assuring all data is correct.

When saving an aircraft from the internal library to the external library, the COMFAA 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 should be used for converting passes to coverages for pavement thickness determination and equivalent aircraft operations.

[2] New FAA layered elastic and finite element pavement design procedures were adopted in AC 150/5320-6E. The pavement thickness mode uses the FAA CBR method and the FAA Westergaard method, identified in previous versions of AC 150/5320-6. These historical procedures are consistent with the ACN/PCN method, an internationally used standard published by ICAO. Data from the historical procedures relative to the existing ICAO standard are included in this AC.

3.5 USING THE COMFAA PROGRAM.

Using the COMFAA program to calculate ACN values to determine PCN is visually interactive and intuitive.

a. ACN. The user—

- Selects the desired aircraft,
- Confirms the physical properties of the aircraft. Only gross weight, percent gross weight on main gear, and tire pressure are changeable. All other properties are fixed by the ICAO standard.
- Clicks on the "MORE" button, and
- Clicks on the ACN Flexible or ACN Rigid button to determine the ACN for the four standard subgrade conditions.
- Clicks on the "Details" button to view parameters used to compute ACN.

b. PCN. The user—

- Adds the runway traffic mix aircraft to an external file,
- Confirms the physical properties of each individual aircraft in the traffic mix,
- Inputs either annual departures or coverages of the aircraft,
- Inputs the evaluation thickness and the subgrade support strength,
- Inputs the concrete strength if analyzing a rigid pavement,
- Clicks on the "LESS" button to activate the PCN Batch computational mode, and
- Clicks on the PCN Flexible Batch or PCN Rigid Batch button to determine the PCN of the pavement.
- Clicks on the "Details" button to view the Results Tables.

The program includes a help file to assist users. Figures 3-1, 3-2, and 3-3 summarize the operation of the COMFAA program.

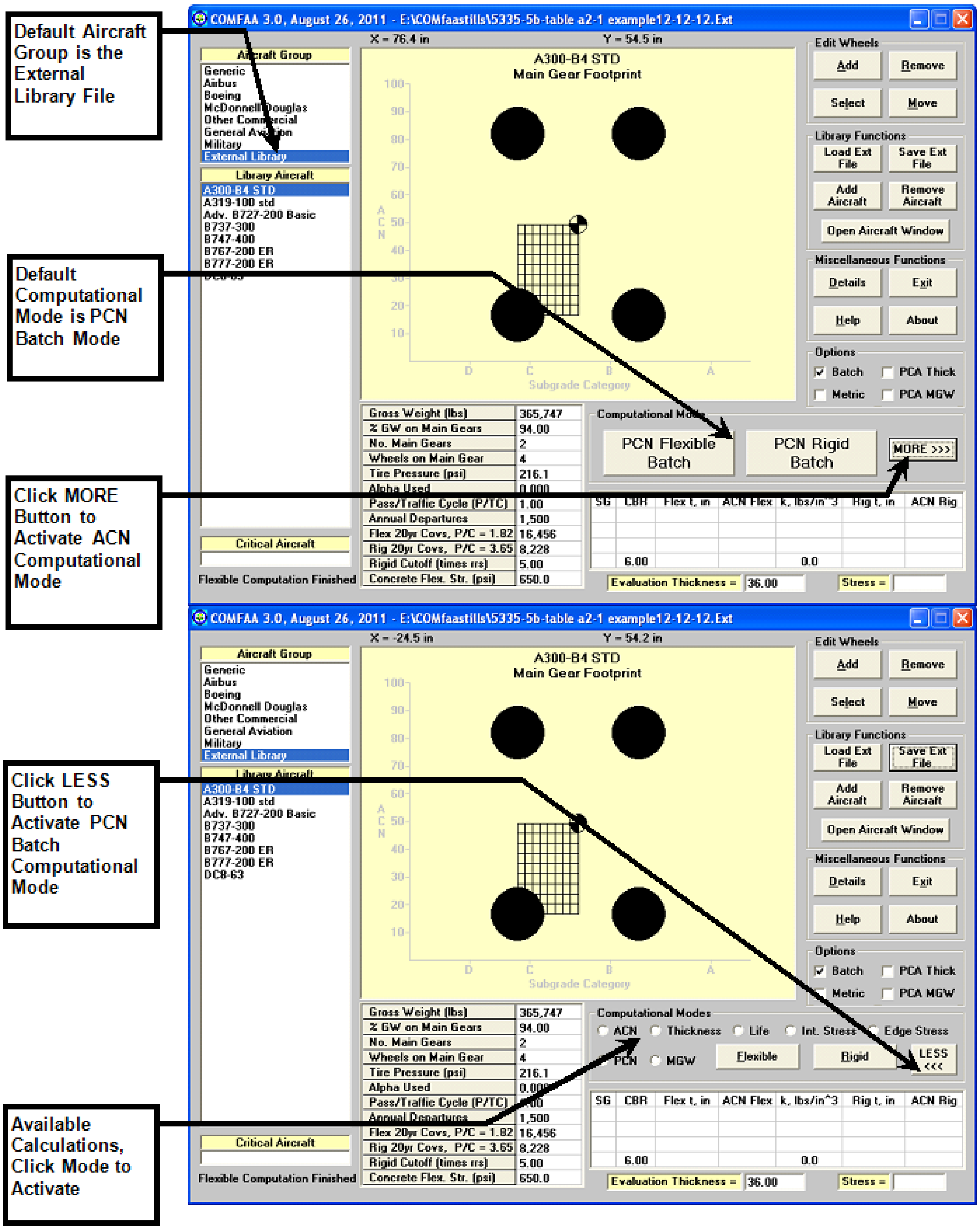

Figure 3-1. Computational Modes of the COMFAA Program

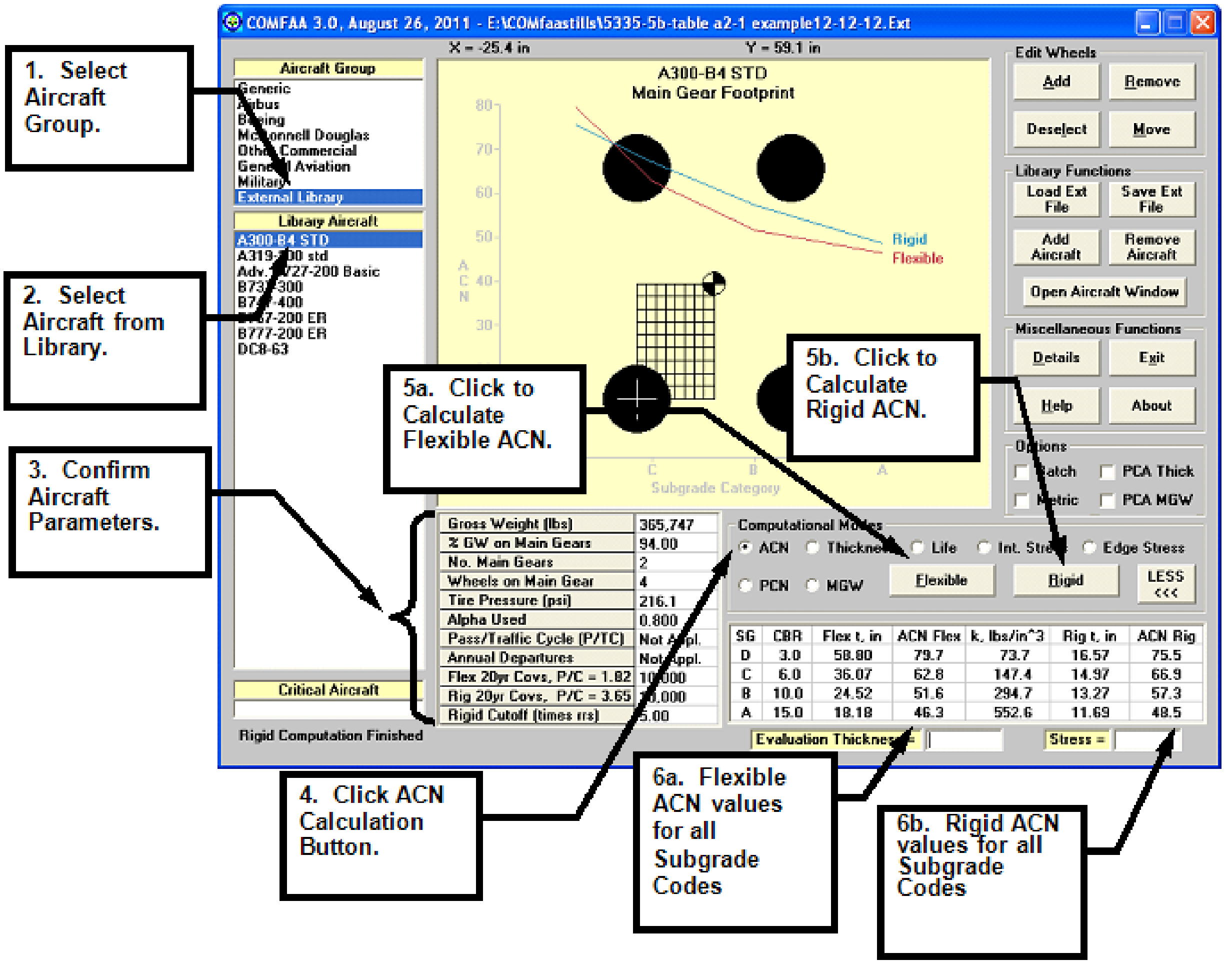

Figure 3-2. Operation of the COMFAA Program in ACN Mode

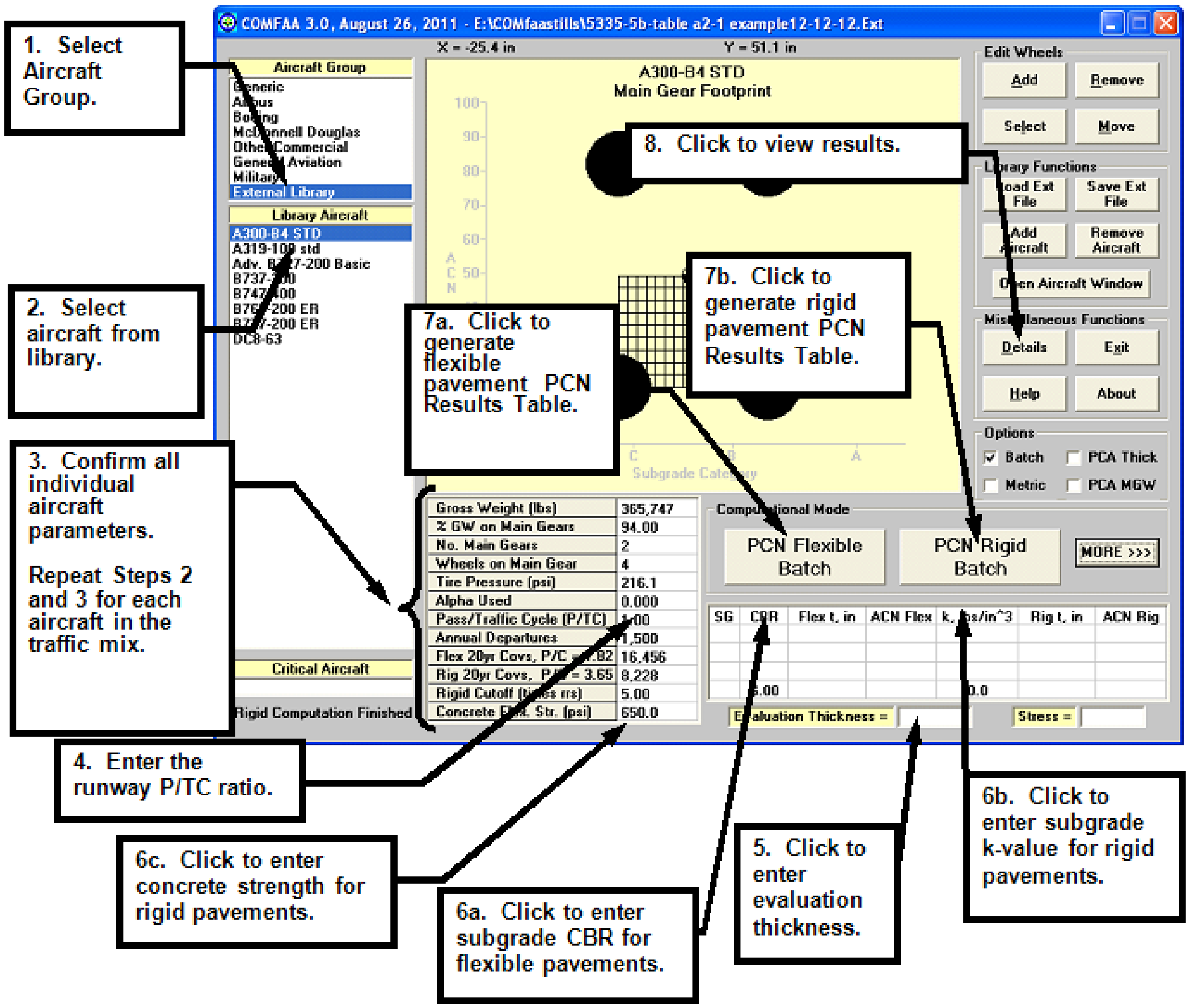

Figure 3-3. Operation of the COMFAA Program in PCN Batch Mode

CHAPTER 4. DETERMINATION OF PCN NUMERICAL VALUE

4.0 PCN CONCEPT.

The determination of a pavement rating in terms of PCN is a process of (1) determining the ACN for each aircraft considered to be significant to the traffic mixture operating of the subject pavement and (2) reporting the ACN value as the PCN for the pavement structure. Under these conditions, any aircraft with an ACN equal to or less than the reported PCN value can safely operate on the pavement subject to any limitations on tire pressure.

Note: PCN values determined in accordance with this AC depend upon the aircraft traffic used to determine the PCN value. Airports should re-evaluate their posted PCN value if significant changes to the original aircraft traffic occur.

4.1 DETERMINATION OF NUMERICAL PCN VALUE.

Determination of the numerical PCN 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 PCN values will be determined based upon internally developed pavement evaluation procedures. Either procedure may be used to determine a PCN, but the methodology used must be reported as part of the posted rating.

4.2 USING AIRCRAFT METHOD TO DETERMINE PCN.

The Using aircraft method is a simple procedure where ACN values for all aircraft currently permitted to use the pavement facility are determined and the largest ACN value is reported as the PCN. This method is easy to apply and does not require detailed knowledge of the pavement structure. Figures 4-1 and 4-2 show an example of the the Using Method. The subgrade support category IS NOT a critical input when reporting PCN based on the Using Method. The recommended subgrade support category when information IS NOT available should be Category B.

a. 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 mixture, and that each aircraft is capable of operating on the pavement structure without **weight** restriction. From a technical point of view, the Using Aircraft method assumes that the number of total operations is equal to 10,000 coverages of the using aircraft with the highest ACN. The methodology used to determine ACN/PCN does not consider the critical design aircraft used to determine airport dimensional requirements.

b. Inaccuracies of the Using Aircraft Method. The accuracy of this method is greatly improved when aircraft traffic information is available. 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 PCN. 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. A consistent method based on a design period minimum frequency is recommended and presented in Appendix C. The frequency recommended is equal to 1,000 coverages of the aircraft with the highest ACN for the Using method. *Use of the Using aircraft method is discouraged on a long-term basis due to the concerns listed above.*

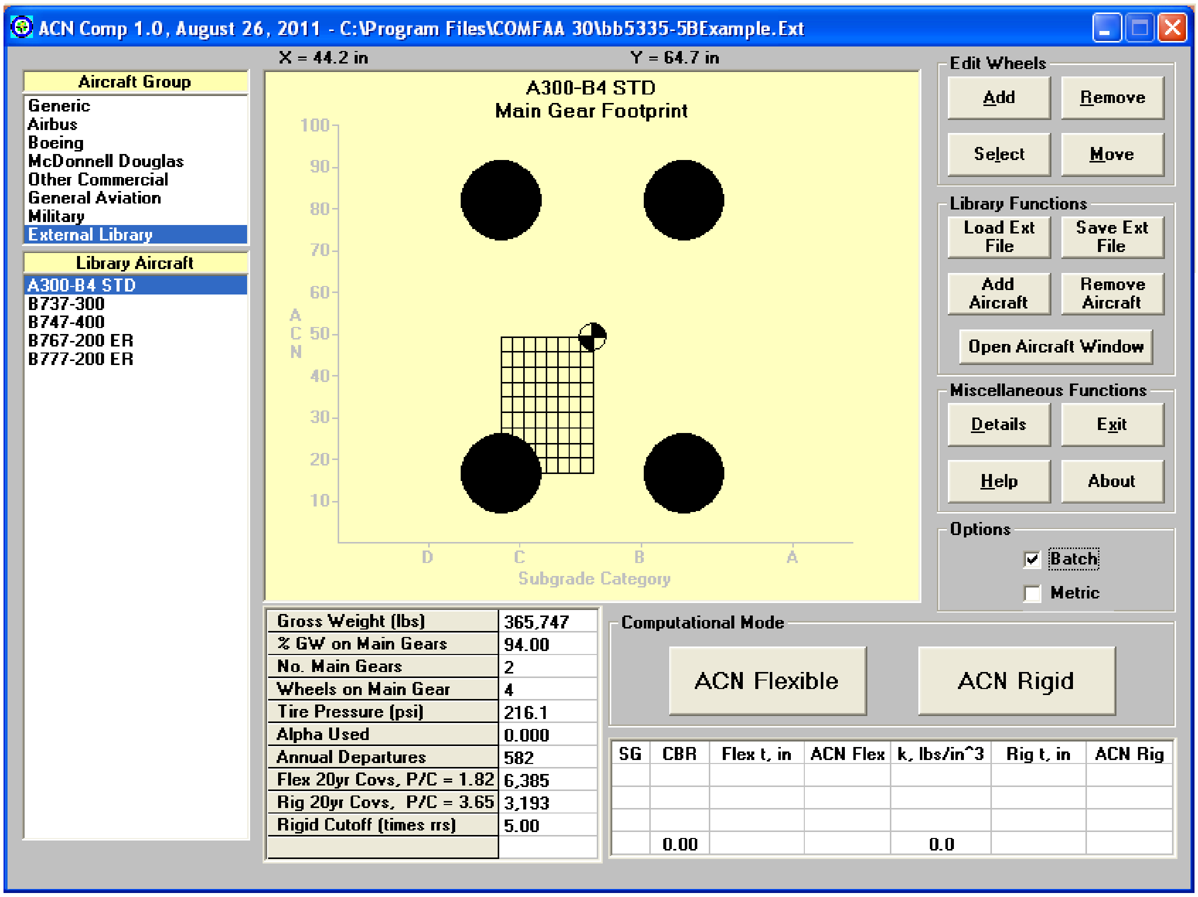

Figure 4-1. Operation of COMFAA ACN only Program, Version in Batch Mode

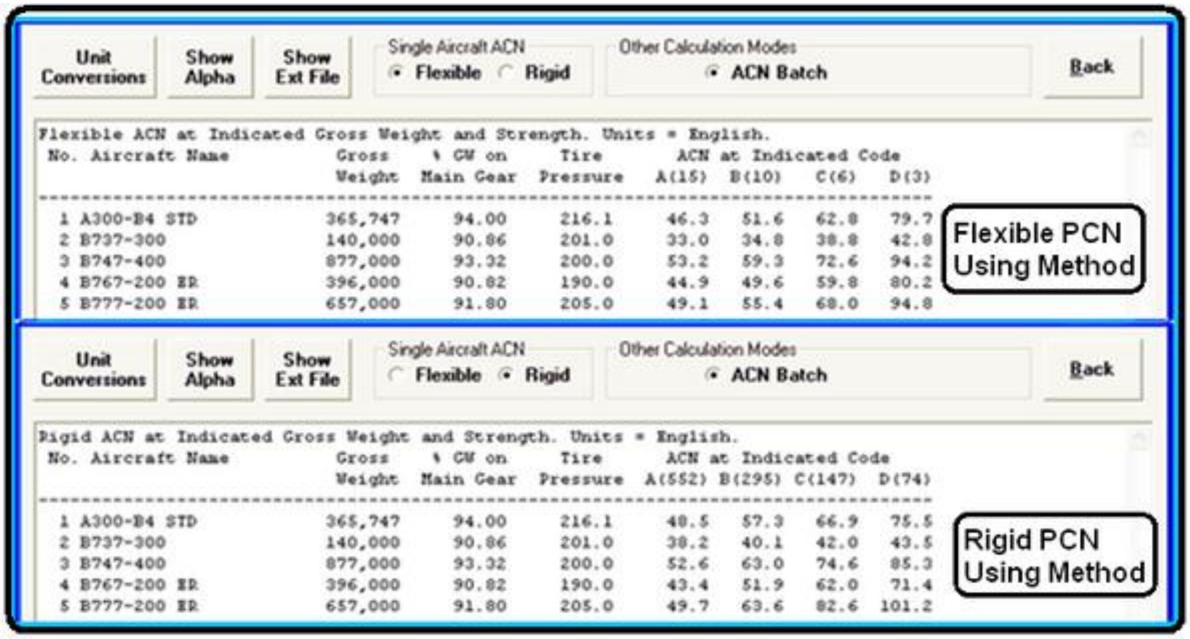

Figure 4-2. COMFAA Program, ACN Only Version in Batch Mode

4.3 TECHNICAL EVALUATION METHOD TO DETERMINE PCN.

The strength of a pavement section is difficult to summarize in a precise manner and will vary depending on the unique combination of aircraft loading conditions, frequency of operation, and pavement 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 ACN-PCN 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.

The accuracy of a technical evaluation is better than that produced with the Using aircraft procedure but requires a considerable increase in time and resources. 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 volume over the intended life of the pavement. The subgrade support category is a necessary input when reporting PCN based on the Technical Method. There is no recommended subgrade support category when information is not available.

a. Determination of the PCN Value. The PCN numerical value is determined from an allowable load rating. While it is important not to confuse the PCN value with a pavement design parameter, the PCN is developed in a similar fashion. An allowable load rating is determined by applying the same principles as those used for pavement design. The process for determining the allowable load rating takes factors such as frequency of operations and permissible stress levels into account. Allowable load ratings are often discussed in terms of aircraft gear type and maximum gross aircraft weight, as these variables are used in the pavement design procedure. Missing from the allowable load rating, but just as important, is frequency of operation. In determining an allowable load rating, the evaluation must address whether the allowable load rating represents the pavement strength over a reasonable frequency of operation. Once the allowable load rating is established, the determination of the PCN value is a simple process of determining the ACN of the aircraft representing the allowable load and reporting the value as the PCN.

b. Concept of Equivalent Traffic. The ACN-PCN method is based on design procedures that evaluate one aircraft against the pavement structure. Calculations necessary to determine the PCN can only be performed for one aircraft at a time. The ACN-PCN method does not directly address how to represent a traffic mixture as a single aircraft. To address this limitation, the FAA uses the equivalent annual departure concept to consolidate entire traffic mixtures into equivalent annual departures of one representative aircraft. The procedure for evaluating equivalent annual departures for a given aircraft from a traffic mixture is based on the cumulative damage factor concept discussed in Appendix A.

c. Counting Aircraft Operations. When evaluating or designing a pavement section, it is important to account for the number of times the pavement will be stressed. As discussed in paragraph 2.2, an aircraft may have to pass over a given section of pavement numerous times before the portion of pavement considered for evaluation receives one full stress application. While statistical procedures exist to determine the passes required for one full stress application, the evaluation of a pavement section for PCN determination must also consider how aircraft use the pavement in question. The FAA uses a conservative approach for pavement design procedures by assuming that each aircraft using the airport must land and take off once per cycle. Since the arrival or landing weight of the aircraft is usually less than the departure weight, the design procedure only counts one pass at the departure weight for analysis. The one pass at departure weight is considered as one annual departure and the arrival event is ignored. Appendix A provides a detailed discussion of traffic analysis.

4.4 LIMITATIONS OF THE PCN.

The PCN value is for reporting relative pavement strength only and 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 PCN rating system uses a continuous scale to compare pavement strength where higher values represent pavements with larger load capacity.

4.5 REPORTING THE PCN.

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

An example of a PCN code is 80/R/B/W/T, which is further explained in paragraph 4.5.f.

a. Numerical PCN Value. The PCN numerical value indicates the load-carrying capacity of a pavement in terms of a standard single wheel load at a tire pressure of 181 psi (1.25 MPa). The PCN should be determined on any pavement considered to be controlling to ground traffic control. The PCN value should be reported in whole numbers, rounding off any fractional parts to the nearest whole number. For pavements of diverse strengths, the controlling PCN numerical value for the weakest segment of the pavement should normally be reported as the strength of the pavement. Engineering judgment may be required in that 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 PCN.

b. Pavement Type. For the purpose of reporting PCN 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 PCN.

Table 4–1. Pavement Codes for Reporting PCN

Pavement Type	Pavement Code
Flexible	F
Rigid	R

i) Flexible Pavement. Flexible pavements support loads through bearing rather than flexural action. They comprise several layers of selected 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.

ii) 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.

iii) 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. The method used in computing the PCN is the best guide in determining how to report the pavement type. For example, if a pavement is composed of a rigid pavement with a bituminous overlay, the usual manner of determining the load-carrying capacity is to convert the pavement to an equivalent thickness of rigid pavement. In this instance, the pavement type should be reported as a rigid structure. A general guideline is that when the bituminous overlay reaches 75 to 100 percent of the rigid pavement thickness the pavement can be considered as a flexible pavement. It is permissible to include a note stating that the pavement is of composite construction but only the rating type, “R” or “F”, is used in the assessment of the pavement load capacity.

c. Subgrade Strength Category. As discussed in paragraph 2.1, there are four standard subgrade strengths identified for calculating and reporting ACN or PCN values. Tables 2-1 and 2-2 list the values for rigid and flexible pavements.

d. Allowable Tire Pressure. Table 4-2 lists the allowable tire pressure categories identified by the ACN-PCN 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 PCN

Category	Code	Tire Pressure Range
High	W	No pressure limit
Medium	X	Pressure limited to 218 psi (1.5 MPa)
Low	Y	Pressure limited to 145 psi (1.00 MPa)
Very Low	Z	Pressure limited to 73 psi (0.50 MPa)

i) Tire Pressures on Rigid Pavements. Aircraft tire pressure will have little effect on pavements with Portland 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.

ii) 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, Plant Mix Bituminous Pavements, is provided in the current version of AC 150/5370-10, Standards for Specifying Construction of Airports. Improperly prepared and placed mixtures 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) in thickness can generally be rated with code X or W, while thinner pavement of poorer quality asphalt should not be rated above code Y.

e. Method Used to Determine PCN. The PCN 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 PCN. Using aircraft evaluation means the PCN was determined by selecting the highest ACN among the aircraft currently using the facility and not causing pavement distress. PCN values computed by the technical evaluation method should be reported to the NASR database and shown on the FAA Form 5010, Airport Master Record. Publication of a Using aircraft evaluation in the Airport Master Record, Form 5010, and the NASR database is permitted only by mutual agreement between the airport owner and the FAA.

f. Example PCN Reporting. An example of a PCN code is 80/R/B/W/T—with 80 expressing the PCN numerical value, R for rigid pavement, B for medium strength subgrade, W for high allowable tire pressure, and T for a PCN value obtained by a technical evaluation.

g. Report PCN Values to FAA (See Appendix E). Once a PCN value and the coded entries are determined, the PCN code should be reported to the appropriate regional FAA Airports Division, either in writing or as part of the annual update to the Airport Master Record, FAA Form 5010-l. The PCN code will be disseminated by the National Flight Data Center through aeronautical publications such as the Airport/Facility Directory (AFD) and the Aeronautical Information Publication (AIP). An aircraft's ACN can then be compared with published PCN's to determine if pavement strength places any restrictions on the aircraft operating on that pavement, such as the aircraft's tire pressure or load.

