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# TRI-SERVICE PAVEMENTS WORKING GROUP (TSPWG) MANUAL

# AIRFIELD PAVEMENT EVALUATION STANDARDS AND PROCEDURES

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# TRI-SERVICE PAVEMENTS WORKING GROUP MANUAL (TSPWG M)

# AIRFIELD PAVEMENT EVALUATION STANDARDS AND PROCEDURES



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U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND

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**This TSPWG Manual supersedes Air Force ETL 02-19, *Airfield Pavement Evaluation Standards and Procedures*, dated 12 November 2002.**

# FOREWORD

This Tri-Service Pavements Working Group Manual supplements guidance found in other Unified Facilities Criteria, Unified Facilities Guide Specifications, Defense Logistics Agency Specifications, and Service-specific publications. All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and, in some instances, Bilateral Infrastructure Agreements (BIA). Therefore, the acquisition team must ensure compliance with the most stringent of the TSPWG Manual, the SOFA, the HNFA, and the BIA, as applicable. This manual provides guidance on performing PCI field explorations and report preparations. The information in this TSPWG Manual is referenced in technical publications found on the Whole Building Design Guide. It is not intended to take the place of Service-specific doctrine, technical orders (T.O.s), field manuals, technical manuals, handbooks, Tactics, Techniques, and Procedures (TTPs), or contract specifications, but to be used along with these to help ensure pavements meet mission requirements.

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# TRI-SERVICE PAVEMENTS WORKING GROUP MANUAL (TSPWG M)
# NEW SUMMARY SHEET

**Document:** TSPWG Manual 3-260-03.02-19, *Airfield Pavement Evaluation Standards and Procedures*

**Superseding:** Air Force ETL 02-19, *Airfield Pavement Evaluation Standards and Procedures*, 12 November 2002

**Description:** This document provides guidance for performing field investigation work, analysis, and report preparation for runway pavements.

**Reasons for Document:** This document provides procedural and substantive updates to the information previously in ETL 02-19.

**Impact:** There is no cost impact. The following benefits should be realized:

- PCI survey techniques and reporting habits are more formalized and static than before. New aircraft are included in the charts and tables and retired aircraft have been removed from the document.
- The document provides field personnel with more complete and easier-to-interpret instructions for completing surveys, analyses, and reports. The ultimate impact will be better surveys and reports, minimizing errors and lowering over-all long-term costs.

**Unification Issues:** None

**Note:** The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Department of Defense (DOD).

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# CHAPTER 1 INTRODUCTION

## 1-1 PURPOSE AND SCOPE.

This manual provides criteria and guidance for the structural evaluation of airfields using conventional evaluation methods.

## 1-2 APPLICABILITY.

This manual is applicable to all Department of Defense (DOD) organizations responsible for evaluating airfields.

## 1-3 GLOSSARY.

Appendix J contains acronyms, abbreviations, and terms.

## 1-4 REFERENCES.

Appendix K contains a list of references used in this document. The publication date of the code or standard is not included in this document. Unless otherwise specified, the most recent edition of the referenced publication applies.

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# CHAPTER 2 CONDUCTING AIRFIELD EVALUATIONS

## 2-1 INTRODUCTION.

**2-1.1** This manual presents the basic criteria and procedures used to determine the structural suitability or load-bearing capability of an airfield to sustain aircraft operations using conventional evaluation procedures. Appropriate evaluation charts are included for the various fighter, transport, and tanker aircraft commonly used in DOD operations. Charts will be added for additional aircraft as they become available. This manual does not address the geometric characteristics of an airfield such as runway length and width, gradient criteria, or airfield and airspace clearances. Geometric criteria for DOD military facilities are contained in Unified Facilities Criteria (UFC) 3-260-01, *Airfield and Heliport Planning and Design*. Contingency airfield geometric criteria are contained in UFC 3-260-01, Chapter 7.

**2-1.2** The AFCEC Pavement Evaluation Team is tasked to assess the structural capability of airfields for projection of U.S. forces in support of regional conflicts or peacetime humane relief operations. Other DOD units such as USAF RED HORSE squadrons, USAF Air Mobility Operations Groups (AMOG), USAF Tanker Airlift Control Elements (TALCE), USAF Contingency Response Groups (CRG), and AFSOC Special Tactics Teams (STT) are also tasked to perform airfield evaluations. These taskings have increased substantially in recent years and have highlighted the need to ensure those tasked are sufficiently trained and to standardize evaluation procedures.

**2-1.3** The procedures presented here are required to adequately evaluate an airfield. In cases where in-the-field evaluation time is limited and judgments are made on limited available data, the reliability of the evaluation is questionable. Contact AFCEC before reporting airfield capability in such situations.

**2-1.4** Those tasked to evaluate airfields must be adequately trained and certified. Initial classroom training in evaluation procedures and software will be conducted at AFCEC. Subsequent on-the-job training (OJT) or home station training will be established by and conducted under the guidance of the pavement engineer. Upon completion of initial and home station training, the pavement engineer will submit the names to AFCEC for certification. Those certified should receive annual recurring training at AFCEC to retain certification, but this may not always be possible. The recurring training may have to be postponed but be accomplished as soon as scheduling and mission requirements permit. A certification will be valid for a period not to exceed two years.

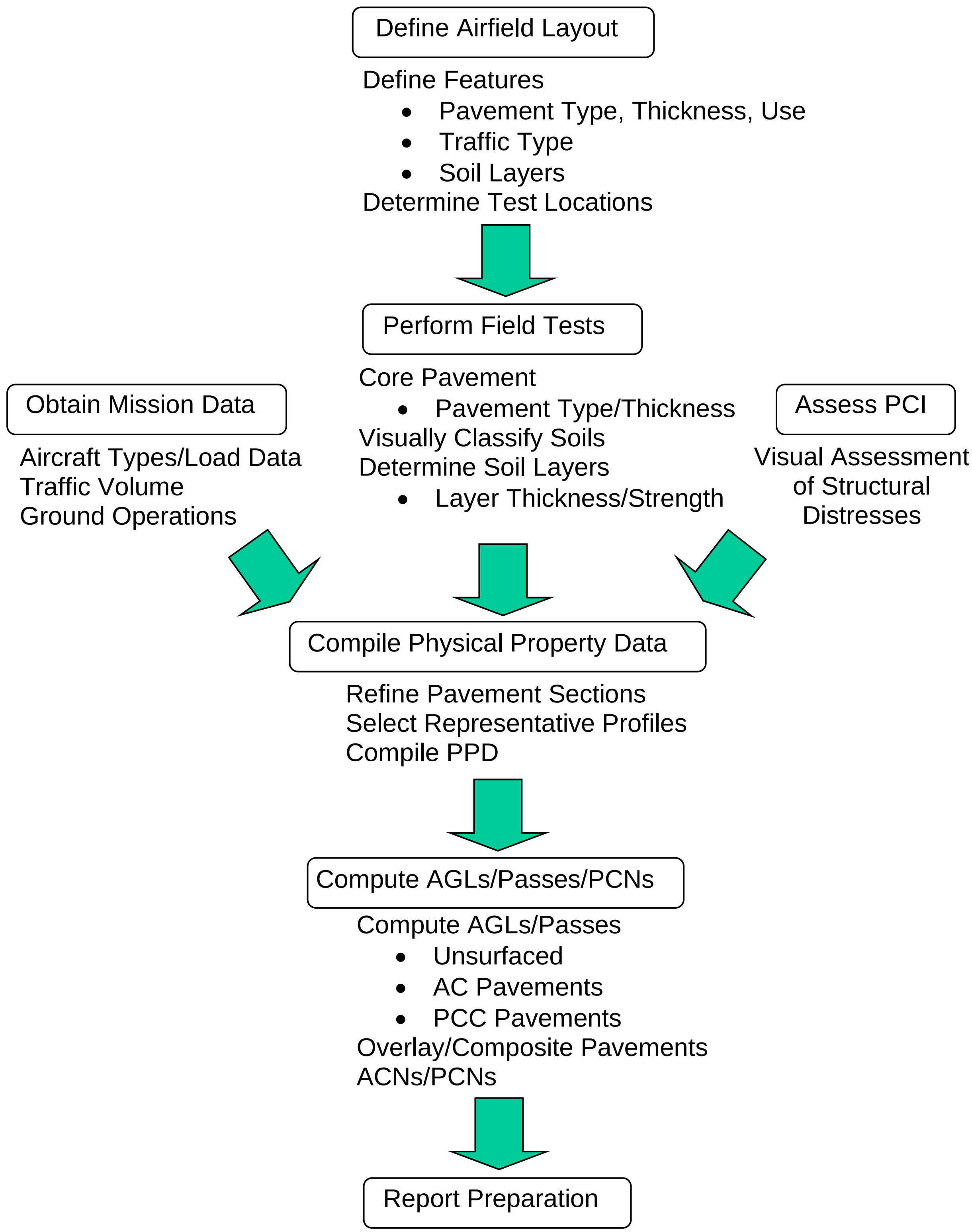
**2-1.5** If questions arise in the field, contact the Airfield Pavement Evaluation team through the AFCEC Reachback Center:

AFCEC Reachback Center

Toll Free: 1 (888) 232-3721
DSN: (312) 523-6995
COM: (850) 283-6995
Email: afcec.rbc@us.af.mil

**2-1.6** Structural evaluation of an airfield can be broken down into steps, as shown in Figure 2-1. Each of these steps is detailed in this manual.

**Figure 2-1 Evaluation Procedures**



## 2-2 DEFINE INITIAL AIRFIELD LAYOUT.

### 2-2.1 Define Scope of Evaluation.

Make an initial tour of the airfield to:

- Identify operational surfaces and define the scope of the evaluation.
- Identify any limiting factors, such as areas with visual evidence of problems (e.g., drainage, high-severity distresses, major repairs) or areas unsuitable for operations due to geometrics.

**2-2.1.1** Verify the dimensions of airfield pavements and accuracy of existing drawings, if available. Existing information on the airfield is helpful, such as soil boring data and geological, topographical, agricultural, and aerial photographs. Several unclassified sources are available that provide information on airfields.

- Airfield Pavement Evaluation Team. Contact the AFCEC Reachback Center, DSN (312) 523-6995, commercial (850) 283-6995, toll-free 1 (888) 232-3721, afcec.rbc@us.af.mil.
- AMC Global Decision Support System (GDSS) or Airfield Suitability and Restrictions Report (ASRR), HQ AMC DOVS, DSN (312) 779-3112, commercial (618) 229-3112, https://www.afd.scott.af.mil
- Aeronautical Content Exploitation System (ACES) for access to Flight Information Publications (FLIP), https://aerodata.leidos.com/AeroDownload/
- Host nation data, if available.

**2-2.1.2** If time is limited or if high-tech surveying equipment such as Total Station or Global Positioning System (GPS) is not available, use expedient methods to survey (taping, measuring wheel, or pacing).

**2-2.1.3** Update existing plans or make new scaled drawings as required.

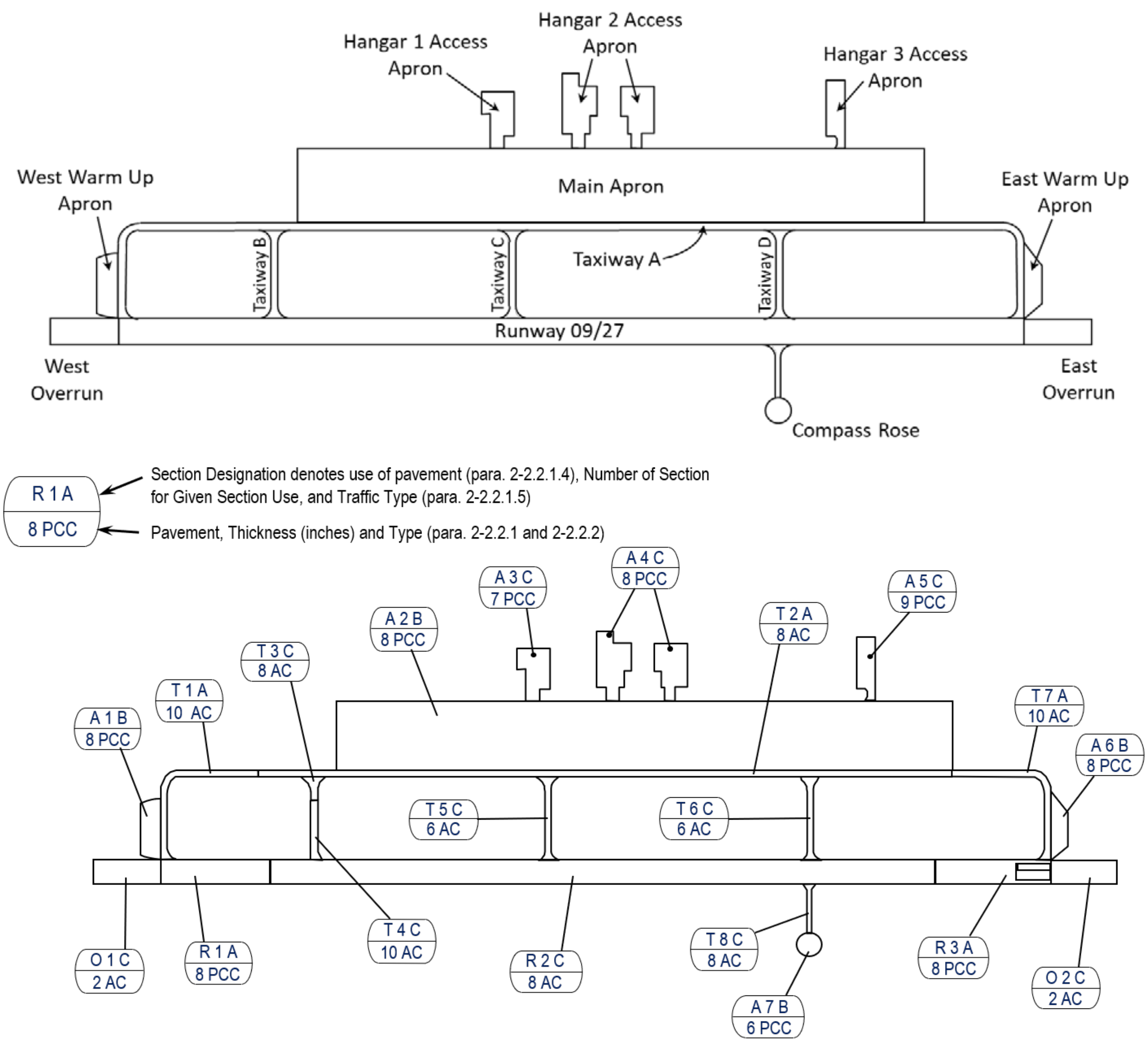
### 2-2.2 Define All Airfield Features.

Divide the airfield pavement system into features based upon common characteristics: pavement type, thickness, surface condition, and construction history data; available subsurface layer data; pavement use; and traffic type (see Figure 2-2).

A branch is an identifiable part of the pavement network that is a single entity and has a distinct function. For example, runways, named taxiways, and apron areas are all separate branches (see Figure 2-2).

A section is a subset of a branch and is an area of pavement having a consistent or uniform pavement type, thickness, and condition, as well as the same pavement use, traffic type, construction/maintenance history, and subsurface layer structure (see Figure 2-2).

**Figure 2-2 Airfield Layout/Feature Plan**




### 2-2.2.1 Pavement Types.

A specific feature contains only one pavement type.

- Flexible asphalt concrete (AC)
- Rigid portland cement concrete (PCC)
- Flexible overlay on rigid base (AC over PCC)
- Rigid overlay on rigid base (PCC over PCC)

- Composite, rigid overlay on flexible overlay on rigid base (PCC over AC over PCC)
- Reinforced portland cement concrete (RPCC)
- Double bituminous surface treatment (DBST)
- AM-2 mat
- Semi-prepared (gravel/unsurfaced)
- Other overlay combinations

### 2-2.2.2 Pavement Thickness and Construction History Data.

All pavement sections in a specific feature share a constant nominal thickness, uniform surface type, and a common construction history. Construction history is composed of data on the materials used and year of original construction and all subsequent maintenance and repair materials and techniques.

### 2-2.2.3 Subsurface Layers.

- Types
- Thicknesses
- Strengths

### 2-2.2.4 Pavement Use.

- R = Runway
- O = Overrun
- T = Taxiway
- A = Apron

### 2-2.2.5 Traffic Type.

Traffic type is categorized by traffic area as a function of traffic distribution and aircraft weight.

#### 2-2.2.5.1 Type A Traffic Area.

Evaluate for channelized traffic and full design weight of aircraft.

- First 1,000 feet (305 m) at each end of the runway
- Primary taxiways
- Other sections of runway if required for back-taxi operations
- **All operational surfaces of semi-prepared or unsurfaced airfields**

- **All operational surfaces during an expedient airfield pavement evaluation**

#### 2-2.2.5.2 Type B Traffic Area.

Evaluate for non-channelized traffic and full design weight of aircraft.

- Aprons

#### 2-2.2.5.3 Type C Traffic Area.

Evaluate for non-channelized traffic and 75% of design weight of aircraft.

- Center section of runway if not required for back-taxi operations
- Secondary taxiways
- Hangar access aprons and wash racks
- Overruns if not required for taxi/takeoff operations

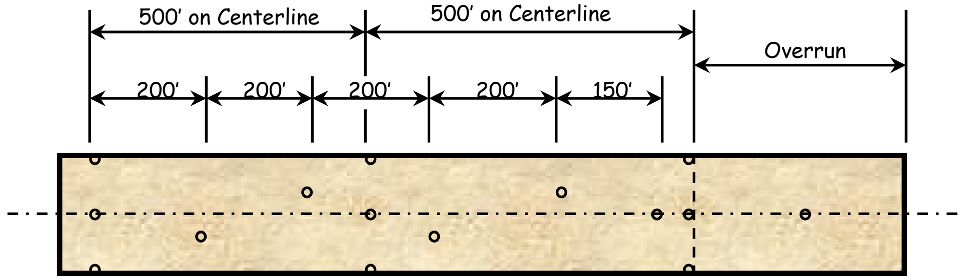
### 2-2.3 Determine Test Locations.

The numbers and locations of pavement cores, soil strength tests, and soil samples will vary with the type of airfield, size of airfield, proposed mission of the airfield, number of features, and time available for conducting the tests. Choose test locations wisely and to accurately cover each feature or aspect of the airfield, yet the number of locations may need to be minimized due to aircraft operations or time constraints. Soil conditions are extremely variable; therefore, **perform as many tests as time and circumstances permit**. The strength range and uniformity of the area will control the number of tests required. **In all cases, it is advisable to test apparent weak areas first, since the weakest conditions often control the pavement evaluation**.

#### 2-2.3.1 Prioritize Test Locations.

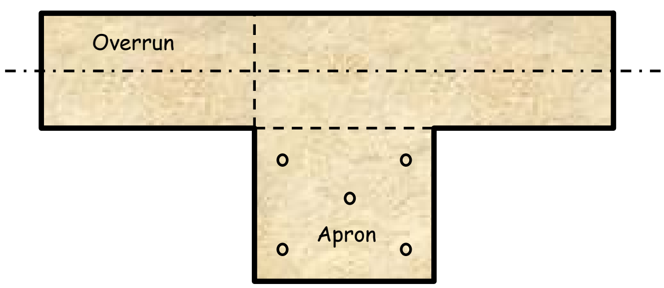
On semi-prepared airfields, the first priorities for testing are those items that typically cannot be predetermined until the evaluator is onsite, i.e., determine the impact that any soft spots, wet areas, or repaired areas will have on the projected operations. Look for wet areas, discolored soil, changes in surface texture, or vegetation which often indicate drainage problems and weakened soils. Animal burrows such as gopher, prairie dog, snake holes, and anthills may indicate subsurface air pockets or voids in the soil. Previously forested areas may also contain excessive subsurface roots and organic matter that decay and create an extremely weak soil structure. Look for evidence of weakened soil structure such as ruts, soft spots, or excessive loose surface material. Following an assessment of potential weak areas, consider which areas on the airfields will receive the most severe damage during aircraft operations, such as the touchdown zone, area of maximum aircraft braking, aircraft turnaround areas, and the surface at the point of rotation during takeoff. These areas tend to degrade rapidly under aircraft traffic. Figures 2-3 and 2-4 show recommended test locations for semi-prepared or aggregate-surfaced airfields.

**Figure 2-3 Recommended Test Locations for Semi-prepared Airfields**




**Typical Semi-prepared Airfield**

**Note:** For an unimproved airfield, continue this pattern throughout the length. For aggregate-surfaced airfields, the pattern may be more widely spaced on the remaining portion of the airfield.

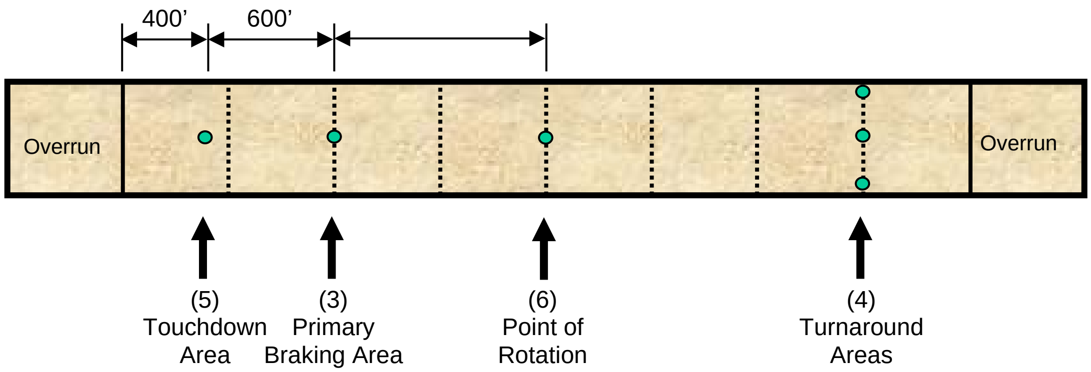



**Typical Apron/Turnaround**

**(a) Priority Testing**

1. Soft spots
2. Offsets (in wheel paths of main gear)
3. Centerline
4. Aircraft turnarounds
5. Any area where the aircraft stops
6. Overrun, one test in center (If overrun is used as a turnaround or for takeoffs, more tests are required)
7. Along edges at 500-foot (152-m) intervals

**Figure 2-4 Priority of Test Locations to Validate LZs when Testing is Limited Due to Time Constraints**




(1) Identified soft spots / wet areas
(2) Repaired areas
(7) LZ end 50 feet (15 m) from threshold
(8) Offsets along LZ centerline

**Note:** Perform as many tests as time permits but prioritize locations.

### 2-2.3.2 Paved Airfields.

On paved surface airfields, areas with high-level distresses or evidence of drainage problems often indicate weakened soil conditions. In areas of doubtful strength or where evidence of changing layer structure occurs, the tests may be closely spaced; however, in areas where the structure appears to be firm and uniform, tests may be few and widely spaced. After weak areas have been tested, test the areas of high traffic intensity or loading such as take-off/touch-down zones, runway/taxiway intersections, and taxi lanes on aprons. Figures 2-5, 2-6, and 2-7 show recommended test locations for AC- or PCC-surfaced airfields.

**Figure 2-5 Recommended Test Locations for AC- and/or PCC-Surfaced Airfields, Permanent or Standard Evaluation**

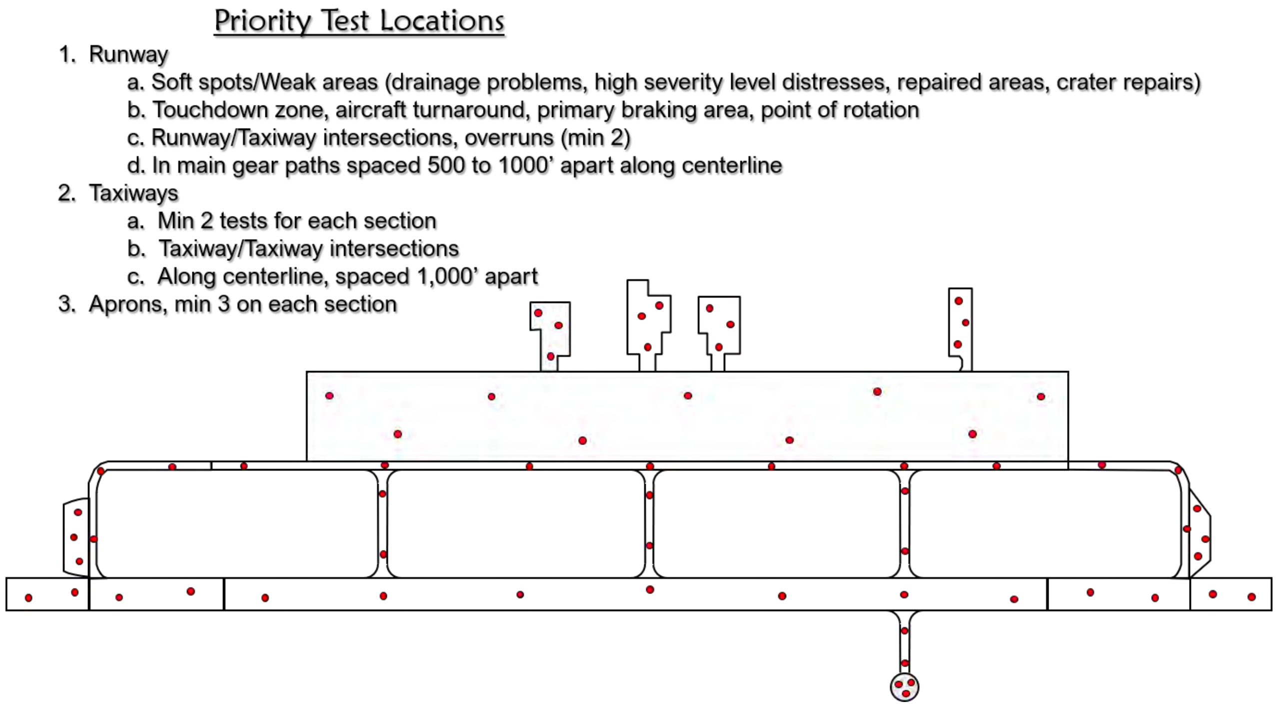



**Figure 2-6 Minimum Test Locations for AC- and/or PCC-Surfaced Airfields, Sustainment Evaluation**

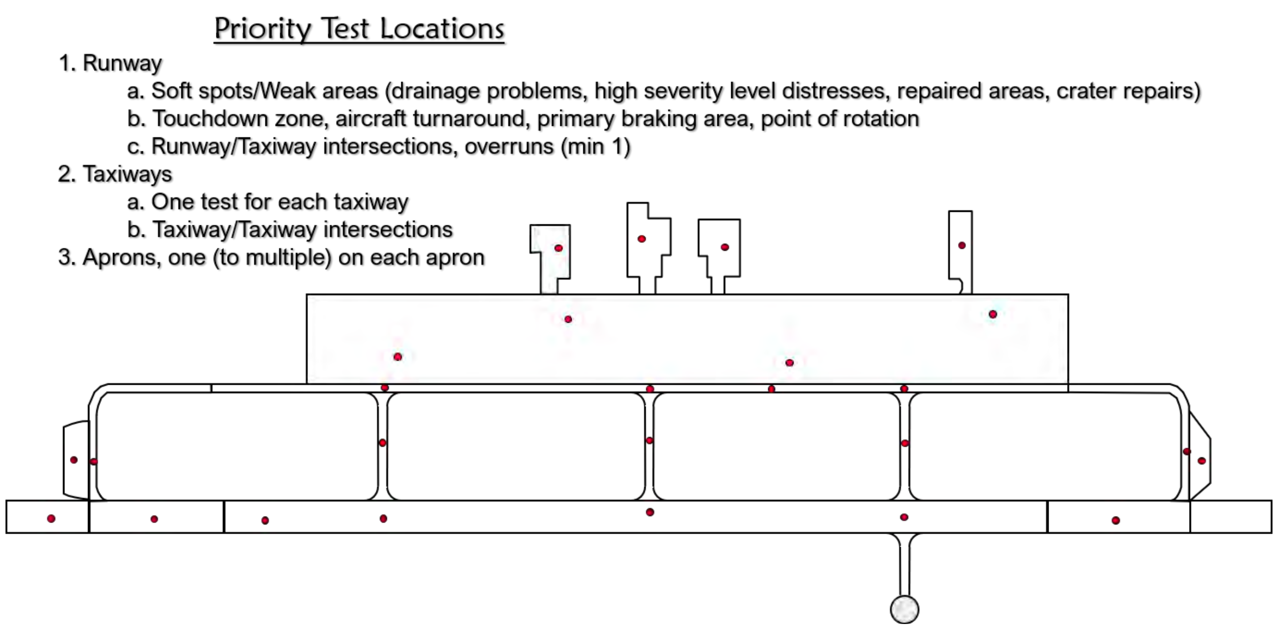
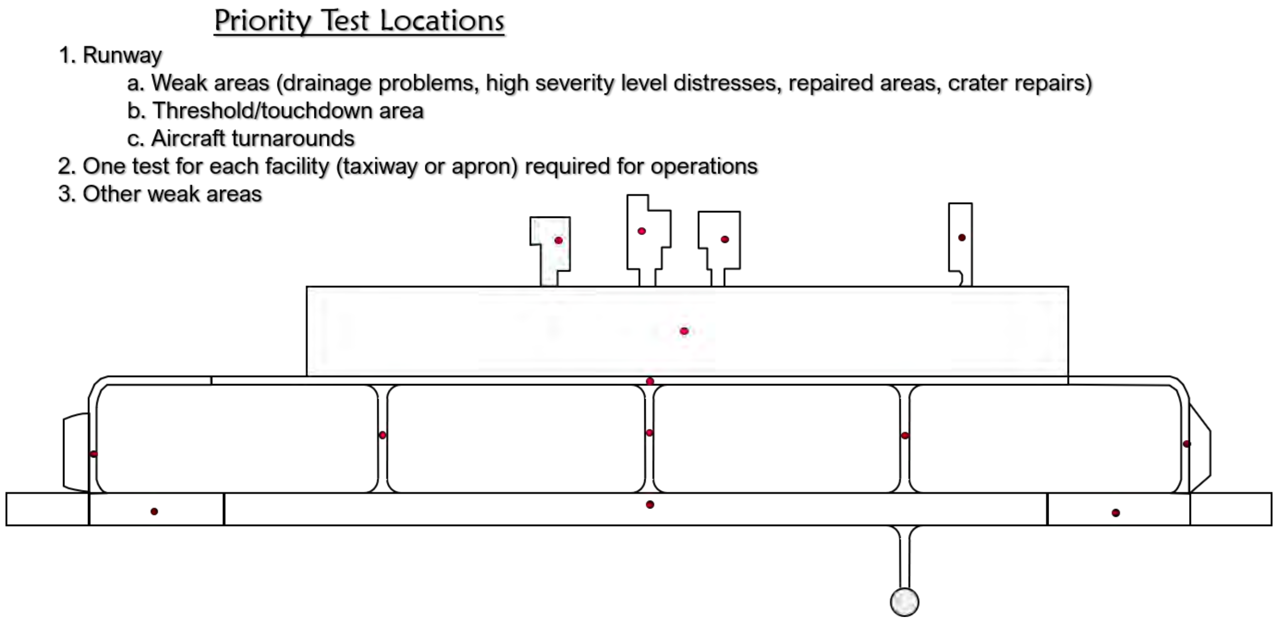


**Figure 2-7 Minimum Test Locations for AC- and/or PCC-Surfaced Airfields, Expedient Evaluation**




### 2-2.3.3 Drainage.

Moisture and poor pavement drainage are significant factors in the deterioration of both paved and semi-prepared airfield surfaces. Some assessment of drainage conditions during pavement evaluation is highly recommended. Include an overview of the drainage characteristics of the airfield in conjunction with the evaluation of the surface condition. Consider both the operational surface drainage (slopes) and lateral drainage (ditches or storm sewers). Slope pavements such that they quickly shed water off the surface. Size ditches large enough and adequately sloped to drain the pavement and remove surface water efficiently into adjacent waterways and be well maintained.

### 2-2.3.4 Watch for Underground Utility Lines and Features.

Consider where not to perform penetration tests on an airfield. Unless one knows the depth of the lines and can confirm they are well below the projected testing depth, avoid testing on top of service utility lines such as power lines, water lines, fuel lines, communication cables, or on top of culverts or drainage lines. Look for locations of NAVAIDS and airfield lighting, manholes, handhole and valve covers, grates, hydrants, or other utility markers on or adjacent to the pavement surface that may indicate the presence of underground utilities. Look for patches that cut across the pavement and might be caused by the placement of new utilities or repairs to existing subsurface lines. Always discuss test locations with onsite personnel such as airfield managers and site engineers and address utility locations. A review of construction or as-built drawings may also be helpful, if available.

## 2-3 COLLECT FIELD DATA TO DETERMINE PAVEMENT STRUCTURAL PROPERTIES.

### 2-3.1 Pavement.

Visually identify the pavement types and measure thicknesses. When coring equipment is available, take cores in the wheel paths (see Table 2-1) to verify layers and thicknesses and retain as needed for laboratory testing. **If coring in PCC, core in the center of the slab to avoid thickened edges**. If coring is not possible then drill through the pavement to verify thickness and access subsurface layers. When drilling in preparation for penetration tests, a hole size of 1- to 1.25-inch (25- to 32-mm) diameter is recommended. This will be large enough to permit access to the penetrometer tip. Using larger diameter drill bits will not provide any benefit but will require more powerful generators or inverters. If the pavement thickness cannot be determined when drilling, it is advisable to dig a hole or small pit adjacent to the pavement edge to verify the pavement thickness. In cases where the host nation will not permit any disturbance of the pavement and no means are available to determine thickness in the traffic paths, assume thickness based on measurements taken at the pavement edge or construction history data. This hole adjacent to the pavement will also help identify any overlays or composite pavements or any nontraditional pavements such as thin surface seals or macadam pavements. It will also be useful in the proper determination of the Unified Soil Classification System (USCS) soil types of the base, subbase, and subgrade materials and help identify any altered materials such as crushed or stabilized layers, assessing soil moisture conditions, assigning strength soil factors in the event that penetrometer testing cannot be performed, or the need to assign subgrade CBRs based upon general area subgrade soil characteristics.

**Table 2-1 Wheel Path Offsets**

| Distance from Runway Centerline to Main Gear Centerline | Aircraft |
|---|---|
| 4.5 feet (1.4 m) | F-15, F-16, F-22, B-52 |
| 7 feet (2.1 m) | C-130, B-1B, V-2 |
| 9 feet (2.7 m) | F-4, C-40, A-10, 727, 737 |
| 11 feet (3.4 m) | KC-135, E-3, 707 |
| 12 to 13 feet (3.7 to 4 m) | C-5, C-17, 757 |
| 15 feet (4.6 m) | P-3, 767 |
| 18 feet (5.5 m) | KC-10, 747, 777, L-1011 |
| 20 feet (6.1 m) | B-2 |

**2-3.1.1** For evaluation of flexible pavements, no strength parameters are required for the flexible pavement surface layer. For evaluation of rigid (PCC) pavements, the flexural strength is required. If this data is not available, assign a strength based on:

- Type of aggregate in the mix and apparent bonding
- Visual assessment of pavement condition (severity of structural distresses)

**Note: For stateside bases or other areas where quality control is good, use 700 pounds per square inch (psi). For other areas where quality control is uncertain, use 600 psi.**

**2-3.1.2** For expedient evaluation of rigid pavements, do not assume the existence of reinforcing if you do not see it. Evaluate it as plain PCC pavement.

**2-3.2 Soil Layers.**

**2-3.2.1 Types.**

- Identify base, subbase, and subgrade materials using field identification methods, and classify using the USCS. See Appendix A.
- If field classification methods do not produce clear results or require validation, obtain samples for follow-up laboratory testing.
- Identify materials that have been altered or have additives as in the case of dense, crushed rock layers or stabilized soil layers.

**2-3.2.2 Thicknesses.**

- Use dynamic cone penetrometer (DCP) data to determine layer thicknesses; or
- Measure actual layer thicknesses through core holes as samples are collected.

**Note:** Be aware of other sources of strata information, such as ditches, excavations, or engineering documents—these provide useful information on the subbase/subgrade.

**2-3.2.3 Strengths.**

Shearing resistance is one of the most important properties a soil possesses. A soil's shearing resistance under given conditions is related to its ability to withstand a load. The shearing resistance is especially important in its relation to the supporting strength or bearing capacity of a soil used as a base or subgrade beneath airfield pavements.

**2-3.2.3.1** For contingency pavement evaluations, the California Bearing Ratio (CBR) value of a soil is used as an empirical measure of soil strength. CBRs are used directly to evaluate unsurfaced and flexible (asphalt) pavement systems. CBRs are converted to K-values (modulus of soil reaction) to evaluate rigid (concrete) pavement systems. To determine the CBR, a dynamic load is applied to a piston whose end is 3 square inches in area, forcing it to penetrate the soil at a rate of 0.05 inch/minute. The psi load required to force penetration gives the modulus of shear that is converted to a CBR using established load factors. **The CBR value is expressed as a ratio in percent from 0 to 100. CBRs in excess of 100 will not be used.** A nominal 0.75-inch, well-graded crushed limestone serves as the benchmark material for CBRs, with a CBR of 100. Laboratory methods for determining CBR values are time-consuming and thus impractical for expedient or contingency evaluations. Several methods are available to determine soil strengths and correlate their results to CBRs in the field, as set out below.

#### 2-3.2.3.1.1 Airfield Cone Penetrometer (ACP).

The ACP is a probe-type instrument that, when pushed down through the soil, gives an airfield index (AI) of soil strength; these AIs are then correlated to CBR values. This instrument was once commonly used by Special Tactics Teams for expedient evaluations because of its portability and simple operation. Its range is limited to 0 to 18 CBR and it will not penetrate many crusts, thin base courses, or gravel materials. Consistency of test results is also difficult due to variability of soil strengths that impact the rate of penetration. The ACP is primarily now used in covert operations where use of a DCP draws unwanted attention to personnel.

#### 2-3.2.3.1.2 DCP.

**The DCP is the preferred method of obtaining CBR field data.** It will measure soil strengths ranging from 1 to 100 CBR. It is a powerful, relatively compact, sturdy device that produces consistent results. See paragraph 2-3.2.3.3.

#### 2-3.2.3.1.3 Automated Dynamic Cone Penetrometer (ADCP).

Several automated versions of the DCP exist. These range from portable ADCPs that require manual lifting of the DCP weight coupled with automated data collection to those that are truck-mounted and provide automated DCP operation and automated data collection along with coring capability. The data is analyzed in the same manner as the manual DCP data.

#### 2-3.2.3.1.4 Mosquito.

A relatively small automated penetrometer data collection system has been developed for the special tactics community. It is highly portable and, in the limited testing conducted to date alongside the manual DCP, it seems to provide penetration data that correlates well with that obtained with the manual DCP. It is not suitable for stronger soils.

**2-3.2.3.1.5 Small Aperture CBR Test.**

Standard CBR tests may also be performed through core holes in the pavement surface. This use is normally limited to tests on the surface of the base course. These tests may be performed in conjunction with DCP tests to validate the data or as stand-alone tests in cases where use of the DCP is not applicable. These tests are described in detail in FM 5-472/NAVFAC MO 330/AFJMAN 32-1221(I), *Materials Testing*.

**2-3.2.3.1.6 USCS Correlation.**

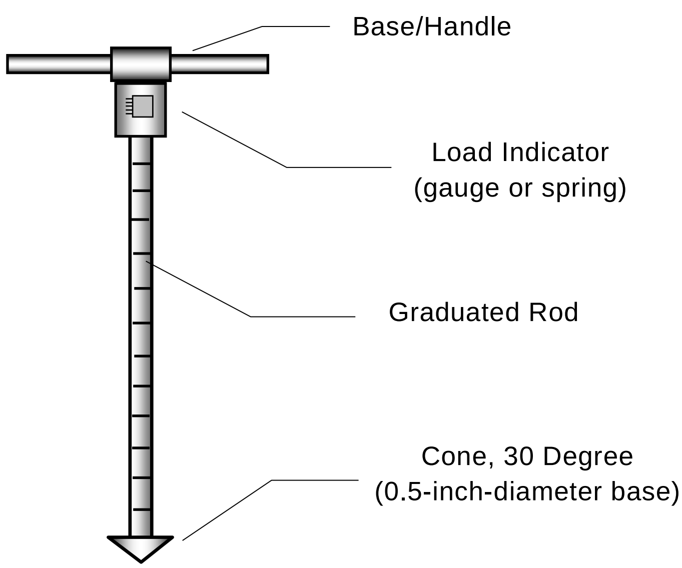
**This is the quickest, yet least-accurate, method of determining CBR values.** For each soil type, empirical studies have determined a range of CBR values. These values are shown on the Soil Characteristics Charts in Appendix A (Tables A-2 and A-3). These CBR ranges are only estimates; due to the varying soil types and strengths encountered across an airfield, use the lowest CBR values in the range.

**2-3.2.3.2 Measure Soil Layer Thicknesses and Strengths Using the ACP.**

**2-3.2.3.2.1 Description.**

The ACP is a 0.375-inch (9.5-mm) -diameter rod with a cone attached to one end and a handle/load indicator on the other (see Figure 2-8). The angle of the cone is 30 degrees and the diameter of the base of the cone is 0.5 inch (13 mm). For C-130 operations, two 12.625-inch long rods, graduated in 2-inch increments, are assembled to facilitate measuring soil strengths to a depth of 24 inches (600 mm) for C-17 operations; an additional rod may be attached extending its depth to 36 inches.

**Figure 2-8 ACP**



**2-3.2.3.2.2 Operation.**

The ACP is placed in a vertical position and a downward force is slowly applied to the handle to ensure penetration into the soil at a rate of 0.5 to 1 inch (13 to 25 mm) per second. Take readings at each 2-inch (50-mm) increment during penetration. **Continue the test to a depth of 24 inches (600 mm).** Because soil is not consistent and maintaining the proper rate of penetration is difficult, make five penetrations using an X configuration at each test location, as shown in Figure 2-9, and record on a form similar to the one in Figure 2-10. Calculate the average of these readings to determine the AI with depth at each test location. These AIs can then be correlated to CBR values using Figure 2-11.

**Figure 2-9 Layout of Penetrations per ACP Test Location**

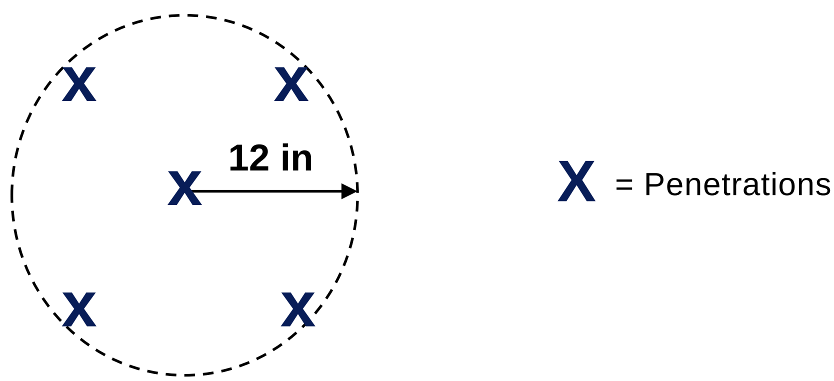
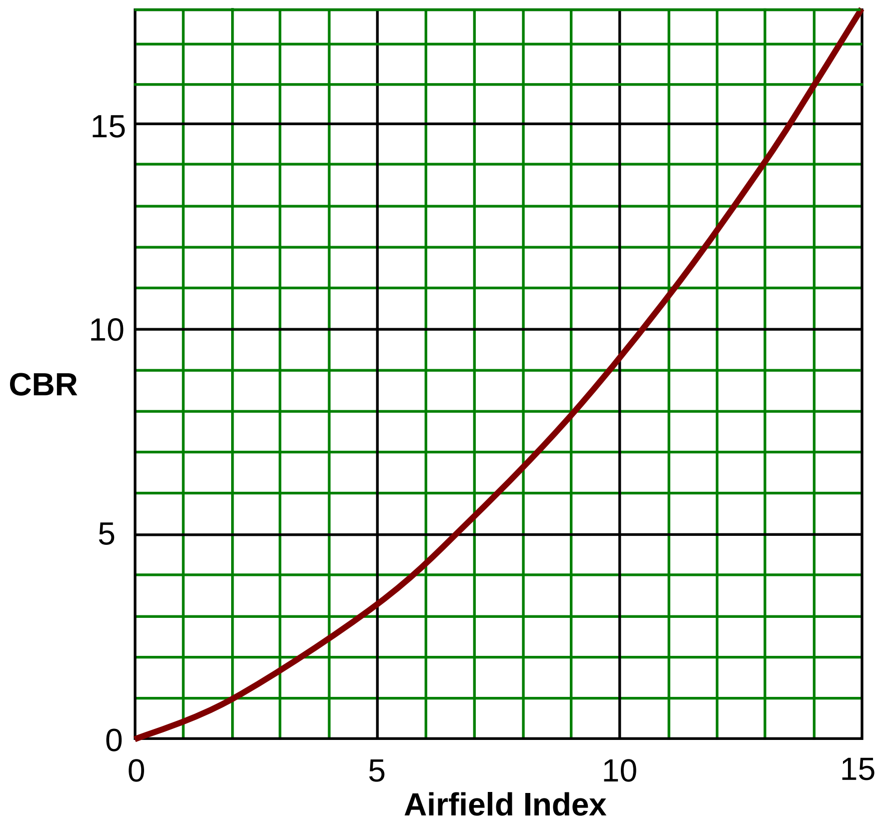


**Figure 2-10 Recording and Averaging ACP Data**

| Location: | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Depth** | **Airfield Index** | | | | | **Sum** | **Avg** |
| 0 | -- | -- | -- | -- | -- | -- | -- |
| 2 | 3 | 3 | 2 | 2 | 3 | 13 | 3 |
| 4 | 4 | 4 | 3 | 4 | 3 | 18 | 4 |
| 6 | 4 | 5 | 4 | 5 | 4 | 22 | 4 |
| 8 | 5 | 5 | 5 | 7 | 4 | 26 | 5 |
| 10 | 6 | 6 | 6 | 7 | 5 | 30 | 6 |
| 12 | 6 | 6 | 7 | 7 | 5 | 31 | 6 |
| 14 | 6 | 7 | 8 | 8 | 5 | 34 | 7 |
| 16 | 7 | 8 | 9 | 10 | 6 | 40 | 8 |
| 18 | 8 | 8 | 10 | 11 | 7 | 44 | 9 |
| 20 | 9 | 9 | 11 | 12 | 8 | 49 | 10 |
| 22 | 10 | 11 | 12 | 13 | 10 | 56 | 11 |
| 24 | 12 | 13 | 13 | 13 | 11 | 62 | 12 |
| Comments: | | | | | | | |

**Figure 2-11 AI Correlation to CBR**




**2-3.2.3.2.3 Special Considerations.**

**2-3.2.3.2.3.1** The ACP works best in weak, fine-grained soils such as silt and clay. It is not suitable for coarse-grained soils such as gravels. **If it will not penetrate through stronger soil layers, do not assume the soil strength underneath the impenetrable layer is adequate.**

**2-3.2.3.2.3.2** If high-strength materials prevent penetration, remove the ACP and use an auger to remove the material to 2 inches (50 mm) below the depth where penetration ceased. Then resume the ACP test and assign a CBR to the impenetrable layer. Continue this ACP/auger procedure in 2-inch (50-mm) increments through the depth of the impenetrable layer or to a total depth of 24 inches (600 mm) beneath the surface for C-130 operations or 36 inches (900 mm) for C-17 operations. This ensures that any soft subsurface soil layers are identified.

**2-3.2.3.2.3.3** Carefully select CBR values for impenetrable materials. **If the impenetrable layer is subsurface or not identifiable, assign a value of CBR 20.** If the impenetrable layer is on the surface or can be identified, the following CBR values may be used:

- Graded crushed aggregate 100

| | | |
|---|---|---|
| • | Limerock | 80 |
| • | Stabilized aggregate | 80 |
| • | Soil cement | 80 |
| • | Sand/shell or shell | 80 |
| • | Gravel, with minimal (< 10%) fines | 40 |
| • | Gravel, with > 10% silts and/or clays | 25 |
| • | Sand, with minimal (< 10%) fines | 20 |

**2-3.2.3.2.3.4** Soil behavior where coarse sands and gravels are involved is greatly dependent on the relative quantities of coarser particles and plastic fines. The presence of cobbles in the soil, which might prevent use of the ACP, does not in itself indicate a strong soil. If there are sufficient fines to overfill the voids between the cobbles, these cobbles are separated and no longer in contact. This soil acts much like a fine-grained soil. If, however, the fines are limited and do not overfill the voids between the coarse particles, the soil structure will be relatively stable.

**2-3.2.3.2.3.5** Depth tests of 24 inches (600 mm) are usually adequate for C-130 operations but soils are influenced to greater depths by heavier aircraft. If weak areas are suspected to exist at levels deeper than 24 inches (600 mm) then continue tests deep enough to identify them.

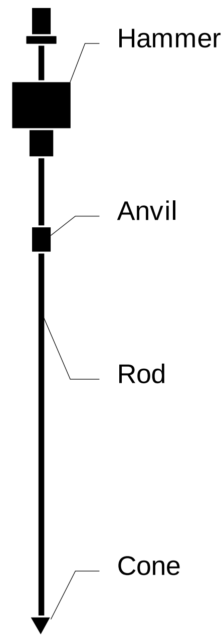
**2-3.2.3.3 Measure Soil Layer Thickness and Strengths Using the DCP.**

**2-3.2.3.3.1 Description.**

The standard DCP in use today in DOD is a slide-hammer-type penetrometer. The four main components of the DCP are the cone, rod, anvil, and hammer. Energy is applied to the 60-degree angled cone tip, through the rod, by dropping a 17.6-pound (8-kilogram) hammer a distance of 22.6 inches (575 mm) against the anvil. The diameter of the cone tip is 0.16 inch (4 mm) larger than that of the rod to ensure that only tip resistance is measured. By assessing the recorded number of hammer blows necessary to advance the cone into the soil, the soil strength is quantified in terms of a DCP index. The DCP index is the ratio of the depth of penetration to the number of blows of the hammer and has been empirically correlated to the CBR and K-value.

**2-3.2.3.3.1.1.** The standard DCP rod, 0.625 inch (16 mm) in diameter, varies in length. The length of the top section is standard, but the length of the bottom section can vary. The bottom rod is either a graduated version or smooth, requiring the use of an adjacent measuring scale (see Figure 2-12). The US Army Corps of Engineers (USACE) established the specifications for the DCP used by DOD and determined the lower rod is sufficiently long to provide data to a depth of 3 feet (1 m) into the soil. As a result, most rods commercially available are 39 inches (991 mm) long. This length is adequate for most Army airfields with thin pavement systems or for evaluating semi-prepared airfields, but the standard rod used for Air Force paved surfaces is long enough to provide data to a depth of at least 4 feet (1.2 m) into the soil. Much longer rods have been used, but their use is not recommended due to unmeasured inertia effects, side friction, potential compression of the rod, and other unknown factors.

**Figure 2-12 DCP**




**2-3.2.3.3.1.2.** Keep the DCP hammer weight of 17.6 pounds and the length of the top rod (drop height) constant to ensure acceptable test results. All correlations used to derive the soil strength from the penetration of the rod are based upon the anvil receiving the same impact force each time the hammer is dropped. USACE developed and patented a dual-mass DCP. The hammer, when fully assembled, weighs the standard 17.6 pounds (8 kg) and is used in most tests. The outer sleeve or doughnut of the dual-mass hammer can be removed, allowing use of the inner 10.1-pound (4.6-kilogram) weight alone when testing in weaker (CBR < 10) soils. When using only the inner weight, the resulting penetration is multiplied by a hammer factor of two to determine the DCP index. Tests utilizing the inner weight alone are not generally recommended for Air Force evaluations.

**2-3.2.3.3.1.3.** Most DCP kits come with both solid reusable and disposable cone tips. Disposable cone tips mount on a rod adapter connected to the bottom rod. Upon completion of penetration, the disposable cone tip detaches from the rod adapter and remains in the soil as the rod is extracted. Some DCP kits have disposable cone tips to be used in cases where the cone is difficult to remove from the soil. This eases rod extraction and can increase the number of tests per day that can be accomplished. Solid cone tips also have some advantages. Although not constructed to be used in cohesive-type soils, they can be used in strong materials where one may need to pull out the rod and drill or auger through the soil to complete the test to full depth. When using the solid reusable cone tip, use a go/no-go gauge to ensure the tip is not too worn or deformed from previous use and will still provide satisfactory test results.