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APPENDIX A. EQUIVALENT TRAFFIC

1.0 EQUIVALENT TRAFFIC.

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 ACN 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 PCN that includes the effects of all traffic becomes possible. The methodology used to determine ACN/PCN does not consider the critical design aircraft used to determine airport dimensional requirements.

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

In order to arrive at a technically derived PCN, 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 PCN determination. However, with this knowledge in hand, an engineer will be able to arrive at a PCN that will have a solid technical foundation.

1.1 EQUIVALENT TRAFFIC TERMINOLOGY.

In order to determine a PCN, 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. Arrival (Landing) and Departure (Takeoff). 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.

b. 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.

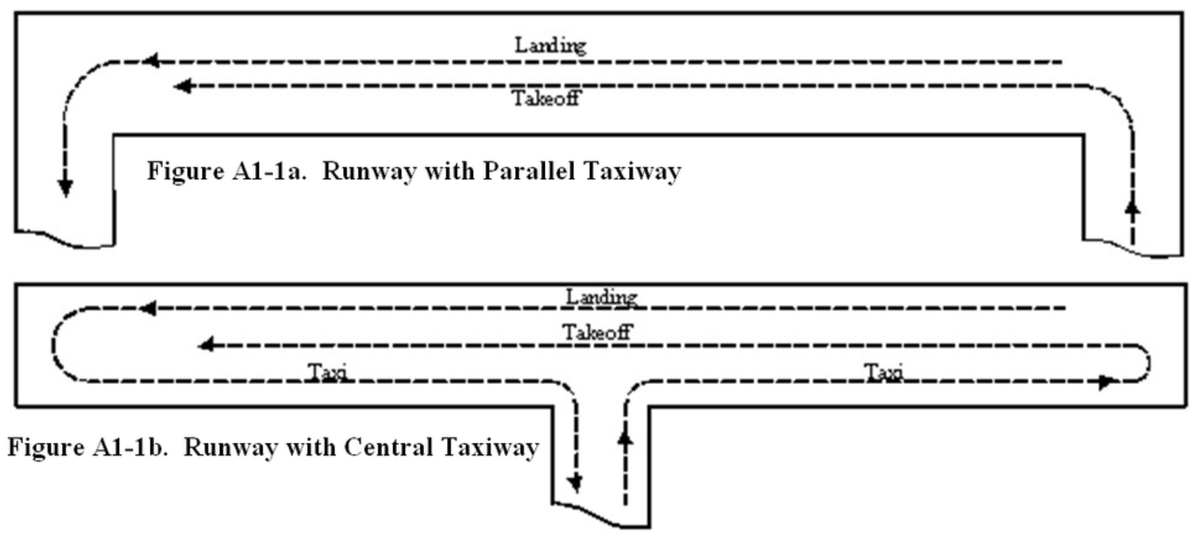

Figure A-1. Traffic Load Distribution Patterns

i) 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.

ii) 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.

iii) A simplified, but less conservative, approach would be 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.

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 fractions 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 PCN of the pavement.

c. Coverage. 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.

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. It is incumbent upon the user to select the proper value for flexible and rigid pavements.

Aircraft passes can be determined (counted) by observation but coverages are used by the COMFAA 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 COMFAA program and the user only need be concerned with passes.

d. 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 often used interchangeably with pass or traffic cycle. When this description of an aircraft activity is used, additional information should be supplied. It is usually preferable to use the more precise terms described in this section.

e. Annual Departure and Traffic Cycle Ratio. The FAA standard for counting traffic cycles at an airport for pavement design purposes is to count one landing, one taxi, and one take-off as a single event called a departure. For pavement evaluation related to determination of PCN, it may be necessary to adjust the number of traffic cycles (departures) based upon the scenarios discussed in paragraph 1.1b of this appendix. Similar to the discussion above regarding P/C ratio, the traffic cycle to coverage (TC/C) ratio is needed to finalize the equivalent traffic determination. The TC/C ratio differs when applied to flexible pavements as opposed to rigid pavements. The ratio in flexible pavement, rather than passes to coverages, is required since there could be one or more passes per traffic cycle. When only one pass on the operating surface is assumed for each traffic count, then the P/C ratio is sufficient. However, when situations are encountered where more than one pass is considered to occur during the landing to takeoff cycle, then the TC/C ratio is necessary in order to properly account for the effects of all of the traffic. These situations occur most often when there are central taxiways or fuel is not obtained at the airport.

Equation A-1 translates the P/C ratio to the TC/C ratio for flexible and rigid pavements by including the previously described ratio of passes to traffic cycles (P/TC):

$$TC/C = P/C \div P/TC \quad \text{(Equation A-1)}$$

Where:

TC = Traffic Cycles
C = Coverages
P = Passes

Since the COMFAA program will automatically determine passes to coverages and convert annual departures to coverages, the conditions described in paragraph 1.1b can be addressed by simply multiplying annual departures by the pass to traffic cycle (P/TC) ratio. COMFAA requires the P/TC ratio parameter and will automatically perform this multiplication.

1.2 EQUIVALENT TRAFFIC CALCULATIONS.

In order to complete the equivalent traffic calculations for converting one of the aircraft in the mix to another, a procedure based on cumulative damage factor (CDF) is used. The CDF method is similar to the one used in the design procedures embodied in the design program FAARFIELD, required by AC 150/5320-6, and provides more consistent results than the wheel load method (as in FAA's CBR and Westergaard methods) when the traffic mix contains a wide range of gear geometries and strut loads. The primary difference between the CDF procedure used here and the one in FAARFIELD is that in FAARFIELD, the CDF is summed over all aircraft to produce the criterion for design whereas in the procedure used here the CDF methodology is used to convert the traffic for the complete mix into an equivalent number of coverages of one of the aircraft in the mix. That aircraft is designated the "critical" aircraft or "most demanding" aircraft for PCN determination or the "design" aircraft for thickness design (FAA's CBR and Westergaard methods). The wheel load method is briefly described before describing the CDF method.

In the wheel load method, select one of the aircraft in the mix to be the critical aircraft and then convert the traffic of the remaining aircraft into equivalent traffic of the critical aircraft. First, with equation A-1, convert the traffic for the gear type of each of the conversion aircraft into equivalent traffic for the same gear type as the critical aircraft.

$$TC_{CRTGE} = TC_{CNV} \times 0.8^{(M-N)} \qquad \text{(Equation A-2)}$$

Where:

- TC_{CNV} = the number of traffic cycles of the conversion aircraft.
- TC_{CRTGE} = the number of traffic cycles of the critical aircraft equivalent to the number of traffic cycles of the conversion aircraft due to gear type equivalency.
- N = the number of wheels on the main gear of the conversion aircraft.
- M = the number of wheels on the main gear of the critical aircraft.

Second, with equation A-3, convert the gear equivalency traffic cycles into equivalent traffic based on load magnitude.

$$\text{Log}\left(TC_{CRTE}\right) = \text{Log}\left(TC_{CRTGE}\right) \times \sqrt{\frac{W_{CRT}}{W_{CNV}}}$$

Or (Equation A-3)

$$TC_{CRTE} = \left(TC_{CRTGE}\right)^{\sqrt{W_{CRT}/W_{CNV}}}$$

Where:

- TC_{CRTE} = the number of traffic cycles of the critical aircraft equivalent to the number of traffic cycles of the conversion aircraft due to gear type and load magnitude equivalencies.
- W_{CNV} = the wheel load of the conversion aircraft.
- W_{CRT} = the wheel load of the critical aircraft.

Alternatively, both operations can be combined into a single equation:

$$TC_{CRTE} = \left(TC_{CNV} \times 0.8^{(M-N)}\right)^{\sqrt{W_{CRT}/W_{CNV}}} \qquad \text{(Equation A-4)}$$

Finally, the equivalent traffic cycles of all of the conversion aircraft are added to the original traffic cycles of the critical aircraft to give the total equivalent traffic cycles of the critical aircraft.

In the CDF method, the number of equivalent traffic cycles of the critical aircraft is defined as the number of traffic cycles of the critical aircraft that will cause the same amount of damage to the pavement as the number of traffic cycles of the conversion aircraft, where damage is defined by CDF.

CDF is derived from Miner's Rule, which states the damage induced in a structural element is proportional to the number of load applications divided by the number of load applications required to fail the structural element. In airport pavement design, load applications are counted in coverages, so the relationship for calculating equivalent traffic is first derived in terms of coverages.

$$CDF_{CNV} = \frac{C_{CNV}}{C_{CNVF}} = \frac{\text{coverages of the conversion aircraft}}{\text{coverages to fail the pavement when loaded by the conversion aircraft}}$$

$$= \text{cumulative damage factor resulting from the coverages of the conversion aircraft}$$

$$CDF_{CRTE} = \frac{C_{CRTE}}{C_{CRTF}} = \frac{\text{equivalent coverages of the critical aircraft}}{\text{coverages to fail the pavement when loaded by the critical aircraft}}$$

$$= \text{cumulative damage factor resulting from the equivalent coverages of the critical aircraft}$$

CDF is the fraction of the total pavement life used up by operating the indicated aircraft on the pavement. It therefore follows that the CDF for the equivalent critical aircraft is equal to the CDF for the conversion aircraft. Or:

$$\frac{C_{CRTE}}{C_{CRTF}} = \frac{C_{CNV}}{C_{CNVF}}, \text{ and}$$

$$C_{CRTE} = \frac{C_{CRTF}}{C_{CNVF}} C_{CNV} \qquad \text{(Equation A-5)}$$

But:

$$TC_{CNV} = PC_{CNV} \times C_{CNV}, \text{ and}$$
$$TC_{CRTE} = PC_{CRT} \times C_{CRTE}$$

Where:

TC_{CNV} = the number of traffic cycles of the conversion aircraft.

TC_{CRTE} = the number of traffic cycles of the critical aircraft equivalent to the number of traffic cycles of the conversion aircraft.
PC_{CNV} = pass-to-coverage ratio for the conversion aircraft.
PC_{CRT} = pass-to-coverage ratio for the critical aircraft.

Therefore, the equivalent traffic cycles of the critical aircraft by the CDF method is given by:

$$TC_{CRTE} = \frac{PC_{CRT}}{PC_{CNV}} \frac{C_{CRTF}}{C_{CNVF}} TC_{CNV} \qquad \text{(Equation A-6)}$$

Equation A-6 can be rewritten as:

$$C_{CRTEI} = C_{CRTF} \times CDF_{CNVI}$$

Where:
C_{CRTEI} = the number of equivalent coverages of the Ith aircraft in the list, including the critical aircraft.
CDF_{CNVI} = the CDF of the Ith aircraft in the list, including the critical aircraft.

Summing over all aircraft in the list gives the total number of equivalent coverages of the critical aircraft, $C_{CRTETotal}$, as:

$$C_{CRTETotal} = \sum_{I=1}^{N} C_{CRTEI} = \sum_{I=1}^{N} C_{CRTF} \times CDF_{CNVI} = C_{CRTF} \sum_{I=1}^{N} CDF_{CNVI}$$

Where N = the total number of aircraft in the list, including the critical aircraft.

Defining the total CDF for the traffic mix, CDF_T, as the total number of equivalent coverages of the critical aircraft divided by the number of coverages to failure of the critical aircraft, gives the equation:

$$CDF_T = \frac{C_{CRTETotal}}{C_{CRTF}} = \sum_{I=1}^{N} CDF_{CNVI} \qquad \text{(Equation A-7)}$$

The total CDF for the traffic mix is therefore, by this definition, the sum of the CDFs of all of the aircraft in the traffic mix, including that of the critical aircraft.

Table A-2 shows how the above calculations are combined, using the COMFAA Life calculation with the Batch option checked, to determine the equivalent traffic cycles of the critical aircraft. The pavement is assumed to be a flexible structure 33.80 inches thick on a CBR 8 subgrade. For this example, assume that the B747-400 is the critical aircraft. Also assume that the P/TC ratio is 1.0 so Traffic Cycles equals Annual Departures. Referring to the Top table, the CDF contribution of each aircraft on the pavement is calculated by dividing 20-year Coverages (Column 7) by Life (Column 9), with results shown in the Bottom portion of the table. The B747-400 is the assumed critical aircraft, so the operations of all other aircraft are equated to the B747-400. The results are shown in Column 11 of the

Bottom portion of the table. Column 11 results use equation A-6, i.e., (3000/0.6543)*Col. 10. The sum of the equivalent annual departures (Equation A-7) indicates that all other aircraft are equivalent to 468 departures of the B747-400.

Table A-2. Example of COMFAA Batch Life Calculations

Top

CBR = 8.00
Evaluation pavement thickness = 33.80 in

Results Table: Life Computations

No.	Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Col 5 Annual Deps	6D Thick	Col 7 20-yr Coverages	Life Thick	Col 9 Coverages to Failure (Life)
1	A300-B4 STD	365,747	94.00	216.1	1,500	29.86	16,456	33.80	310,137
2	A319-100 std	141,978	92.60	172.6	1,200	22.08	6,443	33.80	1,602,794.6E+003
3	Adv. B727-200 Basic	185,200	96.00	148.0	400	25.09	2,754	33.80	385,343
4	B737-300	140,000	90.86	201.0	6,000	25.19	31,003	33.80	2,730,009.4E+002
5	B747-400	877,000	93.32	200.0	3,000	33.15	34,410	33.80	52,590
6	B767-200 ER	396,000	90.82	190.0	2,000	29.44	21,813	33.80	815,894
7	B777-200 ER	657,000	91.80	205.0	300	28.87	4,375	33.80	675,096
8	DC8-63	330,000	96.12	194.0	800	28.10	9,269	33.80	1,080,551

Bottom

Col 10 = Col 7 / Col 9

Col. 1	Col 5	Col 7	Col 9	Col 10 CDF	Col 11 Equivalent Departures
A300-B4 STD	1,500	16,456	310,137	0.0531	243
A319-100 std	1,200	6,443	1.60E+09	0.0000	0
Adv. B727-200 Basic	400	2,754	385,343	0.0071	33
B737-300	6,000	31,003	2.73E+08	0.0001	1
B747-400	3,000	34,410	52,590	0.6543	3,000
B767-200 ER	2,000	21,813	815,894	0.0267	123
B777-200 ER	300	4,375	675,096	0.0065	30
DC8-63	800	9,269	1,080,551	0.0086	39
			Totals	0.7564	3,468

Example using B747-400 as the critical aircraft

Col 11 converts all to B747-400 departures

Col 11 = 3,000 multiplied by (Col 10) / 0.6543

CBR = 8.00
Evaluation pavement thickness = 33.80 in

All Departures converted to B747-400 3,468 --> 0.7564 Life
39778/52590 = 0.7564 Life

Results Table: Life Computations

No.	Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	6D Thick	20-yr Coverages	Life Thick	Coverages to Failure (Life)
5	B747-400	877,000	93.32	200.0	3,468	33.38	39,778	33.80	52,590

The Top portion of the table can be viewed in the Details window in the program after executing the Life function for Flexible pavement with all computation features available (shown when the "MORE" button is clicked). Pavement thickness and subgrade strength must be entered in the program for the Life function to work correctly. Results for all aircraft in the list will be computed and displayed if the Batch box is checked. Otherwise, results for only one aircraft is displayed. Detailed instructions are given later for operating the program.

Coverages to failure for each individual aircraft is computed in the program by changing the number of coverages for that aircraft until the design thickness by the CBR method (for flexible pavements) is the same as the evaluation pavement thickness, in this case 33.8 inches. As explained above, CDF is the ratio of applied coverages to coverages to failure, and is a measure of the amount of damage done to the pavement by that aircraft over a period of 20 years (under the assumptions implicit in the design procedure). If the CDF for any aircraft is equal to one, then the pavement is predicted to fail in 20 years if it is the only aircraft in operation. If the sum of the CDFs for all aircraft in the list is equal to one, then the pavement is predicted to fail in 20 years with all of the aircraft operating at their assumed operating weights and annual departures. The sum of the CDFs in this example is 0.7564, indicating that the pavement is being operated under a set of conservative assumptions.

It should be noted that the sum of the CDFs as calculated in COMFAA do not strictly provide a prediction of pavement damage caused by the accumulation of damage from all of the aircraft because not all of the aircraft landing gears pass down the same longitudinal path. The summation given here would therefore provide a somewhat conservative result than expected. In comparison with the FAARFIELD computer program, the COMFAA values correspond to the “CDF Max for Aircraft” values from FAARFIELD. The “CDF Contribution” values from FAARFIELD are summed along defined longitudinal paths and do not correspond to the values from COMFAA, except when the Contribution and Max for Aircraft values coincide. This discussion indicates how, all other things being equal, the equivalent critical aircraft concept used in FAA’s CBR and Westergaard methods and in COMFAA, produces more conservative designs than the procedure used in FAARFIELD, and why the two methodologies can never be made to produce the same predictions of pavement life for different traffic mixes.

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APPENDIX B. TECHNICAL EVALUATION METHOD—EVALUATION PAVEMENT PROPERTIES DETERMINATION

1.0. TECHNICAL EVALUATION METHOD.

The Technical Evaluation method for determining a PCN requires pavement thickness and cross-sectional properties as well as traffic mix details.

1.1 FLEXIBLE PAVEMENT CROSS-SECTION PROPERTIES—EQUIVALENT THICKNESS DETERMINATION.

For evaluation purposes, the thickness of the flexible pavement section under consideration must be referenced to standard flexible pavement sections. The standard section is the total thickness requirement calculated by the COMFAA program assuming minimum layer thickness for the asphalt surface, minimum base layer thickness of material with a CBR 80 or higher, and a variable thickness subbase layer with a CBR 20 or greater. For flexible pavement systems, two standard structural reference sections are used.

When no aircraft in the traffic mix have four or more wheels on a main gear, the minimum asphalt surface course thickness requirement is 3 inches and the minimum high quality crushed aggregate base course thickness requirement is 6 inches.

When one or more aircraft in the traffic mix have four or more wheels on a main gear, the minimum asphalt surface course thickness requirement is 5 inches and the minimum high quality crushed aggregate base course thickness requirement is 8 inches.

Reference Structural Layer Thickness (inches)	Less than Four Wheels on Main Gear	Four or More Wheels on Main Gear
Asphaltic Concrete (FAA Item P-401)	3	5
High Quality Granular Base (FAA Item P-209)	6	8

If the pavement has excess material or improved materials, the total pavement thickness may be increased according to the FAA CBR method summarized herein as Figures B-1 and B-2 and Table B-1. The pavement is considered to have excess asphalt, which can be converted to extra equivalent thickness, when the asphalt thickness is greater than the minimum thickness of asphalt surfacing of the referenced pavement section. The pavement may also be considered to have excess aggregate base thickness when the cross-section has a high quality crushed aggregate base thickness greater than the minimum thickness of high quality crushed aggregate base of the referenced pavement section or when other improved materials, such as asphalt stabilization or cement treated materials, are present. Likewise, additional improved base materials may also be converted to additional subbase material to add to the total pavement thickness.

If the evaluation pavement section is deficient for asphalt pavement surface course (i.e. less than 3 inches) and/or high quality crushed aggregate base course (i.e. less than 6 inches), the subbase thickness is reduced using a slightly more conservative inverse layer equivalency factor for surface course material and/or the subbase thickness is reduced using a slightly more conservative inverse layer equivalency factor for high quality crushed aggregate base material. This is shown in Table B-1.

Table B-1. FAA Flexible Pavement Layer Equivalency Factor Range

Structural Item	Description	Range Convert to P-209	Recommended Convert to P-209	Range Convert to P-154	Recommended Convert to P-154
P-501	Portland Cement Concrete (PCC)	--	--	--	--
P-401	Plant Mix Bituminous Pavements (HMA)	1.2 to 1.6	1.6	1.7 to 2.3	2.3
P-403	Plant Mix Bituminous Pavements (HMA)	1.2 to 1.6	1.6	1.7 to 2.3	2.3
P-306	Econocrete Subbase Course (ESC)	1.2 to 1.6	1.2	1.6 to 2.3	1.6
P-304	Cement Treated Base Course (CTB)	1.2 to 1.6	1.2	1.6 to 2.3	1.6
P-212	Shell Base Course	--	--	--	--
P-213	Sand-Clay Base Course	--	--	--	--
P-220	Caliche Base Course	--	--	--	--
P-209	Crushed Aggregate Base Course	1.0	1.0	1.2 to 1.6	1.4
P-208	Aggregate Base Course	1.0	1.0	1.0 to 1.5	1.2
P-211	Lime Rock Base Course	1.0	1.0	1.0 to 1.5	1.2
P-301	Soil-Cement Base Course	n/a	--	1.0 to 1.5	1.2
P-154	Subbase Course	n/a	--	1.0	1.0
P-501	Portland Cement Concrete (PCC)	Range Convert to P-401 2.2 to 2.5, 2.5 Recommended			

Note: Engineering judgment may be used to adjust recommended factors for all Structural Items within the ranges shown in the table. Include justification for higher or lower conversion factors than recommended factors when reporting PCN values.

1.2 RIGID PAVEMENT CROSS-SECTION PROPERTIES—IMPROVED SUBGRADE SUPPORT DETERMINATION.

The rigid pavement characteristics—including subgrade soil modulus, k, the concrete thickness, and flexural strength—are needed for PCN determination. The foundation modulus (k value) is assigned to the material directly beneath the concrete pavement layer. However, the k value for the subgrade is determined and then adjusted to account for improved layers (subbases) between the subgrade and the concrete layer. There are k value corrections available for uncrushed aggregate subbases, crushed aggregate subbases, and subbases stabilized with asphalt cement or Portland cement. The k value may be increased according to the methods described in the FAA Westergaard method, summarized herein as Figures B-3 through B-6. The thickness of the concrete in a rigid pavement may be increased if an asphalt overlay has been placed on the surface. The thickness may be increased using the factor described in the FAA Westergaard method, summarized herein as Figure B-7. Each 2.5 inches of asphalt may be converted to 1.0 inch of concrete. The references for both improvement subgrade support guidance and additional thickness conversion guidance is summarized in Table B-2.

Table B-2. FAA Rigid Pavement Subbase Effect on Foundation k Value

FAA Pavement Layer	Effect When Uncrushed Aggregate (Bank Run Sand and Gravel) is Used as the Subbase	Effect When Well-Graded Crushed Aggregate is Used as the Subbase	Effect When Asphalt Cement or Portland Cement Stabilized Materials are Used as the Subbase
P-401 and/or P-403			Ref. Figure B-6
P-306			Ref. Figure B-6
P-304			Ref. Figure B-6
P-209		Ref. Figure B-5, Upper Graph	
P-208 and/or P-211	Ref. Figure B-5, Lower Graph		
P-301	Ref. Figure B-5, Lower Graph		
P-154	Ref. Figure B-5, Lower Graph		
	Effect on Rigid Pavement Thickness		
P-401 Overlay	Ref. Figure B-7		

2.0 AVAILABILITY OF SUPPORT PROGRAM TO DETERMINE PAVEMENT CHARACTERISTICS.

To facilitate the use of the ACN-PCN system, FAA developed a software application that incorporates the guidance in this appendix and determines the evaluation thickness for both flexible and rigid pavements and the foundation k value for rigid pavements. The software may be downloaded from the FAA website.[3].

2.1 USING THE SUPPORT PROGRAM.

The support program is a spreadsheet, which may be updated periodically. Examples are shown in Figures C-2.

[3] See http://www.faa.gov/airports/engineering/design_software/. This software is in the public domain.

320. **STABILIZED BASE AND SUBBASE.** Stabilized base and subbase courses are necessary for new pavements designed to accommodate jet aircraft weighing 100,000 pounds (45 350 kg) or more. These stabilized courses may be substituted for granular courses using the equivalency factors discussed in paragraph 322. These equivalency factors are based on research studies which measured pavement performance. See FAA Report No. FAA-RD-73-198, Volumes I, II, and III. Comparative Performance of Structural Layers in Pavement Systems. See Appendix 3. A range of equivalency factors is given because the factor is sensitive to a number of variables such as layer thickness, stabilizing agent type and quantity, location of stabilized layer in the pavement structure, etc. Exceptions to the policy requiring stabilized base and subbase may be made on the basis of superior materials being available, such as 100 percent crushed, hard, closely graded stone. These materials should exhibit a remolded soaked CBR minimum of 100 for base and 35 for subbase. In areas subject to frost penetration, the materials should meet permeability and nonfrost susceptibility tests in addition to the CBR requirements. Other exceptions to the policy requiring stabilized base and subbase should be based on proven performance of a granular material such as lime rock in the State of Florida. Proven performance in this instance means a history of satisfactory airport pavements using the materials. This history of satisfactory performance should be under aircraft loadings and climatic conditions comparable to those anticipated.

321. **SUBBASE AND BASE EQUIVALENCY FACTORS.** It is sometimes advantageous to substitute higher quality materials for subbase and base course than the standard FAA subbase and base material. The structural benefits of using a higher quality material is expressed in the form of equivalency factors. Equivalency factors indicate the substitution thickness ratios applicable to various higher quality layers. Stabilized subbase and base courses are designed in this way. Note that substitution of lesser quality materials for higher quality materials, regardless of thickness, is not permitted. The designer is reminded that even though structural considerations for flexible pavements with high quality subbase and base may result in thinner flexible pavements; frost effects must still be considered and could require thicknesses greater than the thickness for structural considerations.

a. **Minimum Total Pavement Thickness.** The minimum total pavement thickness calculated, after all substitutions and equivalencies have been made, should not be less than the total pavement thickness required by a 20 CBR subgrade on the appropriate design curve.

b. **Granular Subbase.** The FAA standard for granular subbase is Item P-154, Subbase Course. In some instances it may be advantageous to utilize nonstabilized granular material of higher quality than P-154 as subbase course. Since these materials possess higher strength than P-154, equivalency factor ranges are established whereby a lesser thickness of high quality granular may be used in lieu of the required thickness of P-154. In developing the equivalency factors the standard granular subbase course, P-154, was used as the basis. Thicknesses computed from the design curves assume P-154 will be used as the subbase. If a granular material of higher quality is substituted for Item P-154, the thickness of the higher quality layer should be less than P-154. The lesser thickness is computed by dividing the required thickness of granular subbase, P-154, by the appropriate equivalency factor. In establishing the equivalency factors the CBR of the standard granular subbase, P-154, was assumed to be 20. The equivalency factor ranges are given below in Table 3-6:

TABLE 3-6. RECOMMENDED EQUIVALENCY FACTOR RANGES FOR HIGH QUALITY GRANULAR SUBBASE

Material	Equivalency Factor Range
P-208, Aggregate Base Course	1.0 - 1.5
P-209, Crushed Aggregate Base Course	1.2 - 1.8
P-2 I1, Lime Rock Base Course	1.0 - 1.5

Figure B-1. Flexible Pavement Stabilized Base Layer(s) Equivalency Discussion. (FAA CBR method)

c. **Stabilized Subbase.** Stabilized subbases also offer considerably higher strength to the pavement than P-154. Recommended equivalency factors associated with stabilized subbase are presented in Table 3-7.

TABLE 3-7. RECOMMENDED EQUWALENCY FACTOR RANGES FOR STABILIZED SUBBASE

Material	Equivalency Factor Range
P-301, Soil Cement Base Course	1.0 - 1.5
P-304, Cement Treated Base Course	1.6 - 2.3
P-306, Econocrete Subbase Course	1.6 - 2.3
P-401, Plant Mix Bituminous Pavements	1.7 - 2.3

d. **Granular Base.** The FAA standard for granular base is Item P-209, Crushed Aggregate Base Course. In some instances it may be advantageous to utilize other nonstabilized granular material as base course. Other materials acceptable for use as granular base course are as follows:

TABLE 3-8. RECOMMENDED EQUIVALENCY FACTOR RANGES FOR GRANULAR BASE

Material	Equivalency Factor Range
P-208, Aggregate Base Course	1.0'
P-21 1, Lime Rock Base Course	1.0

'Substitution of P-208 for P-209 is permissible only if the gross weight of the design aircraft is 60,000 lbs (27 000 kg) or less. In addition, if P-208 is substituted for P-209, the required thickness of hot mix asphalt surfacing shown on the design curves should be increased 1 inch (25 mm).

e. **Stabilized Base.** Stabilized base courses offer structural benefits to a flexible pavement in much the same manner as stabilized subbase. The benefits are expressed as equivalency factors similar to those shown for stabilized subbase. In developing the equivalency factors Item P-209, Crushed Aggregate Base Course, with an assumed CBR of 80 was used as the basis for comparison. The thickness of stabilized base is computed by dividing the granular base course thickness requirement by the appropriate equivalency factor. The equivalency factor ranges are given below in Table 3-9. Ranges of equivalency factors are shown rather than single values since variations in the quality of materials, construction techniques, and control can influence the equivalency factor. In the selection of equivalency factors, consideration should be given to the traffic using the pavement, total pavement thickness, and the thickness of the individual layer. For example, a thin layer in a pavement structure subjected to heavy loads spread over large areas will result in an equivalency factor near the low end of the range. Conversely, light loads on thick layers will call for equivalency factors near the upper end of the ranges.

TABLE 3-9. RECOMMENDED EQUIVALENCY FACTOR RANGES FOR STABILIZED BASE

Material	Eauivalencv Factor Range
P-304, Cement Treated Base Course	1.2 - 1.6
P-306, Econocrete Subbase Course	1.2 - 1.6
P-401, Plant Mix Bituminous Pavements	1.2 - 1.6

Note: Reflection cracking may be encountered when P-304 or P-306 is used as base for a flexible pavement. The thickness of the hot mix asphalt surfacing course should be at least 4 inches (100 mm) to minimize reflection cracking in these instances.

f. **Example.** As an example of the use of equivalency factors, assume a flexible pavement is required to serve a design aircraft weighing 300,000 pounds (91 000 kg) with a dual tandem gear. The equivalent annual departures are 15,000. The design CBR for the subgrade is 7. Item P-401 will be used for the base course and the subbase course.

Figure B-2. Flexible Pavement Stabilized Base Layer(s) Equivalency Discussion (Continued). (FAA CBR method)

324. GENERAL. Rigid pavements for airports are composed of Portland cement concrete placed on a granular or treated subbase course that is supported on a compacted subgrade. Under certain conditions, a subbase is not required (see paragraph 326).

325. CONCRETE PAVEMENT. The concrete surface must provide a nonskid surface, prevent the infiltration of surface water into the subgrade, and provide structural support to the aircraft. The quality of the concrete, acceptance and control tests, methods of construction and handling, and quality of workmanship are covered in Item P-501, Portland Cement Concrete Pavement.

326. SUBBASE. The purpose of a subbase under a rigid pavement is to provide uniform stable support for the pavement slabs. A minimum thickness of 4 inches (100 mm) of subbase is required under all rigid pavements, except as shown in Table 3-10 below:

TABLE 3-10. CONDITIONS WHERE NO SUBBASE IS REQUIRED

Soil	Good Drainage		Poor Drainage	
Classification	No Frost	Frost	No Frost	Frost
GW	**X**	**X**	**X**	**X**
GP	**X**	**X**	**X**	
GM	**X**			
GC	**X**			
SW	**X**			

Note: X indicates conditions where no subbase is required.

327. SUBBASE QUALITY. The standard FAA subbase for rigid pavements is 4 inches (100 mm) of Item P-154, Subbase Course. In some instances, it may be desirable to use higher-quality materials or thicknesses of P-154 greater than 4 inches (100 mm). The following materials are acceptable for use as subbase under rigid pavements:

Item P-154 – Subbase Course
Item P-208 – Aggregate Base Course
Item P-209 – Crushed Aggregate Base Course
Item P-211 – Lime Rock Base Course
Item P-304 – Cement Treated Base Course
Item P-306 – Econocrete Subbase Course
Item P-401 – Plant Mix Bituminous Pavements

Materials of higher quality than P-154 and/or greater thicknesses of subbase are considered in the design process through the foundation modulus (k value). The costs of providing the additional thickness or higher-quality subbase should be weighed against the savings in concrete thickness.

328. STABILIZED SUBBASE. Stabilized subbase is required for all new rigid pavements designed to accommodate aircraft weighing 100,000 pounds (45 400 kg) or more. Stabilized subbases are as follows:

Item P-304 – Cement Treated Base Course
Item P-306 – Econocrete Subbase Course
Item P-401 – Plant Mix Bituminous Pavements

The structural benefit imparted to a pavement section by a stabilized subbase is reflected in the modulus of subgrade reaction assigned to the foundation. Exceptions to the policy of using stabilized subbase are the same as those given in paragraph 320.

329. SUBGRADE. As with a flexible pavement, the subgrade materials under a rigid pavement should be compacted to provide adequate stability and uniform support; however, the compaction requirements for rigid pavements are not as stringent as for flexible pavement because of the relatively lower subgrade stress. For cohesive soils used in fill sections, the top 6 inches (150 mm) must be compacted to 90 percent maximum density. Fill depths

Figure B-3. Rigid Pavement Stabilized Subbase Layer(s) Discussion. (FAA Westergaard method)

greater than 6 inches (150 mm) must be compacted to 90 percent maximum density or meet the requirements of Table 3-2. For cohesive soils in cut sections, the top 6 inches (150 mm) of the subgrade must be compacted to 90 percent maximum density. For noncohesive soils used in fill sections, the top 6 inches (150 mm) of fill must be compacted to 100 percent maximum density, and the remainder of the fill must be compacted to 95 percent maximum density or meet the requirements of Table 3-2. For cut sections in noncohesive soils, the top 6 inches (150 mm) of subgrade must be compacted to 100 percent maximum density and the next 18 inches (460 mm) of subgrade must be compacted to 95 percent maximum density. Swelling soils require special considerations. Paragraph 314 contains guidance on the identification and treatment of swelling soils.

a. Contamination. In rigid pavement systems, repeated loading might cause intermixing of soft subgrade soils and aggregate base or subbase. This mixing can create voids below the pavement in which moisture can accumulate, causing pumping to occur. Chemical and mechanical stabilization of the subbase or subgrade can effectively reduce aggregate contamination (see paragraph 207). Geotextiles have been found to be effective at providing separation between fine-grained subgrade soils and pavement aggregates (FHWA-HI-90-001 Geotextile Design and Construction Guidelines). Geotextiles should be considered for separation between fine-grained soils and overlying pavement aggregates. In this application, the geotextile is not considered to act as a structural element within the pavement. Therefore, the modulus of the base or subbase is not increased when a geotextile is used for stabilization. For separation applications, the geotextile is designed based on survivability properties. FHWA-HI-90-001 contains additional information about design and construction using separation geotextiles.

330. DETERMINATION OF FOUNDATION MODULUS (k VALUE) FOR RIGID PAVEMENT. In addition to the soils survey and analysis and classification of subgrade conditions, rigid pavement design also requires the determination of the foundation modulus. The k value should be assigned to the material directly beneath the concrete pavement. However, the FAA recommends that a k value be established for the subgrade and then corrected to account for the effects of the subbase.

a. Determination of k Value for Subgrade. The preferred method of determining the subgrade modulus is by testing a limited section of embankment that has been constructed to the required specifications. The plate bearing test procedures are given in AASHTO T 222, Nonrepetitive Static Plate Load Test of Soils and Flexible Pavement Components for Use in Evaluation and Design of Airport and Highway Pavements. If the construction and testing of a test section of embankment is impractical, the values listed in Table 2-3 may be used. The values in Table 2-3, however, are approximate, and engineering judgment should be used when selecting a design value. Fortunately, rigid pavement is not overly sensitive to k value, and an error in estimating k will not have a large impact on rigid pavement thickness.

b. Determination of k Value for Granular Subbase. It is usually not practical to determine a foundation modulus on top of a subbase by testing, at least in the design phase. Usually, the embankment and subbase will not be in place in time to perform any field tests, so the k value will have to be assigned without the benefit of testing. The probable increase in k value associated with various thicknesses of different subbase materials is shown in Figure 2-4. The upper graph in Figure 2-4 should be used when the subbase is composed of well-graded crushed aggregate, such as P-209. The lower graph in Figure 2-4 applies to bank-run sand and gravel, such as P-154. Both curves in Figure 2-4 apply to unstabilized granular materials. Values shown in Figure 2-4 are guides and can be tempered by local experience.

c. Determination of k Value for Stabilized Subbase. As with granular subbase, the effect of stabilized subbase is reflected in the foundation modulus. Figure 3-16 shows the probable increase in k value with various thicknesses of stabilized subbase located on subgrades of varying moduli. Figure 3-16 is applicable to cement stabilized (P-304), Econocrete (P-306), and bituminous stabilized (P-401) layers. Figure 3-16 assumes a stabilized layer is twice as effective as well-graded crushed aggregate in increasing the subgrade modulus. Stabilized layers of lesser quality than P-304, P-306, or P-401 should be assigned somewhat lower k values. After a k value is assigned to the stabilized subbase, the concrete slab thickness design procedure is the same as that described in paragraph 331.

Figure B-4. Rigid Pavement Stabilized Subbase Layer(s) Discussion (Continued). (FAA Westergaard method)

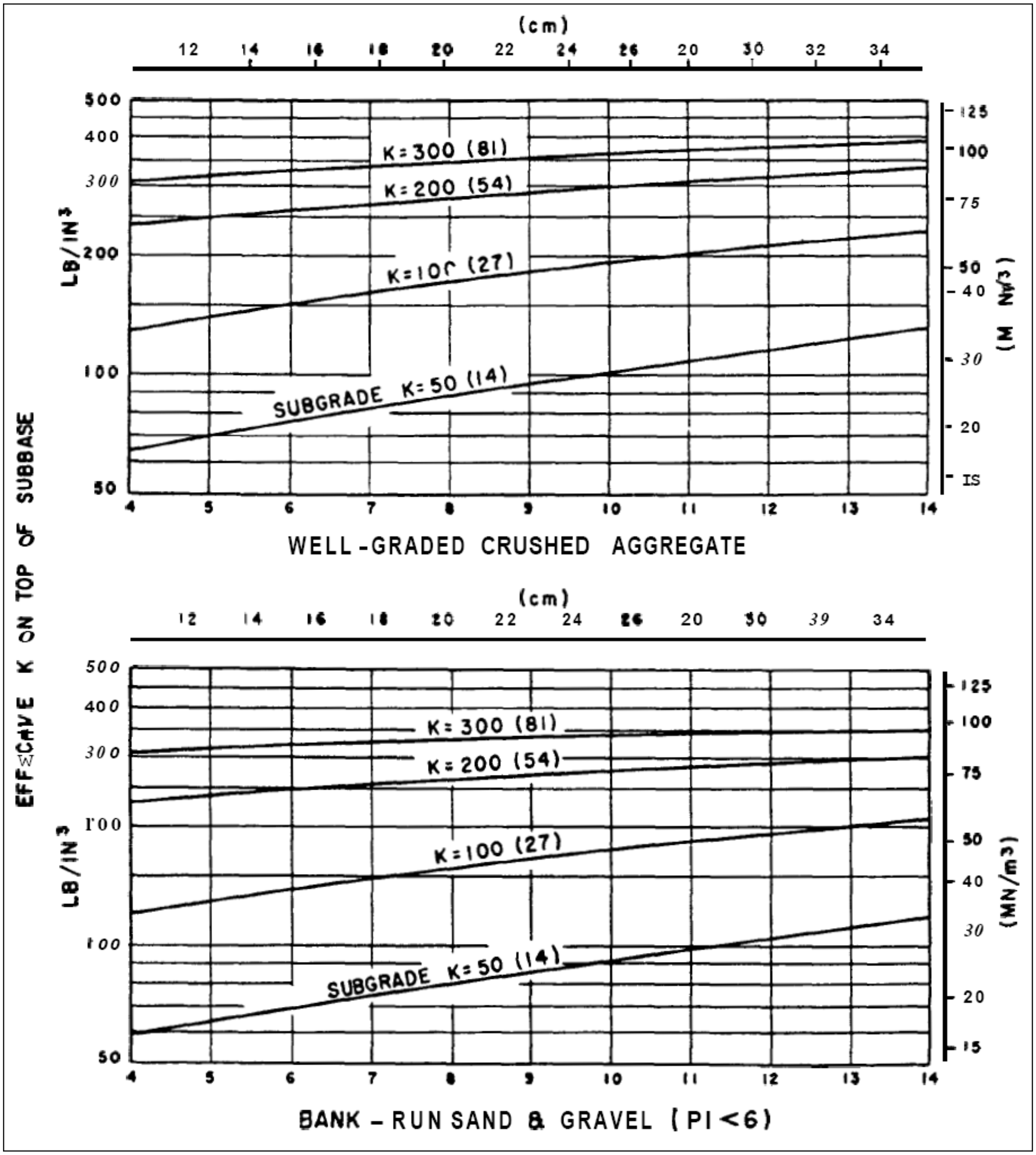


Figure B-5. Subbase Layer Effect on Subgrade Support, k, for Rigid Pavement. (FAA Westergaard method)

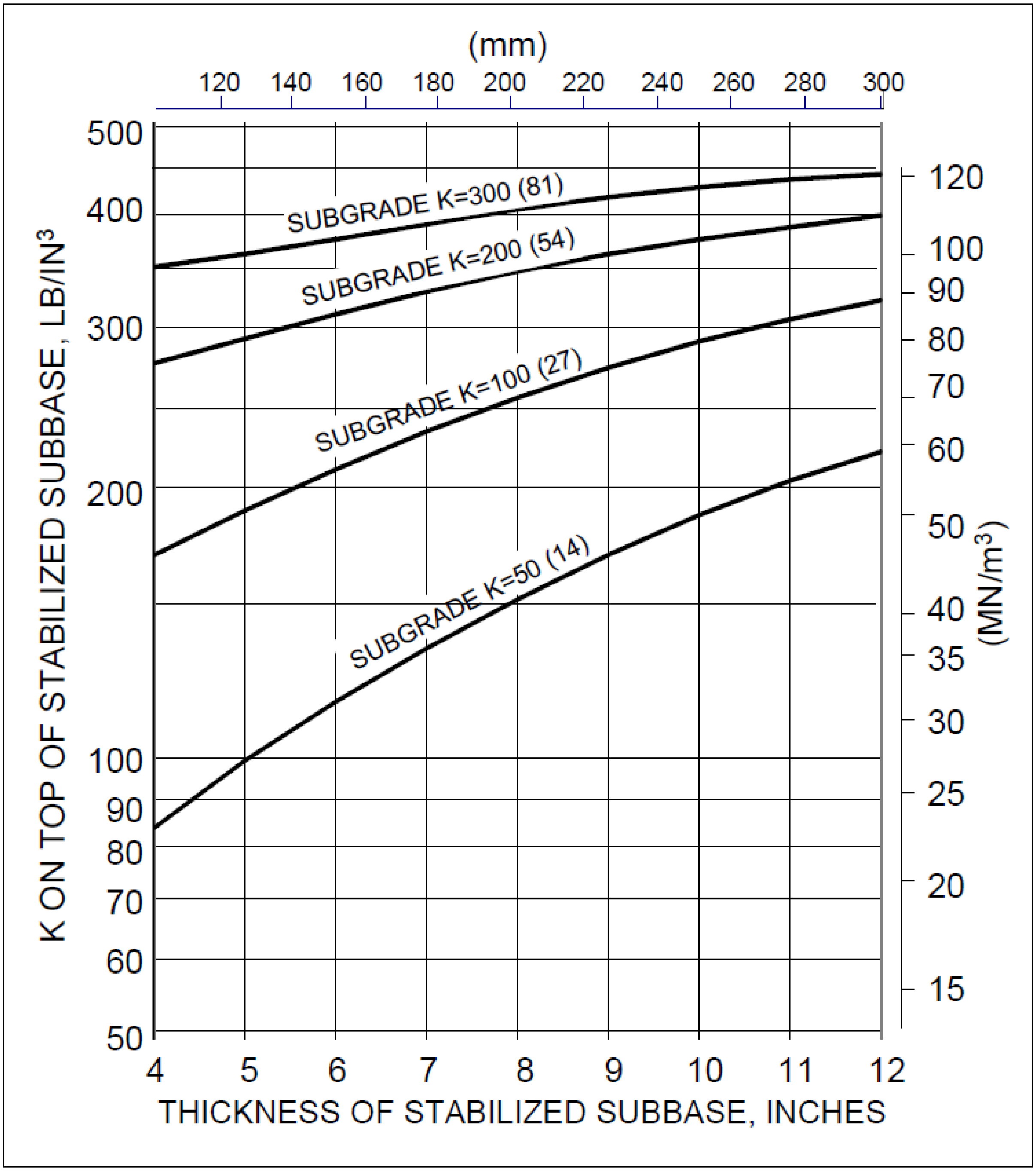


Figure B-6. Stabilized Subbase Layer Effect on Subgrade Support, k, for Rigid Pavement. (FAA Westergaard method)

subbase must be at the equilibrium moisture content when field CBR tests are conducted. Normally, a pavement that has been in place for at least 3 years will be in equilibrium. Procedures for calculating CBR values from NDT tests are also available. Layer conversions (i.e., converting base to subbase, etc.) are largely a matter of engineering judgment. When performing the conversions, it is recommended that any converted thicknesses not be rounded off.

406. HOT MIX ASPHALT OVERLAY ON EXISTING RIGID PAVEMENT. The design of a hot mix asphalt overlay on an existing rigid pavement is also based on a thickness deficiency approach. However, new pavement thickness requirements for rigid pavements are used to compare with the existing rigid pavement. The formula for computing overlay thickness is as follows:

$$t = 2.5(Fh_d - C_b h_e)$$

Where:

t = thickness of hot mix asphalt overlay, inches (mm).

F = a factor which controls the degree of cracking in the base rigid pavement.

h_d = thickness of new rigid pavement required for design conditions, inches (mm). Use the exact value for h_d; do not round off. In calculating h_d use the k value of the existing foundation and the flexural strength of the existing concrete as design parameters.

C_b = a condition factor that indicates the structural integrity of the existing rigid pavement. Values range from 1.0 to 0.75.

h_e = thickness of existing rigid pavement, inches (mm).

a. F Factor. The "F" factor is an empirical method of controlling the amount of cracking that will occur in the rigid pavement beneath the hot mix asphalt overlay. It is a function of the amount of traffic and the foundation strength. The assumed failure mode for a hot mix asphalt overlay on a existing rigid pavement is that the underlying rigid pavement cracks progressively under traffic until the average size of the slab pieces reaches a critical value. Further traffic beyond this point results in shear failures within the foundation, producing a drastic increase in deflections. Since high strength foundations can better resist deflection and shear failure, the F factor is a function of subgrade strength as well as traffic volume. Photographs of various overlay and base pavements shown in Figure 4-2 illustrate the meaning of the F factor. Figures 4-2a, b, and c show how the overlay and base pavements fail as more traffic is applied to a hot mix asphalt overlay on an existing rigid pavement. Normally an F factor of 1.0 is recommended unless the existing pavement is in quite good condition, see paragraph 406b(1) below. Figure 4-3 should be used to determine the appropriate F factor for pavements in good condition.

b. C_b Factor. The condition factor "C_b" applies to the existing rigid pavement. The C_b factor is an assessment of the structural integrity of the existing pavement.

(1) Selection of C_b Factor. The overlay formula is rather sensitive to the C_b value. A great deal of care and judgement are necessary to establish the appropriate C_b. NDT can be a valuable tool in determining a proper value. A C_b value of 1.0 should be used when the existing slabs contain nominal structural cracking and 0.75 when the slabs contain structural cracking. The designer is cautioned that the range of C_b values used in hot mix asphalt overlay designs is different from the "C_r" values used in rigid overlay pavement design. A comparison of C_b and C_r and the recommended F factor to be used for design is shown below:

C_r	C_b	Recommended F factor
0.35 to 0.50	0.75 to 0.80	1.00
0.51 to 0.75	0.81 to 0.90	1.00
0.76 to 0.85	0.91 to 0.95	1.00
0.86 to 1.00	0.96 to 1.00	Use Figure 4.3

The minimum C_b value is 0.75. A single C_b should be established for an entire area. The C_b value should not be varied along a pavement feature. Figures 4-4 and 4-5 illustrate C_b values of 1.0 and 0.75, respectively.

Figure B-7. Flexible Pavement quivalency to Rigid Pavement. (FAA Westergaard method)

APPENDIX C. PCN DETERMINATION EXAMPLES

1.0. THE USING AIRCRAFT METHOD.

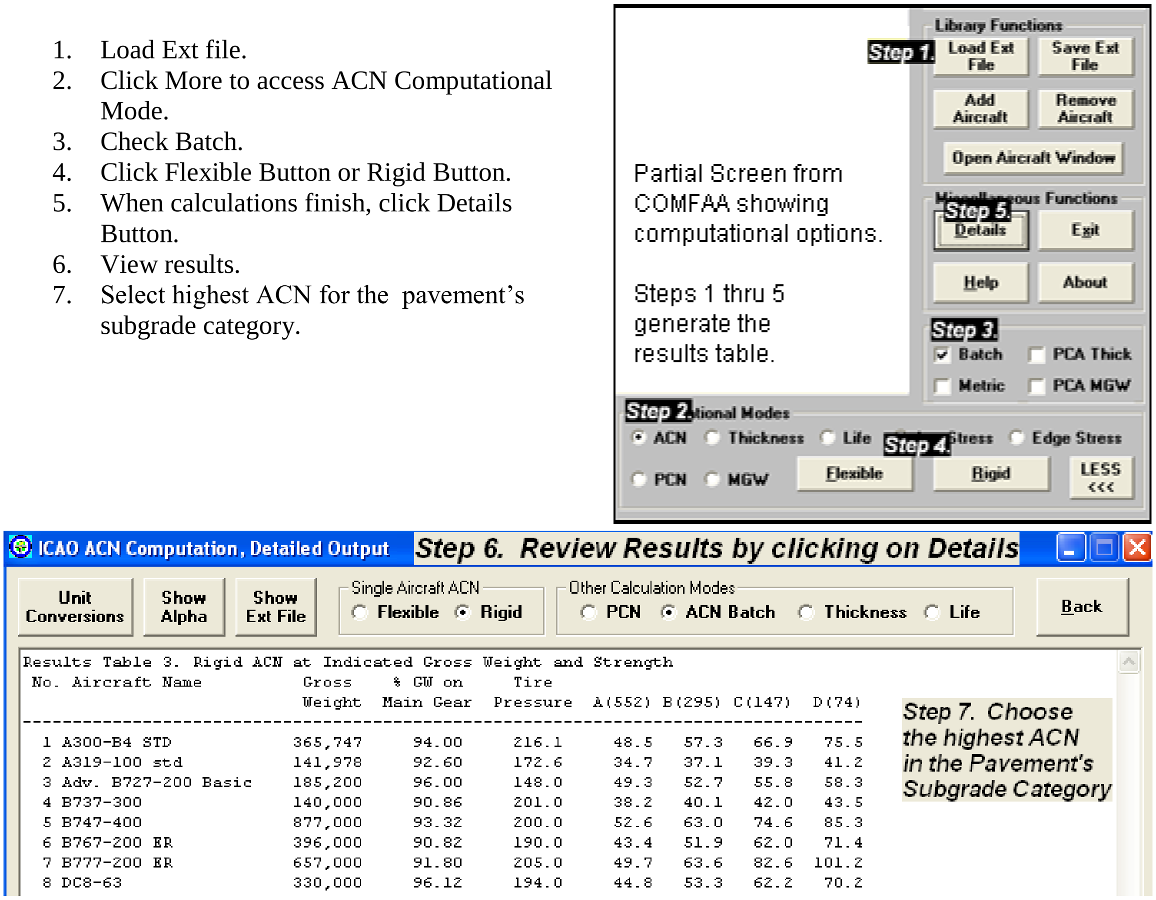
The Using aircraft method of determining PCN is presented in the following steps. This procedure can be used when there is limited knowledge of the existing traffic and runway characteristics. It is also useful when engineering analysis is neither possible nor desired. Airport authorities should be more careful in the application of a Using aircraft PCN in that the rating has not been rigorously determined.

There are basic steps required to arrive at a Using aircraft PCN:

- Determine the ACN for each aircraft in the traffic mix currently using the pavement**.**
- Assign the highest ACN value as the PCN.

These steps are explained below in greater detail. Figure C-1 shows the steps needed to automatically perform the ACN calculations using COMFAA along with the results.

1. Load Ext file.
2. Click More to access ACN Computational Mode.
3. Check Batch.
4. Click Flexible Button or Rigid Button.
5. When calculations finish, click Details Button.
6. View results.
7. Select highest ACN for the pavement's subgrade category.



Results Table 3. Rigid ACN at Indicated Gross Weight and Strength

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	A(552)	B(295)	C(147)	D(74)
1	A300-B4 STD	365,747	94.00	216.1	48.5	57.3	66.9	75.5
2	A319-100 std	141,978	92.60	172.6	34.7	37.1	39.3	41.2
3	Adv. B727-200 Basic	185,200	96.00	148.0	49.3	52.7	55.8	58.3
4	B737-300	140,000	90.86	201.0	38.2	40.1	42.0	43.5
5	B747-400	877,000	93.32	200.0	52.6	63.0	74.6	85.3
6	B767-200 ER	396,000	90.82	190.0	43.4	51.9	62.0	71.4
7	B777-200 ER	657,000	91.80	205.0	49.7	63.6	82.6	101.2
8	DC8-63	330,000	96.12	194.0	44.8	53.3	62.2	70.2

Figure C-1. Example of COMFAA ACN Batch Results

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, make a judgment of Medium or Low

3. Determine which aircraft has the highest ACN 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. ACN values may be determined from the COMFAA program or from ACN graphs found in the manufacturer's published ACAP manuals. Use the same subgrade code for each of the aircraft when determining the maximum ACN. Base ACNs on the highest operating weight of the aircraft at the airport if the data is available; otherwise, use an estimate or the published maximum allowable gross weight of the aircraft in question. Report the ACN from the aircraft with the highest ACN that ***regularly uses the pavement*** as the PCN for the pavement. NOTE: The FAA recommends that an aircraft be considered to 'regularly use' the pavement if the 20-year total of coverages exceeds 1,000. The number of annual departures of the aircraft corresponding to this coverage level can be obtained from COMFAA by switching to PCN or Thickness mode and

entering 1000 in the 'Flex 20yr Coverages' or 'Rigid 20yr Coverages' field, as appropriate. In COMFAA, coverages are independent of subgrade strength, so an arbitrary CBR or k value can be entered in the appropriate field to compute coverages..

4. The PCN is simply the highest ACN with appropriate tire pressure and evaluation codes added. The numerical value of the PCN 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.

5. 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.

6. The evaluation method for the Using aircraft method is reported as U.

1.1 USING AIRCRAFT EXAMPLE FOR FLEXIBLE PAVEMENTS.

The following example illustrates the Using aircraft PCN process for flexible pavements:

An airport has a runway with the known traffic mix shown in Table C-1. The runway has a flexible (asphalt-surfaced) pavement with an estimated subgrade strength of CBR 9, which puts it in subgrade category B. The flexible pavement ACNs for each aircraft in the mix are shown in Table C-1.

Table C-1. Using Aircraft and Traffic for a Flexible Pavement

Unit Conversions | Show Alpha | Show Ext File | Single Aircraft ACN: Flexible, Rigid | Other Calculation Modes: PCN, ACN Batch, Thickness, Lif

Top Portion

Save PCN Output to a Text File

Flexible Pavement Thickness Design by the CBR Method - Units are English

No.	Aircraft Name	Gross Wt.	Ann. Deps.	Coverages	CBR	ESWL	Des. Thickness
1	A300-B4 STD	364,747	1,500	16,434			
2	A319-100 std	141,978	1,200	6,443			
3	B737-300	140,000	6,000	31,003			
4	B747-400	877,000	1,000	11,470			
5	B767-200 ER	396,000	2,000	21,813			
6	B777-200 ER	657,000	1,000	14,583			
7	DC8-63	330,000	3,000	34,581			

Recommended 20-yr Coverages For Regular Using Aircraft is About 1,000

Unit Conversions | Show Alpha | Show Ext File | Single Aircraft ACN: Flexible, Rigid | Other Calculation Modes: PCN, ACN Batch, Thickness, Lif

Bottom Portion

Save PCN Output to a Text File

Flexible ACN at Indicated Gross Weight and Strength. Units = English.