**2-3.2.3.3.2 Operation.**

Two people are required to operate the DCP. The operator holds the device by its handle in a vertical position and taps the device using the slide hammer until the base of the cone is flush with the surface of the soil. The second person, the data recorder, measures the distance between the cone and the surface to establish a baseline reading. The operator then raises and releases the hammer. **Raise the hammer to the point of touching the bottom of the handle but not lifting the rod and cone. Allow the hammer to drop freely with its downward movement—not influenced by any hand movement. Be careful not to exert any downward force on the handle after dropping the hammer.** The recorder ensures the device remains in a vertical position, measures the cone penetration, counts the number of hammer drops between measurements, and records the data. The number of blows or hammer drops between measurements is based on the rate of penetration. **Ensure the cone penetrates at least 25 mm (1 inch) between measurements.** Be alert to any sudden increases in cone penetration rates, which indicate weaker soil layers. Record a measurement at that point to indicate the beginning of that layer. After the DCP has been driven to the desired depth, extract it from the soil by bumping the drop hammer against the handle. Raise the hammer in a vertical direction (rather than in an arching motion) or the rod may be bent or broken where it connects to the anvil. In some soils with large aggregate, the DCP may try to penetrate the soil at a slant rather than from a true vertical direction. Do not apply force to the handle in an attempt to force vertical penetration—this may break the rod or connections**. Instead, discontinue the test if the handle deviates from plumb more than 6 inches (150 mm) or comes in contact with the edge of the pavement. Attempt a new test in close proximity to the failed test.**

**2-3.2.3.3.2.1 Equipment Maintenance.**

Keep the DCP clean and remove all soil before each test. Apply graphite, spray lubricant, or oil to the hammer slide before use each day. Ensure all joints are monitored and kept tight (LOCTITE may be used). Keep the lower rod clean and lubricated when clayey soils are tested.

**2-3.2.3.3.2.2 Recording Data.**

A suggested format for DCP data collection is shown in Figure 2-13. The number of blows and penetration depths is recorded during the test. Depending on the scale used, the depth of penetration readings is measured and recorded to the nearest 5 mm (0.2 inch).

**Figure 2-13 DCP Data Collection Sheet**

| DCP DATA SHEET | | | | | | | |
|---|---|---|---|---|---|---|---|
| BAS | | FEATUR | | DAT | | | |
| TEST | | TEST | | | | | |
| No of Blows (1) | Accum. Penetration mm (2) | Penetration p/Blow Set mm (3) | Penetration per Blow mm (4) | Hammer Blow Factor (5) | DCP Index (6) | CBR % (7) | Depth in. (8) |
| | | | | | | | |
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**How to determine CBR**

(1) No. of hammer blows between test readings

(2) Accumulative cone penetration after each set of hammer blows

(3) Difference in accumulative penetration (2) at start and end of each hammer blow set

(4) (3) divided by (1)

(5) Enter 1 for 17.6 lb hammer, 2 for 10.1 lb hammer

(6) (4) x (5)

(7) From CBR versus DCP correlation (Tables 2-3 or 2-4)

(8) Divide (2) by 25.4, then round off to 0.2 inch

### 2-3.2.3.3.3 Surface Layer Strengths.

Lack of confinement at the top of the surface layer affects the DCP measurements. The penetration depth required to accurately measure the surface layer strength is related to the gradation and plasticity characteristics of the materials. The DCP can measure strengths of thin surface layers of fine-grained plastic materials but requires thicker surface layers for the non-plastic coarse-grained materials. The penetration depth required for measuring actual strength of the surface layer with the DCP for various soil types is shown in Table 2-2.

**Table 2-2 Depth Required to Measure Surface Layer Strength**

| Soil Type | Average Penetration Depth |
|---|---|
| CH | 1 inch (25 mm) |
| CL | 3 inches (75 mm) |
| SC | 4 inches (100 mm) |
| SW-SM | 4 inches (100 mm) |
| SM | 5 inches (125 mm) |
| GP | 5 inches (125 mm) |
| SP | 11 inches (280 mm) |

### 2-3.2.3.3.4 Depth of Tests.

Many aircraft affect the soil to depths of 36 inches (900 mm) or more; therefore, it is recommended that DCP tests be conducted to the full depth of the rod**. If a test is discontinued short of full rod depth, perform a new test nearby.**

### Table 2-3 Tabulated Correlation of DCP Index to CBR, All Soil Types Other Than CH or CL

| mm/blow | inch/blow | CBR | K | mm/blow | inch/blow | CBR | K |
|---|---|---|---|---|---|---|---|
| < 2.615 | < .1029 | 100 | 500 | 5.834 – 5.965 | .2298 - .2348 | 40 | 358 |
| 2.616 – 2.638 | .1030 - .1039 | 99 | 499 | 5.966 – 6.103 | .2349 - .2403 | 39 | 354 |
| 2.639 – 2.663 | .1040 - .1048 | 98 | 498 | 6.104 – 6.248 | .2404 - .2460 | 38 | 349 |
| 2.664 – 2.687 | .1049 - .1058 | 97 | 497 | 6.249 – 6.401 | .2461 - .2520 | 37 | 345 |
| 2.688 – 2.712 | .1059 - .1068 | 96 | 496 | 6.402 – 6.561 | .2521 - .2583 | 36 | 340 |
| 2.713 – 2.738 | .1069 - .1078 | 95 | 495 | 6.562 – 6.731 | .2584 - .2650 | 35 | 336 |
| 2.739 – 2.764 | .1079 - .1088 | 94 | 494 | 6.732 – 6.910 | .2651 - .2720 | 34 | 332 |
| 2.765 – 2.791 | .1089 - .1099 | 93 | 493 | 6.911 – 7.100 | .2721 - .2795 | 33 | 327 |
| 2.792 – 2.818 | .1100 - .1109 | 92 | 492 | 7.101 – 7.300 | .2796 - .2874 | 32 | 322 |
| 2.819 – 2.846 | .1110 - .1120 | 91 | 491 | 7.301 – 7.513 | .2875 - .2958 | 31 | 318 |
| 2.847 – 2.874 | .1121 - .1132 | 90 | 490 | 7.514 – 7.740 | .2959 - .3047 | 30 | 313 |
| 2.875 – 2.903 | .1133 - .1143 | 89 | 489 | 7.741 – 7.982 | .3048 - .3143 | 29 | 309 |
| 2.904 – 2.933 | .1144 - .1155 | 88 | 488 | 7.983 – 8.241 | .3144 - .3244 | 28 | 304 |
| 2.934 – 2.963 | .1156 - .1166 | 87 | 487 | 8.242 – 8.518 | .3245 - .3354 | 27 | 299 |
| 2.964 – 2.994 | .1167 - .1179 | 86 | 486 | 8.519 – 8.815 | .3355 - .3471 | 26 | 294 |
| 2.995 – 3.025 | .1180 - .1191 | 85 | 485 | 8.816 – 9.136 | .3472 - .3597 | 25 | 289 |
| 3.026 – 3.058 | .1192 - .1204 | 84 | 483 | 9.137 – 9.482 | .3598 - .3733 | 24 | 284 |
| 3.059 – 3.091 | .1205 - .1217 | 83 | 482 | 9.483 – 9.857 | .3734 - .3881 | 23 | 279 |
| 3 092 – 3.125 | .1218 - .1230 | 82 | 480 | 9.858 – 10.265 | .3882 - .4042 | 22 | 274 |
| 3.126 – 3.159 | .1231 - .1244 | 81 | 478 | 10.266 – 10.711 | .4043 - .4217 | 21 | 269 |
| 3.160 – 3.195 | .1245 - .1258 | 80 | 477 | 10.712 – 11.200 | .4218 - .4409 | 20 | 263 |
| 3.196 – 3.231 | .1259 - .1272 | 79 | 475 | 11.201 – 11.739 | .4410 - .4622 | 19 | 258 |
| 3.232 – 3.268 | .1273 - .1287 | 78 | 473 | 11.740 – 12.336 | .4623 - .4857 | 18 | 252 |
| 3.269 – 3.306 | .1288 - .1302 | 77 | 471 | 12.337 – 13.001 | .4858 - .5118 | 17 | 246 |
| 3.307 – 3.345 | .1303 - .1317 | 76 | 469 | 13.002 – 13.746 | .5119 - .5412 | 16 | 240 |
| 3.346 – 3.385 | .1318 - .1333 | 75 | 467 | 13.747 – 14.589 | .5413 - .5744 | 15 | 233 |
| 3.386 – 3.427 | .1334 - .1349 | 74 | 465 | 14.590 – 15.550 | .5745 - .6122 | 14 | 226 |
| 3.428 – 3.469 | .1350 - .1366 | 73 | 463 | 15.551 – 16.655 | .6123 - .6557 | 13 | 219 |
| 3.470 – 3.512 | .1367 - .1383 | 72 | 461 | 16.656 – 17.940 | .6558 - .7063 | 12 | 211 |
| 3.513 – 3.556 | .1384 - .1400 | 71 | 459 | 17.941 – 19.458 | .7064 - .7660 | 11 | 203 |
| 3.557 – 3.602 | .1401 - .1418 | 70 | 457 | 19.459 – 21.274 | .7661 - .8376 | 10 | 195 |
| 3.603 – 3.649 | .1419 - .1437 | 69 | 454 | 22.275 – 23.493 | .8377 - .9249 | 9 | 185 |
| 3.650 – 3.697 | .1438 - .1456 | 68 | 452 | 23.494 – 26.267 | .9250 – 1.0341 | 8 | 174 |
| 3.698 – 3.747 | .1457 - .1475 | 67 | 450 | 26.268 – 29.842 | 1.0342 – 1.1749 | 7 | 162 |
| 3.748 – 3.798 | .1476 - .1495 | 66 | 447 | 29.843 – 34.633 | 1.1750 – 1.3635 | 6 | 149 |
| 3.799 – 3.850 | .1496 - .1516 | 65 | 445 | 34.634 – 38.388 | 1.3636 – 1.5113 | 5 | 134 |
| 3.851 – 3.904 | .1517 - .1537 | 64 | 442 | 38.389 – 39.840 | 1.5114 – 1.5685 | 4.8 | 131 |
| 3.905 – 3.960 | .1538 - .1559 | 63 | 439 | 39.841 – 41.414 | 1.5686 – 1.6305 | 4.6 | 128 |
| 3.961 – 4.018 | .1560 - .1582 | 62 | 437 | 41.415 – 43.126 | 1.6306 – 1.6979 | 4.4 | 125 |
| 4.019 – 4.077 | .1583 - .1605 | 61 | 434 | 43.127 – 44.995 | 1.6980 – 1.7714 | 4.2 | 122 |
| 4.078 – 4.138 | .1606 - .1629 | 60 | 431 | 44.996 – 47.044 | 1.7715 – 1.8521 | 4 | 119 |
| 4.139 – 4.201 | .1630 - .1654 | 59 | 428 | 47.045 – 49.302 | 1.8522 – 1.9410 | 3.8 | 116 |
| 4.202 – 4.266 | .1655 - .1680 | 58 | 425 | 49.303 – 51.803 | 1.9411 – 2.0395 | 3.6 | 112 |
| 4.267 – 4.333 | .1681 - .1706 | 57 | 422 | 51.804 – 54.589 | 2.0396 – 2.1492 | 3.4 | 109 |
| 4.334 – 4.403 | .1707 - .1734 | 56 | 419 | 54.590 – 57.712 | 2.1493 – 2.2721 | 3.2 | 105 |
| 4.404 – 4.475 | .1735 - .1762 | 55 | 416 | 57.713 – 61.241 | 2.2722 – 2.4111 | 3 | 101 |
| 4.476 – 4.550 | .1763 - .1791 | 54 | 413 | 61.242 – 65.261 | 2.4112 – 2.5693 | 2.8 | 97 |
| 4.551 – 4.627 | .1792 - .1822 | 53 | 409 | 65.262 – 69.885 | 2.5694 – 2.7514 | 2.6 | 93 |
| 4.628 – 4.707 | .1823 - .1853 | 52 | 406 | 69.886 – 75.263 | 2.7515 – 2.9631 | 2.4 | 89 |
| 4.708 – 4.790 | .1854 - .1886 | 51 | 402 | 75.264 – 81.601 | 2.9632 – 3.2126 | 2.2 | 84 |
| 4.791 – 4.877 | .1887 - .1920 | 50 | 399 | 81.602 – 89.189 | 3.2127 – 3.5114 | 2 | 78 |
| 4.878 – 4.966 | .1921 - .1955 | 49 | 395 | 89.190 – 98.447 | 3.5115 – 3.8759 | 1.8 | 73 |
| 4.967 – 5.059 | .1956 - .1992 | 48 | 391 | 98.448 – 110.010 | 3.8760 – 4.3311 | 1.6 | 68 |
| 5.060 – 5.156 | .1993 - .2030 | 47 | 387 | 110.011 – 124.890 | 4.3312 – 4.9169 | 1.4 | 63 |
| 5.157 – 5.258 | .2031 - .2070 | 46 | 383 | 124.891 – 144.800 | 4.9170 – 5.7008 | 1.2 | 57 |
| 5.259 – 5.363 | .2071 - .2111 | 45 | 379 | 144.801 – 172.904 | 5.7009 – 6.8072 | 1 | 51 |
| 5.364 – 5.473 | .2112 - .2155 | 44 | 375 | 172.905 – 215.794 | 6.8073 – 8.4958 | 0.8 | 43 |
| 5.474 – 5.588 | .2156 - .2200 | 43 | 371 | 215.795 – 289.956 | 8.4959 – 11.4156 | 0.6 | 35 |
| 5.589 – 5.708 | .2201 - .2247 | 42 | 366 | 289.957 – 452.249 | 11.4157 – 17.8050 | 0.4 | 25 |
| 5.709 – 5.833 | .2248 - .2297 | 41 | 362 | 452.25 – 1140.602 | 17.8051 – 44.906 | 0.2 | 15 |

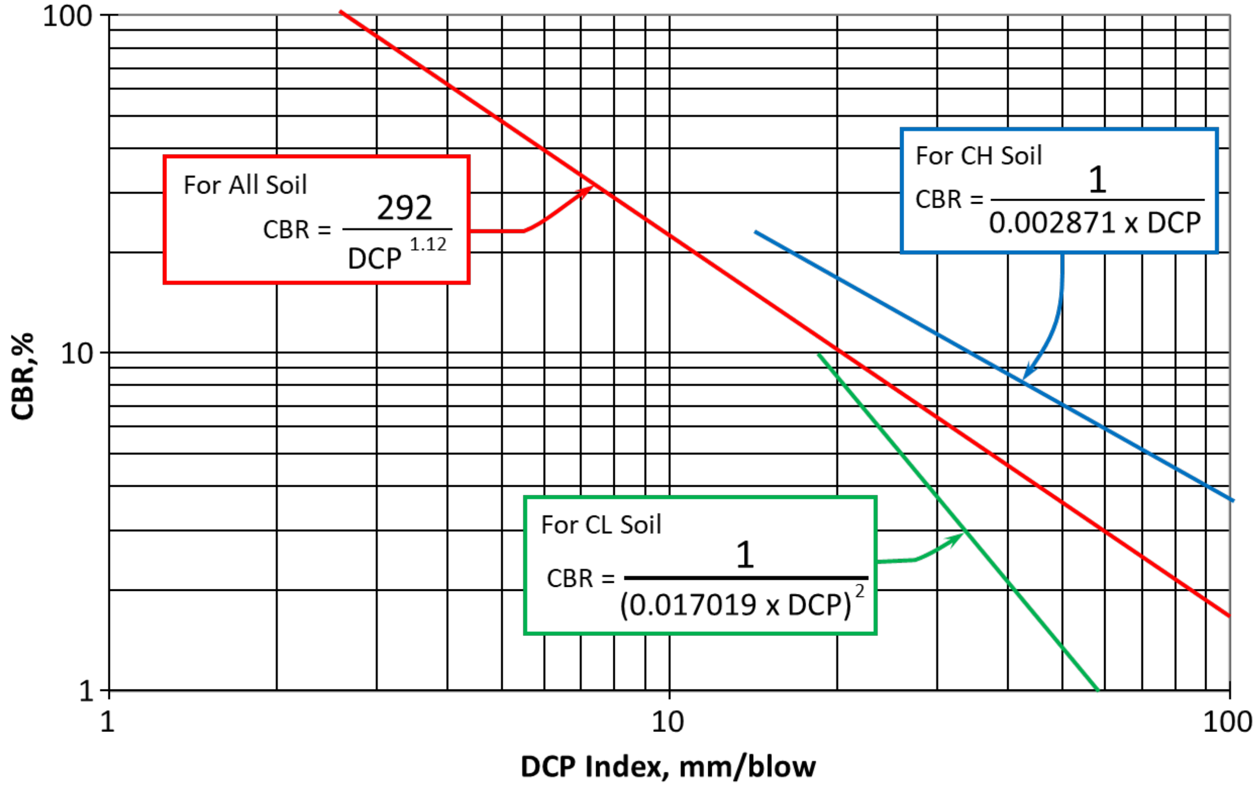
### 2-3.2.3.3.5 Correlation of DCP Readings to CBR.

**2-3.2.3.3.5.1** If using manual field-plotting methods, the CBRs may be obtained from Tables 2-3 and 2-4 or Figure 2-14. Use Table 2-3 correlations for all soil groups other than CH and CL with a CBR below 10. Use Table 2-4 correlations for all CH and CL soils with a CBR less than 10. When using these tables, round the CBRs to the nearest whole number. Figure 2-14 shows a plot of all correlations.

**Table 2-4 Tabulated Correlation of DCP Index to CBR, CH and CL Soils**

| mm/blow | inch/blow | CBR | K | mm/blow | inch/blow | CBR | K |
|---|---|---|---|---|---|---|---|
| <10.094 | <0.398 | 35 | 336 | 46.381 – 53.504 | 1.827 – 2.106 | 7 | 162 |
| 10.094 – 10.394 | 0.398 – 0.409 | 34 | 332 | 53.505 – 63.214 | 2.107 – 2.489 | 6 | 149 |
| 10.395 – 10.714 | 0.410 – 0.422 | 33 | 327 | 63.215 – 70.939 | 2.490 – 2.793 | 5 | 134 |
| 10.715 – 11.054 | 0.423 – 0.435 | 32 | 322 | 70.940 – 73.951 | 2.794 – 2.911 | 4.8 | 131 |
| 11.055 – 11.416 | 0.436 – 0.449 | 31 | 318 | 73.952 – 77.231 | 2.912 – 3.041 | 4.6 | 128 |
| 11.471 – 11.803 | 0.450 – 0.465 | 30 | 313 | 77.232 – 80.815 | 3.042 – 3.182 | 4.4 | 125 |
| 11.804 – 12.217 | 0.466 – 0.481 | 29 | 309 | 80.816 – 84.747 | 3.183 – 3.337 | 4.2 | 122 |
| 12 218 – 12.661 | 0.482 – 0.498 | 28 | 304 | 84.748 – 89.082 | 3.338 – 3.507 | 4 | 119 |
| 12.662 – 13.139 | 0.499 – 0.517 | 27 | 299 | 89.083 – 93.884 | 3.508 – 3.696 | 3.8 | 116 |
| 13.140 – 13.654 | 0.518 – 0.538 | 26 | 294 | 93.885 – 99.234 | 3.697 – 3.907 | 3.6 | 112 |
| 13.655 – 14.211 | 0.539 – 0.559 | 25 | 289 | 99.235 – 105.230 | 3.908 – 4.143 | 3.4 | 109 |
| 14.212 – 14.815 | 0.560 – 0.583 | 24 | 284 | 105.231 – 111.997 | 4.144 – 4.409 | 3.2 | 105 |
| 14.816 – 15.474 | 0.584 – 0.609 | 23 | 279 | 111.998 – 119.694 | 4.410 – 4.712 | 3 | 101 |
| 15.475 – 16.193 | 0.610 – 0.638 | 22 | 274 | 119.695 – 128.528 | 4.713 – 5.060 | 2.8 | 97 |
| 16.194 – 16.982 | 0.639 – 0.669 | 21 | 269 | 128.529 – 138.769 | 5.061 – 5.463 | 2.6 | 93 |
| 16.983 – 17.853 | 0.670 – 0.703 | 20 | 263 | 138.770 – 150.784 | 5.464 – 5.936 | 2.4 | 89 |
| 17.854 – 18.817 | 0.704 – 0.741 | 19 | 258 | 150.785 – 165.076 | 5.937 – 6.499 | 2.2 | 84 |
| 18.818 – 19.892 | 0.742 – 0.783 | 18 | 252 | 165.077 – 182.362 | 6.500 – 7.180 | 2 | 78 |
| 19.893 – 21.097 | 0.784 – 0.831 | 17 | 246 | 182.363 – 203.690 | 7.181 – 8.019 | 1.8 | 73 |
| 21.098 – 22.457 | 0.832 – 0.884 | 16 | 240 | 203.691 – 230.670 | 8.020 – 9.081 | 1.6 | 68 |
| 22.458 – 24.005 | 0.885 – 0.945 | 15 | 233 | 230.671 – 265.886 | 9.082 – 10.468 | 1.4 | 63 |
| 24.006 – 25.782 | 0.946 – 1.015 | 14 | 226 | 265.887 – 313.793 | 10.469 – 12.354 | 1.2 | 57 |
| 25.783 – 27.843 | 1.016 – 1.096 | 13 | 219 | 313.794 – 382.759 | 12.355 – 15.069 | 1 | 51 |
| 27.844 – 30.262 | 1.097 – 1.191 | 12 | 211 | 382.760 – 490.578 | 15.070 – 19.314 | 0.8 | 43 |
| 30.263 – 33.141 | 1.192 – 1.305 | 11 | 203 | 490.579 – 682.962 | 19.315 – 26.888 | 0.6 | 35 |
| 33.142 – 36.626 | 1.306 – 1.442 | 10 | 195 | 682.963 – 1123.583 | 26.889 – 44.236 | 0.4 | 25 |
| 36.627 – 40.930 | 1.443 – 1.611 | 9 | 185 | >1123.583 | >44.236 | 0.2 | 15 |
| 40.931 – 46.380 | 1.612 – 1.826 | 8 | 174 | | | | |

**Figure 2-14 Plotted Correlation of DCP Index to CBR**




**2-3.2.3.3.5.2** If using the USACE Pavement-Transportation Computer Aided Structural Engineering (PCASE) DCP software program, the CBRs are computed for the user based upon the inputted number of blows and penetration depths. The DCP program will also display a graph of the CBR values in relation to the depths measured and is useful in determining layer thicknesses. Extensive experience and training are required before readily accepting the values that the DCP program produces; if in doubt, contact AFCEC.

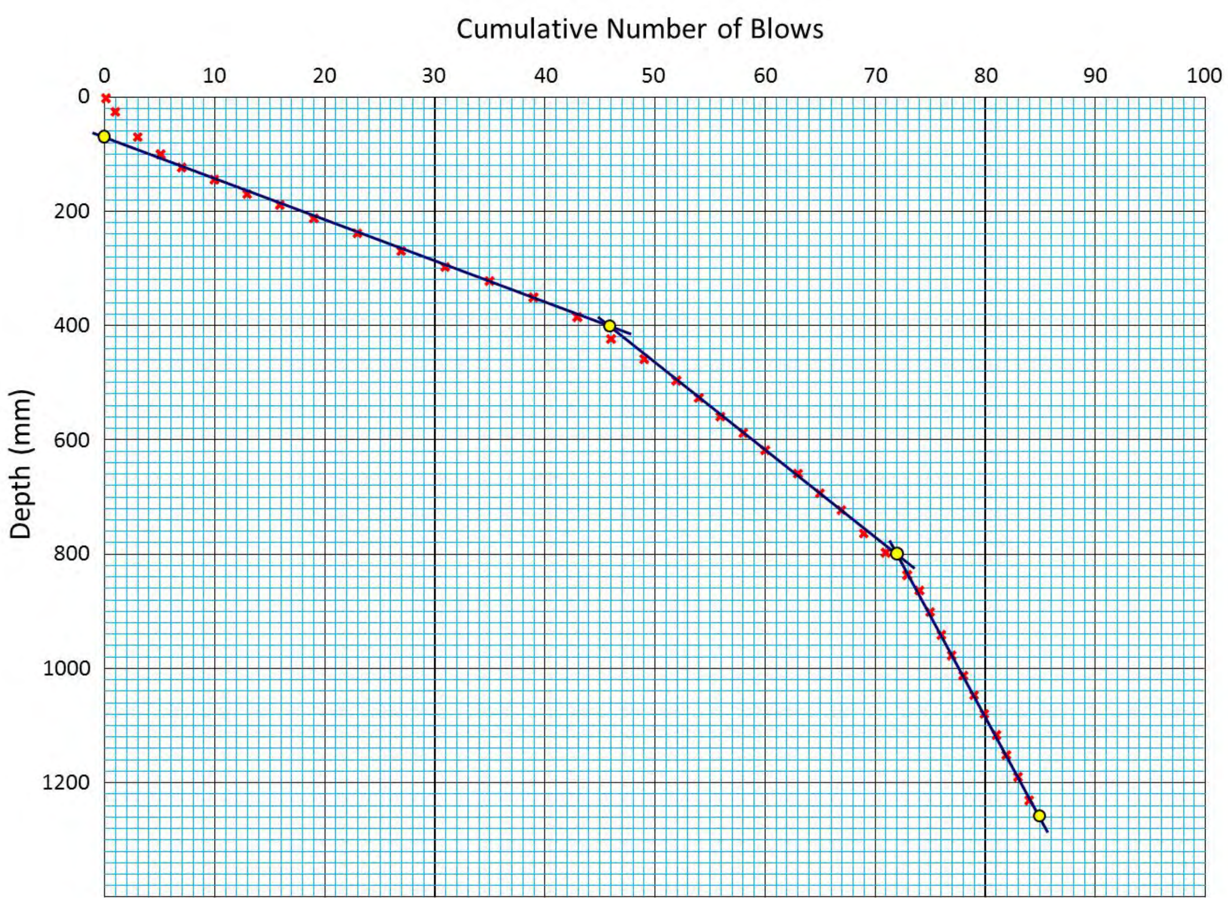
**2-3.2.3.3.5.3** The DCP data may also be easily plotted on graph paper and the resulting soil layer thicknesses and corresponding CBRs determined. Figure 2-15 is an example of this method.