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN at Indicated Code A(15)	B(10)	C(6)	D(3)
1	A300-B4 STD	364,747	94.00	216.1	46.1	51.4	62.5	79.4
2	A319-100 std	141,978	92.60	172.6	31.9	32.8	36.4	42.1
3	B737-300	140,000	90.86	201.0	33.0	34.8	38.8	42.8
4	B747-400 (Max)	877,000	93.32	200.0	53.2	59.3	72.6	94.2
5	B767-200 ER	396,000	90.82	190.0	44.9	49.6	59.8	80.2
6	B777-200 ER	657,000	91.80	205.0	49.1	55.4	68.0	94.8
7	DC8-63	330,000	96.12	196.0	43.2	48.8	58.5	73.3

Table A3-1

- Since this is a flexible pavement, the pavement type code is F, (Table 4-1).

- The subgrade strength under the pavement is CBR 9, or Medium category, so the appropriate code is B (Table 2-2).

- The highest tire pressure of any aircraft in the traffic mix is 216.1 psi, so the tire pressure code is X (Table 4-2).

- From the above list, the critical aircraft is the B747-400, because it has the highest ACN of the group at the operational weights shown (59.3/F/B). Additionally, it has regular service.

- 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 from Paragraph 4.5e is U.

- Based on the results of the previous steps, the runway pavement should tentatively be rated as PCN 59/F/B/X/U, assuming that the pavement is performing satisfactorily under the current traffic.

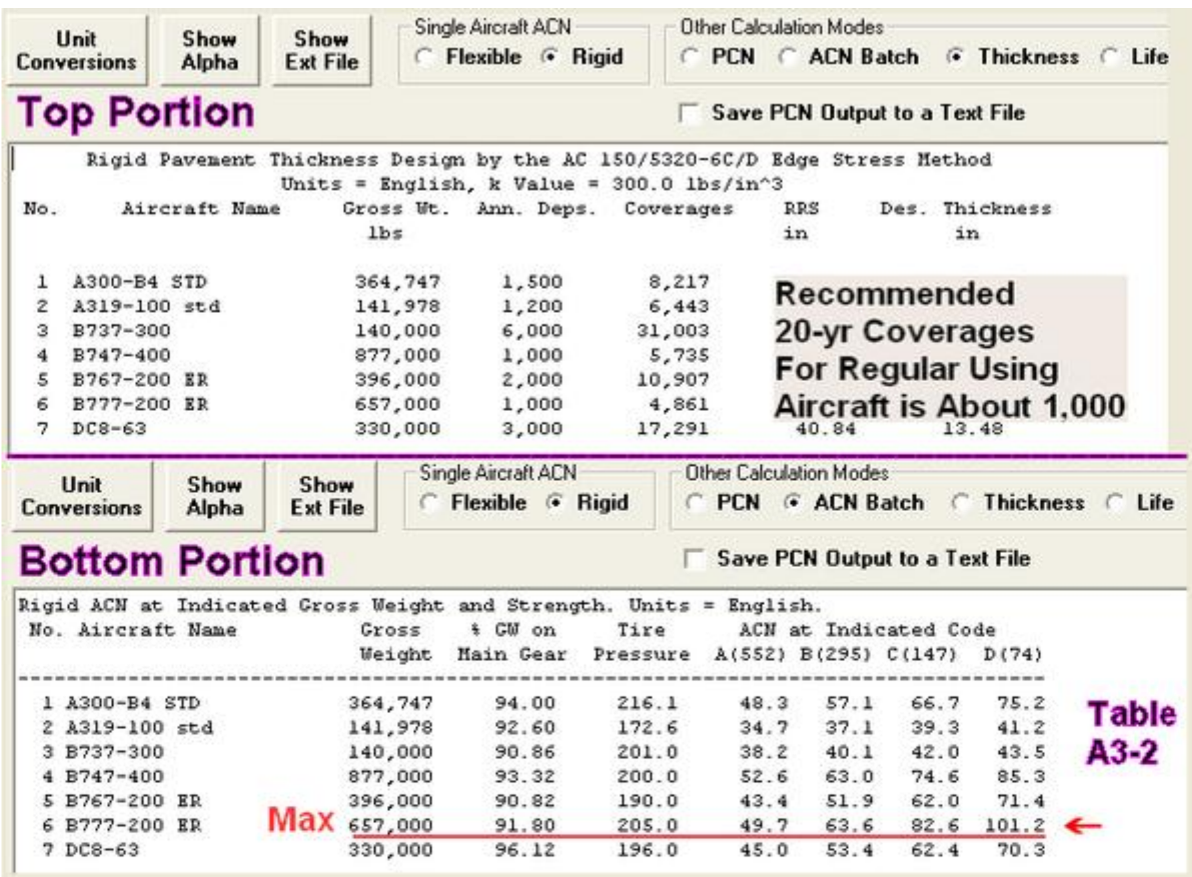
- If this pavement was a taxiway, the airport could rate this taxiway as the same PCN.

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 ACNs that exceed the assigned rating. This may require the airport to restrict the allowable gross weight for those aircraft or consider pavement strengthening.

1.2 USING AIRCRAFT EXAMPLE FOR RIGID PAVEMENTS.

An airport has a runway with the known traffic mix shown in Table C-2. The runway has a rigid (concrete-surfaced) pavement with an estimated k-value of 300 lbs/in3, which puts it in subgrade category B. The rigid pavement ACNs for each aircraft in the mix are shown in Table C-2.

Table C-2. Using Aircraft and Traffic for a Rigid Pavement from COMFAA (Details Window)


Unit Conversions | Show Alpha | Show Ext File | Single Aircraft ACN: Flexible, Rigid (selected) | Other Calculation Modes: PCN, ACN Batch, Thickness (selected), Life

Top Portion

Save PCN Output to a Text File

Rigid Pavement Thickness Design by the AC 150/5320-6C/D Edge Stress Method
Units = English, k Value = 300.0 lbs/in^3

No.	Aircraft Name	Gross Wt. lbs	Ann. Deps.	Coverages	RRS in	Des. Thickness in
1	A300-B4 STD	364,747	1,500	8,217		
2	A319-100 std	141,978	1,200	6,443		
3	B737-300	140,000	6,000	31,003		
4	B747-400	877,000	1,000	5,735		
5	B767-200 ER	396,000	2,000	10,907		
6	B777-200 ER	657,000	1,000	4,861		
7	DC8-63	330,000	3,000	17,291	40.84	13.48

Recommended 20-yr Coverages For Regular Using Aircraft is About 1,000

Unit Conversions | Show Alpha | Show Ext File | Single Aircraft ACN: Flexible, Rigid (selected) | Other Calculation Modes: PCN, ACN Batch (selected), Thickness, Life

Bottom Portion

Save PCN Output to a Text File

Rigid ACN at Indicated Gross Weight and Strength. Units = English.

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN at Indicated Code A(552)	B(295)	C(147)	D(74)
1	A300-B4 STD	364,747	94.00	216.1	48.3	57.1	66.7	75.2
2	A319-100 std	141,978	92.60	172.6	34.7	37.1	39.3	41.2
3	B737-300	140,000	90.86	201.0	38.2	40.1	42.0	43.5
4	B747-400	877,000	93.32	200.0	52.6	63.0	74.6	85.3
5	B767-200 ER	396,000	90.82	190.0	43.4	51.9	62.0	71.4
6	B777-200 ER	657,000	91.80	205.0	49.7	63.6	82.6	101.2
7	DC8-63	330,000	96.12	196.0	45.0	53.4	62.4	70.3

- Since this is a rigid pavement, the pavement type code is *R*, (Table 4-1).
- The subgrade strength under the pavement is k=300 pci, which is Medium category, so the appropriate code is B (Table 2-1).
- Concrete surfaces can tolerate high tire pressures, so tire pressure code W found in Table 4-2 should be used for rigid pavement.

- The B777-200 has the highest ACN of the group at the operational weights shown (63.6/R/B/W).

- 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 from Paragraph 4.5e is U.

- Based on these steps, the pavement should tentatively be rated as PCN 64/R/B/W/U in order to accommodate all of the current traffic.

- 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 ACNs 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.

2.0 THE TECHNICAL EVALUATION METHOD.

Use the technical evaluation method of determining PCN when there is reliable knowledge of the existing traffic and pavement characteristics. Total thickness and cross-sectional data are needed to determine the equivalent pavement thickness as described in detail in section 2.1. Although the technical evaluation provides a good representation of existing conditions, the airport authority should recognize there are many variables in the pavement structure as well as the method of analysis itself. The objective of the technical method is to consolidate all traffic into equivalent annual departures, determine allowable gross weight, and assess the ACN for each aircraft in the traffic mixture so that a realistic PCN is selected.

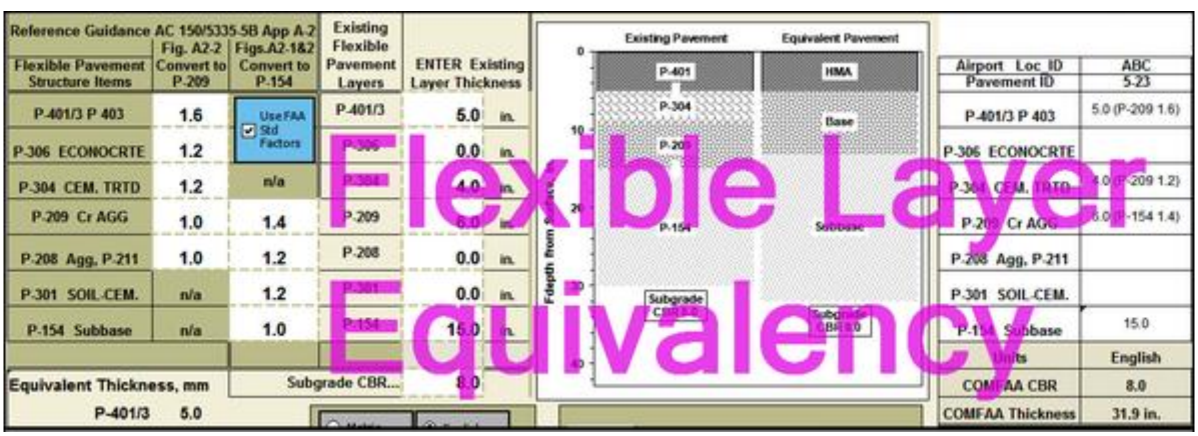


Figure C-2. Flexible Layer Equivalency Spreadsheet to Support COMFAA.

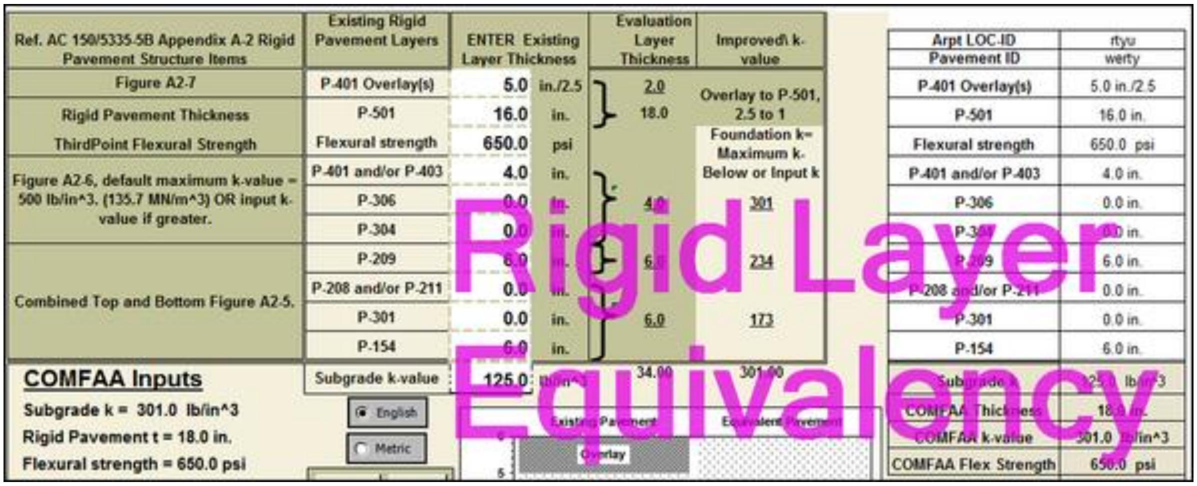


Figure C-3. Rigid Layer Equivalency Spreadsheet to Support COMFAA.

2.1 TECHNICAL EVALUATION FOR FLEXIBLE PAVEMENTS.

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

- Determine the traffic volume in terms of type of aircraft and number of annual departures/traffic cycles of each aircraft that the pavement will experience over its life.

- Determine the appropriate reference section to use based on the number of wheels on main gears.

- Determine pavement characteristics, including the subgrade CBR and equivalent pavement thickness.

- Calculate the maximum allowable gross weight for each aircraft on that pavement at the equivalent annual departure level.

- Calculate the ACN of each aircraft at its maximum allowable gross weight.

- Select the PCN from the ACN data provided by all aircraft.

These steps are explained in greater detail below. These steps are automated in the COMFAA software. The results file is presented in three tables. (This file is displayed by selecting the ‘details’ button in the COMFAA support spreadsheet.)

- Results Table 1 details input traffic data including thickness requirements for each aircraft at evaluation thickness and CBR.
- Results Table 2 displays the PCN values for each aircraft at the evaluation pavement thickness and subgrade CBR, where each aircraft in turn is considered the critical

aircraft (i.e., all operations are converted to operations of the critical aircraft). This table also displays the CDF value representing the damage contribution from each aircraft..

- Results Table 3 lists the ICAO standard ACN values for each aircraft in the traffic mix at the appropriate subgrade category.

Figure C-3 shows an example results file. Several examples using the same traffic mix with different pavement structures at the end of this section further illustrate the process.

Table C-3. Excerpt From COMFAA PCN Batch Results File for Flexible Pavement

```
                                CBR = 8.00 (Subgrade Category is C(6))
             Evaluation pavement thickness = 31.90 in
       Pass to Traffic Cycle (PtoTC) Ratio = 1.00
            Maximum number of wheels per gear = 6
          Maximum number of gears per aircraft = 4

 At least one aircraft has 4 or more wheels per gear.  The FAA recommends a reference section assuming
 5 inches of HMA and 8 inches of crushed aggregate for equivalent thickness calculations.
```

Results Table 1. Input Traffic Data

Top Portion

No.	Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	20-yr Coverages	6D Thick
[illegible]	[illegible]	365,747	94.00	216.1	1,500	16,456	29.86
2	A319-100 std	141,978	92.60	172.6	1,200	6,443	22.08
3	B737-300	140,000	90.86	201.0	6,000	31,003	25.19
4	B747-400	877,000	93.32	200.0	1,000	11,470	31.28
5	B767-200 ER	396,000	90.82	190.0	2,000	21,813	29.44
6	B777-200 ER	657,000	91.80	205.0	1,000	14,583	30.54
7	DC8-63	330,000	96.12	196.0	3,000	34,581	30.13

Results Table 2. PCN Values

Middle Portion

No.	Aircraft Name	Critical Aircraft Total Equiv. Covs.	Thickness for Total Equiv. Covs.	Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on C(6)
1	A300-B4 STD	105,365	32.55	356,000	35.36	0.2580	60.3
[illegible]	[illegible]	[illegible],000,000	32.23	139,738	27.19	0.0001	35.7
3	[illegible]	[illegible],000,000	32.27	137,363	28.03	0.0021	37.9
4	B747-400	26,764	32.75	846,879	37.78	0.7079	68.8
5	B767-200 ER	221,077	32.45	387,137	34.60	0.1630	57.8
6	B777-200 ER	85,242	32.35	644,894	37.00	0.2826	66.0
7	DC8-63	239,928	32.44	322,435	34.27	0.2381	56.6
					Total CDF =	1.6519	

Total CDF>1

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

Bottom Portion

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN Thick	ACN on C(6)
1	A300-B4 STD	365,747	94.00	216.1	36.07	62.8
2	A319-100 std	141,978	92.60	172.6	27.46	36.4
3	B737-300	140,000	90.86	201.0	28.36	38.8
4	B747-400	877,000	93.32	200.0	38.81	72.6
5	B767-200 ER	396,000	90.82	190.0	35.22	59.8
[illegible]	[illegible]	[illegible]57,000	91.80	205.0	37.55	68.0
[illegible]	[illegible]	3[illegible]0,000	96.12	196.0	34.84	58.5

1. Determine the traffic volume in terms of annual departures for each aircraft that has used or is planned to use the airport during the pavement life period. Record all significant traffic, including non-scheduled, charter, and military, as accurately as possible. This includes traffic that has occurred since the original construction or last overlay and traffic that will occur before the next planned overlay or reconstruction. If the pavement life is unknown or undetermined, assume that it will include a

reasonable period of time. The normal design life for pavement is 20 years. However, the expected life can vary depending on the existing pavement conditions, climatic conditions, and maintenance practices.

The information necessary for the traffic volume process is—

- Past, current, and forecasted traffic cycles of each significant aircraft.
- Aircraft operational or maximum gross weights.
- Typical aircraft weight distribution on the main and nose gear. If unknown, AC 150/5320-6 assumes 95 percent weight on the main gear.
- Main gear type (dual, dual tandem, etc.).
- Main gear tire pressure.
- Fuel-loading practices of aircraft at the airport (P/TC ratio).
- Type of taxiway system – parallel or central (P/TC ratio).

2. From field data or construction drawings, document the CBR of the subgrade soil. Alternatively, conduct field or laboratory tests of the subgrade soil in order to determine the CBR. Accurate portrayal of the subgrade CBR value is vital to the technical method because a small variation in CBR could result in a disproportionately large variation in the aircraft allowable gross weight and the corresponding PCN.

3. The COMFAA program calculates pavement thickness requirements based on annual departures. COMFAA allows the user to directly input either coverages or annual departures. Since the pass-to-coverage ratio for flexible pavement may be different than rigid pavement, the user must enter coverages in the appropriate location for each pavement type.

4. Determine the total pavement thickness and cross-sectional properties. The thickness of the pavement section under consideration must be converted to an equivalent pavement thickness based on a standard reference pavement section for evaluation purposes. The equivalent pavement thickness is the total thickness requirement calculated by the COMFAA program assuming minimum layer thickness for the asphalt surface, minimum base layer thickness of material with a CBR 80 or higher, and a variable subbase layer with a CBR 20 or greater. If the pavement has excess material or improved materials, the total pavement thickness may be increased according to the FAA CBR method as detailed in Appendix B. The pavement is considered to have excess asphalt, which can be converted to extra crushed aggregate equivalent thickness, when the asphalt thickness is greater than the minimum thickness of asphalt surfaced. The recommended reference section for this traffic mix is an asphalt surface course thickness of 5 inches. The pavement may also be considered to have excess crushed aggregate base thickness when the cross-section has a high quality crushed aggregate base thickness greater than 8 inches or when other improved materials such as asphalt stabilization or cement treated materials, are present. Likewise, additional subbase thickness or improved subbase materials may also be converted to additional total pavement thickness. Using the support program facilitates converting existing pavement structures to the requisite standard equivalent structure used in COMFAA.

5. Using the annual departures and P/TC ratio for the runway, the equivalent pavement thickness, and the CBR of the subgrade, compute the maximum allowable gross weight for each aircraft at the appropriate ICAO standard subgrade support category using the COMFAA program in the pavement design mode.

6. Assign the subgrade CBR strength found in Step 2 to the appropriate standard ACN-PCN subgrade code as given in Table 2-2.

7. The ACN of each aircraft at the maximum allowable gross weight is determined from the COMFAA program in the ACN mode. Enter the allowable gross weight of the aircraft, and calculate the ACN based on the standard subgrade code corresponding to the CBR found in Step 2. Alternatively, consult an "ACN versus Gross Weight" chart as published in the manufacturer's ACAP manuals.

8. Assign the tire pressure code based on the highest tire pressure in the traffic mix from Table 4-2. Keep in mind the quality of the asphalt surface layer, as discussed in Section 2.1, when assigning this code. NOTE: Code X is recommended for pavements with 5 or more inches of EXISTING asphalt. Code Y is recommended for pavements with 3 or less inches of EXISTING asphalt.

9. When the evaluation method is technical, assign the code of *T*, as described in paragraph 4.5e.

10. The numerical value of the PCN is selected from the list of values in COMFAA Batch PCN Results Table 2. If all aircraft regularly use the airport, then select the highest value and report it as the PCN. If some of the aircraft in the traffic mix use the airport infrequently, then further consideration must be given to the selection of the PCN. If an aircraft that operates infrequently at the airport generates a PCN value considerably higher than the rest of the traffic mix, then using this aircraft to determine the PCN may result in an unrealistic value. A more reasonable PCN can be determined if this aircraft's operations are set to 1,000 coverages.

11. If the calculated maximum allowable gross weight is equal to or greater than the critical aircraft operational gross weight required for the desired pavement life (Total CDF<1), then the pavement is capable of handling the predicted traffic for the time period established in the traffic forecast. Accordingly, the assigned PCN determined in Step 10 is sufficient. If the **allowable gross weight is less than the critical** aircraft gross weight required for the desired pavement life (Total CDF>1), then the pavement may be assigned a PCN equal to the ACN of the critical aircraft at that gross weight, but with a lower expected pavement life. Additionally, it may then be necessary to develop a relationship of allowable gross weight based on the assigned PCN versus pavement life. Any overload (see Appendix D) should be treated in terms of ACN and equivalent critical aircraft operations per individual operation. Allowance for the overload should be negotiated with the airport authority since pre-approval cannot be assumed. Specific procedures on how to relate pavement life and gross weight for flexible pavements are found in Appendix D.

2.2 TECHNICAL EVALUATION EXAMPLES FOR FLEXIBLE PAVEMENTS.

The following four examples demonstrate the technical evaluation method of determining a PCN for flexible pavements. The first example pavement is for an under-strength pavement with a traffic volume that has increased to such a level that pavement life is reduced from the original design (Total CDF > 1). The second pavement has a thickness nearly equal to the structural requirement for the 20-year traffic (Total CDF = 1). The third example pavement is the same as the first, except the taxiway has a central configuration rather than parallel, which effectively doubles the number of coverages and reduces the PCN. The fourth example demonstrates a consistent method to report PCN when the pavement under consideration contains significant excess structural capacity relative to the forecast traffic (Total CDF << 1).

a. Flexible Pavement Example 1. An airport has a flexible (asphalt-surfaced) runway pavement with a subgrade CBR of 8 and a total thickness of 32.0 inches, as shown in Fig. C-4 (5 inch asphalt surface layer, 4 inches of stabilized base, 6 inch base layer and 17 inches subbase layer). The traffic mix is the same as in the Using Aircraft example, section 3.1. 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. The combined thickness of the P-304 and P-209 exceeds the minimum standard for the CDF analysis method and is converted to additional P-154 as shown in Figure C-2 and Table C-4 for an equivalent pavement thickness of 31.9 inches.

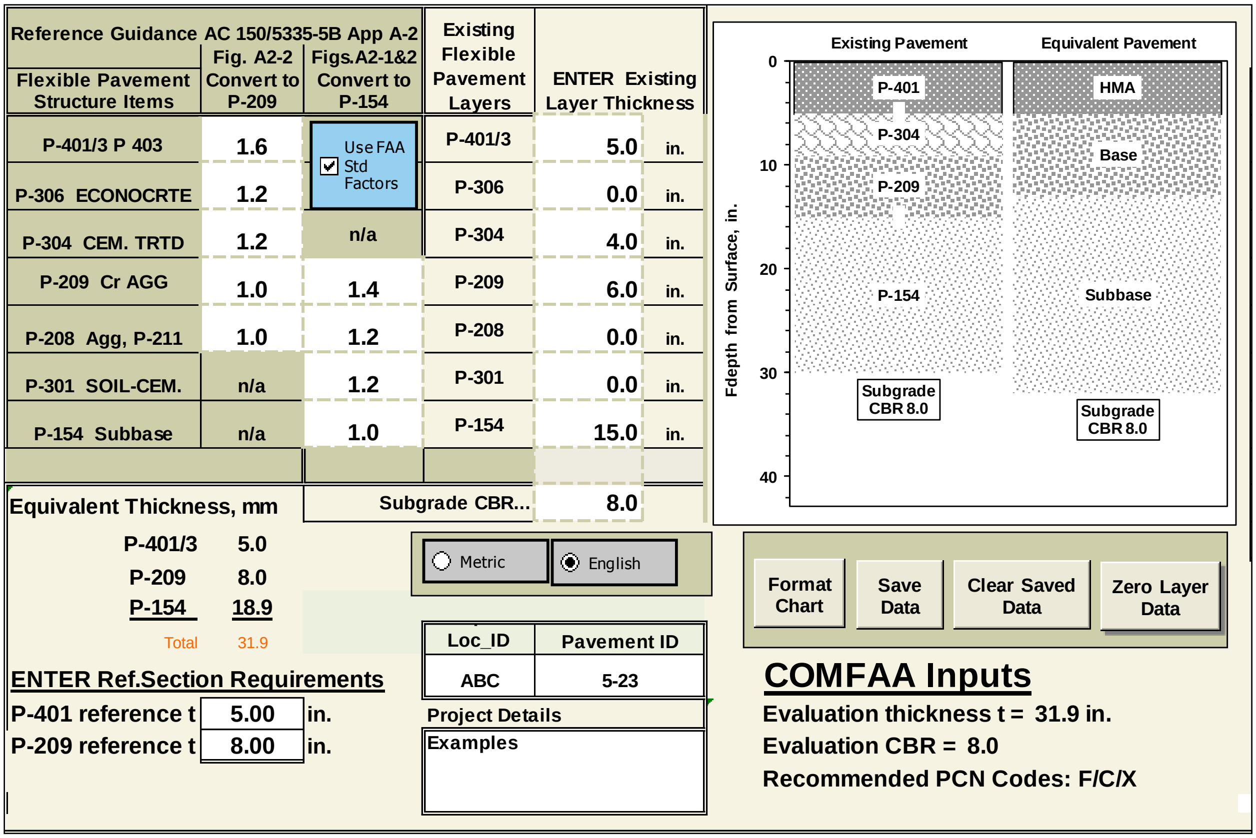


Figure C-4. Screen shot of PCN worksheet in COMFAA support spreadsheet for computing equivalent pavement structure in Flexible Example 1.

Table C-4. Conversion to Equivalent Pavement Structure in Flexible Example 1.

Existing Pavement Structure. P-304 plus P-209 combined exceed P-209 requirements.	Equivalent Pavement Structure. A portion of P-304 is converted to P-209 and excess P-304 converted to P-154. This conversion results in 1.9 inches added to the equivalent pavement thickness.
5 inch asphalt surface layer (P-401) 4 inch base layer (P-304) 6 inch base layer (P-209) 17 inches subbase layer (P-154) Subgrade CBR 8	5 inch asphalt surface layer (P-401) 8 inch base layer (P-209) 20.9 inch subbase layer (P-154) 33.9 inch total thickness Subgrade CBR 8

```
                              CBR = 8.00 (Subgrade Category is C(6))
            Evaluation pavement thickness = 31.90 in
        Pass to Traffic Cycle (PtoTC) Ratio = 1.00
          Maximum number of wheels per gear = 6
       Maximum number of gears per aircraft = 4

At least one aircraft has 4 or more wheels per gear.  The FAA recommends a reference section assuming
5 inches of HMA and 8 inches of crushed aggregate for equivalent thickness calculations.
```

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	20-yr Coverages	6D Thick
1	A300-B4 STD	364,747	94.00	216.1	1,500	16,434	29.79
2	A319-100 std	141,978	92.60	172.6	1,200	6,443	22.08
3	B737-300	140,000	90.86	201.0	6,000	31,003	25.19
4	B747-400	877,000	93.32	200.0	1,000	11,470	31.28
5	B767-200 ER	396,000	90.82	190.0	2,000	21,813	29.44
6	B777-200 ER	657,000	91.80	205.0	1,000	14,583	30.54
7	DC8-63	330,000	96.12	196.0	3,000	34,581	30.13

Results Table 2. PCN Values

No.	Aircraft Name	Critical Aircraft Total Equiv. Covs.	Thickness for Total Equiv. Covs.	Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on C(6)
1	A300-B4 STD	109,787	32.54	355,252	35.31	0.2454	60.1
2	A319-100 std	>5,000,000	32.23	139,771	27.19	0.0001	35.7
3	B737-300	>5,000,000	32.27	137,402	28.03	0.0021	37.9
4	B747-400	26,559	32.73	847,310	37.80	0.7079	68.9
5	B767-200 ER	219,389	32.44	387,270	34.61	0.1630	57.8
6	B777-200 ER	84,591	32.34	645,067	37.01	0.2826	66.1
7	DC8-63	238,096	32.43	322,545	34.27	0.2381	56.6
					Total CDF =	1.6392	

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

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN Thick	ACN on C(6)
1	A300-B4 STD	364,747	94.00	216.1	36.00	62.5
2	A319-100 std	141,978	92.60	172.6	27.46	36.4
3	B737-300	140,000	90.86	201.0	28.36	38.8
4	B747-400	877,000	93.32	200.0	38.81	72.6
5	B767-200 ER	396,000	90.82	190.0	35.22	59.8
6	B777-200 ER	657,000	91.80	205.0	37.55	68.0
7	DC8-63	330,000	96.12	196.0	34.84	58.5

Figure C-5. Detailed COMFAA Batch PCN Output – Flexible Example 1.

Figure C-5 shows the results of the COMFAA Batch PCN Flexible calculations. The top portion of Figure C-5 (Results Table 1) shows the required thickness in accordance with the FAA CBR method for a flexible pavement with a CBR 8 subgrade. The B747-400 aircraft has the greatest individual pavement thickness requirement (31.3 in.) for its total traffic over 20 years. Note that the thickness requirements for several individual aircraft are approximately equal to, or slightly less than, the evaluation pavement thickness of 31.9 in. This indicates that the pavement thickness may be deficient for existing traffic.

The middle portion of Figure C-5 (Results Table 2) shows the results of the detailed method based on the cumulative damage factor (CDF) procedure that calculates the combined damage from multiple aircraft in the traffic mix. The numerical values in the CDF column represent damage to a 31.9-in. thick flexible pavement on a CBR 8 subgrade for each aircraft in the list. The total CDF represents the combined damage from this traffic. Taking each aircraft in turn as the critical aircraft, the program computes total equivalent coverages (based on a CDF analysis), the corresponding thickness for the total equivalent coverages (which is greater than the required thickness for the individual aircraft shown in Results Table 1), and a maximum allowable gross weight. The ACN of the aircraft at the maximum allowable gross weight at 10,000 coverages, at the appropriate ICAO standard CBR, is computed and reported in Results Table 2 as the PCN (last column). In this example, there are two aircraft that can load the pavement over 5,000,000 times before the pavement fails (critical aircraft total equivalent coverages > 5,000,000). These aircraft have little impact on this pavement's structural performance, and the corresponding PCNs are low. The PCN for this pavement can be reported as the highest PCN in the PCN column. Based on the information in Figure C-5, the airport may report a PCN of 69/F/C/W/T or 69/F/C/X/T.

The bottom portion of Figure C-5 shows the ICAO standard ACN of each aircraft at the input values of gross weight, percent gross weight on the main gear, and tire pressure. When the total CDF>1, as is the case in this example, at least one of the ACN values reported in Results Table 3 will exceed all of the PCN values in Results Table 2. In this example, the ACN computed for the B747 is 72.6 on subgrade category C, so the pavement does not have sufficient strength to support existing traffic.

The following notes apply when total CDF > 1:

1. At least one ACN value in Results Table 3 will be greater than all of the PCN values in Results Table 2.

2. For all aircraft, the thickness for total equivalent coverages (Column 3 in Results Table 2) will exceed the evaluation pavement thickness for the input subgrade CBR.

3. For all aircraft that have fewer than 5,000,000 total equivalent coverages as reported in Column 2 of Results Table 2, the corresponding thickness for total equivalent coverages in Column 3 will be greater than the input evaluation thickness.

4. One aircraft in the list will have the fewest equivalent coverages, greatest thickness requirement for total equivalent coverages, and greatest ACN thickness at the maximum allowable gross weight. The largest ACN thickness value in Results Table 2 (the PCN thickness value) will be less than at least one ACN thickness value in Results Table 3.

5. A project to strengthen the pavement to support forecast traffic is required.

6. An overload analysis should be performed.

b. Flexible Pavement Example 2. This second example has the same pavement cross section and subgrade CBR as Example 1, but with reduced traffic that results in a total CDF equal to 1. As in Flexible Example 1, the taxiway has a parallel configuration (Figure A-1b) such that the P/TC ratio = 1. Since the pavement cross section is the same as in

Example 1, the evaluation thickness is likewise the same (31.9 in.). The traffic is given in Table C-5.

Table C-5. Input Traffic Data for Flexible Example 2.

No.	Aircraft Name	Gross Weight, lbs.	Percent GW on Main Gear	Tire Pressure, psi	Annual Departures
1	A300-B4 STD	364,747	94.00	216.1	915
2	A319-100 STD	141,978	92.60	172.6	732
3	B737-300	140,000	90.86	201.0	3,660
4	B747-400	877,000	93.32	200.0	610
5	B767-200 ER	396,000	90.82	190.0	1,220
6	B777-200 ER	657,000	91.80	205.0	610
7	DC8-63	330,000	96.12	196.0	1,830

CBR = 8.00 (Subgrade Category is C(6))
Evaluation pavement thickness = 31.90 in
Pass to Traffic Cycle (PtoTC) Ratio = 1.00
Maximum number of wheels per gear = 6
Maximum number of gears per aircraft = 4

At least one aircraft has 4 or more wheels per gear. The FAA recommends a reference section assuming 5 inches of HMA and 8 inches of crushed aggregate for equivalent thickness calculations.

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	20-yr Coverages	6D Thick
1	A300-B4 STD	364,747	94.00	216.1	915	10,025	28.94
2	A319-100 std	141,978	92.60	172.6	732	3,930	21.27
3	B737-300	140,000	90.86	201.0	3,660	18,912	24.44
4	B747-400	877,000	93.32	200.0	610	6,997	30.34
5	B767-200 ER	396,000	90.82	190.0	1,220	13,306	28.65
6	B777-200 ER	657,000	91.80	205.0	610	8,896	29.90
7	DC8-63	330,000	96.12	196.0	1,830	21,095	29.41

Results Table 2. PCN Values

No.	Aircraft Name	Critical Aircraft Total Equiv. Covs.	Thickness for Total Equiv. Covs.	Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on C(6)
1	A300-B4 STD	66,969	31.90	364,749	36.00	0.1497	62.5
2	A319-100 std	>5,000,000	31.90	141,978	27.46	0.0001	36.4
3	B737-300	>5,000,000	31.90	140,000	28.36	0.0013	38.8
4	B747-400	16,201	31.90	877,004	38.81	0.4318	72.6
5	B767-200 ER	133,827	31.90	396,002	35.22	0.0994	59.8
6	B777-200 ER	51,600	31.90	657,002	37.55	0.1724	68.0
7	DC8-63	145,238	31.90	330,001	34.84	0.1452	58.5
					Total CDF =	0.9999	

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

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN Thick	ACN on C(6)
1	A300-B4 STD	364,747	94.00	216.1	36.00	62.5
2	A319-100 std	141,978	92.60	172.6	27.46	36.4
3	B737-300	140,000	90.86	201.0	28.36	38.8
4	B747-400	877,000	93.32	200.0	38.81	72.6
5	B767-200 ER	396,000	90.82	190.0	35.22	59.8
6	B777-200 ER	657,000	91.80	205.0	37.55	68.0
7	DC8-63	330,000	96.12	196.0	34.84	58.5

Figure C-6. Detailed COMFAA Batch PCN Output – Flexible Example 2.

Figure C-6 shows the results of the COMFAA Batch PCN Flexible calculations for Example 2. The top portion of Figure C-6 (Results Table 1) shows the required thickness using the CBR thickness design in accordance with the FAA CBR method for a flexible pavement with a CBR 8 subgrade. As in Example 1, the B747-400 aircraft has the greatest individual pavement thickness requirement (30.34 inches) for its total traffic over 20 years. In this case, all the individual aircraft thickness requirements are less than the evaluation thickness.

The middle portion of Figure C-6 (Results Table 2) shows the results of the detailed method based on the cumulative damage factor (CDF) procedure that allows the calculation of the combined effect of multiple aircraft in the traffic mix. The various columns are described in Example 1. The PCN for this pavement can be reported as the highest PCN in the last column of Results Table 2. The airport may report a PCN of 73/F/C/W/T or 73/F/C/X/T. Note that the physical structure in this case is the same as Example 1, but the PCN that can be reported is higher than in Example 1, because the technical PCN depends on the anticipated traffic as well as the structure. Results Table 3 shows that all of the aircraft have ACNs at their operating weights that are less than the reported PCN, hence no operating restrictions are needed.

Figure C-7 illustrates a useful feature of the P/TC ratio in COMFAA. In Example 1, the total CDF computed is 1.6392. To determine the reduced level of operations of the same traffic mix that would result in CDF = 1, simple take the reciprocal value of Total CDF (= 1/1.6392 = 0.61). Entering the value 0.61 in the P/TC ratio field instead of 1 results in Total CDF = 1. This allows the user to compute the PCN value applicable to the case where CDF = 1, without having to create a separate external traffic file. As shown in Example 4, this provides a consistent means of reporting PCN for pavements that are extremely strong compared to the traffic-driven structural requirement.

CBR = 8.00 (Subgrade Category is C(6))
Evaluation pavement thickness = 31.90 in
Pass to Traffic Cycle (PtoTC) Ratio = 0.61 (non-standard)
Maximum number of wheels per gear = 6
Maximum number of gears per aircraft = 4

At least one aircraft has 4 or more wheels per gear. The FAA recommends a reference section assuming 5 inches of HMA and 8 inches of crushed aggregate for equivalent thickness calculations.

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	20-yr Coverages	6D Thick
1	A300-B4 STD	364,747	94.00	216.1	1,500	10,026	28.94
2	A319-100 std	141,978	92.60	172.6	1,200	3,930	21.27
3	B737-300	140,000	90.86	201.0	6,000	18,914	24.44
4	B747-400	877,000	93.32	200.0	1,000	6,997	30.34
5	B767-200 ER	396,000	90.82	190.0	2,000	13,307	28.65
6	B777-200 ER	657,000	91.80	205.0	1,000	8,897	29.90
7	DC8-63	330,000	96.12	196.0	3,000	21,096	29.41

Results Table 2. PCN Values

No.	Aircraft Name	Critical Aircraft Total Equiv. Covs.	Thickness for Total Equiv. Covs.	Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on C(6)
1	A300-B4 STD	66,975	31.90	364,747	36.00	0.1497	62.5
2	A319-100 std	>5,000,000	31.90	141,978	27.46	0.0001	36.4
3	B737-300	>5,000,000	31.90	140,000	28.36	0.0013	38.8
4	B747-400	16,203	31.90	876,998	38.81	0.4319	72.6
5	B767-200 ER	133,839	31.90	396,000	35.22	0.0994	59.8
6	B777-200 ER	51,605	31.90	656,999	37.55	0.1724	68.0
7	DC8-63	145,251	31.90	330,000	34.84	0.1452	58.5
					Total CDF =	1.0000	

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

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN Thick	ACN on C(6)
1	A300-B4 STD	364,747	94.00	216.1	36.00	62.5
2	A319-100 std	141,978	92.60	172.6	27.46	36.4
3	B737-300	140,000	90.86	201.0	28.36	38.8
4	B747-400	877,000	93.32	200.0	38.81	72.6
5	B767-200 ER	396,000	90.82	190.0	35.22	59.8
6	B777-200 ER	657,000	91.80	205.0	37.55	68.0
7	DC8-63	330,000	96.12	196.0	34.84	58.5

Figure C-7. Detailed COMFAA Batch PCN Output – Flexible Example 2, computed using the traffic mix from Example 1 and modified P/TC ratio.

The following notes apply when total CDF = 1:

1. For all aircraft, the thickness for total equivalent coverages (Results Table 2, Column 3) will be the same as the COMFAA evaluation thickness.

2. All maximum allowable gross weights in Results Table 2 will be approximately the same as the COMFAA input gross weights and ACN weights in Results Table 3.

3. All PCN values in Results Table 2 will be the same as the ACN values in Results Table 3.

c. Flexible Pavement Example 3. The only change in this example from the second example is that the taxiway has a central configuration rather than parallel, such as that shown in Figure A-1b. Figure C-8 shows the effect when the P/TC ratio changes from 1 to 2, which results in double the number of coverages for each aircraft in the traffic mix. As expected, the required total pavement thickness for each aircraft in the traffic mix has increased. The B747-400 aircraft still has the greatest individual pavement thickness requirement (31.64 inches) for its total traffic over 20 years. Note the thickness requirements for the B747-400 now approaches the evaluation thickness (31.9 in.).

Referring to the results Table 2 in the middle portion of the output, only the B737-300 and the A319-100 std airplanes have little impact on this pavement's performance. It is apparent the pavement is not adequate to accommodate the existing traffic. As expected, changing the taxiway system from parallel to central has lowered the PCN of the pavement by effectively doubling traffic volume. The airport may report 68/F/C/W/T or 68/F/C/X/T. The ACN of two aircraft, the B747-400 and the B777-200 ER exceed the pavement PCN and the airport should plan for a pavement strengthening project or consider placing restrictions on those aircraft. The net effect of the change in taxiway configuration from that of Example 2 is the reduction by 5 in the PCN.

```
                         CBR = 8.00 (Subgrade Category is C(6))
          Evaluation pavement thickness = 31.90 in
      Pass to Traffic Cycle (PtoTC) Ratio = 2.00
        Maximum number of wheels per gear = 6
      Maximum number of gears per aircraft = 4

At least one aircraft has 4 or more wheels per gear.  The FAA recommends a reference section assuming
5 inches of HMA and 8 inches of crushed aggregate for equivalent thickness calculations.
```

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	20-yr Coverages	6D Thick
1	A300-B4 STD	364,747	94.00	216.1	915	20,049	30.12
2	A319-100 std	141,978	92.60	172.6	732	7,860	22.39
3	B737-300	140,000	90.86	201.0	3,660	37,824	25.48
4	B747-400	877,000	93.32	200.0	610	13,993	31.64
5	B767-200 ER	396,000	90.82	190.0	1,220	26,612	29.74
6	B777-200 ER	657,000	91.80	205.0	610	17,792	30.78
7	DC8-63	330,000	96.12	196.0	1,830	42,189	30.40

Results Table 2. PCN Values

No.	Aircraft Name	Critical Aircraft Total Equiv. Covs.	Thickness for Total Equiv. Covs.	Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on C(6)
1	A300-B4 STD	133,940	32.78	351,734	35.05	0.2994	59.2
2	A319-100 std	>5,000,000	32.35	138,930	27.09	0.0001	35.4
3	B737-300	>5,000,000	32.41	136,414	27.90	0.0026	37.5
4	B747-400	32,402	33.06	836,402	37.42	0.8637	67.5
5	B767-200 ER	267,653	32.66	383,894	34.37	0.1988	57.0
6	B777-200 ER	103,201	32.51	640,694	36.82	0.3448	65.4
7	DC8-63	290,476	32.63	319,773	34.07	0.2905	56.0
					Total CDF =	1.9999	

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

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN Thick	ACN on C(6)
1	A300-B4 STD	364,747	94.00	216.1	36.00	62.5
2	A319-100 std	141,978	92.60	172.6	27.46	36.4
3	B737-300	140,000	90.86	201.0	28.36	38.8
4	B747-400	877,000	93.32	200.0	38.81	72.6
5	B767-200 ER	396,000	90.82	190.0	35.22	59.8
6	B777-200 ER	657,000	91.80	205.0	37.55	68.0
7	DC8-63	330,000	96.12	196.0	34.84	58.5

Figure C-8. Detailed COMFAA Batch PCN Output – Flexible Example 3.

c. Flexible Pavement Example 4. In some cases, the pavement to be evaluated has significant excess structural capacity compared with the requirement due to forecast traffic. This situation may arise, for example, when an overlay is added for non-structural purposes, or in cold climates where a very thick subbase may be needed to provide frost protection on a frost-susceptible subgrade. This example shows a consistent way to report PCN for flexible pavements that are extremely strong with respect to the input traffic (total CDF<<1). In Figure C-9, the pavement from Example 1 has been strengthened with a 2-inch overlay. Assuming a reference section with 5 inches of P-401 and 8 inches of P-209, the evaluation thickness for COMFAA is 36.4 inches (versus 31.9 in. prior to the overlay).

Figure C-10 shows the COMFAA output when PCN is computed using the evaluation thickness 36.4 in. and P/TC=1. For the overlaid pavement subject to the forecast traffic, total CDF is much less than 1 (total CDF= 0.0355), indicating that the 20-year traffic mix causes insignificant damage to the pavement. Similarly, the largest value of thickness for total equivalent coverages in Results Table 2 is much less than the COMFAA evaluation thickness at the evaluation CBR. Hence, it is necessary to use an unrealistic allowable gross weight for the critical aircraft to compute PCN. Using the regular COMFAA procedure without adjustment, the airport could report PCN=97/F/C/X/T for this pavement. However, this PCN is based on an unrealistically high allowable gross weight for the B747-400 (1,060,338 lbs.).

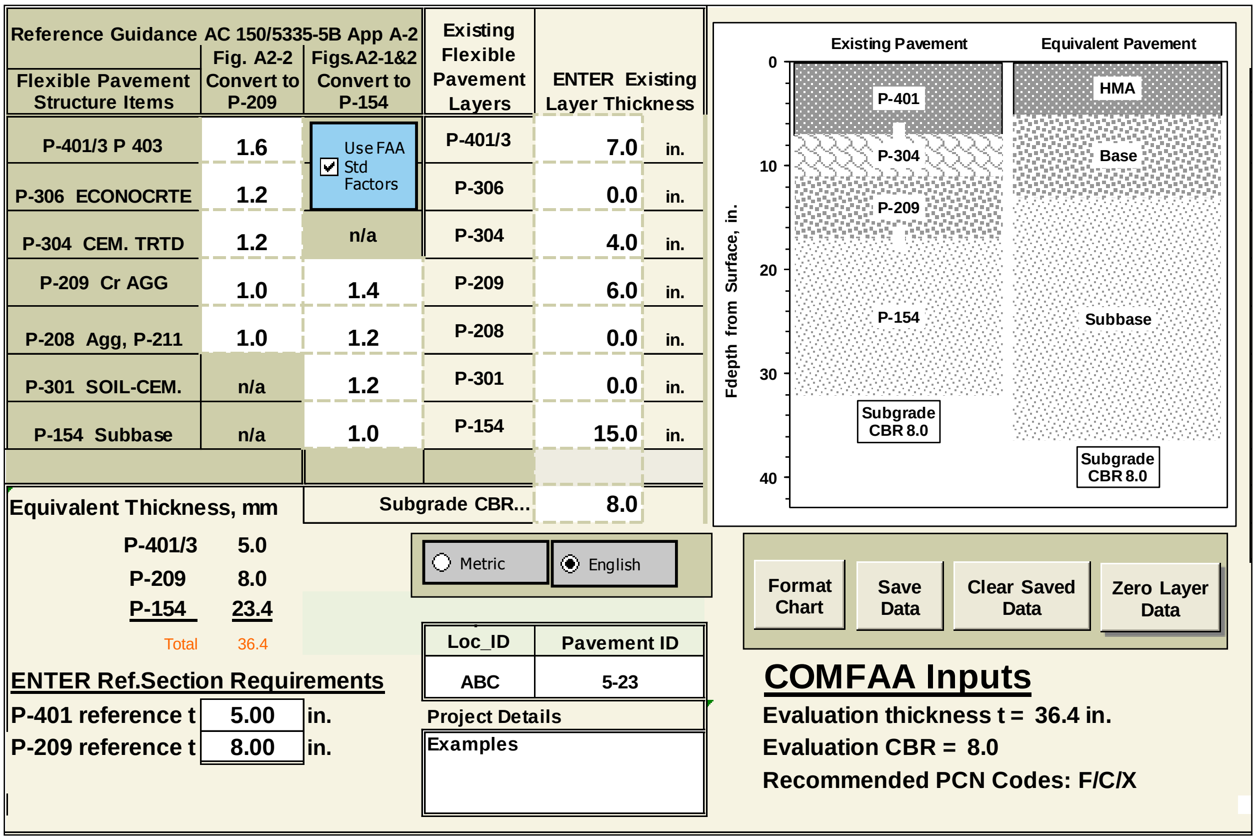


Figure C-9. Screen shot of flexible PCN tab in COMFAA support spreadsheet for computing equivalent pavement structure in Flexible Example 4. The structure is the same as Example 1, but with a 2-inch HMA overlay, for a total P-401 thickness of 7 inches.

CBR = 8.00 (Subgrade Category is C(6))
Evaluation pavement thickness = 36.40 in
Pass to Traffic Cycle (PtoTC) Ratio = 1.00
Maximum number of wheels per gear = 6
Maximum number of gears per aircraft = 4

At least one aircraft has 4 or more wheels per gear. The FAA recommends a reference section assuming 5 inches of HMA and 8 inches of crushed aggregate for equivalent thickness calculations.

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	20-yr Coverages	6D Thick
1	A300-B4 STD	364,747	94.00	216.1	1,500	16,434	29.79
2	A319-100 std	141,978	92.60	172.6	1,200	6,443	22.08
3	B737-300	140,000	90.86	201.0	6,000	31,003	25.19
4	B747-400	877,000	93.32	200.0	1,000	11,470	31.28
5	B767-200 ER	396,000	90.82	190.0	2,000	21,813	29.44
6	B777-200 ER	657,000	91.80	205.0	1,000	14,583	30.54
7	DC8-63	330,000	96.12	196.0	3,000	34,581	30.13

Results Table 2. PCN Values

No.	Aircraft Name	Critical Aircraft Total Equiv. Covs.	Thickness for Total Equiv. Covs.	Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on C(6)
1	A300-B4 STD	264,870	33.56	406,912	39.00	0.0022	73.3
2	A319-100 std	>5,000,000	35.66	146,714	28.03	0.0000	37.9
3	B737-300	>5,000,000	35.35	147,191	29.27	0.0000	41.3
4	B747-400	12,676	31.46	1,060,338	44.83	0.0321	96.9
5	B767-200 ER	1,036,028	34.02	431,320	37.67	0.0007	68.4
6	B777-200 ER	>5,000,000	36.24	660,776	37.72	0.0000	68.6
7	DC8-63	2,881,679	34.56	354,742	36.67	0.0004	64.9
					Total CDF =	0.0355	

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

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN Thick	ACN on C(6)
1	A300-B4 STD	364,747	94.00	216.1	36.00	62.5
2	A319-100 std	141,978	92.60	172.6	27.46	36.4
3	B737-300	140,000	90.86	201.0	28.36	38.8
4	B747-400	877,000	93.32	200.0	38.81	72.6
5	B767-200 ER	396,000	90.82	190.0	35.22	59.8
6	B777-200 ER	657,000	91.80	205.0	37.55	68.0
7	DC8-63	330,000	96.12	196.0	34.84	58.5

Figure C-10. Detailed COMFAA Batch PCN Output – Flexible Example 4 (unadjusted).

The regular COMFAA procedure given in section 2.1 is most suitable when the total CDF > 0.15. When the procedure results in CDF < 0.15, as in this example, the FAA recommends adjusting the input traffic such that the PCN is reported for a total CDF = 0.150. Rather than modifying the COMFAA external aircraft file, the P/TC ratio can be used to obtain total CDF=0.150 as follows.

1. Perform a PCN Flexible Batch operation using the appropriate P/TC ratio based on the criteria in Appendix A.

2. Note the value of Total CDF in Results Table 2.

3. Multiply the original value of P/TC ratio by the factor 0.15/Total CDF, where Total CDF is taken from Step 2.

4. Enter the new value of P/TC ratio in the P/TC field in COMFAA.

5. Repeat the PCN Flexible Batch operation with the new value of P/TC ratio. This will result in a new Total CDF equal to or close to 0.15.

6. Note that the maximum value of P/TC ratio allowed in COMFAA is 10. This should be sufficient in most cases. However, if the value computed in Step 3 exceeds 10, increasing the annual departures of all input aircraft by a factor of 10 and repeating steps 1 through 5 will generally result in Total CDF=0.150.

Figure C-11 shows a re-analysis of the overlaid pavement using an adjusted value of the P/TC ratio equal to 1 × 0.15 / 0.0355 = 4.225. As indicated in Results Table 2, the adjusted Total CDF = 0.15. The airport can report PCN=84/F/C/X/T at Total CDF=0.150, based on a more reasonable maximum allowable gross weight of the B747-400. Results Table 3 shows that all aircraft in the existing mix operate at ACNs much lower than the reported PCN. There is no need to report a PCN higher than 84/F/C/X/T.

CBR = 8.00 (Subgrade Category is C(6))
Evaluation pavement thickness = 36.40 in
Pass to Traffic Cycle (PtoTC) Ratio = 4.23 (non-standard)
Maximum number of wheels per gear = 6
Maximum number of gears per aircraft = 4

At least one aircraft has 4 or more wheels per gear. The FAA recommends a reference section assuming 5 inches of HMA and 8 inches of crushed aggregate for equivalent thickness calculations.

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	20-yr Coverages	6D Thick
1	A300-B4 STD	364,747	94.00	216.1	1,500	69,439	31.95
2	A319-100 std	141,978	92.60	172.6	1,200	27,223	24.22
3	B737-300	140,000	90.86	201.0	6,000	131,000	27.19
4	B747-400	877,000	93.32	200.0	1,000	48,465	33.68
5	B767-200 ER	396,000	90.82	190.0	2,000	92,169	31.43
6	B777-200 ER	657,000	91.80	205.0	1,000	61,620	32.06
7	DC8-63	330,000	96.12	196.0	3,000	146,118	31.91

Results Table 2. PCN Values

No.	Aircraft Name	Critical Aircraft Total Equiv. Covs.	Thickness for Total Equiv. Covs.	Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on C(6)
1	A300-B4 STD	1,119,172	34.97	385,072	37.46	0.0093	67.7
2	A319-100 std	>5,000,000	36.02	144,426	27.75	0.0000	37.2
3	B737-300	>5,000,000	35.85	143,697	28.83	0.0000	40.1
4	B747-400	53,559	33.83	963,201	41.69	0.1357	83.8
5	B767-200 ER	4,377,664	35.19	413,121	36.42	0.0032	64.0
6	B777-200 ER	>5,000,000	36.32	658,812	37.63	0.0000	68.3
7	DC8-63	>5,000,000	35.48	342,077	35.74	0.0018	61.6
					Total CDF =	0.1499	

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

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN Thick	ACN on C(6)
1	A300-B4 STD	364,747	94.00	216.1	36.00	62.5
2	A319-100 std	141,978	92.60	172.6	27.46	36.4
3	B737-300	140,000	90.86	201.0	28.36	38.8
4	B747-400	877,000	93.32	200.0	38.81	72.6
5	B767-200 ER	396,000	90.82	190.0	35.22	59.8
6	B777-200 ER	657,000	91.80	205.0	37.55	68.0
7	DC8-63	330,000	96.12	196.0	34.84	58.5

Figure C-11. Detailed COMFAA Batch PCN Output – Flexible Example 4 (with adjustment to P/TC ratio to force Total CDF = 0.15).

2.3 TECHNICAL EVALUATION FOR RIGID PAVEMENTS.

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

- Determine the traffic volume in terms of type of aircraft and number of annual departures of each aircraft.
- Determine the pavement characteristics, including subgrade soil modulus, k, and the concrete thickness and flexural strength.
- Perform the CDF calculations to determine the maximum allowable gross weight for each aircraft on that pavement at the equivalent annual departure level.
- Calculate the ACN of each aircraft at its maximum allowable gross weight. Select the PCN from the ACN data provided by all aircraft.