- **Plot.** Plot the cumulative number of blows needed in a particular DCP test along one axis of the graph. Annotate the depth of penetration along the other axis. Then plot the points as recorded on the DCP data sheet.
- **Layers**. Draw straight lines tangent to or through the points that are reasonably straight. These lines indicate the soil layers, with the intersecting points indicating the layer breaks. Disregard the top few measurements of the test in this process. In this example, the first layer break is located at 420 mm (16 inches), so the thickness of layer 1 is 16 inches. The second layer break is at 800 mm (31 inches), so the thickness

of layer 2 is 400 mm (15 inches). This is continued throughout the depth of the test.

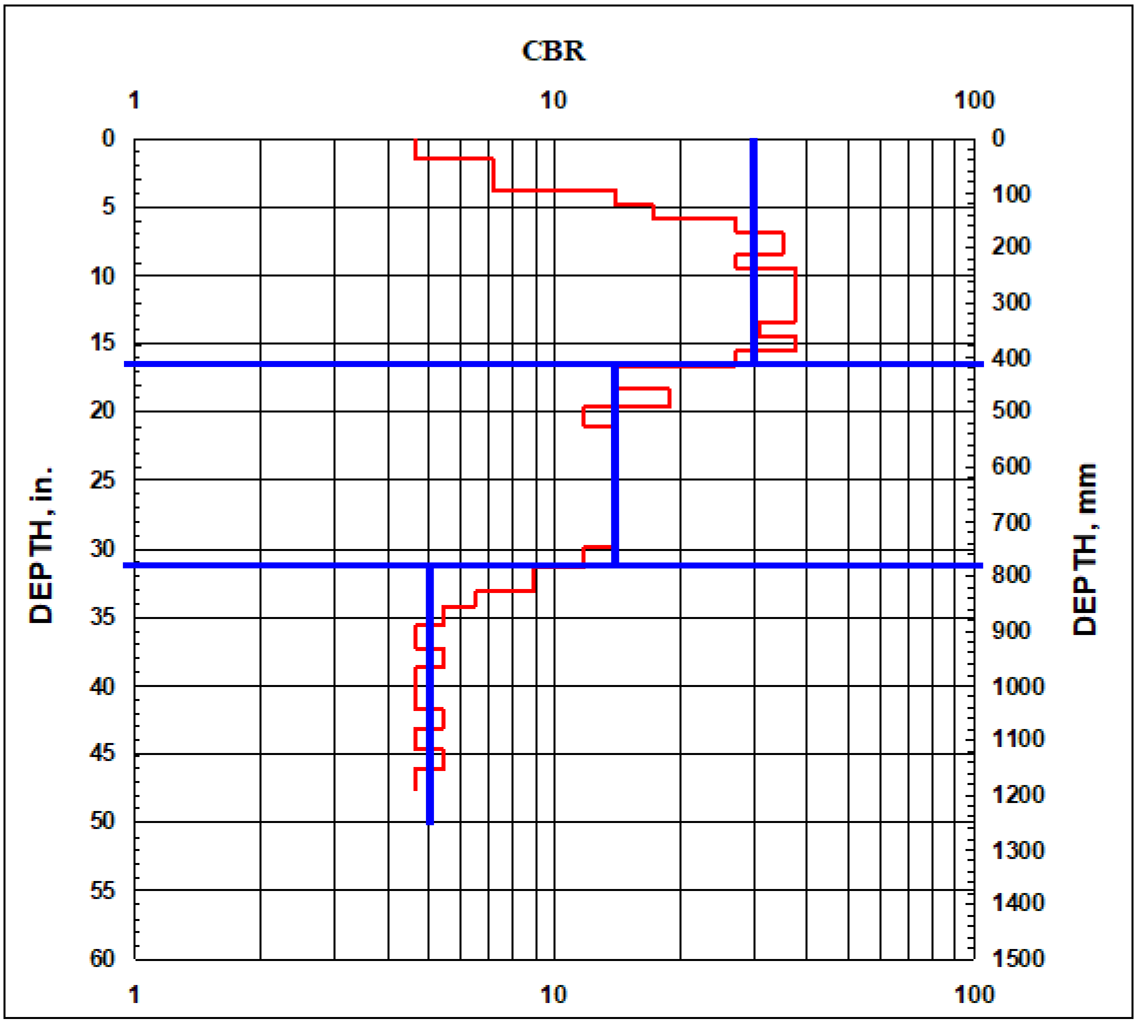
- **DCP Index.** The layer DCP index is established by dividing the depth of penetration by the number of blows. In this example, the first straight line intersected the depth axis at 70 mm (2.8 inches) and the layer break point at 420 mm (16 inches), so the depth for determination of DCP index is 350 mm (14 inches). It took 46 blows to reach the first layer break. Dividing 350 by 46 results in a DCP index of 7.6 for this layer. DCP indexes for the remaining layers are determined the same way by using the number of blows and depth measurements between layer breaks. The DCP index for layer 2 is 14.6 and the DCP index for layer 3 is 35.
- **CBRs.** Tables 2-3 and 2-4 are used to determine the CBRs for each layer. In this example, the soils tested were classified as SP or poorly graded sand, so Table 2-3 was used. The depth measurements were in millimeters, so the table was entered in the DCP index "mm/blow" columns as appropriate to find the corresponding CBRs. A CBR 32 resulted for layer 1, CBR 14 for layer 2, and CBR 5 for layer 3.

**Figure 2-15 Manual Plot of DCP Data**



**2-3.2.3.3.5.4** Figure 2-16 is a plot of the DCP test data in a format similar to that used in the PCASE program or as typically plotted in EXCEL spreadsheets. The red line in this graph depicts the CBR (read from the horizontal scale) of the soil throughout the depth (read from the vertical scale) of the test. Changes in the soil layer structure can be identified by horizontal shifts in the plotted line. The blue horizontal lines were placed at these locations and help determine the layer thicknesses. Vertical lines (also blue in this case) were added to display the assumed CBR for each layer. Again, notice that both plots reflect weaker CBRs at the surface. This weaker data was ignored when determining the layer strength because the DCP test does not reflect the true strength of the near-surface soil due to the lack of confinement or overburden.

**Figure 2-16 Plot of CBR Correlated from DCP Data**



**2-3.2.3.3.6 Special Considerations.**

**2-3.2.3.3.6.1** DCP tests in highly plastic clays are generally accurate for depths to approximately 12 inches (300 mm). At deeper depths, clay sticking to the lower rod may indicate higher CBR values than actually exist. Various references suggest that oiling the rod will help without significantly impacting the test results or that it may be wise to auger out the test hole after each 12-inch (300-mm) depth encountered to eliminate the clay-related friction problems and allow more accurate measurements. Oiling the rod makes a mess and the auger procedure is quite time-consuming, with little benefit. Experience has shown that it is best to just wipe down the rod with a clean cloth before each test. The friction from the clay will have little impact on the test.

**2-3.2.3.3.6.2** Many sands occur in a loose state. Such sands when relatively dry will show low DCP index values for the top few inches and then may show increasing strength with depth. The compressing action of aircraft tires will increase the strength of sand. Avoid aircraft operations on sands and gravels in a “quick” condition (water percolating through them). Base evaluation of moist sands upon DCP test data.

**2-3.2.3.3.6.3** If a soil layer cannot be penetrated by the DCP and the cone does not penetrate after 10 blows, stop the test. Drill or auger through that soil layer, assign a CBR value to that layer and continue the testing beneath it. This augering may need to be performed in increments to ensure the correct thickness of cover is assigned to the weak soils underneath.

**2-3.2.3.3.6.4** If large aggregate is encountered, stop the test and perform a new test within a few feet of the first location. **The DCP is generally not suitable for soils having significant amounts of aggregate larger than 2 inches (50 mm).** Carefully select CBR values for impenetrable materials. **If the impenetrable layer is subsurface or not identifiable, assign a CBR 80.** If the impenetrable layer is on the surface or can be identified, the following CBR values may be used:

- Graded, crushed aggregate 100
- Macadam 100
- Bituminous binder 100
- Limerock 80
- Stabilized aggregate 80
- Soil cement 80
- Sand/shell or shell 80
- Sand asphalt 80

**2-3.2.3.3.6.5** Even if the DCP can be performed through a strong layer, if the DCP indicates a high strength (CBR > 80) and the layer is unidentifiable, assign a maximum value of CBR 80 to that layer.

**2-3.2.3.3.6.6** DCP plots often indicate high strengths (CBR > 80) throughout the entire depth of the test. These excessively high CBRs when assigned to the lower soil layers render unrealistically high predictions of the pavement's structural capability during data analysis. When field tests indicate strong readings for the full depth of the DCP test, add a new layer at the bottom of the collected data with a CBR that one expects to find for the given environment. For example, if other DCP tests on an airfield indicated a more typical subgrade strength of CBR 15, and the DCP test rod used in a particular test that indicted high-strength soils throughout its depth was 36 inches (900 mm) long, add a subgrade layer of 15 CBR at 36 inches (900 mm).

**2-3.2.3.3.6.7** Never consider a DCP test as an absolute indicator of the soil's strength. Consider the material properties of the soil, such as the soil gradation, plasticity, aggregate hardness, stabilization, etc. CBRs are determined from the DCP test taken of the in situ soil at the moisture content and density of the soil at the time of testing. As these properties change, so does the strength of the soil. Engineering judgment and a knowledge of the specific site are necessary to adequately assess DCP data for long-term use. For example, sites located in areas of heavy seasonal rain and flooding. Fine-grained soils that contain large amounts of clays and silts are especially susceptible to strength loss where there is no surface seal to prevent water infiltration. In such cases, document the moisture conditions at the time of testing and consider expected conditions during the projected period of use to determine the validity of the DCP test data.

**2-3.2.3.3.6.8** Various references recommend stopping a DCP test if the rod does not penetrate the soil at least 1 inch (25 mm) in 10 blows. Do not be so quick to stop the test. Identify possible weak soil layers located lower in the pavement structure to assess their impact. If the rod is moving any distance at all, continue the test. If the rod does not penetrate the soil in 10 blows, give it 10 more blows. If the rod does not move in 50 blows, consider augering or starting a new test. If the rod is bouncing or obviously hitting a rock, move over and start a new test.

### 2-3.2.3.3.7 Guidance on Breaking DCP Data into Layers.

Break DCP data plots into layers to evaluate the pavement's load-bearing capability. Multiple people looking at the same data plot will determine different structures. As one becomes more experienced in breaking layers and the more comfortable they become with the process, the more consistent their structures will be.

**2-3.2.3.3.7.1** The following tips may be helpful to determine a pavement layer structure from a single DCP data plot:

**2-3.2.3.3.7.1.1** Minimize the number of layers.

**2-3.2.3.3.7.1.2** Place an emphasis on weaker layers are located at shallower depths or closer to the surface. A weak layer over a strong layer will always control. Each layer's strength will be evaluated based upon the total thickness of cover above it.

**2-3.2.3.3.7.1.3** Do not break the data into thin layers. Look closely before considering any layer less than 4 inches (100 mm) thick. An exception may be a thin layer located very close to the surface.

**2-3.2.3.3.7.1.4** Consider how the pavement structure was constructed and determine if the layer structure makes sense.

**2-3.2.3.3.7.1.5** For a weak layer, assign a CBR more towards the low end of the data for that layer, particularly if the weak layer is close to the surface. The closer a weak layer is in relation to the surface, the more one needs to be concerned about it.

**2-3.2.3.3.7.1.6** In most situations, disregard or place less emphasis on the top few inches of the DCP data plot. There is usually a lack of confinement of the soil and the data does not reflect the soil's true strength. When to consider:

- Surface layer of unimproved or semi-prepared (unpaved) airfield
- Soil weakened by infiltration of water during coring operations
- Soft, loose soil material remaining in the bottom of the hole after drilling through the pavement

**2-3.2.3.3.7.2** Consider multiple DCP plots taken from the same section of pavement and determine a single layer structure used to evaluate that section. The following tips may be helpful to determine a pavement layer structure from multiple DCP data plots:

**2-3.2.3.3.7.2.1** Arrange the data plots for a given pavement section in relation to their locations on the airfield. This will help determine how consistent the test results are for the section or where to place more emphasis due to location. Compare the data plots layer by layer.

**2-3.2.3.3.7.2.2** If the CBR plots are similar for a given layer, consider using an average CBR to represent that layer.

**2-3.2.3.3.7.2.3** If the CBR data for a given layer is a little more variable, consider using a low average CBR to represent that layer. A low average is considered to be 85% of the average, but never lower than the lowest value used to determine the average.

**2-3.2.3.3.7.2.4** If the CBR data for a given layer is more erratic, consider using a CBR more towards the low end of the data. Never average away soft spots in the pavement structure.

**2-3.2.3.3.7.2.5** Always consider the locations of the DCPs on the airfield. Some areas are more critical to aircraft operations than others and weaker CBRs in these critical areas will often control the evaluation.

**2-3.2.3.3.7.2.6** Once the layer thicknesses and CBRs have been determined, consider separating a pavement section into multiple sections for evaluation if the data from multiple DCP tests varies much beyond the allowable deviations shown in Table 2-5.

**Table 2-5 Recommended Maximum Allowable Deviations in Pavement Layer (Thickness and CBR) for Contingency Airfield Evaluations**

| Deviation (Inches) for Layer Thickness | | | Deviation (CBRs) for Layer Types | | |
|---|---|---|---|---|---|
| **Layer Type** | **Average Layer Thickness < 8 inches** | **Average Layer Thickness > 8 inches** | **Layer Type** | **Average Layer CBR** | **Deviation (CBR)** |
| PCC | 1.0 | 2.0 | BC | 80+ | 30 |
| AC | 1.0 | 2.0 | BC/SB | 50–80 | 20 |
| CTB | 1.0 | 2.0 | SB | 30–50 | 15 |
| BC | 1.5 | 2.0 | SB | 20–30 | 10 |
| SB | 2.0 | 3.0 | SG | 13–20 | 6 |
| | | | SG | 7–13 | 4 |
| | | | SG | 1–7 | 2 |

**2-3.2.3.3.7.2.7** Always review DCP test results before leaving the tested airfield. The plots will help define pavement sections. If the data plots fall outside of the allowable ranges shown in Table 2-5 and time is available, perform additional tests. If there are legitimate time constraints and no additional DCP tests can be performed, then ignore these allowable deviations and use the more conservative data or weaker DCPs.

**2-3.2.3.3.7.2.8** In some situations, such as when leveling courses are used to correct variations in elevation or surface gradients, variations in pavement layer thicknesses are common. In these situations, ignore the deviations and use the more conservative data or thinner thickness values encountered.

**2-3.2.3.4** For evaluating PCC pavement structures, convert the soil layer CBRs to K-values (modulus of soil reaction). See Figures 2-17 and 2-18 for correlations. Table 2-6 gives typical K-values for different soil types and moisture contents. Figure 2-19 yields an effective K-value at the surface of the base course as a function of the subgrade K-value and base course thickness. Convert CBR field data taken at different depths to K-values and the K-values in turn plotted on Figures 2-19 through 2-22 to determine the effective K-value of each layer. **Use the lowest effective K-value obtained from the various layers to evaluate the pavement system.**

**Figure 2-17 Correlation of CBR to Modulus of Soil Reaction K**

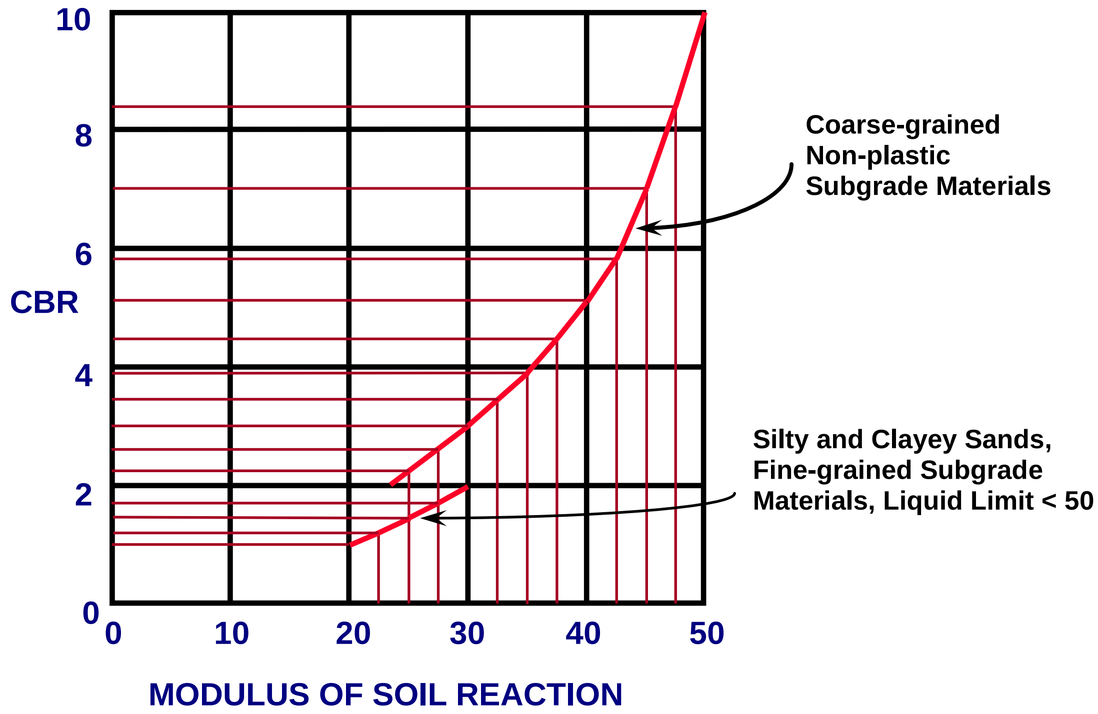



**Figure 2-18 Correlation of CBR to Modulus of Soil Reaction K**

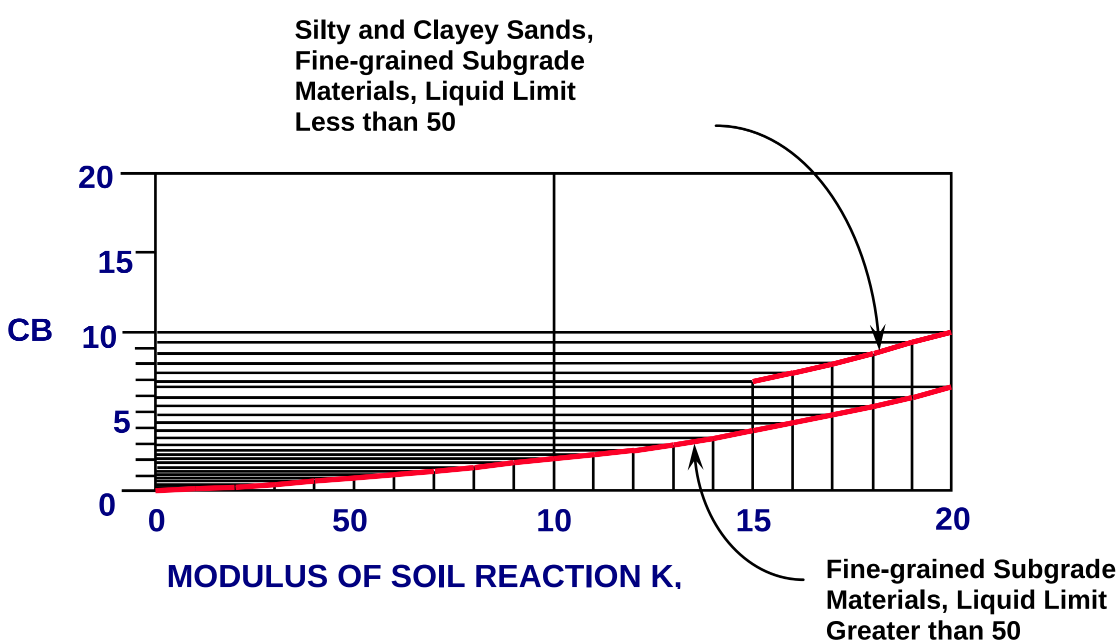


**Table 2-6 Typical Values – Modulus of Soil Reaction K**

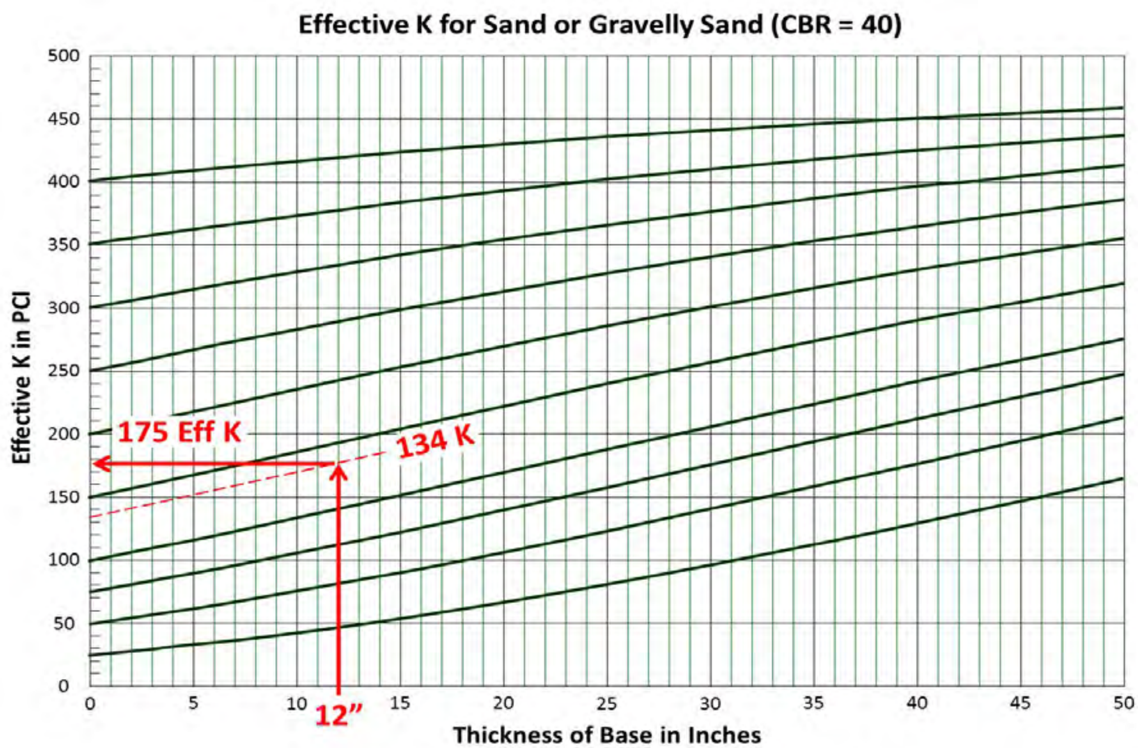
| Type of Material | Modulus of Soil Reaction K for Moisture Content Percentage | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1–4 | 5–8 | 9–12 | 13–16 | 17–20 | 21–24 | 25–28 | Over 28 |
| Silts and clays LL > 50 (OH, CH, MH) | -- | 175 | 150 | 125 | 100 | 75 | 50 | 25 |
| Silts and clays LL < 50 (OL, CL, ML) | -- | 200 | 175 | 150 | 125 | 100 | 75 | 50 |
| Silty and clayey sands (SM & SC) | 300 | 250 | 225 | 200 | 150 | -- | -- | -- |
| Sand and gravelly sands (SW & SP) | 350 | 300 | 250 | -- | -- | -- | -- | -- |
| Silty and clayey gravels (GM & GC) | 400 | 350 | 300 | 250 | -- | -- | -- | -- |
| Gravel and sandy gravels (GW & GP) | 500 | 450 | -- | -- | -- | -- | -- | -- |

Notes:
1. Values of K shown are typical for materials having dry densities of 90% to 95% of the maximum. For materials with dry densities < 90%, reduce values by 50 PCI.
2. K of 25 PCI will be the minimum used for evaluation.
3. K of 500 PCI will be the maximum used for evaluation.

The K-value used for evaluation was previously determined by conducting a plate-bearing test on the soil immediately beneath the PCC pavement. In lieu of a plate-bearing test, the appropriate K-value can be determined from DCP data using the following procedures:

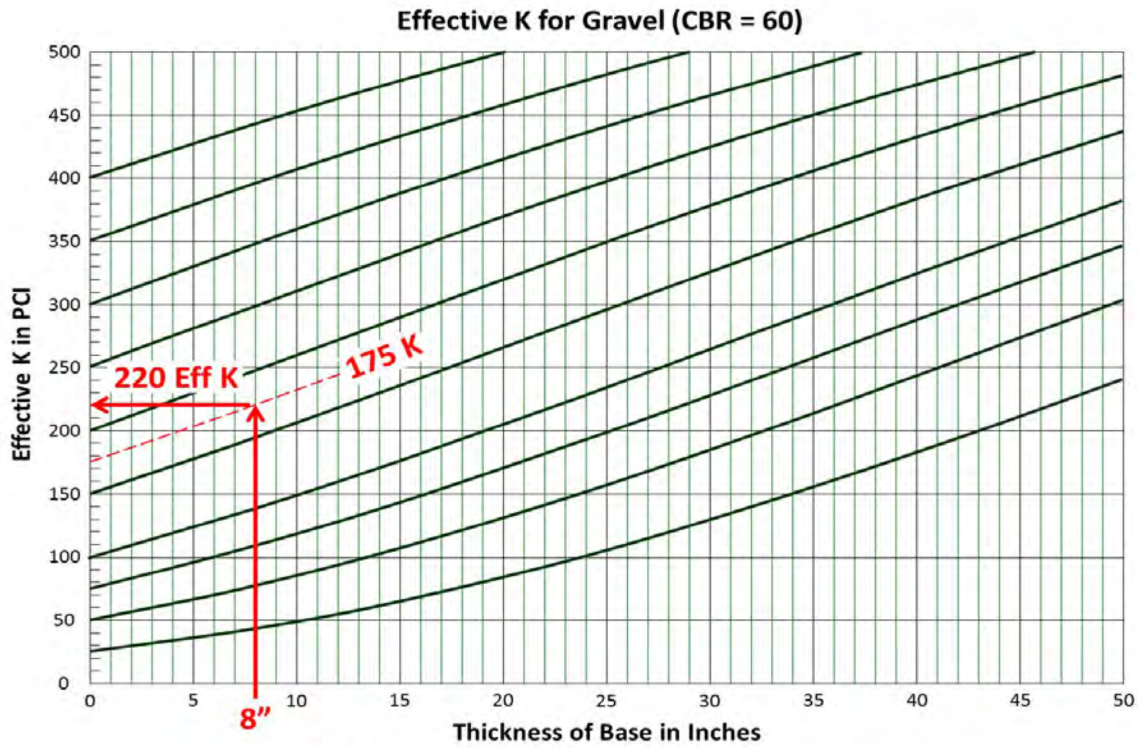
The CBRs correlated from DCP indices can be further correlated to K-values for each soil layer using Tables 2-4, 2-5, and 2-6. To determine the correct K-value to use, the K-values of all identified soil layers are converted to effective K-values based upon the thicknesses and strengths of the overlying soil layers using Figures 2-19 through Figure 2-22.