The above steps are explained in greater detail:

Determine the traffic volume in the same fashion as noted in paragraph C-2.1 for flexible pavements.

1. From field data or construction drawings, document the k value of the subgrade soil. Alternatively, conduct field or laboratory tests of the subgrade soil in order to determine the k value. Accurate portrayal of the subgrade k value is vital to the technical method because a small variation in k value could result in a disproportionately large variation in the aircraft allowable gross weight and the corresponding PCN.

2. Using COMFAA, input annual departure level for each aircraft, input the Pass/Traffic cycle ratio (P/TC) for the runway.

3. The rigid design procedure implemented in the COMFAA program calculates pavement thickness requirements based on the concrete edge stress, which is in turn dependent on load repetitions of the total traffic mix. It is therefore a requirement to convert traffic cycles or passes to load repetitions by using a pass-to-load repetition ratio. P/C ratios for any aircraft on rigid pavement are calculated in the COMFAA program. COMFAA allows the user to directly input annual departures or coverages and will use aircraft-specific pass-to-coverage ratios to automatically convert to coverages for calculation purposes. Since the pass-to-coverage ratio for rigid pavement may be different than flexible pavement, the user must enter coverages in the appropriate location for each pavement type.

4. Obtain the pavement characteristics including the concrete slab thickness, the concrete modulus of rupture, and average modulus, k-value, of the subgrade. Concrete elastic modulus is set at 4,000,000 psi and Poisson's ratio is set at 0.15 in the COMFAA program. Accurate subgrade modulus determination is important to the technical method, but small variations in the modulus will not affect the PCN

results in a disproportionate manner. This is in contrast to flexible pavement subgrade modulus in which strength variations have a significant effect on PCN. If the pavement has a subbase course and/or stabilized subbase layers, then the subgrade modulus is adjusted upwards in the rigid design procedure to an equivalent value in order to account for the improvement in support. Subgrade modulus adjustments are made based on the FAA Westergaard method guidance included herein as Figures B-4 through B-7 and summarized in Table B-2.

5. Using the known slab thickness modified based on overlays (see Figure B-7), subgrade modulus modified based on improvements gained from subbase course(s) (see Figures B-4 and B-6), P/TC ratio for the runway, each individual aircraft's annual departure level, and each aircraft's parameters, compute the maximum allowable gross weight of each aircraft using the COMFAA program in the pavement design mode.

6. Assign the subgrade modulus (k-value) to the nearest standard ACN-PCN subgrade code. The k-value to be reported for PCN purposes is the improved k-value seen at the top of all improved layers (k-value directly beneath the concrete layer). Subgrade codes for k-value ranges are found in Table 2-1.

7. The ACN of each aircraft may now be determined from the COMFAA program. Enter the allowable gross weight of each aircraft. COMFAA calculates the ACN for the appropriate standard subgrade code. Alternatively, consult an "ACN versus Gross Weight" chart as published in the manufacturer's ACAP manual.

8. Assign the tire pressure code based on the highest tire pressure in the traffic mix from Table 4-2. As discussed previously, rigid pavements are typically able to handle high tire pressures, so code W can usually be assigned.

9. The evaluation method is technical, so the code T will be used as discussed in paragraph 4.5e.

10. The numerical value of the PCN is selected from the list of ACN values resulting from Step 6 from all aircraft. If all aircraft regularly use the airport, then select the highest ACN value and report it as the PCN. If some of the aircraft in the traffic mix use the airport infrequently, then further consideration must be given to the selection of the PCN. If an aircraft that operates infrequently at the airport generates a PCN value considerably higher than the rest of the traffic mix, then reporting the ACN of this aircraft as the PCN will require a change to the PCN if the aircraft's usage changes. NOTE: The recommended frequency for regularly using aircraft is equivalent to about 20-yr coverages of 1,000.

11. The numerical value of the PCN is the same as the numerical value of the ACN of the critical aircraft just calculated in Step 11.

12. If the allowable gross weight of Step 11 is equal to or greater than the critical aircraft operational gross weight required for the desired pavement life, then the pavement is capable of handling the predicted traffic for the time period established in the traffic

forecast. Accordingly, the assigned PCN determined in Step 12 is sufficient. If the allowable gross weight from Step 11 is less than the critical aircraft gross weight required for the desired pavement life, then the pavement may be assigned a PCN equal to the ACN of the critical aircraft at that gross weight, but with a reduced pavement life. Additionally, it may then be necessary to develop a relationship of allowable gross weight based on the assigned PCN versus pavement life. Appendix D provides procedures on how to relate pavement life and gross weight for rigid pavements in terms of PCN. Any overload should be treated in terms of ACN and equivalent critical aircraft operations per individual operation. Allowance for the overload should be negotiated with the airport authority, since pre-approval cannot be assumed. Appendix D provides specific procedures on how to relate pavement life and gross weight for rigid pavements.

2.4 TECHNICAL EVALUATION EXAMPLES FOR RIGID PAVEMENTS.

The following four examples help explain the technical evaluation method of determining a PCN for rigid pavements. The first example pavement is under-designed and the traffic volume has increased to such a level that pavement life is reduced from the original design (Total CDF > 1). The second pavement has more than adequate strength to handle the forecasted traffic (Total CDF < 1). The third example pavement is the same as number two, except that the aircraft generally do not obtain fuel at the airport. The fourth example demonstrates a consistent method to report PCN when the pavement under consideration contains significant excess structural capacity relative to the forecast traffic (Total CDF << 1).

a. Rigid Pavement Example 1 (Total CDF>1). An airport has a rigid (concrete surfaced) runway pavement with a subgrade *k*-value of 100 pci and a slab thickness of 14.5 inches, with an existing cross section as shown in the lower right portion of Figure C-12. The concrete has a flexural strength of 650 psi. The runway has a parallel taxiway, and additional fuel is obtained at the airport before departure. The pavement life is estimated to be 20 years from the original construction. The traffic shown in Table C-6 regularly uses the pavement. Table C-7 summarizes the existing rigid structure and the computation of the improved *k*-value for input into COMFAA.

Table C-6. Input Traffic Data for Rigid Example 1.

No.	Aircraft Name	Gross Weight, lbs.	Percent GW on Main Gear	Tire Pressure, psi	Annual Departures
1	A300-B4 STD	364,747	94.00	216.1	1,500
2	A319-100 STD	141,978	92.60	172.6	1,200
3	B737-300	140,000	90.86	201.0	6,000
4	B747-400	877,000	93.32	200.0	1,000
5	B767-200 ER	396,000	90.82	190.0	2,000
6	B777-200 ER	657,000	91.80	205.0	1,000
7	DC8-63	330,000	96.12	196.0	3,000

Table C-7. Conversion to Equivalent Pavement Structure in Rigid Example 1.

Existing Pavement Structure	Equivalent Pavement Structure
Existing top-of-subgrade *k*-value = 100 pci	4 inch P-403 improves *k*-value to 287 pci 12 inch P-209 improves *k*-value to 215 pci
14 inch concrete layer (P-501) 4 inch HMA stabilized subbase layer (P-403) 12 inch crushed aggregate subbase (P-209) Subgrade *k*-value 100 pci Concrete strength 650 psi	14 inch concrete layer (P-501) *k*-value 287 pci Concrete strength 650 psi

The number of load repetitions depends on the number of traffic cycles, which is calculated using Equation A-1 and then converted to coverages in the COMFAA program. Since additional fuel is generally obtained at the airport, and there is a parallel taxiway, P/TC = 1. This value is entered in the appropriate field on the COMFAA main window, along with appropriate values for the concrete strength, PCC slab thickness and the value of improved *k*-value determined above, as shown in Figure C-13.

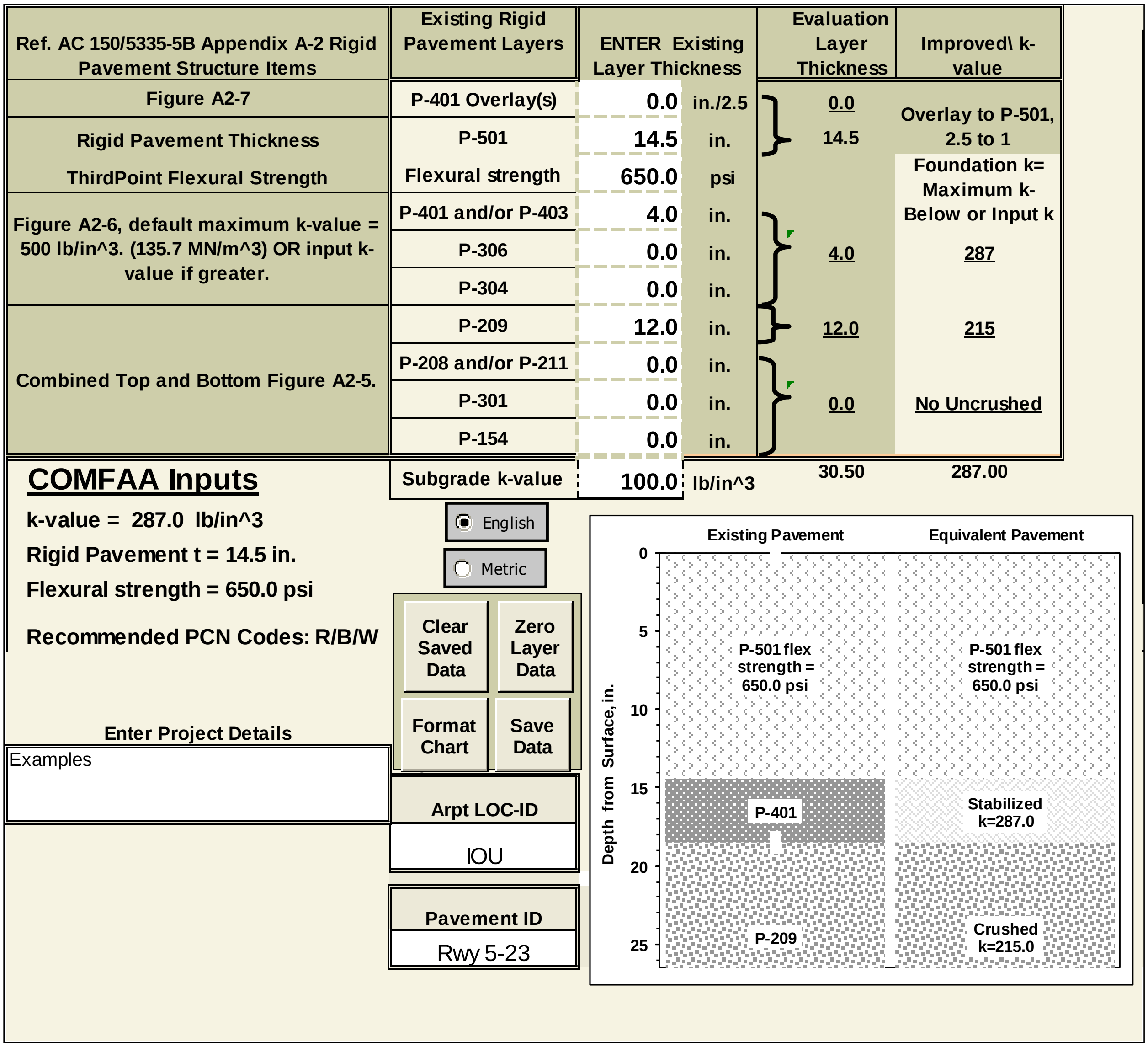


Figure C-12. Screen shot of rigid PCN tab in COMFAA support spreadsheet for computing equivalent pavement structure in Rigid Example 1.

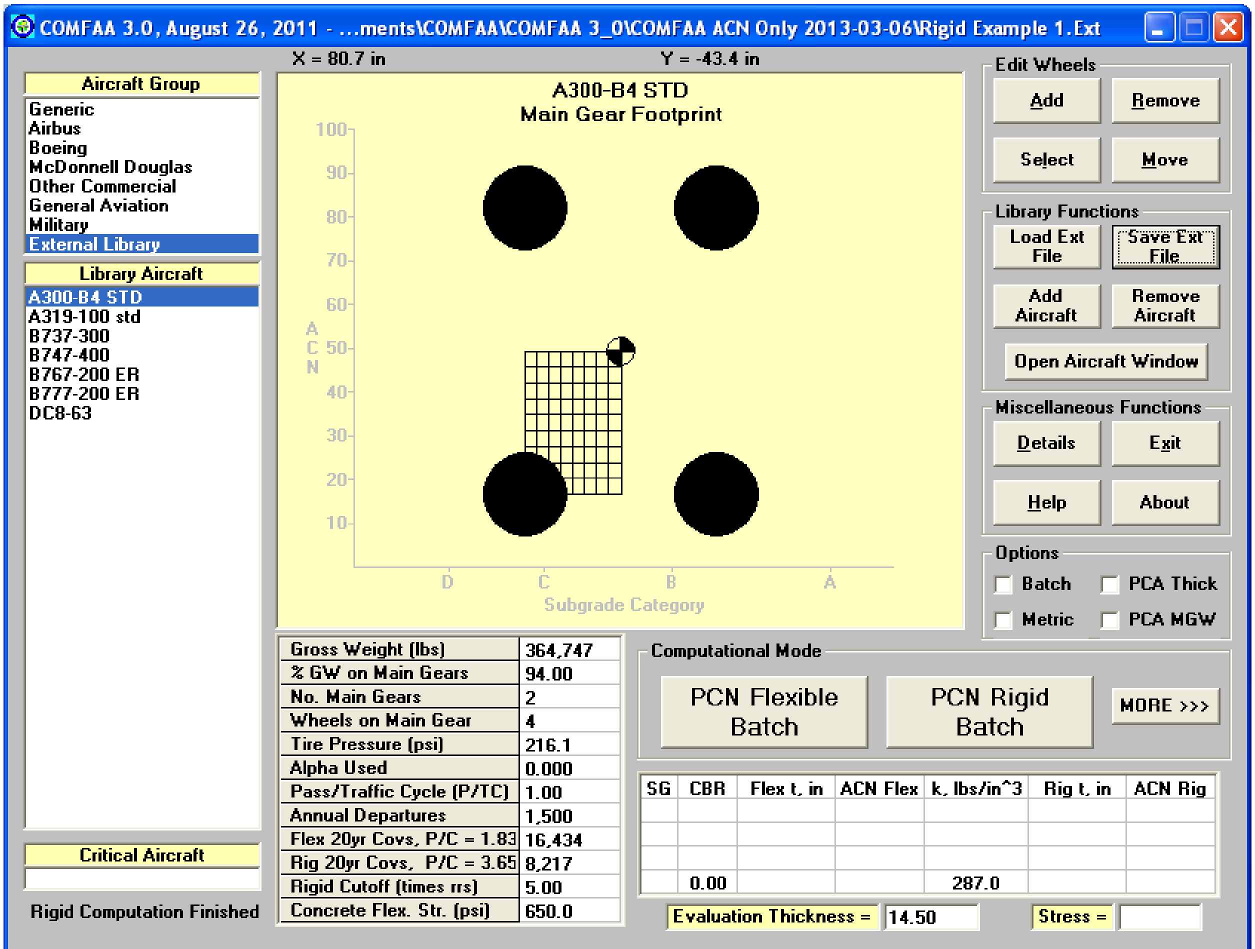


Figure C-13. Screen shot of COMFAA main screen showing the required inputs for Rigid Example 1.

```
                                  k Value = 287.0 lbs/in^3 (Subgrade Category is B(295))
                         flexural strength = 650.0 psi
              Evaluation pavement thickness = 14.50 in
        Pass to Traffic Cycle (PtoTC) Ratio = 1.00

          Maximum number of wheels per gear = 6
       Maximum number of gears per aircraft = 4

Results Table 1. Input Traffic Data
                           Gross   Percent    Tire     Annual      20-yr    6D
 No. Aircraft Name         Weight  Gross Wt   Press     Deps     Coverages  Thick
---------------------------------------------------------------------------------
  1  A300-B4 STD          364,747  94.00      216.1     1,500       8,217   13.24
  2  A319-100 std         141,978  92.60      172.6     1,200       6,443   11.84
  3  B737-300             140,000  90.86      201.0     6,000      31,003   13.59
  4  B747-400             877,000  93.32      200.0     1,000       5,735   13.44
  5  B767-200 ER          396,000  90.82      190.0     2,000      10,907   12.80
  6  B777-200 ER          657,000  91.80      205.0     1,000       4,861   11.98
  7  DC8-63               330,000  96.12      196.0     3,000      17,291   13.61

Results Table 2. PCN Values
                          Critical        Thickness      Maximum      ACN Thick at
                       Aircraft Total     for Total     Allowable    Max. Allowable            PCN on
 No. Aircraft Name       Equiv. Covs.    Equiv. Covs.  Gross Weight   Gross Weight    CDF      B(295)
----------------------------------------------------------------------------------------------------
  1  A300-B4 STD            50,264          14.81        353,550          12.98     0.2332      54.6
  2  A319-100 std          268,124          14.78        136,817          10.62     0.0343      35.5
  3  B737-300              135,137          14.79        134,639          11.01     0.3273      38.3
  4  B747-400               26,352          14.82        848,222          13.55     0.3105      60.0
  5  B767-200 ER           122,316          14.79        383,570          12.41     0.1272      49.7
  6  B777-200 ER           155,472          14.79        636,945          13.60     0.0446      60.5
  7  DC8-63                 70,572          14.80        319,394          12.57     0.3496      51.0
                                                                    Total CDF =    1.4267

Results Table 3. Rigid ACN at Indicated Gross Weight and Strength
 No. Aircraft Name          Gross    % GW on     Tire       ACN     ACN on
                            Weight  Main Gear  Pressure    Thick    B(295)
------------------------------------------------------------------------
  1 A300-B4 STD           364,747     94.00     216.1      13.24      57.1
  2 A319-100 std          141,978     92.60     172.6      10.84      37.1
  3 B737-300              140,000     90.86     201.0      11.25      40.1
  4 B747-400              877,000     93.32     200.0      13.85      63.0
  5 B767-200 ER           396,000     90.82     190.0      12.67      51.9
  6 B777-200 ER           657,000     91.80     205.0      13.92      63.6
  7 DC8-63                330,000     96.12     196.0      12.84      53.4
```

Figure C-14. Detailed COMFAA Batch PCN Output – Rigid Example 1.

Figure C-14 shows the shows the results of the COMFAA Batch PCN Rigid calculations. The top portion of Figure C-14 (Results Table 1) shows the required thickness using the thickness design in accordance with the FAA Westergaard method for a concrete pavement with subgrade *k*-value of 287 pci. Note that the thickness requirements for several traffic aircraft are within about an inch of the evaluation pavement thickness (14.5 in). This indicates the PCN values for the existing traffic in Results Table 2 may be less than the values shown in Results Table 3 (the bottom portion of Figure C-14).

The middle portion of Figure C-14 shows the results of the detailed method based on the cumulative damage factor (CDF) procedure that allows the calculation of the combined effect of multiple aircraft in the traffic mix. The numerical values in the CDF column represent damage to a 14.5-in. thick rigid pavement on an equivalent subgrade with k = 287 pci for each aircraft in the list. The total CDF represents the combined damage from this traffic. Total CDF exceeds 1 in this case, indicating that the pavement is under-designed for the given traffic. Taking each aircraft in turn as the critical aircraft, the program computes total equivalent coverages (based on a CDF analysis), the corresponding thickness for the total equivalent coverages (which is greater than the required thickness for the individual aircraft shown in Results Table 1), and a maximum allowable gross weight. The ACN of the aircraft at the maximum allowable gross weight, at the appropriate ICAO standard *k*-value, is computed and reported in Results Table 2 as the PCN (last column). The PCN for this pavement can be reported as the highest PCN in the PCN column. Based on the information in Figure C-14, the airport may report a PCN of 61/R/B/W/T. Note that the W code should be used for the tire pressure category because this is a rigid pavement.

Referring to the CDF calculation results shown in Results Table 2 of Figure C-14, the A319-100 std and the B777-200 contribute the least to the cumulative damage on this pavement. However, the required thickness in Column 3 of Results Table 2 is consistently greater than the evaluation thickness. This indicates that the pavement does not have sufficient strength to accommodate all existing traffic. The ACNs (Results Table 3) for several aircraft exceed the pavement PCN and the airport should plan for a pavement strengthening project or consider placing restrictions on some aircraft.

The following notes apply when total CDF > 1:

1. At least one ACN value in Results Table 3 will be greater than all of the PCN values in Results Table 2.
2. For all aircraft, the thickness for total equivalent coverages (Column 3 in Results Table 2) will exceed the evaluation pavement thickness for the input subgrade *k*-value.
3. One aircraft in the list will have the greatest thickness requirement for total equivalent coverages, and this “PCN thickness” value will be less than at least one ACN thickness value in Results Table 3.
4. A project to strengthen the pavement to support forecast traffic is required.
5. An overload analysis should be performed.

b. Rigid Pavement Example 2 (Total CDF<1). This second example has the same traffic and other input parameters as the first, except the slab thickness is increased by 0.5 inches to 15 inches. As shown in Figure C-15, the equivalent *k*-value is the same as Example 1.

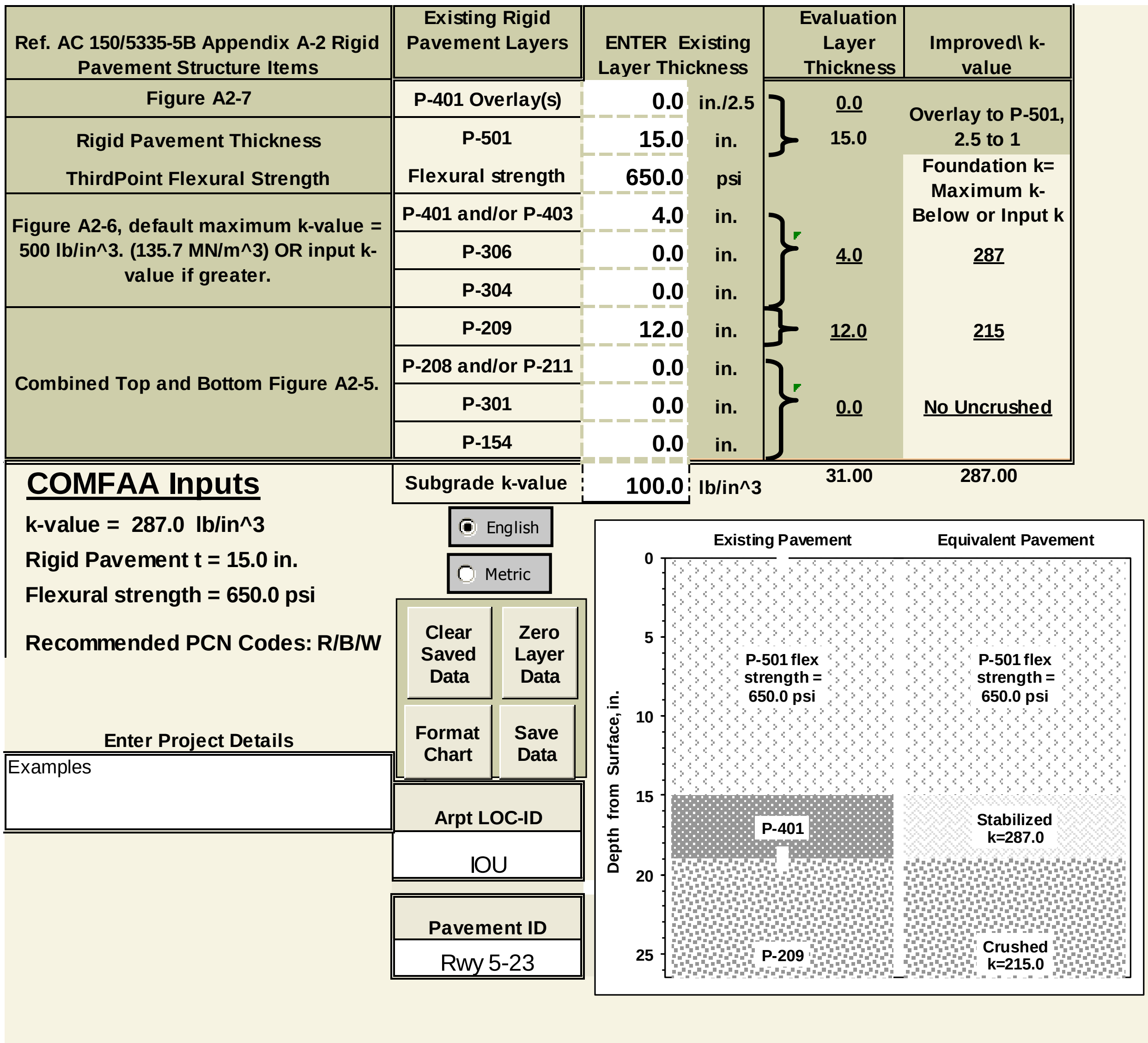


Figure C-15. Screen shot of rigid PCN tab in COMFAA support spreadsheet for computing equivalent pavement structure in Rigid Example 2.

k Value = 287.0 lbs/in^3 (Subgrade Category is B(295))
flexural strength = 650.0 psi
Evaluation pavement thickness = 15.00 in
Pass to Traffic Cycle (PtoTC) Ratio = 1.00

Maximum number of wheels per gear = 6
Maximum number of gears per aircraft = 4

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	20-yr Coverages	6D Thick
1	A300-B4 STD	364,747	94.00	216.1	1,500	8,217	13.24
2	A319-100 std	141,978	92.60	172.6	1,200	6,443	11.84
3	B737-300	140,000	90.86	201.0	6,000	31,003	13.59
4	B747-400	877,000	93.32	200.0	1,000	5,735	13.44
5	B767-200 ER	396,000	90.82	190.0	2,000	10,907	12.80
6	B777-200 ER	657,000	91.80	205.0	1,000	4,861	11.98
7	DC8-63	330,000	96.12	196.0	3,000	17,291	13.61

Results Table 2. PCN Values

No.	Aircraft Name	Critical Aircraft Total Equiv. Covs.	Thickness for Total Equiv. Covs.	Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on B(295)
1	A300-B4 STD	49,717	14.80	372,178	13.42	0.1311	58.8
2	A319-100 std	280,968	14.82	145,308	10.98	0.0182	38.1
3	B737-300	138,304	14.81	143,473	11.40	0.1778	41.3
4	B747-400	25,491	14.79	896,164	14.05	0.1784	64.9
5	B767-200 ER	124,753	14.81	403,882	12.84	0.0693	53.4
6	B777-200 ER	159,887	14.81	670,392	14.13	0.0241	65.7
7	DC8-63	70,626	14.80	336,937	13.02	0.1942	55.0
					Total CDF =	0.7931	

Results Table 3. Rigid ACN at Indicated Gross Weight and Strength

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN Thick	ACN on B(295)
1	A300-B4 STD	364,747	94.00	216.1	13.24	57.1
2	A319-100 std	141,978	92.60	172.6	10.84	37.1
3	B737-300	140,000	90.86	201.0	11.25	40.1
4	B747-400	877,000	93.32	200.0	13.85	63.0
5	B767-200 ER	396,000	90.82	190.0	12.67	51.9
6	B777-200 ER	657,000	91.80	205.0	13.92	63.6
7	DC8-63	330,000	96.12	196.0	12.84	53.4

Figure C-16. Detailed COMFAA Batch PCN Output – Rigid Example 2.

Figure C-16 shows the detailed results from COMFAA. In this case it is seen that the pavement has sufficient strength to support the traffic mix. Results Table 1 (top portion of Figure C-16) shows the required thickness for each aircraft according to the FAA Westergaard method for a concrete pavement with subgrade *k*-value of 287 pci. Note that the individual thickness requirements for all aircraft are less than the evaluation pavement thickness of 15.0 inches. This indicates that the pavement may have sufficient thickness for existing traffic. However, the results from the cumulative damage factor (CDF) procedure are needed for confirmation.

Results Table 2 (middle portion of Figure C-16) shows the results of the detailed method based on the CDF procedure that allows the calculation of the combined effect of multiple aircraft in the traffic mix. Each aircraft in turn is treated as the critical aircraft. For each aircraft, the CDF analysis calculates a maximum allowable gross weight, equivalent coverage level, and corresponding thickness at the evaluation thickness (15.0 in.) and support conditions (287 pci). The total CDF is less than 1 (0.7931) in this case, indicating that there is adequate strength to handle the forecast traffic. The PCN for this pavement can be reported as the highest PCN in the PCN column. Based on the information in Figure C-16, the airport may report a PCN of 66/R/B/W/T. Note that the W code should be used for the tire pressure category because this is a rigid pavement.

Values in Results Table 3 are identical to the corresponding values in Results Table 3 for Example 1. This is because the operating aircraft load data are the same in both examples. All aircraft in the traffic mix have ACNs at their operating weights less than the reported PCN, hence no operating restrictions are needed.

The following notes apply when total CDF < 1:

1. For all aircraft, the thickness for total equivalent coverages (Results Table 2, Column 3) will be the less than the COMFAA evaluation thickness.
2. All maximum allowable gross weights in Results Table 2 will be greater than the corresponding COMFAA input gross weights in Results Table 1 and the ACN weights in Results Table 3.
3. At least one of the PCN values in Results Table 2 will be greater than all ACN values in Results Table 3.

c. Rigid Pavement Example 3. This example is the same as Example 2, except that the taxiway has a central configuration rather than parallel, such as that shown in Figure A-1b. It is still assumed that additional fuel is obtained before departure. Referring to Table C-9, the P/TC ratio changes from 1 to 2. The change results in double the number of coverages for each aircraft in the traffic mix as shown in Results Table 1 of Figure C-17. As expected, the required total pavement thickness for each aircraft in the traffic mix has increased. Note that the thickness requirements for several traffic aircraft are within about an inch of the evaluation pavement thickness (15.0 in), indicating that the pavement strength may be inadequate for the increased number of coverages.

Column 3 of Results Table 2 shows that each aircraft requires a thickness greater than the evaluation thickness when using the CDF method. It is apparent the pavement is not adequate to accommodate double the coverages of the existing traffic. As expected, changing the taxiway system from parallel to central has lowered the PCN of the pavement. The airport may report 60/R/B/W/T. The ACN of two aircraft exceed the pavement PCN and the airport should plan for a pavement strengthening project or consider placing restrictions on those aircraft. The net effect of the change in taxiway configuration from that of Example 2 is the reduction in PCN by 6.

As an alternate way of looking at the effect of a parallel versus central taxiway effects, consider how the pavement life would change instead of the PCN. If the reported PCN from this example were to remain at 60/R/B/W/T, then the pavement life would be reduced by 50%. This is due to the change in the P/TC ratio, which effectively doubled the number of loadings. A similar effect would be noticed if fuel was not obtained at the airport. With a

P/TC ratio of 3, the PCN is reduced further and the pavement life would be one-third the pavement life of the pavement with the original traffic assumptions given for example 2.

k Value = 287.0 lbs/in^3 (Subgrade Category is B(295))
flexural strength = 650.0 psi
Evaluation pavement thickness = 15.00 in
Pass to Traffic Cycle (PtoTC) Ratio = 2.00

Maximum number of wheels per gear = 6
Maximum number of gears per aircraft = 4

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	20-yr Coverages	6D Thick
1	A300-B4 STD	364,747	94.00	216.1	1,500	16,434	13.84
2	A319-100 std	141,978	92.60	172.6	1,200	12,885	12.39
3	B737-300	140,000	90.86	201.0	6,000	62,007	14.15
4	B747-400	877,000	93.32	200.0	1,000	11,470	14.07
5	B767-200 ER	396,000	90.82	190.0	2,000	21,813	13.37
6	B777-200 ER	657,000	91.80	205.0	1,000	9,722	12.54
7	DC8-63	330,000	96.12	196.0	3,000	34,581	14.20

Results Table 2. PCN Values

No.	Aircraft Name	Critical Aircraft Total Equiv. Covs.	Thickness for Total Equiv. Covs.	Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on B(295)
1	A300-B4 STD	99,435	15.40	350,788	12.91	0.2622	54.0
2	A319-100 std	561,937	15.36	135,508	10.57	0.0364	35.1
3	B737-300	276,609	15.38	133,325	10.95	0.3556	37.9
4	B747-400	50,983	15.42	841,137	13.48	0.3569	59.3
5	B767-200 ER	249,506	15.38	380,285	12.34	0.1387	49.1
6	B777-200 ER	319,773	15.38	632,027	13.52	0.0482	59.7
7	DC8-63	141,252	15.39	316,787	12.50	0.3883	50.4
					Total CDF =	1.5863	

Results Table 3. Rigid ACN at Indicated Gross Weight and Strength

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN Thick	ACN on B(295)
1	A300-B4 STD	364,747	94.00	216.1	13.24	57.1
2	A319-100 std	141,978	92.60	172.6	10.84	37.1
3	B737-300	140,000	90.86	201.0	11.25	40.1
4	B747-400	877,000	93.32	200.0	13.85	63.0
5	B767-200 ER	396,000	90.82	190.0	12.67	51.9
6	B777-200 ER	657,000	91.80	205.0	13.92	63.6
7	DC8-63	330,000	96.12	196.0	12.84	53.4

Figure C-17. Detailed COMFAA Batch PCN Output – Rigid Example 3.

d. Rigid Pavement Example 4 (Total CDF<<1). This example demonstrates a consistent method of reporting PCN for rigid pavements that are extremely strong with respect to the input traffic. This situation may arise, for example, where an existing rigid pavement is given a HMA overlay for non-structural reasons. Assume that the rigid pavement in Example 1 receives a 5-in P-401 HMA overlay. Using the Rigid PCN tab of the COMFAA Support Spreadsheet (Figure C-18), the evaluation thickness is 16.5 inches versus 14.5 inches prior to the overlay. The traffic for this example is given in Table C-7, and all other input values are as in Example 1.

Table C-7. Input Traffic Data for Rigid Example 4.

No.	Aircraft Name	Gross Weight, lbs.	Percent GW on Main Gear	Tire Pressure, psi	Annual Departures
1	A300-B4 STD	364,747	94.00	216.1	400
2	A319-100 STD	141,978	92.60	172.6	300
3	B737-300	140,000	90.86	201.0	1,500
4	B747-400	877,000	93.32	200.0	200
5	B767-200 ER	396,000	90.82	190.0	500
6	B777-200 ER	657,000	91.80	205.0	320
7	DC8-63	330,000	96.12	196.0	750

Ref. AC 150/5335-5B Appendix A-2 Rigid Pavement Structure Items	Existing Rigid Pavement Layers	ENTER Existing Layer Thickness		Evaluation Layer Thickness	Improved\ k-value
Figure A2-7	P-401 Overlay(s)	5.0	in./2.5	2.0	Overlay to P-501, 2.5 to 1
Rigid Pavement Thickness	P-501	14.5	in.	16.5	
ThirdPoint Flexural Strength	Flexural strength	650.0	psi		Foundation k= Maximum k- Below or Input k
Figure A2-6, default maximum k-value = 500 lb/in^3. (135.7 MN/m^3) OR input k-value if greater.	P-401 and/or P-403	4.0	in.		
	P-306	0.0	in.	4.0	287
	P-304	0.0	in.		
Combined Top and Bottom Figure A2-5.	P-209	12.0	in.	12.0	215
	P-208 and/or P-211	0.0	in.		
	P-301	0.0	in.	0.0	No Uncrushed
	P-154	0.0	in.		
	Subgrade k-value	100.0	lb/in^3	32.50	287.00

COMFAA Inputs

k-value = 287.0 lb/in^3

Rigid Pavement t = 16.5 in.

Flexural strength = 650.0 psi

Recommended PCN Codes: R/B/X

English | Metric

Clear Saved Data | Zero Layer Data | Format Chart | Save Data

Enter Project Details

Examples

Arpt LOC-ID

IOU

Pavement ID

Rwy 5-23

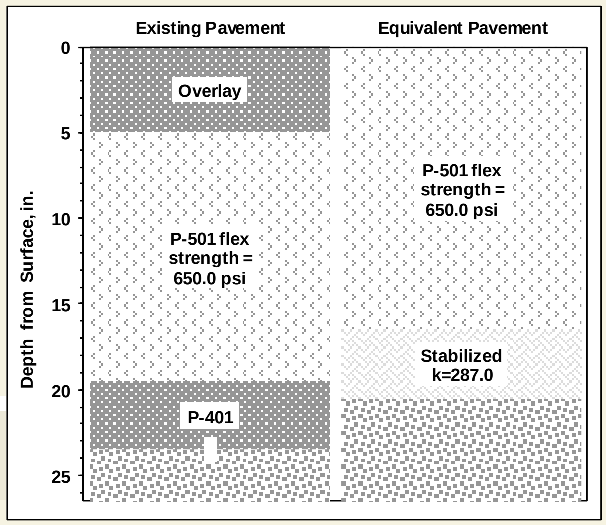


Figure C-18. Screen shot of rigid PCN tab in COMFAA support spreadsheet for computing equivalent pavement structure in Rigid Example 4.

```
                             k Value = 287.0 lbs/in^3 (Subgrade Category is B(295))
                    flexural strength = 650.0 psi
          Evaluation pavement thickness = 16.50 in
     Pass to Traffic Cycle (PtoTC) Ratio = 1.00

       Maximum number of wheels per gear = 6
    Maximum number of gears per aircraft = 4
```

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	20-yr Coverages	6D Thick
1	A300-B4 STD	364,747	94.00	216.1	400	2,191	12.48
2	A319-100 std	141,978	92.60	172.6	300	1,611	11.24
3	B737-300	140,000	90.86	201.0	1,500	7,751	12.45
4	B747-400	877,000	93.32	200.0	200	1,147	12.72
5	B767-200 ER	396,000	90.82	190.0	500	2,727	11.93
6	B777-200 ER	657,000	91.80	205.0	320	1,556	11.57
7	DC8-63	330,000	96.12	196.0	750	4,323	12.49

Results Table 2. PCN Values

No.	Aircraft Name	Critical Aircraft Total Equiv. Covs.	Thickness for Total Equiv. Covs.	Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on B(295)
1	A300-B4 STD	11,697	13.54	487,831	16.06	0.0062	86.6
2	A319-100 std	78,605	13.81	198,394	13.03	0.0007	55.1
3	B737-300	36,045	13.71	197,844	13.61	0.0071	60.5
4	B747-400	5,610	13.42	1,202,217	17.10	0.0068	99.3
5	B767-200 ER	32,180	13.69	527,343	15.33	0.0028	78.3
6	B777-200 ER	42,279	13.73	857,882	17.04	0.0012	98.6
7	DC8-63	17,210	13.60	441,572	15.59	0.0083	81.3
					Total CDF =	0.0331	

Results Table 3. Rigid ACN at Indicated Gross Weight and Strength

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN Thick	ACN on B(295)
1	A300-B4 STD	364,747	94.00	216.1	13.24	57.1
2	A319-100 std	141,978	92.60	172.6	10.84	37.1
3	B737-300	140,000	90.86	201.0	11.25	40.1
4	B747-400	877,000	93.32	200.0	13.85	63.0
5	B767-200 ER	396,000	90.82	190.0	12.67	51.9
6	B777-200 ER	657,000	91.80	205.0	13.92	63.6
7	DC8-63	330,000	96.12	196.0	12.84	53.4

Figure C-19. Detailed COMFAA Batch PCN Output – Rigid Example 4 (unadjusted).

Figure C-19 shows the COMFAA output when PCN is computed using the evaluation thickness 16.5 in. and P/TC=1. For the overlaid pavement subject to the forecast traffic, total CDF is much less than 1 (total CDF= 0.0331), indicating that the 20-year traffic mix causes insignificant damage to the pavement. Similarly, the largest value of thickness for total equivalent coverages in Results Table 2 is much less than the COMFAA evaluation thickness at the evaluation *k*-value. Hence, it may be necessary to use an unrealistic allowable gross weight for the critical aircraft to compute PCN. Using the regular COMFAA procedure without adjustment, the airport could report PCN=99/R/B/X/T for this pavement. However, this PCN is based on an unrealistically high allowable gross weight for the B747-400 (1,202,217 lbs.).

The regular COMFAA procedure given in section 2.3 is most suitable when the total CDF > 0.15. When the procedure results in CDF < 0.15, as in this example, the FAA recommends adjusting the input traffic such that the PCN is reported for a total CDF = 0.150. Rather than modifying the COMFAA external aircraft file, the P/TC ratio can be used to obtain total CDF=0.150 as follows.

1. Perform a PCN Rigid Batch operation using the appropriate P/TC ratio based on the criteria in Appendix A.

2. Note the value of Total CDF in Results Table 2.

3. Multiply the original value of P/TC ratio by the factor 0.15/Total CDF, where Total CDF is taken from Step 2.

4. Enter the new value of P/TC ratio in the P/TC field in COMFAA.

5. Repeat the PCN Rigid Batch operation with the new value of P/TC ratio. This will result in a new Total CDF equal to or close to 0.15.

6. Note that the maximum value of P/TC ratio allowed in COMFAA is 10. This should be sufficient in most cases. However, if the value computed in Step 3 exceeds 10, increasing the annual departures of all input aircraft by a factor of 10 and repeating steps 1 through 5 will generally result in Total CDF=0.150.

Figure C-20 shows a re-analysis of the overlaid pavement using an adjusted value of the P/TC ratio equal to 1 × 0.15 / 0.0331 = 4.532. As indicated in Results Table 2, the adjusted Total CDF = 0.15. The airport can report PCN=83/R/B/X/T or 83/R/B/W/T at Total CDF=0.150, based on a more reasonable maximum allowable gross weight of the B777-200 ER. Results Table 3 shows that all aircraft in the existing mix operate at ACNs much lower than the reported PCN. There is no need to report a PCN higher than 83.

```
                                 k Value = 287.0 lbs/in^3 (Subgrade Category is B(295))
                        flexural strength = 650.0 psi
             Evaluation pavement thickness = 16.50 in
       Pass to Traffic Cycle (PtoTC) Ratio = 4.53 (non-standard)

         Maximum number of wheels per gear = 6
       Maximum number of gears per aircraft = 4
```

Results Table 1. Input Traffic Data

No.	Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	20-yr Coverages	6D Thick
1	A300-B4 STD	364,747	94.00	216.1	400	9,930	13.40
2	A319-100 std	141,978	92.60	172.6	300	7,300	11.94
3	B737-300	140,000	90.86	201.0	1,500	35,127	13.69
4	B747-400	877,000	93.32	200.0	200	5,198	13.36
5	B767-200 ER	396,000	90.82	190.0	500	12,357	12.90
6	B777-200 ER	657,000	91.80	205.0	320	7,050	12.27
7	DC8-63	330,000	96.12	196.0	750	19,590	13.71

Results Table 2. PCN Values

No.	Aircraft Name	Critical Aircraft Total Equiv. Covs.	Thickness for Total Equiv. Covs.	Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on B(295)
1	A300-B4 STD	53,012	14.85	422,581	14.60	0.0281	70.5
2	A319-100 std	356,237	15.00	169,542	11.95	0.0031	45.7
3	B737-300	163,356	14.95	168,242	12.44	0.0323	49.9
4	B747-400	25,424	14.79	1,044,448	15.56	0.0307	80.9
5	B767-200 ER	145,838	14.94	459,691	13.98	0.0127	64.2
6	B777-200 ER	191,606	14.96	772,114	15.72	0.0055	82.7
7	DC8-63	77,997	14.89	386,745	14.27	0.0377	67.1
					Total CDF =	0.1501	

Results Table 3. Rigid ACN at Indicated Gross Weight and Strength

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN Thick	ACN on B(295)
1	A300-B4 STD	364,747	94.00	216.1	13.24	57.1
2	A319-100 std	141,978	92.60	172.6	10.84	37.1
3	B737-300	140,000	90.86	201.0	11.25	40.1
4	B747-400	877,000	93.32	200.0	13.85	63.0
5	B767-200 ER	396,000	90.82	190.0	12.67	51.9
6	B777-200 ER	657,000	91.80	205.0	13.92	63.6
7	DC8-63	330,000	96.12	196.0	12.84	53.4

Figure C-20. Detailed COMFAA Batch PCN Output – Rigid Example 4 (with adjustment to P/TC ratio to force Total CDF = 0.15).

APPENDIX D. PAVEMENT OVERLOAD EVALUATION BY THE ACN-PCN SYSTEM

1.0 ICAO PAVEMENT OVERLOAD EVALUATION GUIDANCE.

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 PCN.

The ICAO procedure for overload operations is based on minor or limited traffic having ACNs that exceed the reported PCN. Loads that are larger than the defined PCN 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 in their structural behavior do not suddenly or catastrophically fail. As a result, occasional minor aircraft overloading is acceptable with only limited loss of pavement life expectancy and relatively small acceleration of pavement deterioration. For those operations in which the magnitude of overload and/or frequency does not justify a detailed (technical) analysis, the following criteria are suggested.

- For flexible pavements, occasional traffic cycles by aircraft with an ACN not exceeding 10 percent above the reported PCN should not adversely affect the pavement. For example, a pavement with PCN=60 can support some limited traffic of aircraft with ACN=66.

- For rigid or composite pavements, occasional traffic cycles by aircraft with an ACN not exceeding 5 percent above the reported PCN should not adversely affect the pavement. For example, a pavement with PCN=60 can support some limited traffic of aircraft with ACN=63.

- The annual number of overload traffic cycles should not exceed approximately 5 percent of the total annual aircraft traffic cycles. There is no exact guidance for choosing a number of operations that represents 5 percent. For consistency, the FAA recommends using 500 coverages of aircraft with ACN=1.1xPCN for flexible pavements ACN=1.05xPCN for rigid pavements. The PCN is 10,000 coverages of an aircraft with a derived ACN=PCN when CDF=1, five percent of this total equivalent operations is 500 coverages.

- Overloads should not normally be permitted on pavements exhibiting signs of distress, during periods of thaw following frost penetration, or when the strength of the pavement or its subgrade could be weakened by water.

- Where overload operations are conducted, the airport authority should review the relevant pavement condition on a regular basis and should also review the criteria for overload operations periodically, since excessive repetition of overloads can cause severe shortening of pavement life or require major rehabilitation of the pavement.

These criteria provide consistent, repeatable guidance the airport authority can use to monitor the impact of these overload operations on the pavement in terms of pavement life reduction or increased maintenance requirements. This appendix 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.

1.1 OVERLOAD GUIDANCE.

The overload evaluation guidance in this appendix applies primarily to flexible and rigid pavements that have PCN 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. The procedures presented here rely on the COMFAA program.

The adjustments for pavement overloads start with the assumption that some of the aircraft in the traffic mix have ACNs that exceed the PCN. If the steps outlined in Appendix C have been followed for the technical method, then most of the necessary data already exists to perform an examination of overloading.

The recommended PCN is not adequate for the traffic mix when the Total CDF>1. The airport authority has three options when making a pavement strength rating selection:

1. Let the PCN 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 ACNs that exceed the published PCN or at a reduced weight to not exceed the PCN.

2. Provide for an increased PCN by adding an overlay or by reconstruction to accommodate aircraft with higher ACNs.

3. Adjust the PCN upward to that of the aircraft with the highest ACN, but recognize the need to expect possible severe maintenance. This will result in earlier and increased costs for reconstruction or overlay projects.

1.2 ADJUSTMENTS FOR FLEXIBLE PAVEMENT OVERLOADS.

The first option requires that the airport authority be constantly aware of the composition of the entire traffic mix in terms of operating gross weights and loading frequency. If the traffic mix has changes that affect the factors involved in developing a technically based PCN, then the PCN will need to be adjusted to reflect the changes. The airport authority will also have to internally make allowance for or prevent aircraft operations that exceed the PCN. A consistent method to determine when aircraft ACN and frequency exceed allowable overloads is presented.

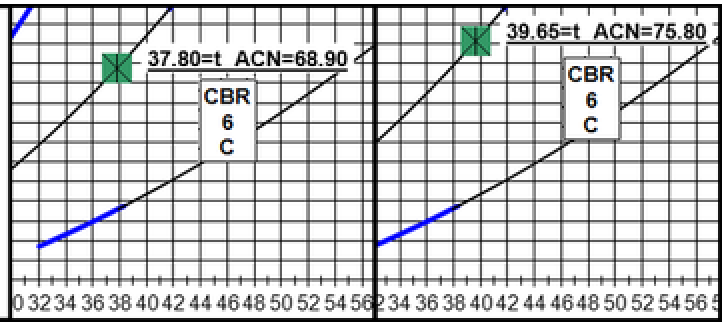
For flexible pavement example Total CDF>1. The B-747-400 has the highest CDF-PCN combination. The traffic aircraft with the highest CDF-PCN combination is the basis for overload analysis. The PCN=68.9 and the traffic mix is equivalent to 10,000 coverages of a

B747-400 with a gross weight, MGW=847,310 lbs. on a 37.8 in. pavement with CBR = 6. Aircraft with PCN=(1.1x68,9)=75.8 can operate at 500 coverages total with minimal impact on the load carrying capacity. The gross weight of a B747-400 at ACN=75.8 is the MGW from COMFAA using 10,000 coverages, 39.65 in., and CBR=6.

Results Table 2. PCN Values

Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on C(6)
355,252	35.31	0.2454	60.1
139,771	27.19	0.0001	35.7
137,402	28.03	0.0021	37.9
847,310	37.80	0.7079	68.9
387,270	34.61	0.1630	57.8
645,067	37.01	0.2826	66.1
322,545	34.27	0.2381	56.6
	Total CDF =	1.6392	

Total CDF>1



COMFAA MGW results at 39.65 in., CBR=6 for the B747-400 traffic aircraft is MGW=901,739 lbs.. COMFAA Batch ACN results confirm that increasing MGW from 847,310 lbs. to 901,739 lbs. increases ACN 10 percent.

CBR = 6.00
Evaluation pavement thickness = 39.65 in

Results Table: Maximum Allowable Gross Weight Computations, Units = Imperial.

No.	Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	6D Thick	20-yr Coverages	Max. Allowable Gross Weight
1	B747-400orig	847,310	93.32	200.0	887	37.80	10,000	901,739

Flexible ACN at Indicated Gross Weight and Strength. Units = English.

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN at Indicated Code A(15)	B(10)	C(6)	D(3)
1	B747-400orig	847,310	93.32	200.0	51.0	56.5	68.9	90.1
2	B747-400	901,739	93.32	200.0	55.2	61	75.8	97.7

COMFAA PCN results with 500 coverages of the aircraft with 10 percent higher ACN confirms minor impact on this flexible pavement. However, the PCN=74.8, which is less than ACN=75.8. Overloads are occurring at the input traffic gross weight and frequency.

CBR = 6.00 Subgrade Category is C(6), Thickness = 37.80 in

Results Table 1. Input Traffic Data

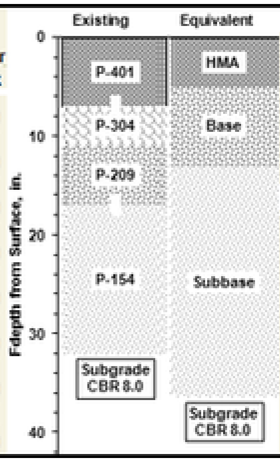
No.	Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	20-yr Coverages	6D Thick
1	B747-400orig	847,310	93.32	200.0	887	10,000	37.80
2	B747-400	901,739	93.32	200.0	43	500	30.62

Results Table 2. PCN Values

No.	Aircraft Name	Critical Aircraft Total Equiv. Covs.	Thickness for Total Equiv. Covs.	Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on C(6)
1	B747-400orig	11,022	38.02	840,892	37.58	0.9980	68.1
2	B747-400	5,390	38.06	893,804	39.38	0.1020	74.8
				Total CDF>1	Total CDF =	1.1000	

<u>The second option</u> alleviates the problems discussed for the first option, but it does require additional expense to bring the pavement up to the strength required by the combination of aircraft in the traffic mix. The two inch overlay increases the PCN from 68.9 to 96.9. Providing added pavement strength allows operations at current levels and weights until the overlay project is programmed.

Flexible Layers	Layer Thick
P-401/3	7.0
P-306	0.0
P-304	4.0
P-209	6.0
P-208	0.0
P-301	0.0
P-154	15.0
CBR	8.0



CBR = 8.00 (Subgrade Category is C(6))
Evaluation pavement thickness = 36.40 in

Results Table 2. PCN Values

Aircraft	Critical Aircraft Tot Equiv. Covs.	Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on C(6)
A300-B4	264,870	406,912	39.00	0.0022	73.3
A319-100	>5,000,000	146,714	28.03	0.0000	37.9
B737-300	>5,000,000	147,191	29.27	0.0000	41.3
B747-400	12,676	1,060,338	44.83	0.0321	96.9
B767-200	1,036,028	431,320	37.67	0.0007	68.4
B777-200	>5,000,000	660,776	37.72	0.0000	68.6
DC8-63	2,881,679	354,742	36.67	0.0004	64.9

Total CDF = 0.0355
Total CDF<<1

<u>The third option</u> has the benefit of allowing all aircraft in the traffic mix to operate as necessary. However, by increasing the PCN, which only implies higher pavement strength, the pavement life will be reduced by an estimated 40 percent.

Results Table 1.
Input Traffic Data

No.	Aircraft Name	Gross Weight	Total CDF 1.6392 Annual Deps	Total CDF 1.1001 Annual Deps
1	A300-B4 STD	364,747	1,500	1,007
2	A319-100 std	141,978	1,200	805
3	B737-300	140,000	6,000	4,026
4	B747-400	877,000	1,000	671
5	B767-200 ER	396,000	2,000	1,342
6	B777-200 ER	657,000	1,000	671
7	DC8-63	330,000	3,000	2,013

COMFAA can be used to analyze the sensitivity of the traffic characteristics on the pavement. In the example the Total CDF=1.6392 for input traffic and Total CDF=1.10 at overload level. Setting P/TC ratio to 1.10/1.6392 shows how the additional damage is expressed as an Annual Departure reduction.

1.3 ADJUSTMENTS FOR RIGID PAVEMENT OVERLOADS.

<u>The first option</u> requires that the airport authority be constantly aware of the composition of the entire traffic mix in terms of operating gross weights and loading frequency. If the traffic mix has changes that affect the factors involved in developing a technically based PCN, then the PCN will need to be adjusted to reflect the changes. The airport authority will also have to internally make allowance for or prevent aircraft operations that exceed the PCN. A consistent method to determine when aircraft ACN and frequency exceed allowable ♦

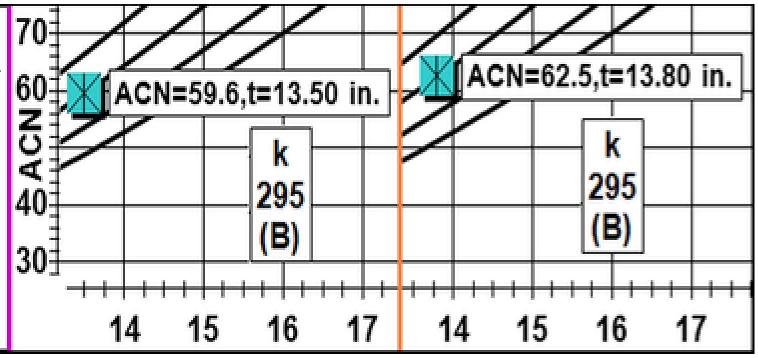
For rigid pavement example Total CDF>1. The B-747-400 has the highest CDF-PCN combination. The traffic aircraft with the highest CDF-PCN combination is the basis for overload analysis. The PCN=59.4 and the traffic mix is equivalent to 10,000 coverages of a

B747-400 with a gross weight, MGW=841,758 lbs. on a 13.49 in. pavement with k-value=295 pci. Aircraft with PCN=(1.05x59.4)=62.4 can operate at 500 coverages total with minimal impact on the load carrying capacity. The gross weight of a B747-400 at ACN=62.4 is the MGW from COMFAA using 10,000 coverages, 13.49 in., and k-value=295 pci.