**Figure 2-19 Effect of Base Course Thickness on Modulus of Soil Reaction**



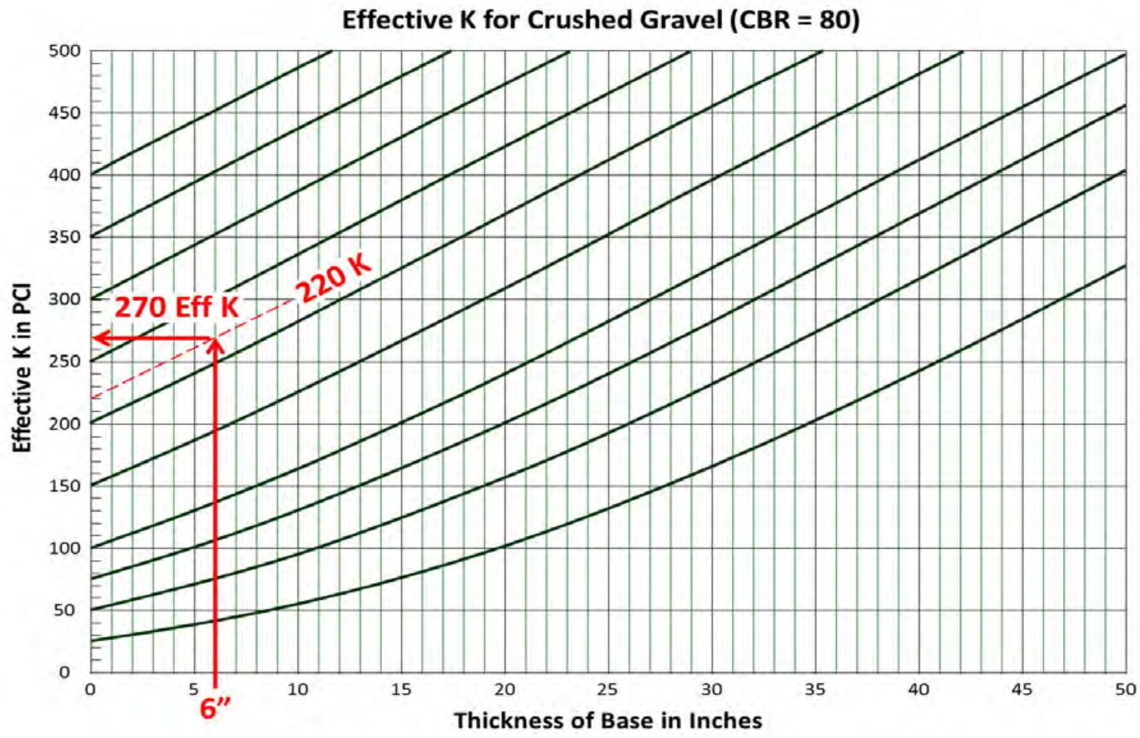

Use this chart if the CBR of the soil layer is < 50.

**Figure 2-20 Effect of Base Course Thickness on Modulus of Soil Reaction**



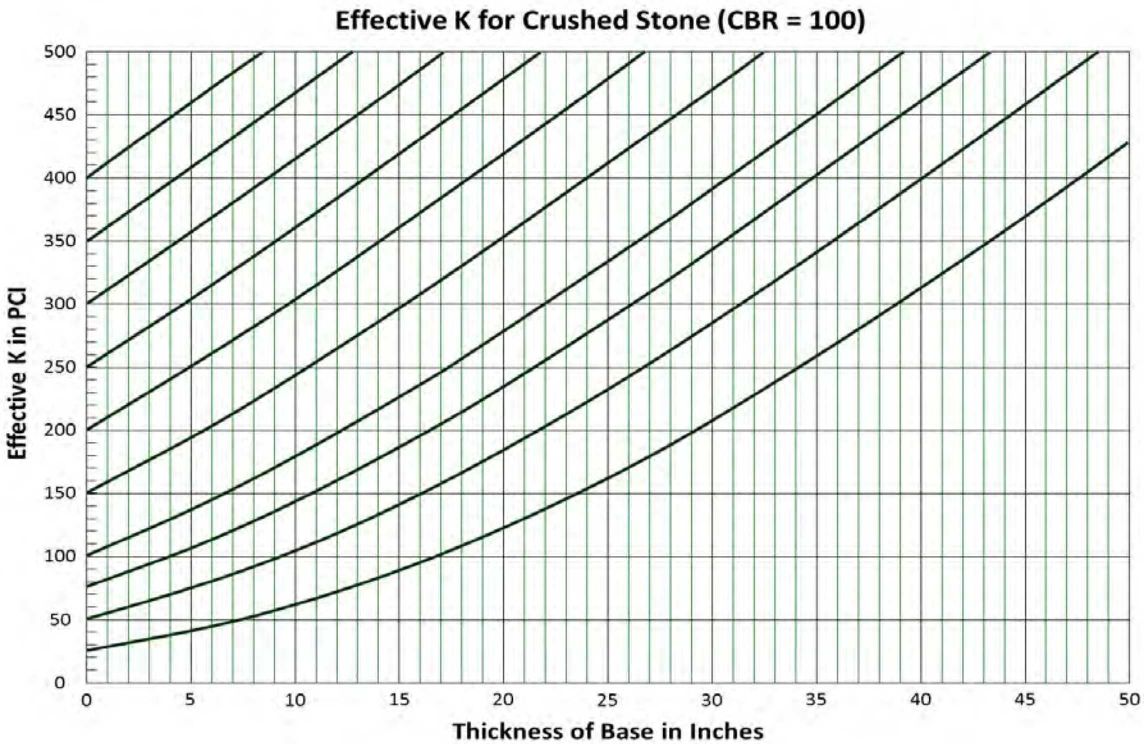

Use this chart if the CBR of the soil layer is ≥ 50, but < 70.

**Figure 2-21 Effect of Base Course Thickness on Modulus of Soil Reaction**




Use this chart if the CBR of the soil layer is ≥ 70, but < 90.

**Figure 2-22 Effect of Base Course Thickness on Modulus of Soil Reaction**




**Use this chart if the CBR of the soil layer is ≥ 90.**

**2-3.2.3.5** The procedure to determine the appropriate effective K-value to use for the evaluation is a bottom-up process, considering all of the soil layers determined by the DCP data in a successive manner. The K-value of the bottom or subgrade layer is converted to an effective K-value based upon the thickness and strength of the (subbase) layer immediately above it. This effective K-value is compared to the K-value of that subbase layer and the lowest value is used to determine the effective K-value of the next layer (base) in the structure. That value is converted to a new effective K-value based upon the thickness and strength of the (base) layer immediately above it. That new effective K-value is compared to the K-value of that base layer and the lowest value is used to evaluate the pavement section's load-bearing capability.

**Example:** Determine the correct effective K-value to be used to evaluate a rigid pavement with the following cross-section:

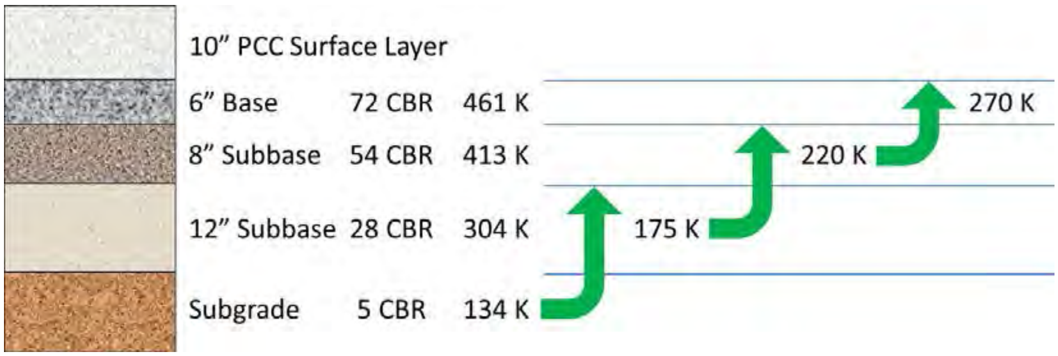
- 10-inch PCC
- 6-inch base course with a DCP index of 3.5 mm/blow
- 8-inch subbase course with a DCP index of 4.5 mm/blow
- 12-inch subbase course with a DCP index of 8 mm/blow
- Subgrade with a DCP index of 35 mm/blow

Solution:

- Step 1. Convert DCP index of each soil layer to CBR (see Table 2-3)
    - DCP Index of 3.5 mm/blow = CBR 72
    - DCP Index of 4.5 mm/blow = CBR 54
    - DCP Index of 8 mm/blow = CBR 28
    - DCP Index of 35 mm/blow = CBR 5
- Step 2. Convert CBR of each soil layer to K-value (see Tables 2-3 and 2-4)
    - CBR 72 = 461 K
    - CBR 54 = 413 K
    - CBR 28 = 304 K
    - CBR 5 = 134 K
- Step 3. Convert K-value of each layer to effective K-value (see Figures 2-19 through 2-22)
    - Convert subgrade K-value at an effective K-value using Figure 2-19 based upon the strength (CBR 28) of the layer immediately above it. Enter the bottom of Figure 2-19 with the thickness (12 inches [300 mm]) of the layer immediately above the subgrade. Project a line vertically to 134 K and then horizontally to the left side of the chart to obtain an effective K-value of 175.
    - Compare this effective K-value (175) to the K-value of that subbase layer (304) and use the lowest value (175) to continue the process.
    - Convert that value (175) to a new effective K-value using Figure 2-20 based upon the strength (CBR 54) of the next upper soil layer. Enter the bottom of Figure 2-20 with the thickness (8 inches [200 mm]) of the next upper layer. Project a line vertically to 175 K and then horizontally to the left side of the chart to obtain an effective K-value of 220.
    - Compare this effective K-value (220) to the K-value of that subbase layer (413) and use the lowest value (220) to continue the process.
    - Convert that value (220) to a new effective K-value using Figure 2-21 based upon the strength (CBR 72) of the next upper soil layer. Enter the bottom of Figure 2-21 with the thickness (6 inches [150 mm]) of the next upper layer. Project a line vertically to 220 K and then horizontally to the left side of the chart to obtain an effective K-value of 270.

- o Compare this effective K-value (270) to the K-value of that subbase layer (461) and use the lowest effective K-value (270) to evaluate the pavement structure. See Figure 2-23.

**Figure 2-23 Illustration of Effective K Bottom-Up Procedure**




### 2-3.2.3.6 Other Strength Factors.

### 2-3.2.3.6.1 Surface and Subsurface Drainage.

- Locate depth of water table
- Look at contours in area, signs of surface drainage problems, and wet or swampy areas
- Coarse-grained soils have better internal drainage
- Moisture content plays a significant role in bearing capacity
- Note the size and depth of any storm drain culverts under the pavement

### 2-3.2.3.6.2 Cut/Fill Areas.

Cut/fill areas indicate possible feature changes based on changing subsurface layers.

### 2-3.2.3.6.3 Frost Areas.

**The impact of frost need not be considered in an expedient evaluation.** When performing a sustainment evaluation and the operational period will extend into the thaw-weakened season or when performing a permanent evaluation, consider frost and thawing effects of the subgrade, subbase, and base material.

**2-3.2.3.6.3.1** Subgrade strengths are significantly reduced during thaw periods if the potential exists for structural weakening due to frost. Detrimental frost action will occur only if the subgrade contains frost-susceptible materials, frost penetrates the susceptible materials, and an ample supply of ground water is available. If all three conditions exist, look for signs of frost action. If none exist, do not consider frost in the evaluation. Some easily identifiable signs of frost action are:

**2-3.2.3.6.3.1.1** Differential heave of the pavement caused by swelling of the soils or differential settlement caused by soil reconsolidation following the heave. Look for slabs in rigid pavements that are at different surface elevations or not flush with each other. The unevenness of the pavement along joints and/or cracks may be due to frost action.

**2-3.2.3.6.3.1.2** On rigid pavements, look for pumping along the joints and cracks, “D” or durability cracking, or excessive spalling of the joints and cracks. Load-related distresses such as longitudinal cracking in non-traffic areas of the pavement may also indicate frost action in the underlying soils.

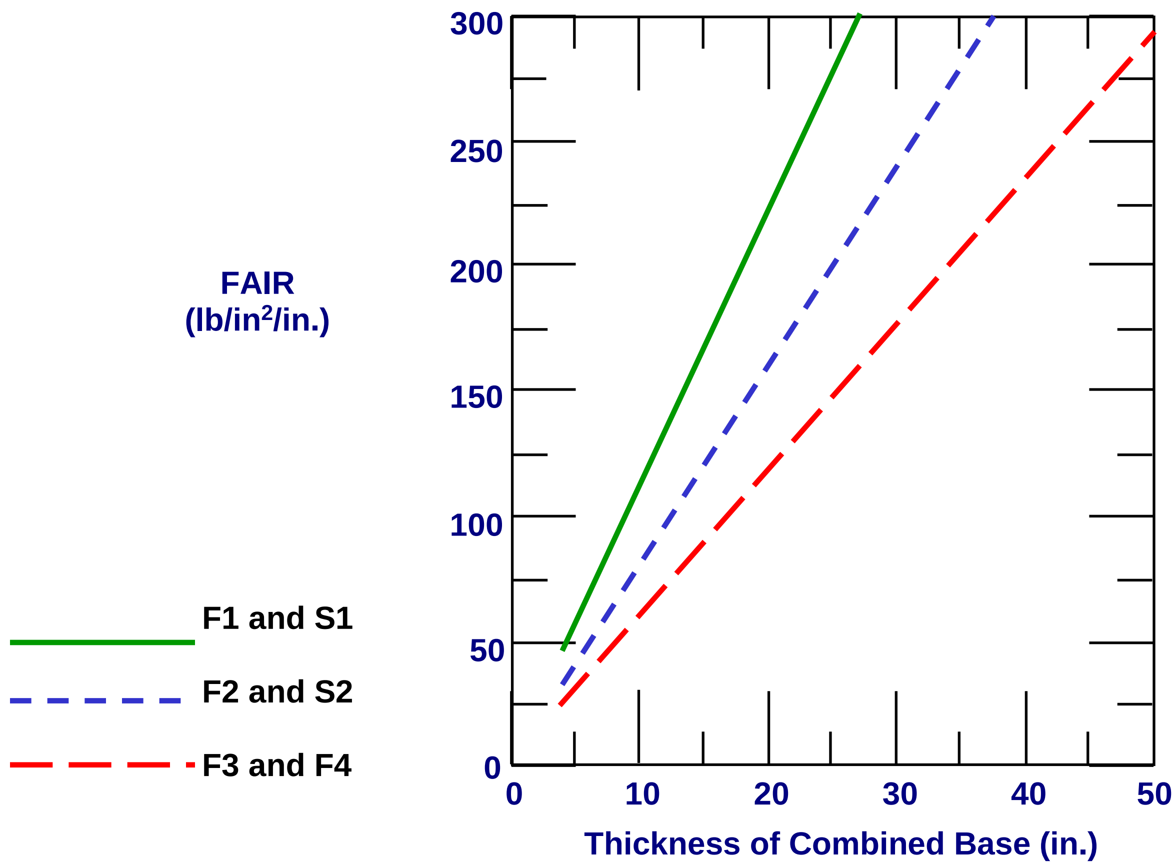
**2-3.2.3.6.3.1.3** On flexible pavements, look for accelerated deterioration along cracks. Load-related distresses such as alligator or fatigue cracking in non-traffic areas of the pavement may also indicate potential frost action in the soil. Something other than traffic is causing the problem and when the site is located in the northern tier, consider frost.

**2-3.2.3.6.3.2** Frost Area Soil Support Indexes (FASSI) are used in lieu of CBRs for evaluating flexible pavements.

- F1 and S1 Soils = 9.0 FASSI
- F2 and S2 Soils = 6.5 FASSI
- F3 and F4 Soils = 3.5 FASSI

**2-3.2.3.6.3.3** When evaluating rigid pavements in frost conditions, Frost Area Index of Reaction (FAIR) values are used in lieu of K-values (see Figure 2-24).

**Figure 2-24 FAIR Values**




**2-3.2.3.6.3.4** Clays, silts, and some gravelly and sandy soils with high percentages of fines are susceptible to frost (see Table 2-7).

**2-3.2.3.6.3.5** Areas of frost heave, when no longer frozen, may have large subsurface voids and will not support projected loads.

## Table 2-7 Frost Design Soil Classifications

| Frost Group | Kind of Soil | Percentage Finer than 0.02 mm by Weight | Percentage Finer than #200 Sieve by Weight* | Typical Soil Types under USCS |
|---|---|---|---|---|
| NFS† | (a) Gravels<br>Crushed stone<br>Crushed rock | 0–1.5 | 0–3 | GW, GP |
| | (b) Sands | 0–3 | 0–7 | SW, SP |
| PFS‡ | (a) Gravels<br>Crushed stone<br>Crushed rock | 1.5–3 | 3–7 | GW, GP |
| | (b) Sands | 3–10 | | SW, SP |
| S1 | Gravelly soils | 3–6 | 7–15 | GW, GP, GW-GM, GP-GM, GW-GC, GP-GC |
| S2 | Sandy soils | 3–6 | 7–15 | SW, SP, SW-SM, SP-SM, SW-SC, SP-SC |
| F1 | Gravelly soils | 6–10 | | GM, GC, GM-GC, GW-GM, GP-GM, GW-GC, GP-GC |
| F2 | (a) Gravelly soils | 10–20 | | GM, GC, GM-GC, GW-GM, GP-GM, GW-GC, GP-GC |
| | (b) Sands | 6–15 | | SM, SW-SM, SP-SM, SC, SW-SC, SP-SC, SM-SC |
| F3 | (a) Gravelly soils | Over 20 | | GM, GC, GM-GC |
| | (b) Sands, except very fine silty sands | Over 15 | | SM, SC, SM-SC |
| | (c) Clays, PI > 12 | -- | | CL, CH |
| F4 | (a) Silts | -- | | ML, MH, ML-CL |
| | (b) Very fine silty sands | Over 15 | | SM, SC, SM-SC |
| | (c) Clays, PI < 12 | -- | | CL, ML-CL |
| | (d) Varved clays or other fine-grained banded sediments | -- | | CL or CH layered with ML, MH, ML-CL, SM, SC, or SM-SC |

* These are rough estimates. If there are surface indications of frost action, then conduct frost-susceptibility tests. Use only if percent finer than 0.02 mm is not available.

† Nonfrost-susceptible

‡ Possibly frost-susceptible; requires lab test for void ratio to determine frost design soil classification.
Gravel with void ratio > 0.25 is NFS
Gravel with void ratio < 0.25 is S1
Sands with void ratio > 0.30 is NFS
Sands with void ratio < 0.30 is S2 or F2

#### 2-3.2.3.6.4 Wet Climate.

**2-3.2.3.6.4.1** Soil layer strengths in areas subject to heavy seasonal rains or flooding may react similarly to those in frost-susceptible areas. This is particularly true in the case of fine-grained materials containing clays and/or silts where there is no adequate surface seal.

**2-3.2.3.6.4.2** Document moisture conditions at the time of testing (dry, damp, or wet) and anticipated conditions for the projected use period considered in determining the validity of test data for intended aircraft operations.

## 2-4 AIRCRAFT OPERATIONAL REQUIREMENTS.

Obtain aircraft operational requirements from the site operations officer, local command section, or the tasking office of primary responsibility (OPR).

### 2-4.1 Data Required.

#### 2-4.1.1 Aircraft Types.

Data essential for evaluation can be extracted from various sources. For example, gear configuration establishes the traffic paths in relation to pavement centerlines and determines test locations. Testing is usually performed in the main gear wheel paths. Aircraft weights are shown in Table 2-8. Several sources in DOD provide data on aircraft characteristics:

- TSC Report 13-2, USACE Transportation Systems Center, *Aircraft Characteristics for Airfield Pavement Design and Evaluation—Air Force and Army Aircraft*
- TSC Report 13-3, USACE Transportation Systems Center, *Aircraft Characteristics for Airfield Pavement Design and Evaluatio*n—*Selective Commercial Aircraft*
- Vehicle Edit Module in Pavement-Transportation Computer Assisted Structural Engineering (PCASE) program, https://transportation.erdc.dren.mil/pcase/

## Table 2-8 Aircraft Characteristics

| Aircraft | Minimum Weight (pounds) | Maximum Weight (pounds) | Length (feet) | Wingspan (feet) | Runway Length (feet) | Runway Width (feet) | Taxiway Width (feet) |
|---|---|---|---|---|---|---|---|
| C-130 Hercules | 69,000 | 175,000 | *99.5 | 132.6 | 3,000 | 60 | 30 |
| C-5 Galaxy | 375,000 | 837,000 | 247.8 | 222.7 | 6,000 | 147 | 75 |
| C-17 Globemaster III | 279,000 | 585,000 normal ops on paved<br>502,000 assault ops on paved<br>486,000 on unimproved or semi-prepared | 174.0 | 169.8 | 3,500 | 90 | 60 |
| KC-10 Extender | 270,000 | 590,000 | 181.6 | 165.3 | 7,000 | 147 | 75 |
| KC-135 Stratotanker | 135,000 | 302,000 | 136.2 | *130.8 | 7,000 | 147 | 74 |
| KC-46 Pegasus | 273,000 | 416,000 | 165.5 | 156.1 | 7,000 | 147 | 74 |
| A-10 Thunderbolt | 28,000 | 51,000 | 53.3 | 57.5 | 10,000 | 150 | 75 |
| F-15 Eagle | 31,700 | 81,000 | 63.8 | 42.8 | 10,000 | 150 | 75 |
| F-16 Fighting Falcon | 17,400 | 37,500 | 49.5 | 32.8 | 10,000 | 150 | 75 |

**Notes:** * Length or width varies per aircraft model number.
Maximum weight for semi-prepared surface is 447,000 pounds.
Runway lengths are given for planning purposes only. Obtain actual requirements from operations personnel.

| Aircraft | Flexible Pavement ACNs | | | | Rigid Pavement ACNs | | | | LCN |
|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | A | B | C | D | |
| C-130 Hercules | 27 | 32 | 35 | 41 | 31 | 34 | 37 | 40 | 45 |
| C-5 Galaxy | 36 | 40 | 49 | 67 | 29 | 35 | 45 | 56 | 37 |
| C-17 Globemaster III | 50 | 57 | 68 | 90 | 52 | 50 | 54 | 66 | 62 |
| KC-10 Extender | 56 | 61 | 74 | 101 | 45 | 55 | 67 | 77 | 82 |
| KC-46 Pegasus | 49 | 54 | 66 | 87 | 48 | 57 | 68 | 78 | 69 |
| KC-135 Stratotanker | 36 | 40 | 49 | 63 | 31 | 38 | 46 | 52 | 67 |
| A-10 Thunderbolt | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 27 |
| F-15 Eagle | 33 | 33 | 33 | 33 | 37 | 37 | 37 | 37 | 57 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| F-16 Fighting Falcon | 16 | 16 | 16 | 16 | 18 | 18 | 18 | 18 | 26 |

#### 2-4.1.2 Loads.

Loads are the gross weights of anticipated mission aircraft, including cargo and fuel.

#### 2-4.1.3 Traffic Volume.

Traffic volume is the expected number of passes anticipated for each aircraft type. For a runway, passes are determined by the number of aircraft movements across an imaginary transverse line placed within 500 feet (150 m) of the end of the runway. Simply stated, it is one aircraft movement over a given area. For taxiways and aprons, passes are determined by the number of aircraft cycles across a line on the primary taxiway that connects the runway and parking areas. The configuration of the airfield influences the number of passes per mission. In a case where a parallel taxiway is available and the aircraft lands and takes off in the same direction, one landing and one takeoff equals one pass on the runway because full loads on landing and takeoff are on opposite ends of the runway.

#### 2-4.1.4 Turnarounds/Taxi Routes.

Aircraft ground operations such as turnarounds and taxi routes determine the designation of feature types and resulting gross loads. For example, if back-taxiing were required on the runway after each landing and before takeoff, the number of passes per mission increases.

## 2-5 CONDUCT CURSORY SURFACE CONDITION ASSESSMENT.

### 2-5.1 Pavement Condition Index (PCI) for Rigid or Flexible Pavement Surfaces.

**2-5.1.1** The PCI is a numerical scale (on a scale of 0 to 100, with 0 being the worst possible condition and 100 being the best possible condition) determined by a visual pavement survey, based on procedures in ASTM D5340, *Standard Test Method for Airport Pavement Condition Index Surveys*. The pavement condition rating is a verbal description of the pavement condition as a function of the PCI value that varies from “failed” to “good.” See Table 2-25 and Appendix B.

The purpose of a PCI survey in contingency operations is three-fold: first, a visual survey of the pavement surface can provide information on apparent structural integrity, operational condition, and projected performance to help identify potential pavement problems that preclude aircraft operations; second, these ratings will impact the AGL or pass level computations—**specifically, if the feature is rated poor or below, the AGLs will be reduced by 25%**; third, the PCI ratings, with supporting photographs, if accomplished prior to contingency operations, will serve as a baseline to assess any pavement damage caused by aircraft ground operations. This is important to determine costs or liabilities associated with aircraft deployments.