Results Table 2. PCN Values

Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on B(295)
351,047	12.92	0.2564	54.1
135,813	10.58	0.0362	35.2
133,544	10.96	0.3412	38.0
841,758	13.49	0.3388	→ 59.4
381,236	12.36	0.1401	49.2
632,397	13.53	0.0491	59.8
317,177	12.51	0.3784	50.5
	Total CDF =	1.5402	

Total CDF>1



COMFAA MGW results at 13.8 in., and k-value=295 pci for the B747-400 traffic aircraft is MGW=871,000 lbs.. COMFAA Batch ACN results confirm that increasing MGW from 841,758 lbs. to 871,000 lbs. increases ACN 5 percent

k Value = 295.0 lbs/in^3
flexural strength = 650.0 psi
Evaluation pavement thickness = 13.79 in

Maximum Allowable Gross Weight Computations, Units = Imperial.

Aircraft Name	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	6D Thick	20-yr Coverages	Max. Allowable Gross Weight
B747-400 at 105pct	871,700	93.32	200.0	1,749	13.79	10,000	→ 871,800

Rigid ACN at Indicated Gross Weight and Strength. Units = English.

Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN at Indicated Code A(552)	B(295)	C(147)	D(74)
B747-400 at 105pct	871,800	93.32	200.0	52.	→ 62.4	74.0	84.6
B747-400 at 13.49in	841,758	93.32	200.0	49.	→ 59.4	70.5	80.7

COMFAA PCN results with 500 coverages of the aircraft with 5 percent higher ACN confirms minor impact on this rigid pavement. However, the PCN=62.0, which is less than ACN=63.6. Overloads are occurring at the input traffic gross weight and frequency.

Results Table 1. Input Traffic Data

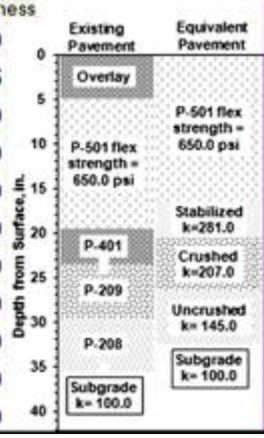
Aircraft	Gross Weight	Percent Gross Wt	Tire Press	Annual Deps	20-yr Coverages	6D Thick
B747-400 orig	841,758	93.32	200.0	1,779	10,000	13.48
B747-400 105pct	871,800	93.32	200.0	87	500	12.24

Results Table 2. PCN Values

Aircraft	Critical Aircraft Total Equiv. Covs.	Thickness for Total Equiv.Covs.	Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on B(295)
B747-400 orig	10,711	13.54	837,343	13.44	0.9843	59.0
B747-400 105pct	7,534	13.54	867,181	13.75	0.070	62.0
		Total CDF>1		Total CDF =	1.0543	

The second option alleviates the problems discussed for the first option, but it does require additional expense to bring the pavement up to the strength required by the combination of aircraft in the traffic mix. The five inch flexible overlay is converted to an additional two inches of rigid pavement. The PCN increases from PCN=63.6 to PCN= 98.1 Providing added pavement strength allows operations at current levels and weights until the overlay project is programmed.

Pavement Layers	Thickness
P-401 Overlay(s)	5.0
P-501	14.5
Flexural strength	650.0
P-401 and/or P-403	4.0
P-306	0.0
P-304	0.0
P-209	6.0
P-208 and/or P-211	6.0
P-301	0.0
P-154	0.0
Subgrade k-value	100.0



Aircraft	Maximum Allowable Gross Weight	ACN Thick at Max. Allowable Gross Weight	CDF	PCN on B(295)
A300-B4 STD	485,122	16.00	0.0069	86.0
A319-100 st(	196,884	12.98	0.0007	54.6
B737-300	196,092	13.54	0.0075	59.9
B747-400	1,192,659	17.01	0.0075	98.1
B767-200 ER	524,353	15.27	0.0031	77.7
B777-200 ER	850,329	16.92	0.0014	97.1
DC8-63	438,214	15.51	0.0091	80.4
		Total CDF =	0.0362	
			Total CDF<<1	

Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	ACN Thick	ACN on B(295)
B747-400	877,000	93.32	200.0	13.85	63.0
B777-200 ER	657,000	91.80	205.0	13.92	63.6

The third option has the benefit of allowing all aircraft in the traffic mix to operate as necessary. However, by increasing the PCN, which only implies higher pavement strength, the pavement life will be reduced by an estimated 40 percent.

k-value=281 pci, Flex Stren=650.0 psi, Thick=14.5 in

Traffic Aircraft	Gross Weight	Percent GrossWt	Tire Press	Annual Deps	Annual Deps
A300-B4	364,747	94.00	216.1	1,500	662
A319-100	141,978	92.60	172.6	1,200	821
B737-300	140,000	90.86	201.0	6,000	4,107
B747-400	877,000	93.32	200.0	1,000	685
B767-200	396,000	90.82	190.0	2,000	1,369
B777-200	657,000	91.80	205.0	1,000	685
DC8-63	330,000	96.12	196.0	3,000	2,054
				CDF=1.5402	CDF=0.9919

COMFAA can be used to analyze the sensitivity of the traffic characteristics on the pavement. In the example the Total CDF=1.5402 for input traffic and Total CDF=1.0543 at overload level. Setting P/TC ratio to 1.0543/1.5402 shows how the additional damage is expressed as an Annual Departure reduction.

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APPENDIX E. REPORTING CHANGES TO CERTAIN AIRPORT RUNWAY DATA ELEMENTS

This Advisory Circular affects the following airport runway data.

1.0 ALLOWABLE GROSS WEIGHT.

FAA pavement design guidance has been revised. Previously, the aircraft gross weight data referred to a "design aircraft." The term is no longer used. Aircraft gross weight data reported using the guidance in this AC is calculated based on the PCN of the pavement.

a. Source of Data. The source for Runway Weight Bearing Capacity Data is the FAA Engineer or Program Manager at the local FAA Regional Office (RO) or FAA Airports District Office (ADO). Currently, RO and ADO specialists may submit changes to single wheel type landing gear (S), dual wheel type landing gear (D), dual tandem wheel type landing gear (2D), and double dual tandem wheel type landing gear (2D/2D2) electronically to FAA Air Traffic Aeronautical Information Services for publication in FAA flight information manuals using the secure web site 5010WEB, monitored by GCR & Associates on behalf of the FAA. State airport inspectors may not submit changes to Runway Weight Bearing Capacity Data directly to Aeronautical Information Services for publication. Instead, they must submit the data changes to the RO and ADO for validation, and in turn, the RO or ADO submits changes to Runway Weight Bearing Capacity Data electronically to Aeronautical Information Services using the steps enumerated above on behalf of the State Aviation Agency.

b. Reporting Allowable Gross Weight. For purposes of airport runway data elements generally published on FAA Form 5010, Airport Master Record, the Allowable Gross Weight is the maximum weight expressed in thousands of pounds that aircraft with a specific main gear configuration can operate on a pavement. A list of PCN-based maximum gross weights for reporting Runway Weight Bearing Capacity Data has been developed. The listing is posted on the FAA website with this AC. Local experience can be considered to report a lower weight, but higher weights are not recommended.

1.1 PAVEMENT CLASSIFICATION NUMBER (PCN).

a. Source of Data. The source for Pavement Classification Number (PCN) data is the airport operator. FAA Part 139 airport inspectors and State non-Part 139 airport inspectors are instructed to request PCN data from the airport manager as part of the manager interview before an airport inspection. If the airport manager has PCN data, the inspector may accept the data for immediate publication in flight information publications; however, if the airport manager does not have PCN data, then the inspector has no PCN data available for publication.

b. Reporting PCN. For purposes of airport runway data elements generally published on FAA Form 5010, Airport Master Record, the PCN is a number that expresses the load-carrying capacity of a pavement based on all aircraft traffic that regularly operates on the pavement. The PCN determined earlier (see Appendices 1 through 3) is the PCN to report.

2.0 ASSIGNING AIRCRAFT GROSS WEIGHT DATA.

Tables E-1 and E-2 summarize the process used to assign allowable aircraft gross weight. Table E-1 shows the flexible ACNs. Table E-2 shows the rigid ACNs. Allowable gross weight is based on aircraft gear configuration as issued in FAA Order 5300.7, Standard Naming Convention for Aircraft Landing Gear Configurations (October 6, 2005), coupled with tire pressure and wheel spacing ranges. The ACN for these standard aircraft results in a recommended maximum gross weight for Runway Weight Bearing Capacity. See Chapter 3 for instructions for using the COMFAA software to determine ACN values under certain conditions. The COMFAA external file will be posted on the FAA website.

Table E-1. Flexible ACN Data Used to Establish Allowable Gross Weight

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

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	A(15)	B(10)	C(6)	D(3)
1	S-7.5std	7,500	95.00	52.5	1.4	1.9	2.5	2.8
2	S-15std	15,000	95.00	60.0	3.2	4.2	5.2	5.8
3	S-30std	30,000	95.00	75.0	8.0	9.6	11.3	11.8
4	S-45std	45,000	95.00	90.0	13.7	16.1	17.5	18.3
5	S-60std	60,000	95.00	105.0	20.3	22.6	23.7	24.8
6	S-75std	75,000	95.00	120.0	27.4	29.8	30.2	31.3
7	S-90st	90,000	95.00	135.0	35.1	37.2	36.9	37.8
8	S-105std	105,000	95.00	150.0	42.4	43.6	43.2	44.4
9	S-120std	120,000	95.00	165.0	50.5	50.3	50.5	51.0
10	D-37.5	37,500	95.00	65.0	5.5	7.1	8.8	10.9
11	D-50	50,000	95.00	80.0	8.9	11.0	12.9	15.2
12	D-75	75,000	95.00	110.0	16.9	19.0	21.8	24.0
13	D-100	100,000	95.00	140.0	25.8	27.6	30.7	32.8
14	D-125	125,000	95.00	150.0	31.7	33.6	37.8	40.7
15	D-150	150,000	95.00	160.0	37.4	39.3	44.5	48.5
16	D-175	175,000	95.00	180.0	44.0	47.1	52.5	56.8
17	D-200	200,000	95.00	200.0	51.1	54.7	60.4	65.2
18	D-225	225,000	95.00	220.0	58.3	62.1	68.3	73.5
19	D-250	250,000	95.00	240.0	65.3	69.3	76.1	81.7
20	2D-100	100,000	95.00	120.0	10.6	11.5	13.9	17.4
21	2D-150	150,000	95.00	140.0	18.2	20.3	24.2	29.6
22	2D-200	200,000	95.00	160.0	26.4	30.2	35.0	42.9
23	2D-250	250,000	95.00	170.0	34.1	39.2	45.4	55.5
24	2D-300	300,000	95.00	190.0	42.3	48.4	56.0	68.1
25	2D-350	350,000	95.00	190.0	49.5	56.9	66.2	80.4
26	2D-400	400,000	95.00	200.0	56.6	64.9	76.2	92.4
27	2D-450	450,000	95.00	210.0	62.3	71.8	85.3	103.8
28	2D-500	500,000	95.00	220.0	67.3	76.4	92.2	113.8
29	2D-550	550,000	95.00	230.0	70.9	79.3	96.1	121.6
30	2D/2D2-40	640,000	95.00	210.0	36.6	39.6	46.2	63.1
31	2D/2D2-50	800,000	95.00	220.0	48.9	53.7	64.9	85.6
32	2D/2D2-60	960,000	95.00	230.0	62.2	69.4	85.9	108.3
33	2D/2D2-70	1,120,000	95.00	240.0	77.7	87.4	108.4	131.1
34	3D-40	480,000	95.00	210.0	34.2	37.5	44.4	62.9
35	3D-50	600,000	95.00	220.0	46.4	51.2	62.4	87.4
36	3D-60	720,000	95.00	230.0	60.1	66.8	83.1	113.1
37	3D-70	840,000	95.00	240.0	74.6	83.7	105.9	138.6
38	2D/3D2-40W	800,000	36.75	210.0	32.7	34.5	38.7	51.3
39	2D/3D2-50W	1,000,000	36.75	220.0	43.0	46.0	52.5	72.1
40	2D/3D2-60W	1,200,000	36.75	230.0	54.1	58.6	68.4	93.6
41	2D/3D2-70W	1,400,000	36.75	240.0	65.6	72.2	86.7	115.4
42	2D/3D2-40B	800,000	55.75	210.0	30.8	33.1	38.0	52.0
43	2D/3D2-50B	1,000,000	55.75	220.0	41.0	44.7	52.5	74.1
44	2D/3D2-60B	1,200,000	55.75	230.0	52.5	57.4	69.0	97.4
45	2D/3D2-70B	1,400,000	55.75	240.0	65.3	71.7	87.7	121.8

Table E-2. Rigid ACN Data Used to Establish Allowable Gross Weight

Results Table 3. Rigid ACN at Indicated Gross Weight and Strength

No.	Aircraft Name	Gross Weight	% GW on Main Gear	Tire Pressure	A(552)	B(295)	C(147)	D(74)
1	S-7.5std	7,500	95.00	52.5	2.1	2.2	2.3	2.2
2	S-15std	15,000	95.00	60.0	4.3	4.5	4.7	4.8
3	S-30std	30,000	95.00	75.0	9.3	9.7	10.0	10.2
4	S-45std	45,000	95.00	90.0	14.9	15.4	15.8	16.1
5	S-60std	60,000	95.00	105.0	21.1	21.6	22.1	22.4
6	S-75std	75,000	95.00	120.0	27.7	28.2	28.7	29.0
7	S-90st	90,000	95.00	135.0	34.8	35.2	35.6	35.9
8	S-105std	105,000	95.00	150.0	42.2	42.6	42.9	43.1
9	S-120std	120,000	95.00	165.0	50.0	50.2	50.4	50.5
10	D-37.5	37,500	95.00	65.0	7.3	8.1	9.0	9.6
11	D-50	50,000	95.00	80.0	11.0	12.1	13.0	13.8
12	D-75	75,000	95.00	110.0	19.4	20.8	22.0	23.0
13	D-100	100,000	95.00	140.0	28.7	30.3	31.7	32.8
14	D-125	125,000	95.00	150.0	35.1	37.1	39.0	40.4
15	D-150	150,000	95.00	160.0	41.3	43.8	46.1	47.9
16	D-175	175,000	95.00	180.0	49.8	52.6	55.1	57.1
17	D-200	200,000	95.00	200.0	58.6	61.5	64.2	66.4
18	D-225	225,000	95.00	220.0	67.4	70.6	73.4	75.8
19	D-250	250,000	95.00	240.0	76.4	79.7	82.7	85.2
20	2D-100	100,000	95.00	120.0	10.3	12.2	14.6	16.9
21	2D-150	150,000	95.00	140.0	18.5	22.1	26.0	29.6
22	2D-200	200,000	95.00	160.0	28.1	33.2	38.5	43.1
23	2D-250	250,000	95.00	170.0	36.6	43.2	49.8	55.5
24	2D-300	300,000	95.00	190.0	45.8	53.8	61.7	68.4
25	2D-350	350,000	95.00	190.0	52.9	62.4	71.8	79.8
26	2D-400	400,000	95.00	200.0	60.2	71.0	81.8	91.0
27	2D-450	450,000	95.00	210.0	66.3	78.3	90.5	101.0
28	2D-500	500,000	95.00	220.0	70.1	83.0	96.6	108.5
29	2D-550	550,000	95.00	230.0	72.0	85.0	99.7	113.0
30	2D/2D2-40	640,000	95.00	210.0	36.2	42.2	49.9	57.6
31	2D/2D2-50	800,000	95.00	220.0	49.4	58.4	68.8	78.4
32	2D/2D2-60	960,000	95.00	230.0	64.7	76.5	89.4	100.9
33	2D/2D2-70	1,120,000	95.00	240.0	81.9	96.5	111.7	124.9
34	3D-40	480,000	95.00	210.0	34.9	41.6	53.5	66.7
35	3D-50	600,000	95.00	220.0	47.3	59.5	76.7	94.0
36	3D-60	720,000	95.00	230.0	62.9	80.8	103.2	124.1
37	3D-70	840,000	95.00	240.0	80.7	104.3	131.4	155.7
38	2D/3D2-40W	800,000	36.75	210.0	31.4	35.1	40.8	47.5
39	2D/3D2-50W	1,000,000	36.75	220.0	41.5	47.4	55.8	64.8
40	2D/3D2-60W	1,200,000	36.75	230.0	53.1	61.5	72.5	83.6
41	2D/3D2-70W	1,400,000	36.75	240.0	65.9	77.0	90.7	103.8
42	2D/3D2-40B	800,000	55.75	210.0	34.0	34.8	42.9	54.2
43	2D/3D2-50B	1,000,000	55.75	220.0	43.3	47.9	61.1	76.9
44	2D/3D2-60B	1,200,000	55.75	230.0	52.6	63.7	82.2	102.2
45	2D/3D2-70B	1,400,000	55.75	240.0	65.5	82.0	105.9	129.9

The data in the tables were used to develop a list of maximum gross weights for Runway Weight Bearing Capacity Data. The listings that correlates gross weights with known PCN values for flexible and rigid pavement (see Appendix F) provide recommended maximum gross weights based on PCN determination.

There will be cases where the gross weight of an aircraft exceeds the gross weight in Tables E-1 and E-2 for a reported PCN determined using the procedures in Appendices 1 through 3. The values in the tables are not as accurate as the gross weights associated with the ACN assigned by the aircraft manufacturer. The reported PCN is the basis for data in the tables, and the airport manager should rely on the reported PCN rather than the gross weight data in the table when the ACN of the departing or landing aircraft is known.

Table E-3 shows the format of the list and brief instructions on its use. The first example shown in the table is for a pavement that supports single, dual, and dual tandem wheel gear aircraft, and the airport can report a PCN of 30 with subgrade category B support. At the intersection of the PCN value with the gear types SW, DW, and DTWS and Subgrade Support Category B, 76,000 pounds is the maximum allowable gross weight for single wheel aircraft, 115,000 pounds is the maximum allowable gross weight for dual wheel aircraft, and 215,000 pounds is the maximum allowable gross weight for dual tandem wheel aircraft. Local experience can be considered to use a lower weight, but higher weights are not recommended.

Table E-3. Excerpt From Listing of Maximum Gross Weight Data Based on PCN of Pavement–Example 1 and 2

FLEXIBLE PCN					RIGID PCN			
Airplane gross weight (1,000's lbs) for each Subgrade Category B								
	SW	DW	DTW	DDTW	SW	DW	DTW	DDTW
	B(10)	B(10)	B(10)	B(10)	B(295)	B(295)	B(295)	B(295)
PCN								
23	62	90	180	----	64	80	160	----
24	64	90	185	----	66	85	160	----
25	[illegible]	[illegible]5	[illegible]90	----	69	85	165	----
30	76	115	215	----	80	100	190	----
35	87	140	245	----	91	120	215	----
37	91	145	260	620	[illegible]5	130	225	----
40	98	160	275	660	101	140	245	630
45	111	175	305	720	111	160	265	680
4[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	*PCN = 43RBWT, perform straight line interpolation*							
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 PCN of 43/R/B/W/T. The gross weights at the intersection of the PCN value for a B category subgrade with each gear type is between PCN values 40 and 45. Straight line interpolation between values is recommended. Single wheel gross weight is 107,000 pounds. Dual wheel gross weight is 152,000. Local experience can be considered to use lower weights, but higher weights are not recommended.

APPENDIX F. MAXIMUM AIRCRAFT GROSS WEIGHT TABLES FOR FAA FORM 5010 REPORTING BASED ON PCN DETERMINATION

Table F-1. Subgrade Strength Category A

	FLEXIBLE PCN Subgrade Category A				RIGID PCN Subgrade Category A			
	Aircraft gross weight (1,000's lbs): Subgrade Category A							
PCN	SW A(15)	DW A(15)	DTW A(15)	DDTW A(15)	SW A(552)	DW A(552)	DTW A(552)	DDTW A(552)
3	15	---	---	---	---	---	---	---
4	18	---	---	---	14	---	---	---
5	21	---	---	---	17	---	---	---
6	25	40	---	---	21	---	---	---
7	27	45	---	---	23	35	---	---
8	30	45	---	---	27	40	---	---
9	33	50	---	---	30	45	---	---
10	36	55	95	---	32	50	100	---
12	41	60	110	---	38	55	115	---
13	44	65	120	---	41	60	120	---
14	47	65	125	---	43	60	125	---
15	49	70	130	---	46	65	135	---
16	51	75	140	---	49	65	140	---
17	53	75	145	---	51	70	145	---
18	56	80	150	---	53	70	150	---
19	58	80	160	---	56	75	155	---
20	60	85	165	---	58	80	160	---
25	71	100	195	---	70	90	190	---
30	81	120	230	---	81	110	220	---
34	89	140	260	---	89	125	245	625
35	91	145	265	630	92	130	250	635
40	102	165	295	700	102	150	275	700
45	111	185	335	770	112	165	310	765
48	116	195	355	810	116	175	335	800
49	---	195	360	820	---	175	340	810
50	---	200	370	835	---	180	350	825
55	---	220	410	900	---	195	385	880
60	---	240	460	960	---	210	425	930
65	---	---	520	1015	---	225	485	980
70	---	---	---	1065	---	240	---	1030
71	---	---	---	1075	---	240	---	1040
72	---	---	---	1085	---	---	---	1050
75	---	---	---	---	---	---	---	1080

Note: When the PCN falls between two values, use straight line interpolation to determine the allowable gross weight for the gear types.

Table F-2. Subgrade Strength Category B

FLEXIBLE PCN Subgrade Category B					RIGID PCN Subgrade Category B			
Airplane gross weight (1,000's lbs): Subgrade Category B								
PCN	SW B(10)	DW B(10)	DTW B(10)	DDTW B(10)	SW B(295)	DW B(295)	DTW B(295)	DDTW B(295)
3	15	---	---	---	14	---	---	---
6	23	35	---	---	22	---	---	---
7	26	40	---	---	25	35	---	---
8	29	45	100	---	28	40	---	---
9	32	50	105	---	32	45	---	---
10	34	50	110	---	34	50	---	---
11	36	55	120	---	37	50	100	---
12	38	60	125	---	39	55	105	---
13	41	60	130	---	42	55	110	---
14	43	65	135	---	45	60	115	---
16	48	70	150	---	50	65	130	---
18	52	75	160	---	55	70	140	---
20	57	80	170	---	59	75	150	---
22	62	90	180	---	64	80	160	---
24	66	95	190	---	69	85	165	---
25	76	115	215	---	80	100	190	---
30	87	140	245	---	91	120	215	---
35	91	145	260	620	95	130	225	---
37	98	160	275	660	101	140	245	630
40	111	175	305	720	111	160	265	680
45	116	185	325	755	116	165	280	715
48	---	190	335	780	---	170	290	735
50	---	210	370	835	---	185	325	785
55	---	225	400	885	---	200	355	835
60	---	---	440	935	---	215	385	880
65	---	---	505	985	---	230	420	925
70	---	---	---	1005	---	235	435	940
72	---	---	---	1015	---	240	440	950
73	---	---	---	1025	---	240	450	960
74	---	---	---	1035	---	---	455	965
75	---	---	---	1045	---	---	470	975
76	---	---	---	1055	---	---	490	985
77	---	---	---	1065	---	---	515	990
78	---	---	---	1080	---	---	---	1010
80	---	---	---	---	---	---	---	1050
85	---	---	---	---	---	---	---	1085
89	---	---	---	---	---	---	---	---

Note: When the PCN falls between two values, use straight line interpolation to determine the allowable gross weight for the gear types.

Table F-3. Subgrade Strength Category C

FLEXIBLE PCN Subgrade Category C					RIGID PCN Subgrade Category C			
Airplane gross weight (1,000's lbs): Subgrade Category C								
PCN	SW C(6)	DW C(6)	DTW C(6)	DDTW C(6)	SW C(147)	DW C(147)	DTW C(147)	DDTW C(147)
4	12	---	---	---	13	---	---	---
6	17	---	---	---	19	---	---	---
8	22	---	---	---	25	---	---	---
10	27	40	---	---	31	40	---	---
12	32	50	---	---	36	50	---	---
13	35	50	100	---	38	50	---	---
14	37	55	105	---	41	55	100	---
15	40	60	110	---	44	55	105	---
20	52	70	135	---	56	70	130	---
25	64	85	160	---	68	85	150	---
30	76	100	180	---	79	100	170	---
35	87	120	205	---	90	115	190	---
40	99	140	230	---	100	135	215	---
43	106	150	245	625	107	145	230	---
45	111	155	255	640	111	150	235	---
46	113	160	260	650	113	155	240	---
47	115	165	265	660	115	155	245	625
48	116	165	270	670	116	160	250	635
50	---	170	280	690	---	165	260	655
55	---	190	305	735	---	180	280	700
60	---	205	330	780	---	195	305	745
65	---	220	355	820	---	205	330	785
70	---	240	385	860	---	220	355	830
71	---	240	390	870	---	225	360	835
75	---	---	415	900	---	235	385	870
76	---	---	420	905	---	240	390	875
77	---	---	425	915	---	240	395	885
80	---	---	440	940	---	---	410	910
85	---	---	480	975	---	---	440	945
88	---	---	520	1000	---	---	465	970
90	---	---	---	1015	---	---	490	985
92	---	---	---	1030	---	---	525	1000
95	---	---	---	1050	---	---	---	1025
100	---	---	---	1085	---	---	---	1060
102	---	---	---	---	---	---	---	1075
103	---	---	---	---	---	---	---	1080

Note: When the PCN falls between two values, use straight line interpolation to determine the allowable gross weight for the gear types.

Table F-4. Subgrade Strength Category D

FLEXIBLE PCN Subgrade Category D Airplane gross weight (1,000's lbs): Subgrade Category D					RIGID PCN Subgrade Category D			
PCN	SW D(3)	DW D(3)	DTW D(3)	DDTW D(3)	SW D(74)	DW D(74)	DTW D(74)	DDTW D(74)
4	---	---	---	---	13	---	---	---
5	13	---	---	---	16	---	---	---
6	16	---	---	---	19	---	---	---
8	21	---	---	---	24	---	---	---
10	26	---	---	---	30	40	---	---
11	29	40	---	---	32	45	---	---
12	31	40	---	---	35	45	---	---
15	38	50	---	---	43	55	---	---
16	40	55	---	---	46	55	100	---
20	50	65	115	---	55	70	115	---
25	62	80	135	---	67	80	135	---
30	74	95	155	---	78	95	155	---
35	85	110	175	---	89	110	175	---
40	97	125	195	---	100	130	195	---
45	109	145	215	---	111	145	215	---
48	116	155	225	---	116	155	225	---
50	---	160	235	---	---	160	235	---
54	---	170	250	---	---	170	250	625
59	---	185	270	625	---	185	270	665
60	---	190	275	630	---	185	275	675
65	---	205	295	670	---	200	295	715
70	---	220	320	705	---	215	320	755
75	---	235	340	740	---	230	345	790
77	---	245	350	755	---	235	350	810
80	---	---	360	780	---	240	365	830
85	---	---	380	815	---	---	390	865
90	---	---	405	850	---	---	415	905
95	---	---	425	885	---	---	440	940
100	---	---	450	920	---	---	475	975
105	---	---	475	960	---	---	530	1010
110	---	---	510	995	---	---	---	1045
113	---	---	530	1015	---	---	---	1065
115	---	---	---	1030	---	---	---	1080
116	---	---	---	1040	---	---	---	1085
120	---	---	---	1065	---	---	---	---
122	---	---	---	1080	---	---	---	---

Note: When the PCN falls between two values, use straight line interpolation to determine the allowable gross weight for the gear types.

APPENDIX G. RELATED READING MATERIAL

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

a. AC 150/5320-6, Airport Pavement Design and Evaluation . The FAA makes this publication available for free on the FAA website at http://www.faa.gov.

b. 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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