**Figure 2-25 PCI Rating Scale**

| PCI Index | Cursory Rating | | Cursory Definition |
|---|---|---|---|
| 71–100 | Green (0/128/0) | Good | Pavement only requires routine maintenance and has few, scattered low-severity distresses. |
| 56–70 | Yellow (255/255/0) | Fair | Pavement has a combination of generally low- and medium-severity distresses. Near-term maintenance and repair needs are routine to major. |
| 41–55 | Red (255/0/0) | Poor | Pavement has low-, medium-, and high-severity distresses that probably cause some operational problems. Maintenance and repair needs range from routine to reconstruction in the near term. |
| 0–40 | | Poor ≤ 40 | Pavement has a number of medium- and high-severity distresses that may require intensive maintenance and frequent repairs to support aircraft operations. |

**2-5.1.2** Perform a cursory inspection of the pavement features and the distress types, quantities, and identify severity levels as described in ASTM D5340. Assign overall condition ratings to each feature. Place an emphasis on structural- or foreign-object-damage- (FOD) -related distresses. Use UFC 3-270-16, *O&M Manual: Standard Practice for Airfield Pavement Condition Surveys*, as a guide for this inspection.

**2-5.1.3** A cursory visual survey is not as detailed as outlined in ASTM D5340; however, the pavements are categorized in general terms based on this guidance. Pavement condition ratings range from GOOD (like new) to FAILED (unsafe for aircraft operations). **These ratings are a qualitative assessment of the pavement surface condition and not to be confused with the structural capacity of a pavement.** For example, a pavement surface may rate GOOD but have underlying pavement or soil conditions that could result in pavement failure under the applied load of a given aircraft. On the other hand, a pavement may be structurally sound, but the surface condition may be hazardous for aircraft traffic (e.g., FOD). The pavement condition rating scale used in this type of analysis is shown in Figure 2-25 and described in more detail in Figure 2-26.

**Figure 2-26 PCI Rating Descriptions**

| PCI Index | PCI Rating | | Descriptions |
|---|---|---|---|
| 86–100 | Green (0/128/0) | Good | Pavement has minor or no distresses and will require only routine maintenance. |
| 71–85 | Bright Green (0/255/0) | Satisfactory | Pavement has scattered low-severity distresses that only needs routine maintenance. |
| 56–70 | Yellow (255/255/0) | Fair | Pavement has a combination of generally low- and medium-severity distresses. Maintenance and repair needs range from routine to major in the near term. |
| 41–55 | Rose (255/153/204) | Poor | Pavement has low-, medium-, and high-severity distresses that probably cause some operational problems. Maintenance and repair needs range from routine to reconstruction in the near term. |
| 26–40 | Red (255/0/0) | Very Poor | Pavement has predominantly medium- and high-severity distresses causing considerable maintenance and operational problems. Near-term maintenance and repair needs will be intensive. |
| 11–25 | Dark Red (128/0/0) | Serious | Pavement has mainly high-severity distresses that cause operational restrictions. Repair needs are immediate. |
| 0–10 | Light Gray (192/192/192) | Failed | Pavement deterioration has progressed to the point that safe aircraft operations are no longer possible. Complete reconstruction is required. |

**2-5.1.4** Pavement condition assessments affect the reported capacity of an airfield and can make or break the mission for the operational community. Narratively quantify the level of effort and subsequent statistical reliability of PCI ratings in evaluation reports. Pavement condition assessments are classified as standard, simplified (contingency), or cursory. Although the evaluation methods are similar, the number of sample units inspected, and procedures used greatly influence the reliability of the results.

**2-5.1.5** A standard pavement condition survey denotes an assessment conducted using procedures described in ASTM D5340, with an appropriate number of sampling units in order to achieve a 95% confidence level. This is generally required for project-level pavement inspections. Place an emphasis on structural- or FOD-related distresses in contingency scenarios.

**2-5.1.6** A simplified (or contingency) pavement condition survey denotes an assessment conducted using procedures described in ASTM D5340, but with a reduced number of sampling units, as outlined in ASTM D5340 as the “lesser sampling rate.” This will provide sufficient reliability for most contingency operations. Place an emphasis on structural- or FOD-related distresses.

**2-5.1.7** A cursory pavement condition survey is an assessment in which the number of inspected sampling units fails to meet the minimum requirements of either a simplified or standard PCI evaluation. Report the results of a cursory visual survey as a qualitative assessment of the pavement surface condition and do not confuse with the structural capacity of the pavement. Exercise particular care and attention to identifying distresses that will cause limitations or mission impacts to the proposed aircraft. If the results of a cursory visual survey are to be presented in a tabular or map format, use the three-color scale as shown in Figure 2-25.

**2-5.1.7.1** When the pavement condition ratings that result from a cursory pavement condition survey are listed and/or discussed in various sections, tables, and/or maps in the evaluation report, clearly state that they were estimated using cursory survey methods and were not determined using standard or simplified PCI procedures.

**2-5.1.7.2** When cursory survey methods are used to determine and report the pavement condition, similar to reports based upon a limited number of DCP tests, consider the evaluation an "expedient"-type evaluation for limited and/or immediate use only. Determine the pavement condition ratings for higher level evaluations (sustainment or permanent) using simplified or standard PCI procedures.

**2-5.1.8** Regardless of the number of sample units selected and the amount of time available to conduct surveys, the evaluator's most important task is to accurately identify and quantify the pavement distresses. Especially in contingency scenarios, consider the causes of the identified distresses and their impact on the structural or load-bearing capability of the pavement section. Specifically, if the assessment results in a pavement condition rating of very poor (PCI 40) or below, its capability in terms of AGL is reduced by 25%.

**2-5.1.9** Give particular attention to pavement distresses or other surface conditions that potentially present safety issues or cause operational limitations for the proposed mission aircraft, such as abrupt changes in surface elevation, sharp edges, ponding potential, excessive FOD, or improper or inadequate surface repairs. Every evaluation is different and ultimately it is up to the evaluator to exercise engineering judgment based upon the intended mission, keeping in mind that either the structural or surface condition can be of greater importance based upon the amount of time available for data collection.

**2-5.1.10** Locations of the distresses in relation to proposed aircraft operations are also significant. For example, one blow-up located adjacent to the runway centerline can or will render the airfield unusable while others located in areas that can be avoided during operations may have little or no impact. If a particular surface distress or condition indeed restricts or limits operations, clearly address its location and impact in the report.

**2-5.1.11** When performing a PCI in a contingency situation, place an emphasis on structural- or FOD-related distresses.

**2-5.1.11.1 Flexible Pavement Structural Distresses.**

- Alligator or fatigue cracking occurs primarily where aircraft traffic is overloading the pavement and is considered a major structural distress.
- Corrugation caused by traffic action combined with an unstable pavement surface or base.
- Depression caused by settlement of supporting soil layers due to overloading or poor initial construction.
- Rutting caused by consolidation or lateral movement of the pavement, base, and/or subgrade due to traffic loads that can lead to major structural failure.
- Slippage cracking produced in areas of braking and turning when there is an unstable surface mix or poor bond between the surface and underlying pavement layer.

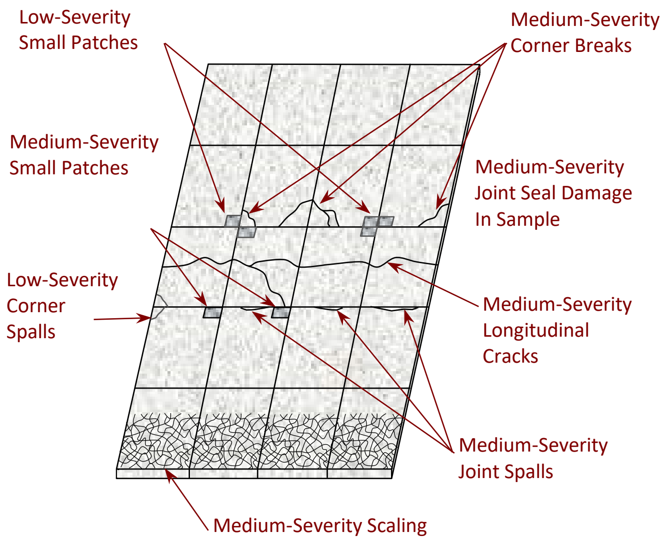
**2-5.1.11.2 Rigid Pavement Structural Distresses.**

- Blow-up occurs at joints or at junctures with PCC and AC pavements and has severe damage potential to aircraft.
- Corner break can be caused by load repetitions and/or loss of subgrade support.
- Longitudinal, transverse, and diagonal cracks can be caused by load repetitions and are considered major structural distresses of medium or high severity.
- Pumping indicates poor joint sealant and loss of support, which will lead to cracking under repeated loads.
- Settlement or faulting caused by upheaval or consolidation.
- Shattered slab/intersecting cracks due to overloading or inadequate support.

**2-5.1.12** Compute the total deduct value (TDV) for each sample surveyed.

**2-5.1.12.1** Perform a thorough survey of each sample area, noting all distress types found, along with their severity levels and densities. In the evaluation of flexible pavements, the distresses and their resultant densities are determined in some cases by the length (in feet) of the distress and in other cases by the area (in square feet) covered by the distress. In the evaluation of rigid pavements, the density of each distress is determined by the percentage of the slabs in the sample area that contain the distress in relation to the total number of slabs in the sample area. If a given distress is found on one slab in the sample area, its density is recorded as 1 of 20 or 5%. In the example shown in Figure 2-27; five slabs contain low-severity small patches, three slabs contain medium-severity corner breaks, four slabs contain medium-severity longitudinal cracks, four slabs contain medium-severity scaling or map cracking, two slabs contain medium-severity small patches, two slabs contain low-severity corner spalls, three slabs contain medium-severity joint spalls, and medium-severity joint seal damage is noted for the sample.

**Figure 2-27 Example Sample Area (20 Slabs) with Distresses Identified**




**2-5.1.12.2** Using the distress deduct value curves in ASTM D5340, Appendix B for flexible pavements, or Appendix C for rigid pavements, determine a deduct value for each distress type and severity level combination noted during the survey. Enter the bottom of the appropriate deduct value chart with the distress density, project a line vertically until it intersects with the severity level of the distress then horizontally to determine the deduct value. List the deduct values determined for all distresses noted in the sample area in descending order and then totaled to compute the TDV for the sample. Adding the deduct values together for this example sample area in Figure 2-27 results in a TDV of 97 (see Table 2-9).

**Table 2-9 Example Summary of Individual Distress Densities and Deduct Values**

| Distress Type | Severity | Density | Deduct Value |
|---|---|---|---|
| Longitudinal cracks | Medium | 4 Slabs = 20% | 28 |
| Corner breaks | Medium | 3 Slabs = 15% | 20 |
| Scaling | Medium | 4 Sabs = 20% | 17 |
| Joint spalls | Medium | 3 Slabs = 15% | 11 |
| Joint seal damage | Medium | N/A | 7 |
| Small patches | Medium | 2 Slabs = 10% | 6 |
| Small patches | Low | 5 Slabs = 25% | 4 |
| Corner spalls | Low | 2 Slabs = 10% | 4 |

**2-5.1.12.3** Alternatively, Figures 2-28 and 2-29 can be used in lieu of the curves in ASTM D5340. Select the appropriate chart based upon the pavement type, flexible or rigid. Enter the side of the chart with the calculated distress density and project horizontally to the appropriate distress type and severity level. The example sample, Figure 2-27, is a rigid pavement section so use Figure 2-29 to determine the deduct values for each distress noted.

## Figure 2-28 Flexible Pavement Distress Deduct Values

| DISTRESS DENSITY % | 41 | | | 42 | 43 | | | 44 | | | 45 | | | 46 | 47 | | | 48 | | | 49 | 50 | | | 51 | 52 | | | 53 | | | 54 | | | 55 | 56 | | | 57 | | | DISTRESS DENSITY % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ALLIGATOR CRACKING (SF) | | | BLEEDING (SF) | BLOCK CRACKING (SF) | | | CORRUGATION (SF) | | | DEPRESSION (SF) | | | JET BLAST EROSION (SF) | JOINT REFLECTIVE CRACKING (LF) | | | LONGITUDINAL AND TRANSVERSE CRACKING (LF) | | | OIL SPILLAGE (SF) | PATCHING AND UTILITY CUT (SF) | | | POLISHED AGGREGATE (SF) | RAVELING (SF) | | | RUTTING (SF) | | | SHOVING OF FLEX PAVEMENT BY PCC SLABS (SF) | | | SLIPPAGE CRACKING (SF) | SWELL (SF) | | | WEATHERING (SF) | | | |
| | L | M | H | N/A | L | M | H | L | M | H | L | M | H | ANY | L | M | H | L | M | H | ANY | L | M | H | ANY | L | M | H | L | M | H | L | M | H | ANY | L | M | H | L | M | H | |
| 0.1 | 7 | 10 | 16 | 0 | 5 | 8 | 10 | 2 | 6 | 11 | 0 | 5 | 12 | 0 | 0 | 0 | 1 | 3 | 4 | 7 | 2 | 2 | 7 | 15 | 2 | 2 | 5 | 7 | 9 | 13 | 19 | 3 | 6 | 10 | 5 | 2 | 10 | 28 | 1 | 2 | 3 | 0.1 |
| 0.2 | 9 | 16 | 23 | 1 | 5 | 8 | 11 | 3 | 7 | 16 | 1 | 6 | 16 | 1 | 0 | 1 | 4 | 3 | 5 | 9 | 2 | 2 | 7 | 16 | 2 | 2 | 5 | 8 | 10 | 16 | 24 | 3 | 7 | 13 | 6 | 2 | 11 | 29 | 1 | 2 | 4 | 0.2 |
| 0.3 | 12 | 18 | 25 | 2 | 6 | 8 | 13 | 4 | 9 | 19 | 1 | 7 | 17 | 2 | 0 | 3 | 5 | 3 | 6 | 11 | 3 | 2 | 7 | 16 | 2 | 2 | 6 | 9 | 11 | 17 | 26 | 4 | 8 | 15 | 7 | 2 | 12 | 30 | 1 | 2 | 5 | 0.3 |
| 0.4 | 13 | 21 | 28 | 3 | 6 | 9 | 14 | 5 | 11 | 23 | 2 | 8 | 19 | 2 | 0 | 4 | 7 | 3 | 7 | 13 | 3 | 3 | 7 | 17 | 2 | 2 | 6 | 10 | 12 | 19 | 27 | 4 | 10 | 17 | 8 | 2 | 12 | 31 | 1 | 2 | 6 | 0.4 |
| 0.5 | 15 | 23 | 30 | 4 | 6 | 9 | 15 | 6 | 13 | 25 | 3 | 10 | 21 | 3 | 0 | 4 | 8 | 4 | 8 | 14 | 3 | 3 | 8 | 17 | 2 | 2 | 7 | 11 | 13 | 20 | 29 | 5 | 11 | 19 | 8 | 3 | 13 | 32 | 1 | 2 | 7 | 0.5 |
| 0.6 | 16 | 25 | 32 | 4 | 7 | 10 | 16 | 7 | 14 | 27 | 3 | 11 | 22 | 4 | 1 | 5 | 10 | 4 | 8 | 15 | 4 | 3 | 8 | 17 | 2 | 3 | 7 | 12 | 14 | 21 | 30 | 5 | 12 | 20 | 9 | 3 | 13 | 32 | 1 | 2 | 7 | 0.6 |
| 0.7 | 18 | 26 | 33 | 5 | 7 | 10 | 17 | 7 | 16 | 28 | 4 | 13 | 23 | 4 | 2 | 6 | 12 | 4 | 9 | 16 | 4 | 4 | 8 | 18 | 3 | 3 | 7 | 13 | 14 | 22 | 32 | 6 | 13 | 22 | 9 | 3 | 13 | 33 | 1 | 2 | 7 | 0.7 |
| 0.8 | 19 | 27 | 34 | 6 | 7 | 11 | 17 | 8 | 17 | 30 | 5 | 14 | 24 | 5 | 2 | 7 | 13 | 4 | 9 | 17 | 4 | 4 | 9 | 18 | 3 | 3 | 8 | 14 | 15 | 23 | 33 | 6 | 14 | 23 | 10 | 3 | 14 | 33 | 1 | 2 | 8 | 0.8 |
| 0.9 | 20 | 28 | 36 | 6 | 7 | 11 | 18 | 8 | 18 | 31 | 6 | 14 | 25 | 5 | 3 | 8 | 14 | 5 | 10 | 18 | 4 | 4 | 9 | 18 | 3 | 3 | 8 | 15 | 15 | 24 | 34 | 7 | 14 | 24 | 11 | 3 | 14 | 33 | 1 | 2 | 8 | 0.9 |
| 1 | 21 | 29 | 37 | 7 | 8 | 12 | 19 | 9 | 19 | 33 | 7 | 15 | 26 | 6 | 3 | 9 | 16 | 5 | 11 | 19 | 4 | 4 | 10 | 19 | 3 | 3 | 8 | 16 | 16 | 24 | 35 | 7 | 15 | 25 | 12 | 4 | 14 | 33 | 1 | 2 | 8 | 1 |
| 2 | 27 | 36 | 45 | 11 | 9 | 14 | 24 | 14 | 26 | 42 | 12 | 22 | 32 | 9 | 6 | 16 | 25 | 7 | 16 | 27 | 6 | 6 | 13 | 23 | 6 | 4 | 11 | 25 | 18 | 29 | 41 | 10 | 20 | 32 | 19 | 6 | 17 | 37 | 1 | 2 | 11 | 2 |
| 3 | 31 | 41 | 50 | 16 | 11 | 16 | 28 | 17 | 31 | 47 | 15 | 26 | 36 | 12 | 7 | 21 | 31 | 9 | 19 | 33 | 7 | 7 | 15 | 27 | 7 | 6 | 13 | 33 | 21 | 33 | 45 | 11 | 23 | 35 | 26 | 7 | 20 | 42 | 1 | 2 | 13 | 3 |
| 4 | 34 | 44 | 54 | 20 | 12 | 17 | 31 | 20 | 34 | 52 | 17 | 29 | 40 | 14 | 9 | 25 | 36 | 12 | 22 | 36 | 9 | 8 | 17 | 29 | 9 | 7 | 14 | 39 | 23 | 35 | 49 | 13 | 25 | 39 | 31 | 9 | 23 | 45 | 1 | 3 | 15 | 4 |
| 5 | 36 | 47 | 58 | 25 | 13 | 18 | 34 | 22 | 37 | 55 | 19 | 32 | 43 | 16 | 11 | 28 | 40 | 14 | 25 | 40 | 10 | 10 | 19 | 33 | 11 | 7 | 16 | 43 | 24 | 37 | 52 | 14 | 27 | 42 | 35 | 11 | 25 | 47 | 1 | 3 | 16 | 5 |
| 6 | 37 | 48 | 61 | 28 | 14 | 20 | 36 | 24 | 40 | 58 | 22 | 34 | 45 | 18 | 13 | 31 | 44 | 16 | 27 | 43 | 11 | 11 | 22 | 35 | 13 | 8 | 16 | 45 | 25 | 38 | 54 | 15 | 28 | 44 | 39 | 13 | 27 | 49 | 1 | 4 | 17 | 6 |
| 7 | 39 | 51 | 64 | 32 | 15 | 21 | 37 | 26 | 43 | 61 | 23 | 36 | 47 | 20 | 14 | 34 | 47 | 18 | 29 | 46 | 13 | 12 | 23 | 37 | 13 | 8 | 17 | 48 | 26 | 40 | 56 | 16 | 30 | 45 | 43 | 14 | 29 | 52 | 1 | 4 | 18 | 7 |
| 8 | 41 | 53 | 66 | 35 | 16 | 22 | 39 | 27 | 45 | 64 | 25 | 37 | 48 | 22 | 14 | 35 | 50 | 20 | 32 | 49 | 14 | 13 | 25 | 39 | 14 | 9 | 18 | 50 | 27 | 42 | 58 | 17 | 32 | 47 | 46 | 15 | 31 | 54 | 2 | 5 | 20 | 8 |
| 9 | 42 | 54 | 68 | 38 | 16 | 23 | 40 | 28 | 47 | 66 | 26 | 39 | 50 | 24 | 15 | 36 | 53 | 22 | 34 | 51 | 15 | 14 | 26 | 41 | 16 | 10 | 19 | 52 | 28 | 43 | 60 | 18 | 33 | 49 | 48 | 16 | 33 | 55 | 2 | 5 | 22 | 9 |
| 10 | 43 | 56 | 71 | 40 | 17 | 24 | 42 | 29 | 48 | 68 | 27 | 40 | 52 | 25 | 16 | 38 | 55 | 24 | 36 | 54 | 17 | 15 | 27 | 43 | 17 | 10 | 20 | 53 | 28 | 44 | 62 | 19 | 34 | 50 | 52 | 17 | 34 | 56 | 2 | 6 | 23 | 10 |
| 20 | 51 | 66 | 84 | 51 | 21 | 29 | 51 | 39 | 61 | 83 | 36 | 51 | 63 | 35 | 22 | 47 | 68 | 33 | 50 | 69 | 24 | 21 | 38 | 56 | 25 | 14 | 28 | 61 | 35 | 52 | 74 | 24 | 41 | 60 | 66 | 25 | 45 | 68 | 3 | 8 | 29 | 20 |
| 30 | 56 | 72 | 90 | 57 | 24 | 33 | 57 | 46 | 70 | 93 | 41 | 58 | 70 | 38 | 25 | 52 | 76 | 38 | 56 | 77 | 26 | 25 | 46 | 66 | 30 | 17 | 35 | 65 | 38 | 57 | 83 | 28 | 46 | 67 | 71 | 30 | 52 | 76 | 3 | 12 | 34 | 30 |
| 40 | 60 | 75 | 94 | 60 | 26 | 37 | 61 | 50 | 77 | 100 | 46 | 64 | 76 | 39 | 27 | 55 | 81 | 41 | 61 | 84 | 26 | 27 | 51 | 74 | 34 | 19 | 40 | 66 | 42 | 62 | 89 | 30 | 49 | 72 | 74 | 34 | 57 | 84 | 4 | 13 | 38 | 40 |
| 50 | 64 | 77 | 96 | 62 | 28 | 40 | 65 | 55 | 84 | 100 | 49 | 67 | 80 | 40 | 29 | 57 | 84 | 44 | 64 | 87 | 27 | 30 | 55 | 80 | 38 | 21 | 44 | 68 | 44 | 65 | 95 | 32 | 53 | 75 | 75 | 36 | 61 | 88 | 4 | 15 | 43 | 50 |
| 60 | 66 | 79 | 97 | 64 | 30 | 43 | 68 | 58 | 88 | 100 | 53 | 72 | 85 | 41 | 31 | 58 | 87 | 46 | 67 | 90 | 27 | 32 | 59 | 86 | 41 | 22 | 47 | 68 | 46 | 68 | 99 | 34 | 55 | 78 | 77 | 39 | 65 | 93 | 4 | 16 | 46 | 60 |
| 70 | 68 | 81 | 98 | 65 | 32 | 46 | 72 | 63 | 95 | 100 | 56 | 76 | 88 | 41 | 32 | 60 | 88 | 47 | 68 | 94 | 28 | 34 | 63 | 90 | 44 | 24 | 50 | 69 | 47 | 71 | 100 | 35 | 58 | 82 | 78 | 42 | 68 | 97 | 5 | 17 | 49 | 70 |
| 80 | 70 | 82 | 99 | 66 | 33 | 49 | 74 | 66 | 100 | 100 | 58 | 78 | 92 | 42 | 33 | 61 | 91 | 48 | 70 | 95 | 28 | 36 | 65 | 94 | 46 | 25 | 54 | 70 | 48 | 74 | 100 | 36 | 60 | 84 | 78 | 44 | 70 | 100 | 5 | 18 | 52 | 80 |
| 90 | 73 | 83 | 100 | 67 | 34 | 52 | 76 | 69 | 100 | 100 | 60 | 82 | 95 | 42 | 34 | 62 | 92 | 49 | 72 | 96 | 28 | 37 | 67 | 97 | 48 | 26 | 55 | 70 | 49 | 76 | 100 | 38 | 62 | 86 | 79 | 45 | 73 | 100 | 5 | 19 | 55 | 90 |
| 100 | 74 | 84 | 100 | 67 | 35 | 55 | 78 | 72 | 100 | 100 | 62 | 85 | 97 | 42 | 34 | 63 | 93 | 50 | 73 | 97 | 28 | 38 | 70 | 100 | 50 | 27 | 57 | 70 | 50 | 79 | 100 | 39 | 64 | 88 | 80 | 46 | 75 | 100 | 6 | 20 | 57 | 100 |

## Figure 2-29 Rigid Pavement Distress Deduct Values

| DISTRESS DENSITY % | 61 | | | 62 | | | 63 | | | 64 | | | 65 | | | 66 | | | 67 | | | 68 | 69 | 70 | | | 71 | | | 72 | | | 73 | 74 | | | 75 | | | 76 | | | DISTRESS DENSITY % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BLOW-UP | | | CORNER BREAK | | | LONG / TRANS / DIAG CRACKS | | | DURABILITY "D" CRACKING | | | JOINT SEAL DAMAGE | | | SMALL PATCH (<5 SF) | | | LARGE PATCH (>5 SF) | | | POPOUTS >3/SY | PUMPING | MAP CRACKING SCALING | | | SETTLEMENT OR FAULTING | | | INTERSECTING CRACK SHATTERED SLAB | | | SHRINKAGE CRACK | JOINT SPALLING | | | CORNER SPALLING | | | ASR | | | |
| | L | M | H | L | M | H | L | M | H | L | M | H | L | M | H | L | M | H | L | M | H | N/A | ANY | L | M | H | L | M | H | L | M | H | ANY | L | M | H | L | M | H | L | M | H | |
| 5 | 14 | 32 | 100 | 4 | 8 | 13 | 5 | 11 | 15 | 3 | 10 | 18 | 2 | 7 | 12 | 1 | 3 | 7 | 3 | 12 | 19 | 4 | 5 | 2 | 5 | 18 | 4 | 8 | 15 | 10 | 20 | 30 | 2 | 2 | 4 | 13 | 2 | 4 | 5 | 5 | 14 | 24 | 5 |
| 10 | 22 | 43 | 100 | 8 | 15 | 23 | 9 | 19 | 25 | 6 | 16 | 29 | | | | 1 | 6 | 11 | 6 | 16 | 29 | 7 | 10 | 2 | 10 | 30 | 8 | 14 | 26 | 17 | 27 | 40 | 2 | 3 | 7 | 21 | 4 | 7 | 10 | 8 | 23 | 38 | 10 |
| 15 | 27 | 48 | 100 | 12 | 20 | 30 | 11 | 23 | 33 | 8 | 21 | 35 | | | | 2 | 8 | 14 | 8 | 21 | 36 | 10 | 14 | 2 | 14 | 37 | 12 | 19 | 33 | 22 | 33 | 46 | 3 | 5 | 11 | 25 | 6 | 10 | 13 | 11 | 28 | 46 | 15 |
| 20 | 34 | 54 | 100 | 15 | 24 | 36 | 13 | 28 | 39 | 10 | 25 | 41 | | | | 3 | 10 | 17 | 10 | 24 | 42 | 12 | 18 | 3 | 17 | 42 | 14 | 24 | 39 | 26 | 39 | 52 | 3 | 6 | 13 | 29 | 7 | 12 | 16 | 12 | 32 | 51 | 20 |
| 25 | 39 | 58 | 100 | 18 | 28 | 41 | 15 | 32 | 45 | 12 | 27 | 47 | | | | 4 | 12 | 20 | 12 | 26 | 47 | 14 | 23 | 3 | 21 | 47 | 17 | 27 | 44 | 30 | 43 | 56 | 4 | 7 | 16 | 32 | 8 | 14 | 19 | 13 | 35 | 56 | 25 |
| 30 | 44 | 64 | 100 | 21 | 32 | 45 | 17 | 35 | 50 | 13 | 30 | 52 | | | | 5 | 13 | 22 | 14 | 30 | 52 | 15 | 26 | 3 | 23 | 52 | 20 | 30 | 49 | 33 | 47 | 61 | 4 | 8 | 18 | 34 | 10 | 16 | 23 | 14 | 37 | 59 | 30 |
| 35 | 49 | 69 | 100 | 23 | 35 | 50 | 18 | 37 | 54 | 14 | 32 | 56 | | | | 5 | 14 | 24 | 15 | 32 | 56 | 17 | 29 | 3 | 26 | 56 | 22 | 33 | 53 | 35 | 51 | 65 | 5 | 9 | 21 | 36 | 11 | 17 | 25 | 15 | 38 | 63 | 35 |
| 40 | 54 | 75 | 100 | 25 | 39 | 54 | 19 | 40 | 58 | 15 | 35 | 60 | | | | 6 | 15 | 27 | 16 | 34 | 60 | 18 | 32 | 4 | 28 | 60 | 24 | 35 | 57 | 37 | 54 | 70 | 6 | 10 | 23 | 38 | 12 | 18 | 27 | 16 | 40 | 66 | 40 |
| 45 | 59 | 81 | 100 | 27 | 42 | 58 | 20 | 43 | 62 | 16 | 37 | 64 | | | | 7 | 16 | 28 | 17 | 36 | 63 | 19 | 35 | 4 | 30 | 63 | 25 | 37 | 61 | 40 | 57 | 73 | 7 | 11 | 24 | 41 | 13 | 20 | 30 | 17 | 42 | 69 | 45 |
| 50 | 65 | 86 | 100 | 29 | 45 | 62 | 20 | 45 | 65 | 17 | 38 | 67 | | | | 8 | 17 | 30 | 18 | 37 | 67 | 20 | 38 | 4 | 31 | 66 | 27 | 40 | 64 | 42 | 61 | 77 | 7 | 11 | 26 | 42 | 14 | 21 | 32 | 18 | 43 | 72 | 50 |
| 55 | 70 | 91 | 100 | 31 | 48 | 65 | 20 | 47 | 68 | 18 | 40 | 70 | | | | 8 | 18 | 32 | 19 | 40 | 70 | 21 | 41 | 5 | 32 | 68 | 28 | 43 | 67 | 44 | 63 | 81 | 8 | 12 | 27 | 44 | 14 | 22 | 34 | 19 | 44 | 74 | 55 |
| 60 | 75 | 96 | 100 | 33 | 51 | 69 | 21 | 49 | 71 | 19 | 42 | 73 | | | | 9 | 18 | 33 | 20 | 42 | 73 | 22 | 43 | 5 | 33 | 70 | 30 | 44 | 71 | 46 | 66 | 84 | 9 | 12 | 29 | 45 | 15 | 23 | 36 | 19 | 45 | 76 | 60 |
| 65 | 81 | 100 | 100 | 35 | 54 | 72 | 21 | 50 | 73 | 20 | 43 | 76 | | | | 9 | 20 | 35 | 20 | 43 | 75 | 22 | 45 | 5 | 34 | 72 | 32 | 46 | 74 | 47 | 68 | 87 | 10 | 13 | 31 | 46 | 16 | 24 | 37 | 20 | 46 | 78 | 65 |
| 70 | 86 | 100 | 100 | 37 | 56 | 75 | 22 | 52 | 75 | 20 | 44 | 78 | | | | 9 | 20 | 36 | 21 | 44 | 78 | 22 | 47 | 5 | 35 | 73 | 33 | 48 | 76 | 49 | 71 | 89 | 11 | 13 | 33 | 47 | 16 | 24 | 39 | 21 | 47 | 79 | 70 |
| 75 | 91 | 100 | 100 | 38 | 59 | 79 | 22 | 53 | 77 | 21 | 45 | 81 | | | | 9 | 21 | 37 | 21 | 45 | 80 | 22 | 48 | 5 | 36 | 74 | 34 | 50 | 78 | 51 | 73 | 93 | 12 | 13 | 33 | 48 | 17 | 25 | 41 | 22 | 48 | 80 | 75 |
| 80 | 96 | 100 | 100 | 39 | 62 | 82 | 22 | 54 | 79 | 21 | 46 | 83 | | | | 10 | 22 | 38 | 21 | 46 | 83 | 22 | 50 | 6 | 37 | 76 | 34 | 52 | 82 | 53 | 75 | 95 | 12 | 14 | 34 | 49 | 17 | 26 | 43 | 22 | 48 | 81 | 80 |
| 85 | 100 | 100 | 100 | 40 | 65 | 84 | 22 | 55 | 81 | 22 | 47 | 84 | | | | 10 | 22 | 39 | 22 | 47 | 84 | 22 | 51 | 6 | 37 | 77 | 35 | 53 | 83 | 54 | 77 | 97 | 13 | 14 | 35 | 50 | 18 | 26 | 44 | 22 | 48 | 81 | 85 |
| 90 | 100 | 100 | 100 | 41 | 67 | 87 | 22 | 56 | 82 | 22 | 48 | 86 | | | | 10 | 22 | 40 | 22 | 48 | 86 | 22 | 52 | 6 | 38 | 78 | 36 | 54 | 86 | 55 | 79 | 100 | 13 | 14 | 36 | 51 | 19 | 27 | 45 | 22 | 49 | 81 | 90 |
| 95 | 100 | 100 | 100 | 41 | 70 | 89 | 22 | 57 | 83 | 22 | 49 | 87 | | | | 10 | 22 | 41 | 22 | 48 | 87 | 22 | 52 | 7 | 38 | 80 | 37 | 55 | 87 | 56 | 82 | 100 | 14 | 14 | 36 | 51 | 19 | 28 | 46 | 22 | 49 | 82 | 95 |
| 100 | 100 | 100 | 100 | 42 | 73 | 91 | 22 | 58 | 84 | 22 | 50 | 88 | | | | 10 | 22 | 41 | 22 | 49 | 88 | 22 | 52 | 7 | 39 | 81 | 37 | 56 | 90 | 57 | 83 | 100 | 14 | 14 | 36 | 52 | 19 | 28 | 46 | 22 | 50 | 82 | 100 |

**2-5.1.13** Determine "m," the maximum allowable number of distress deduct values that can be used to calculate the corrected deduct values and in turn the PCI for the surveyed sample by using the following formula:

$$m = 1 + [(9/95) \times (100 - HDV)]$$

HDV = highest individual deduct value

**2-5.1.14** In this example, the HDV is 28, so

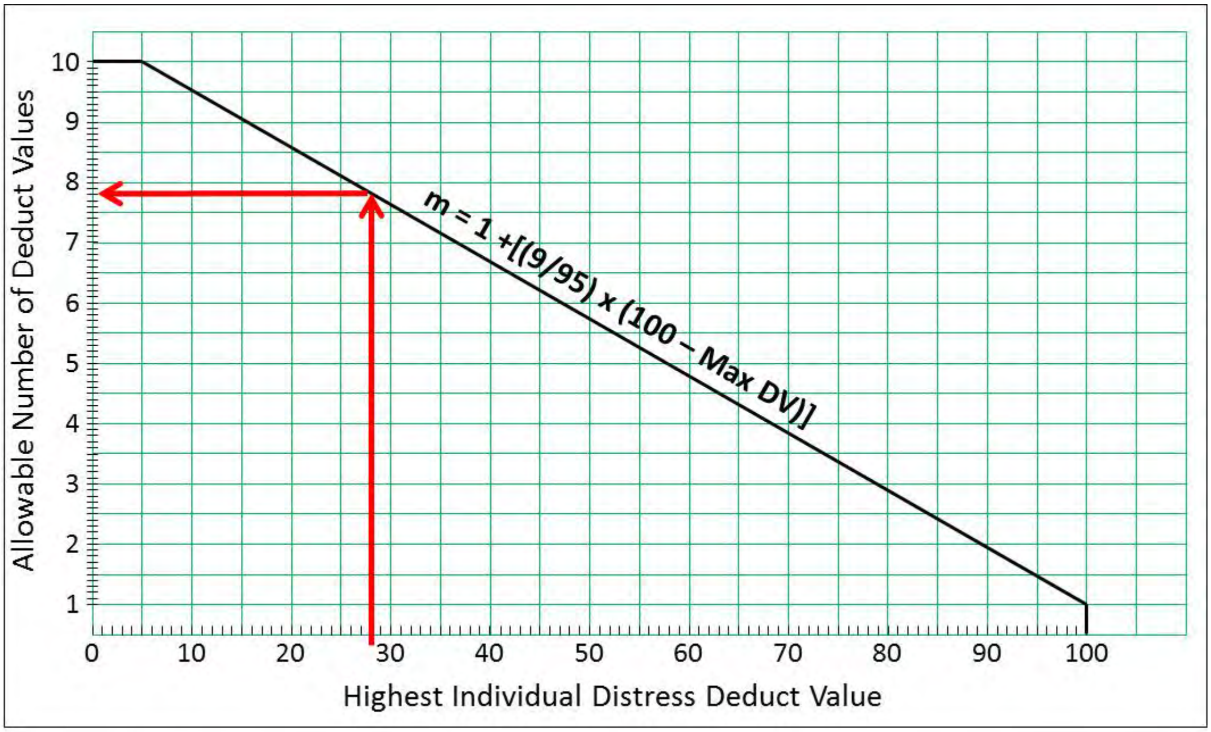
$$m = 1 + [(9/95) \times (100 - 28)] = 7.82$$

The first seven deduct values can be used as calculated but only 82% of the eighth deduct value can be used to determine the PCI. If additional distress deduct values had been identified, they are not included in the calculations.

**2-5.1.15** If none or only one of the individual distress deduct values is greater than 5, use the TDV to calculate the PCI; otherwise, determine the maximum corrected deduct value (CDV).

**2-5.1.16** Alternatively, Figure 2-30 may be used to determine the "m" number of distress deduct values than can be considered. Enter the bottom of Figure 2-30 with the HDV of the individual distress deduct values and project a line vertically to the "m" line. At this intersection, project a line horizontally to determine the allowable number of deduct values. This "m" number will always be less than or equal to 10. In the example sample area, entering the chart with an HDV of 28 results in an "m" number of 7.82.

**Figure 2-30 Allowable Number "m" of Deduct Values**




**2-5.1.16.1** Enter the individual distress deduct values on line one of Figure 2-31 in descending order. Sum the deduct values and enter it under "TDV." Count the number of deduct values greater than 5 and enter it under "q."

**Figure 2-31 Maximum CDV Chart**

| # | Deduct Values | | | | | | | | | | TDV | q | CDV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 28 | 20 | 17 | 11 | 7 | 6 | 4 | 3 | | | 96 | 6 | 62 |
| 2 | 28 | 20 | 17 | 11 | 7 | 5 | 4 | 3 | | | 95 | 5 | 64 |
| 3 | 28 | 20 | 17 | 11 | 5 | 5 | 4 | 3 | | | 93 | 4 | 64 |
| 4 | 28 | 20 | 17 | 5 | 5 | 5 | 4 | 3 | | | 87 | 3 | 66 |
| 5 | 28 | 20 | 5 | 5 | 5 | 5 | 4 | 3 | | | 75 | 2 | 64 |
| 6 | 28 | 5 | 5 | 5 | 5 | 5 | 4 | 3 | | | 60 | 1 | 60 |

**2-5.1.16.2** Using the appropriate CDV chart in ASTM D5340, enter the bottom of the chart with the TDV and project a line vertically until it intersects with the appropriate "q" line ("q" is the number of distresses that have deduct values greater than 5) then horizontally to determine the CDV. In the example in Table 2-9, six distresses have deduct values greater than 5. Entering the CDV chart with a TDV of 96 and projecting a line vertically to the "q" = 6 curve and then horizontally to the CDV scale results in a CDV of 62 for the surveyed sample.

**2-5.1.16.3** Alternatively, Figures 2-32 and 2-33 can be used in lieu of the curves in ASTM D5340. Select the appropriate chart based upon the pavement type, flexible or rigid. Enter the chart with the calculated TDV and project horizontally to the appropriate "q" value column to read the appropriate CDV. The example sample, Figure 2-27, is a rigid pavement section, so use Figure 2-33 to determine the CDVs to enter on each line in Figure 2-31.

**2-5.1.16.4** Copy the deduct values on the current line onto the next line, changing the smallest deduct value greater than 5 to 5, as shown in Figure 2-31. For this example, the second line has the smallest value (6) from line one, with a deduct value greater than 5 reduced to 5. The values on this line are totaled and the "q" value is reduced to 5. Repeat this process until "q" = 1. The third line has the next smallest value (7) from line two, with a deduct value greater than 5 reduced to 5. The values on this line are totaled and the "q" value is reduced to 4. The fourth line has the next smallest value (11) from line three, with a deduct value greater than 5 reduced to 5. The values on this line are totaled and the "q" value is reduced to 3. The fifth line has the next smallest value (17) from line four, with a deduct value greater than 5 reduced to 5. The values on this line are totaled and the "q" value is reduced to 2. The sixth line has the next smallest value (20) from line five, with a deduct value greater than 5 reduced to 5. The values on this line (totaled) and the "q" value are reduced to 1. Again, using the appropriate CDV chart, determine the CDV for each line. Compare the CDVs for each line. The maximum CDV is the largest value in the "CDV" column. The maximum CDV in this example is 66.

**2-5.1.17** Determine the PCI for each sample. A pavement sample area with no distresses has a PCI of 100. For any given pavement sample 100 – maximum CDV = PCI. In the example in Figure 2-27, the reported PCI = (100 – 66) = 34.

**2-5.1.18** Determine the PCI for each entire pavement section. The section PCI is determined by averaging the PCIs of all the samples surveyed in the section. If the average of the sampled units in the pavement section was 34, it results in a VERY POOR rating. Because the PCI is < 40, the computed allowable gross loads for this example pavement section is reduced by 25%.

**2-5.1.19** Pavements are rated in general terms based on their PCIs. Pavement condition ratings range from GOOD (like new) to FAILED (unsafe for aircraft operations). **These ratings are a qualitative assessment of the pavement surface condition and not to be confused with the structural capacity of a pavement.** For example, a pavement surface may rate GOOD but have underlying pavement or soil conditions that can result in pavement failure under the applied load of a given aircraft. On the other hand, a pavement may be structurally sound but the surface condition may be hazardous for aircraft traffic (e.g., FOD).

## Figure 2-32 Flexible Pavement Corrected Deduct Values

| Total Deduct Values (TDV) | q = Number of distresses with deduct values greater than 5 | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 1 | | | | | |
| 2 | 2 | | | | | |
| 3 | 3 | | | | | |
| 4 | 4 | | | | | |
| 5 | 5 | | | | | |
| 6 | 6 | | | | | |
| 7 | 7 | | | | | |
| 8 | 8 | | | | | |
| 9 | 9 | | | | | |
| 10 | 10 | | | | | |
| 11 | 11 | 4 | | | | |
| 12 | 12 | 5 | | | | |
| 13 | 13 | 6 | | | | |
| 14 | 14 | 6 | | | | |
| 15 | 15 | 7 | | | | |
| 16 | 16 | 8 | | | | |
| 17 | 17 | 9 | 5 | | | |
| 18 | 18 | 9 | 5 | | | |
| 19 | 19 | 10 | 6 | | | |
| 20 | 20 | 11 | 7 | | | |
| 21 | 21 | 11 | 8 | | | |
| 22 | 22 | 12 | 8 | | | |
| 23 | 23 | 13 | 9 | | | |
| 24 | 24 | 14 | 10 | | | |
| 25 | 25 | 14 | 10 | 5 | | |
| 26 | 26 | 15 | 11 | 6 | | |
| 27 | 27 | 16 | 12 | 7 | | |
| 28 | 28 | 17 | 13 | 7 | | |
| 29 | 29 | 17 | 13 | 8 | | |
| 30 | 30 | 18 | 14 | 9 | | |
| 31 | 31 | 19 | 15 | 9 | | |
| 32 | 32 | 19 | 16 | 10 | | |
| 33 | 33 | 20 | 16 | 11 | | |
| 34 | 34 | 21 | 17 | 12 | | |
| 35 | 35 | 22 | 18 | 12 | | |
| 36 | 36 | 22 | 18 | 13 | | |
| 37 | 37 | 23 | 19 | 14 | | |
| 38 | 38 | 24 | 20 | 15 | | |
| 39 | 39 | 25 | 21 | 15 | | |
| 40 | 40 | 25 | 22 | 16 | | |
| 41 | 41 | 26 | 22 | 17 | | |
| 42 | 42 | 27 | 23 | 18 | | |
| 43 | 43 | 28 | 24 | 18 | | |
| 44 | 44 | 28 | 24 | 19 | | |
| 45 | 45 | 29 | 25 | 20 | | |
| 46 | 46 | 30 | 26 | 20 | | |
| 47 | 47 | 31 | 27 | 21 | | |
| 48 | 48 | 31 | 27 | 22 | | |
| 49 | 49 | 32 | 28 | 22 | | |
| 50 | 50 | 33 | 29 | 23 | | |
| 51 | 51 | 34 | 30 | 24 | | |
| 52 | 52 | 35 | 31 | 25 | | |
| 53 | 53 | 35 | 31 | 25 | | |
| 54 | 54 | 36 | 32 | 26 | | |
| 55 | 55 | 37 | 33 | 27 | | |
| 56 | 56 | 38 | 34 | 27 | | |
| 57 | 57 | 38 | 35 | 28 | | |
| 58 | 58 | 39 | 36 | 28 | | |
| 59 | 59 | 40 | 36 | 29 | | |
| 60 | 60 | 41 | 37 | 30 | | |

| Total Deduct Values (TDV) | q = Number of distresses with deduct values greater than 5 | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 61 | 61 | 41 | 37 | 31 | | |
| 62 | 62 | 42 | 38 | 31 | | |
| 63 | 63 | 43 | 38 | 32 | | |
| 64 | 64 | 44 | 39 | 32 | | |
| 65 | 65 | 44 | 40 | 33 | | |
| 66 | 66 | 45 | 41 | 34 | | |
| 67 | 67 | 46 | 41 | 34 | | |
| 68 | 68 | 47 | 42 | 35 | | |
| 69 | 69 | 47 | 43 | 35 | | |
| 70 | 70 | 48 | 43 | 36 | | |
| 71 | 71 | 49 | 44 | 37 | | |
| 72 | 72 | 50 | 45 | 38 | | |
| 73 | 73 | 51 | 46 | 38 | | |
| 74 | 74 | 52 | 46 | 39 | | |
| 75 | 75 | 52 | 47 | 39 | | |
| 76 | 76 | 53 | 48 | 40 | | |
| 77 | 77 | 54 | 48 | 41 | | |
| 78 | 78 | 55 | 49 | 41 | | |
| 79 | 79 | 55 | 50 | 42 | | |
| 80 | 80 | 56 | 51 | 42 | | |
| 81 | 81 | 57 | 51 | 43 | | |
| 82 | 82 | 57 | 52 | 43 | | |
| 83 | 83 | 58 | 53 | 44 | | |
| 84 | 84 | 59 | 54 | 44 | | |
| 85 | 85 | 60 | 54 | 45 | | |
| 86 | 86 | 60 | 55 | 46 | | |
| 87 | 87 | 61 | 55 | 46 | | |
| 88 | 88 | 62 | 56 | 47 | | |
| 89 | 89 | 62 | 56 | 47 | | |
| 90 | 90 | 63 | 57 | 48 | | |
| 91 | 91 | 64 | 57 | 48 | | |
| 92 | 92 | 64 | 58 | 49 | | |
| 93 | 93 | 65 | 59 | 49 | | |
| 94 | 94 | 66 | 59 | 50 | | |
| 95 | 95 | 66 | 60 | 50 | | |
| 96 | 96 | 67 | 60 | 51 | 51 | 51 |
| 97 | 97 | 68 | 61 | 51 | 51 | 51 |
| 98 | 98 | 68 | 61 | 52 | 52 | 52 |
| 99 | 99 | 69 | 62 | 52 | 52 | 52 |
| 100 | 100 | 69 | 63 | 53 | 53 | 53 |
| 101 | | 70 | 63 | 53 | 53 | 53 |
| 102 | | 71 | 64 | 54 | 53 | 53 |
| 103 | | 71 | 64 | 54 | 54 | 54 |
| 104 | | 72 | 65 | 55 | 54 | 54 |
| 105 | | 73 | 65 | 55 | 54 | 54 |
| 106 | | 73 | 66 | 56 | 55 | 55 |
| 107 | | 74 | 66 | 56 | 55 | 55 |
| 108 | | 74 | 67 | 57 | 56 | 56 |
| 109 | | 75 | 67 | 57 | 56 | 56 |
| 110 | | 76 | 68 | 58 | 57 | 56 |
| 111 | | 76 | 68 | 58 | 57 | 57 |
| 112 | | 77 | 69 | 59 | 58 | 57 |
| 113 | | 78 | 69 | 59 | 58 | 58 |
| 114 | | 78 | 70 | 60 | 59 | 58 |
| 115 | | 79 | 70 | 60 | 59 | 58 |
| 116 | | 79 | 71 | 61 | 60 | 59 |
| 117 | | 80 | 72 | 61 | 60 | 59 |
| 118 | | 81 | 72 | 62 | 61 | 60 |
| 119 | | 81 | 73 | 62 | 61 | 60 |
| 120 | | 82 | 73 | 63 | 62 | 61 |

| Total Deduct Values (TDV) | q = Number of distresses with deduct values greater than 5 | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 121 | | 82 | 74 | 63 | 62 | 61 |
| 122 | | 83 | 74 | 64 | 62 | 61 |
| 123 | | 83 | 75 | 64 | 63 | 62 |
| 124 | | 84 | 75 | 64 | 63 | 62 |
| 125 | | 84 | 76 | 65 | 63 | 62 |
| 126 | | 85 | 76 | 65 | 64 | 63 |
| 127 | | 86 | 77 | 66 | 64 | 63 |
| 128 | | 96 | 77 | 66 | 65 | 63 |
| 129 | | 87 | 78 | 67 | 65 | 64 |
| 130 | | 87 | 78 | 67 | 66 | 64 |
| 131 | | 88 | 78 | 68 | 66 | 64 |
| 132 | | 89 | 79 | 68 | 66 | 65 |
| 133 | | 90 | 80 | 68 | 67 | 65 |
| 134 | | 90 | 80 | 69 | 67 | 65 |
| 135 | | 91 | 81 | 69 | 67 | 66 |
| 136 | | 91 | 81 | 70 | 68 | 66 |
| 137 | | 92 | 81 | 70 | 68 | 66 |
| 138 | | 92 | 82 | 71 | 69 | 67 |
| 139 | | 92 | 82 | 71 | 69 | 67 |
| 140 | | 93 | 83 | 72 | 70 | 67 |
| 141 | | 93 | 83 | 72 | 70 | 68 |
| 142 | | 93 | 84 | 73 | 71 | 68 |
| 143 | | 93 | 84 | 73 | 71 | 68 |
| 144 | | 94 | 85 | 73 | 71 | 69 |
| 145 | | 94 | 85 | 74 | 72 | 69 |
| 146 | | 95 | 85 | 74 | 72 | 70 |
| 147 | | 95 | 86 | 74 | 72 | 70 |
| 148 | | 96 | 86 | 75 | 73 | 70 |
| 149 | | 96 | 87 | 75 | 73 | 71 |
| 150 | | 97 | 87 | 76 | 74 | 71 |
| 151 | | 97 | 88 | 76 | 74 | 71 |
| 152 | | 97 | 88 | 76 | 74 | 71 |
| 153 | | 98 | 88 | 77 | 75 | 72 |
| 154 | | 98 | 89 | 77 | 75 | 72 |
| 155 | | 99 | 89 | 77 | 75 | 72 |
| 156 | | 99 | 90 | 78 | 76 | 73 |
| 157 | | 100 | 90 | 78 | 76 | 73 |
| 158 | | 100 | 90 | 78 | 76 | 73 |
| 159 | | 101 | 91 | 79 | 77 | 74 |
| 160 | | 101 | 91 | 79 | 77 | 74 |
| 161 | | 102 | 92 | 80 | 77 | 74 |
| 162 | | 102 | 92 | 80 | 78 | 74 |
| 163 | | 103 | 93 | 81 | 78 | 75 |
| 164 | | 103 | 93 | 81 | 78 | 75 |
| 165 | | 103 | 93 | 81 | 78 | **75** |
| 166 | | 104 | 94 | 82 | 79 | 75 |
| 167 | | 104 | 94 | 82 | 79 | 76 |
| 168 | | 104 | 94 | 82 | 79 | 76 |
| 169 | | 105 | 95 | 82 | 79 | 76 |
| 170 | | 105 | 95 | 83 | 80 | 76 |
| 171 | | | 95 | 83 | 80 | 77 |
| 172 | | | 96 | 83 | 80 | 77 |
| 173 | | | 96 | 83 | 80 | 77 |
| 174 | | | 97 | 84 | 80 | 77 |
| 175 | | | 97 | 84 | 81 | 78 |
| 176 | | | 97 | 84 | 81 | 78 |
| 177 | | | 98 | 85 | 81 | 78 |
| 178 | | | 98 | 85 | 82 | 78 |
| 179 | | | 98 | 85 | 82 | 78 |
| 180 | | | 98 | 85 | 82 | 79 |

## Figure 2-33 Rigid Pavement Corrected Deduct Values

| Total Deduct Value (TDV) | q = Number of distresses with deduct values greater than 5 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | 1 | | | | | | | |
| 2 | 2 | | | | | | | |
| 3 | 3 | | | | | | | |
| 4 | 4 | | | | | | | |
| 5 | 5 | | | | | | | |
| 6 | 6 | | | | | | | |
| 7 | 7 | | | | | | | |
| 8 | 8 | | | | | | | |
| 9 | 9 | | | | | | | |
| 10 | 10 | 7 | | | | | | |
| 11 | 11 | 8 | | | | | | |
| 12 | 12 | 9 | | | | | | |
| 13 | 13 | 10 | | | | | | |
| 14 | 14 | 11 | | | | | | |
| 15 | 15 | 12 | | | | | | |
| 16 | 16 | 13 | | | | | | |
| 17 | 17 | 14 | | | | | | |
| 18 | 18 | 14 | 14 | | | | | |
| 19 | 19 | 15 | 14 | | | | | |
| 20 | 20 | 16 | 15 | | | | | |
| 21 | 21 | 17 | 15 | | | | | |
| 22 | 22 | 18 | 16 | | | | | |
| 23 | 23 | 19 | 17 | | | | | |
| 24 | 24 | 20 | 18 | | | | | |
| 25 | 25 | 20 | 18 | 16 | | | | |
| 26 | 26 | 21 | 19 | 17 | | | | |
| 27 | 27 | 22 | 20 | 18 | | | | |
| 28 | 28 | 23 | 21 | 18 | | | | |
| 29 | 29 | 24 | 21 | 19 | | | | |
| 30 | 30 | 25 | 22 | 20 | | | | |
| 31 | 31 | 25 | 22 | 21 | | | | |
| 32 | 32 | 26 | 23 | 21 | | | | |
| 33 | 33 | 27 | 24 | 22 | | | | |
| 34 | 34 | 28 | 25 | 23 | | | | |
| 35 | 35 | 29 | 25 | 24 | | | | |
| 36 | 36 | 30 | 26 | 24 | | | | |
| 37 | 37 | 31 | 27 | 25 | | | | |
| 38 | 38 | 31 | 28 | 26 | | | | |
| 39 | 39 | 32 | 29 | 26 | | | | |
| 40 | 40 | 33 | 30 | 27 | | | | |
| 41 | 41 | 34 | 30 | 28 | | | | |
| 42 | 42 | 35 | 31 | 29 | | | | |
| 43 | 43 | 36 | 32 | 30 | 29 | 28 | | |
| 44 | 44 | 37 | 32 | 30 | 29 | 28 | | |
| 45 | 45 | 38 | 33 | 31 | 30 | 29 | | |
| 46 | 46 | 39 | 34 | 32 | 31 | 30 | | |
| 47 | 47 | 40 | 35 | 33 | 32 | 31 | | |
| 48 | 48 | 40 | 36 | 33 | 32 | 31 | | |
| 49 | 49 | 41 | 36 | 34 | 33 | 32 | 31 | 30 |
| 50 | 50 | 42 | 37 | 35 | 34 | 33 | 32 | 31 |
| 51 | 51 | 43 | 38 | 35 | 34 | 33 | 32 | 31 |
| 52 | 52 | 44 | 38 | 36 | 35 | 34 | 33 | 32 |
| 53 | 53 | 45 | 39 | 37 | 36 | 35 | 33 | 32 |
| 54 | 54 | 46 | 40 | 37 | 36 | 35 | 34 | 33 |
| 55 | 55 | 46 | 41 | 38 | 37 | 36 | 35 | 34 |
| 56 | 56 | 47 | 42 | 39 | 38 | 37 | 36 | 34 |
| 57 | 57 | 48 | 43 | 40 | 39 | 37 | 36 | 35 |
| 58 | 58 | 49 | 43 | 40 | 39 | 38 | 37 | 35 |
| 59 | 59 | 50 | 44 | 41 | 40 | 39 | 38 | 36 |
| 60 | 60 | 51 | 45 | 42 | 41 | 40 | 39 | 37 |

| Total Deduct Value (TDV) | q = Number of distresses with deduct values greater than 5 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 61 | 61 | 52 | 46 | 43 | 42 | 40 | 40 | 37 |
| 62 | 62 | 53 | 47 | 43 | 42 | 41 | 40 | 38 |
| 63 | 63 | 54 | 47 | 44 | 43 | 42 | 41 | 39 |
| 64 | 64 | 55 | 48 | 45 | 43 | 42 | 41 | 39 |
| 65 | 65 | 55 | 49 | 46 | 44 | 43 | 42 | 40 |
| 66 | 66 | 56 | 50 | 46 | 45 | 44 | 42 | 40 |
| 67 | 67 | 57 | 51 | 47 | 46 | 44 | 43 | 41 |
| 68 | 68 | 58 | 51 | 48 | 46 | 45 | 43 | 42 |
| 69 | 69 | 59 | 52 | 48 | 47 | 46 | 44 | 42 |
| 70 | 70 | 60 | 53 | 49 | 47 | 46 | 44 | 43 |
| 71 | 71 | 61 | 54 | 50 | 48 | 47 | 45 | 43 |
| 72 | 72 | 62 | 55 | 50 | 48 | 47 | 46 | 44 |
| 73 | 73 | 63 | 56 | 51 | 49 | 48 | 47 | 45 |
| 74 | 74 | 64 | 56 | 51 | 50 | 49 | 47 | 45 |
| 75 | 75 | 64 | 57 | 52 | 51 | 49 | 48 | 46 |
| 76 | 76 | 65 | 58 | 53 | 52 | 50 | 48 | 46 |
| 77 | 77 | 66 | 58 | 54 | 52 | 51 | 49 | 47 |
| 78 | 78 | 67 | 59 | 55 | 53 | 51 | 49 | 47 |
| 79 | 79 | 68 | 60 | 56 | 54 | 52 | 50 | 48 |
| 80 | 80 | 69 | 61 | 56 | 55 | 53 | 51 | 49 |
| 81 | 81 | 70 | 62 | 57 | 55 | 53 | 51 | 49 |
| 82 | 82 | 70 | 63 | 58 | 56 | 54 | 52 | 50 |
| 83 | 83 | 71 | 64 | 58 | 57 | 55 | 53 | 51 |
| 84 | 84 | 72 | 65 | 59 | 57 | 55 | 53 | 51 |
| 85 | 85 | 73 | 65 | 60 | 58 | 56 | 54 | 52 |
| 86 | 86 | 74 | 65 | 60 | 58 | 56 | 54 | 52 |
| 87 | 87 | 74 | 66 | 61 | 59 | 57 | 55 | 53 |
| 88 | 88 | 75 | 67 | 62 | 60 | 57 | 55 | 53 |
| 89 | 89 | 76 | 68 | 62 | 60 | 58 | 56 | 54 |
| 90 | 90 | 77 | 69 | 63 | 61 | 59 | 57 | 55 |
| 91 | 91 | 78 | 69 | 63 | 61 | 59 | 57 | 55 |
| 92 | 92 | 79 | 70 | 63 | 62 | 60 | 58 | 56 |
| 93 | 93 | 79 | 71 | 64 | 62 | 60 | 58 | 56 |
| 94 | 94 | 80 | 71 | 65 | 63 | 61 | 59 | 57 |
| 95 | 95 | 81 | 72 | 66 | 64 | 62 | 59 | 57 |
| 96 | 96 | 82 | 73 | 66 | 64 | 62 | 60 | 58 |
| 97 | 97 | 83 | 74 | 67 | 65 | 63 | 60 | 58 |
| 98 | 98 | 83 | 74 | 68 | 65 | 63 | 61 | 59 |
| 99 | 99 | 84 | 75 | 68 | 66 | 64 | 61 | 59 |
| 100 | 100 | 85 | 76 | 69 | 67 | 65 | 62 | 60 |
| 101 | | 85 | 76 | 69 | 67 | 65 | 62 | 60 |
| 102 | | 86 | 77 | 70 | 68 | 65 | 63 | 61 |
| 103 | | 87 | 78 | 70 | 68 | 66 | 63 | 61 |
| 104 | | 87 | 78 | 71 | 69 | 67 | 64 | 62 |
| 105 | | 88 | 79 | 72 | 69 | 67 | 64 | 62 |
| 106 | | 89 | 80 | 72 | 70 | 68 | 65 | 63 |
| 107 | | 89 | 80 | 73 | 70 | 68 | 66 | 63 |
| 108 | | 90 | 81 | 73 | 71 | 68 | 66 | 64 |
| 109 | | 91 | 82 | 74 | 71 | 69 | 67 | 64 |
| 110 | | 91 | 83 | 74 | 72 | 70 | 68 | 65 |
| 111 | | 92 | 83 | 75 | 72 | 70 | 68 | 65 |
| 112 | | 93 | 84 | 75 | 73 | 71 | 69 | 66 |
| 113 | | 93 | 84 | 76 | 73 | 71 | 69 | 66 |
| 114 | | 94 | 85 | 76 | 74 | 72 | 70 | 67 |
| 115 | | 94 | 85 | 77 | 74 | 72 | 70 | 67 |
| 116 | | 95 | 86 | 77 | 75 | 73 | 71 | 68 |
| 117 | | 95 | 86 | 78 | 75 | 73 | 71 | 68 |
| 118 | | 96 | 87 | 78 | 76 | 74 | 72 | 69 |
| 119 | | 96 | 87 | 79 | 76 | 74 | 72 | 69 |
| 120 | | 97 | 88 | 79 | 77 | 75 | 73 | 70 |

| Total Deduct Value (TDV) | q = Number of distresses with deduct values greater than 5 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 121 | | 97 | 88 | 80 | 77 | 75 | 73 | 70 |
| 122 | | 98 | 89 | 80 | 78 | 76 | 73 | 71 |
| 123 | | 98 | 90 | 81 | 78 | 76 | 74 | 71 |
| 124 | | 99 | 90 | 81 | 79 | 77 | 74 | 71 |
| 125 | | 99 | 91 | 82 | 79 | 77 | 75 | 72 |
| 126 | | 100 | 91 | 82 | 80 | 78 | 75 | 72 |
| 127 | | | 92 | 82 | 80 | 78 | 76 | 73 |
| 128 | | | 92 | 83 | 81 | 78 | 76 | 73 |
| 129 | | | 93 | 83 | 81 | 79 | 77 | 74 |
| 130 | | | 93 | 84 | 82 | 80 | 77 | 74 |
| 131 | | | 94 | 84 | 82 | 80 | 77 | 74 |
| 132 | | | 94 | 85 | 83 | 80 | 78 | 75 |
| 133 | | | 95 | 85 | 83 | 81 | 78 | 75 |
| 134 | | | 95 | 86 | 84 | 81 | 78 | 76 |
| 135 | | | 96 | 86 | 84 | 82 | 79 | 76 |
| 136 | | | 96 | 86 | 84 | 82 | 79 | 76 |
| 137 | | | 96 | 87 | 85 | 83 | 80 | 77 |
| 138 | | | 97 | 87 | 85 | 83 | 80 | 77 |
| 139 | | | 97 | 88 | 86 | 83 | 81 | 78 |
| 140 | | | 98 | 88 | 86 | 84 | 81 | 78 |
| 141 | | | 98 | 88 | 86 | 84 | 82 | 78 |
| 142 | | | 98 | 89 | 87 | 85 | 82 | 79 |
| 143 | | | 98 | 89 | 87 | 85 | 82 | 79 |
| 144 | | | 99 | 90 | 87 | 85 | 82 | 79 |
| 145 | | | 99 | 90 | 88 | 86 | 83 | 80 |
| 146 | | | 99 | 91 | 88 | 86 | 83 | 80 |
| 147 | | | 100 | 91 | 89 | 87 | 84 | 81 |
| 148 | | | | 91 | 89 | 87 | 84 | 81 |
| 149 | | | | 92 | 89 | 87 | 84 | 81 |
| 150 | | | | 92 | 90 | 88 | 85 | 82 |
| 151 | | | | 92 | 90 | 88 | 85 | 82 |
| 152 | | | | 93 | 91 | 88 | 85 | 82 |
| 153 | | | | 93 | 91 | 89 | 86 | 83 |
| 154 | | | | 94 | 92 | 89 | 86 | 83 |
| 155 | | | | 94 | 92 | 90 | 87 | 83 |
| 156 | | | | 94 | 92 | 90 | 87 | 84 |
| 157 | | | | 95 | 93 | 90 | 87 | 84 |
| 158 | | | | 95 | 93 | 91 | 88 | 84 |
| 159 | | | | 95 | 93 | 91 | 88 | 85 |
| 160 | | | | 96 | 94 | 91 | 88 | 85 |
| 161 | | | | 96 | 94 | 92 | 89 | 85 |
| 162 | | | | 96 | 94 | 92 | 89 | 86 |
| 163 | | | | 96 | 94 | 92 | 89 | 86 |
| 164 | | | | 97 | 95 | 93 | 90 | 87 |
| 165 | | | | 97 | 95 | 93 | 90 | 87 |
| 166 | | | | 97 | 95 | 93 | 90 | 87 |
| 167 | | | | 97 | 95 | 93 | 90 | 87 |
| 168 | | | | 98 | 96 | 94 | 91 | 88 |
| 169 | | | | 98 | 96 | 94 | 91 | 88 |
| 170 | | | | 98 | 97 | 94 | 91 | 88 |
| 171 | | | | 99 | 97 | 95 | 92 | 89 |
| 172 | | | | 99 | 97 | 95 | 92 | 89 |
| 173 | | | | 99 | 97 | 95 | 92 | 89 |
| 174 | | | | 99 | 97 | 95 | 92 | 89 |
| 175 | | | | 99 | 98 | 96 | 93 | 89 |
| 176 | | | | 100 | 98 | 96 | 93 | 90 |
| 177 | | | | | 98 | 96 | 93 | 90 |
| 178 | | | | | 98 | 96 | 93 | 90 |
| 179 | | | | | 99 | 97 | 94 | 90 |
| 180 | | | | | 99 | 97 | 95 | 91 |

### 2-5.2 Semi-Prepared Airfield Condition Index (SPACI) for Unsurfaced or Aggregate Surfaces.

#### 2-5.2.1 Procedure.

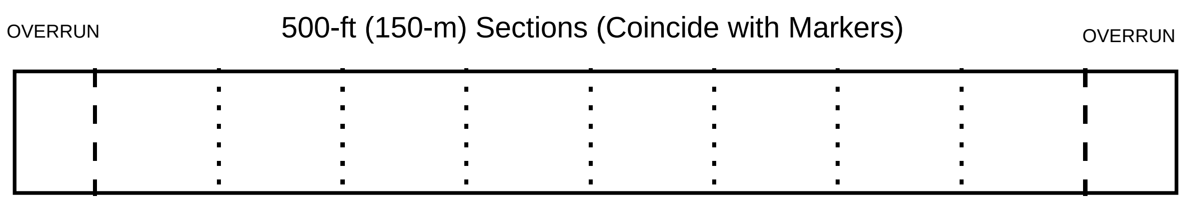
It is essential that the evaluation team personnel have the ability to quickly and accurately assess the surface condition of a semi-prepared airfield and determine its suitability for aircraft operations. The rating system, which prescribes the procedures necessary to determine the SPACI, is useful for engineering units tasked to maintain the airfield but for contingency operations a more simplified method is used to determine the impact of surface distresses. This guidance has been expanded to include C-130 aircraft operations. The following procedures outline the steps necessary to perform a simplified PCI:

**Step 1.** Divide the entire field into sections and sample areas.

- Each sample area located on the runway or taxiway is 250 feet (76 m) long and the width of the runway or taxiway.
- Make each hammerhead and overrun a section.
- Divide the aprons into sections of approximately 25,000 square feet (2322 $m^2$).

**Figure 2-34 Semi-prepared Airfield Layout**

**Runway Layout**




**Step 2.** Select samples areas to inspect. As a minimum for contingency operations, inspect the sections in the touchdown area, in the primary braking area at approximately 1000 to 1500 feet, at the point of aircraft rotation at approximately 2000 to 2500 feet (600 to 750 m), and at the last 500 feet (150 m) of the runway. (The point of rotation may move due to pressure and altitude changes.) These sections include the areas most likely to be damaged by landing, braking, stopping, acceleration, and takeoff for the runway in use. Inspect and monitor additional areas where degradation develops.

**Step 3.** Inspect sample areas and record any identified distresses.

- Conduct as detailed and accurate an inspection as time and conditions permit.
- Note all distresses and the appropriate severity levels for each (see Figure 2-35.

**Figure 2-35 SPACI Sample Survey**

| Distress Type | | 91 | 92 | 93 | 94 | 95 | 96 | 97 |
|---|---|---|---|---|---|---|---|---|
| Severity | G | | | ✓ | | | | |
| | A | | ✓ | | ✓ | ✓ | | |
| | R | | | | | | | |

**Step 4.** Assign distress deduct values to each identified distress type.

- Total the distress deduct values, and compute sample area SPACI (see Figures 2-36 and 2-37.
- The deduct values for sections located on the runway/taxiway are different than the deduct values for sections located on aprons/hammerheads.

**Figure 2-36 Assigning SPACI Distress Deduct Values**

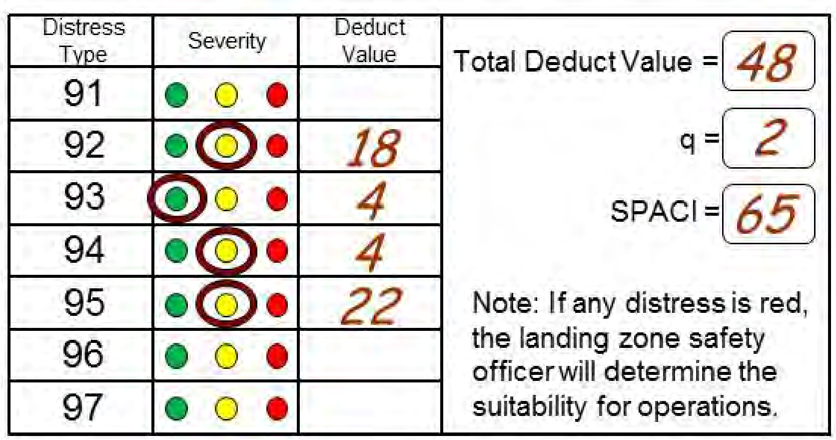


**Figure 2-37 SPACI Distress Deduct Values**

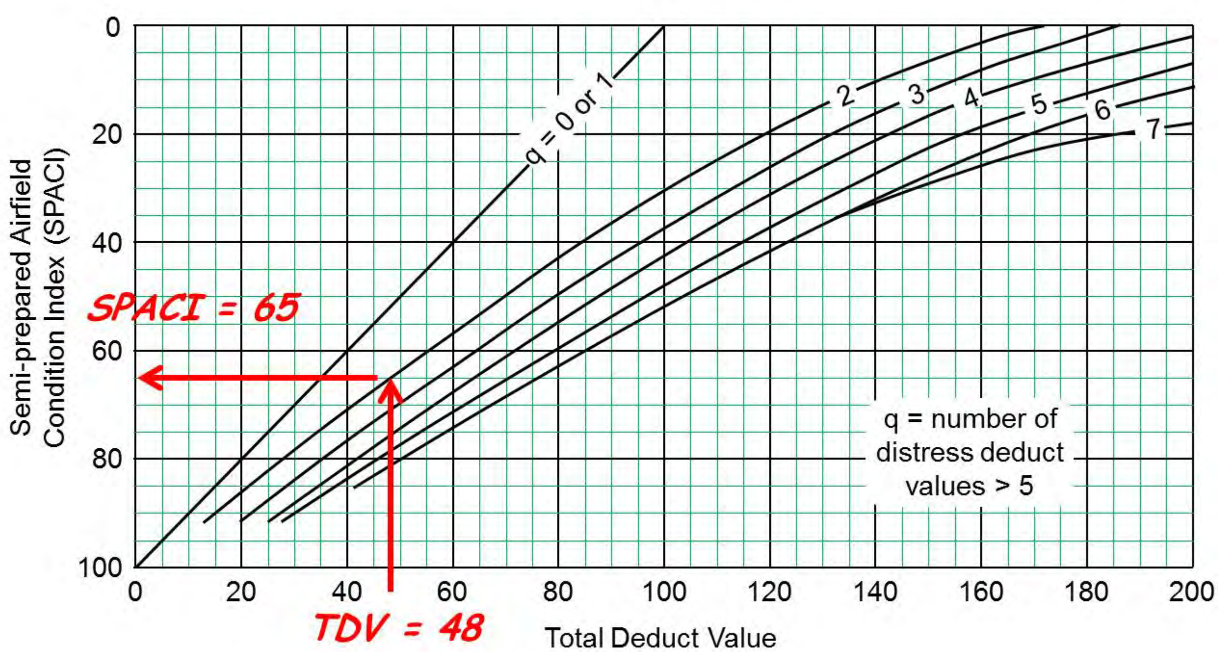
**Deduct Values for C-17 Operations**

| | | *Green* | | *Amber* | | *Red* | |
|---|---|---|---|---|---|---|---|
| | *Distress* | *R/T** | *H/A*** | *R/T* | *H/A* | *R/T* | *H/A* |
| 91 | Potholes | 4 | 2 | 10 | 6 | 20 | 12 |
| 92 | Ruts | 14 | 4 | 18 | 6 | 24 | 10 |
| 93 | Loose Aggregate | 4 | 15 | 6 | 30 | 8 | 45 |
| 94 | Dust | 2 | 15 | 4 | 30 | 6 | 45 |
| 95 | Rolling Resistant Material | 18 | 2 | 22 | 4 | 26 | 15 |
| 96 | Jet Blast Erosion | 5 | 10 | 10 | 30 | 15 | 40 |
| 97 | Stabilized Layer Failure | 5 | 15 | 10 | 25 | 15 | 35 |

*R/T – runways and taxiways
**H/A – hammerheads and aprons

**Step 5.** Determine the corrected SPACI using Figure 2-37 or Figures 2-39 and 2-40.

**Figure 2-38 Corrected SPACI Curves**




**Step 6.** Average sample area SPACI values to determine section SPACI. For example, if samples were inspected at the touchdown, maximum braking, turnaround, and point of rotation areas on the runway and the individual sample area SPACI values were 63, 67, 55, and 71 then the runway SPACI is 64.

**Step 7.** Average section SPACIs to determine airfield SPACI, if desired.

A SPACI of 76 to 100 is rated “Green.” A SPACI of 26 to 75 is rated “Amber.” A SPACI of 0 to 25 is rated “Red.” Maintain training LZs in “Green” condition. Maintain contingency LZs in “Green” or “Amber” condition. Regardless of the overall SPACI rating, if any individual distress is rated as “Red,” the landing zone safety officer will determine the feasibility of each operation.

## Figure 2-39 Corrected SPACI, 0 to 100 TDV

| Semi-prepared Surface Corrected SPACI Value Chart | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Deduct Value | q = Number of distresses with deduct values greater than 5 | | | | | | |
| | 0 or 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 99 | | | | | | |
| 2 | 98 | | | | | | |
| 3 | 97 | | | | | | |
| 4 | 96 | | | | | | |
| 5 | 95 | | | | | | |
| 6 | 94 | | | | | | |
| 7 | 93 | | | | | | |
| 8 | 92 | | | | | | |
| 9 | 91 | | | | | | |
| 10 | 90 | | | | | | |
| 11 | 89 | | | | | | |
| 12 | 88 | 92 | | | | | |
| 13 | 87 | 91 | | | | | |
| 14 | 86 | 90 | | | | | |
| 15 | 85 | 90 | | | | | |
| 16 | 84 | 89 | | | | | |
| 17 | 83 | 88 | | | | | |
| 18 | 82 | 87 | | | | | |
| 19 | 81 | 86 | | | | | |
| 20 | 80 | 86 | 91 | | | | |
| 21 | 79 | 85 | 90 | | | | |
| 22 | 78 | 84 | 90 | | | | |
| 23 | 77 | 83 | 89 | | | | |
| 24 | 76 | 82 | 88 | | | | |
| 25 | 75 | 82 | 87 | | | | |
| 26 | 74 | 81 | 87 | 91 | | | |
| 27 | 73 | 80 | 86 | 90 | | | |
| 28 | 72 | 79 | 85 | 89 | | | |
| 29 | 71 | 79 | 84 | 89 | 91 | | |
| 30 | 70 | 78 | 84 | 88 | 90 | | |
| 31 | 69 | 77 | 83 | 87 | 89 | | |
| 32 | 68 | 77 | 82 | 87 | 89 | | |
| 33 | 67 | 76 | 81 | 86 | 88 | | |
| 34 | 66 | 75 | 81 | 85 | 87 | | |
| 35 | 65 | 74 | 80 | 84 | 87 | | |
| 36 | 64 | 74 | 79 | 84 | 86 | | |
| 37 | 63 | 73 | 79 | 83 | 85 | | |
| 38 | 62 | 72 | 78 | 82 | 85 | | |
| 39 | 61 | 71 | 77 | 82 | 84 | | |
| 40 | 60 | 71 | 76 | 81 | 84 | | |
| 41 | 59 | 70 | 75 | 80 | 83 | 85 | |
| 42 | 58 | 69 | 75 | 80 | 82 | 85 | |
| 43 | 57 | 68 | 74 | 79 | 82 | 84 | |
| 44 | 56 | 68 | 74 | 78 | 81 | 83 | |
| 45 | 55 | 67 | 73 | 78 | 80 | 83 | |
| 46 | 54 | 66 | 72 | 77 | 80 | 82 | |
| 47 | 53 | 66 | 71 | 76 | 79 | 82 | |
| 48 | 52 | 65 | 71 | 75 | 78 | 81 | |
| 49 | 51 | 64 | 70 | 75 | 78 | 80 | |
| 50 | 50 | 63 | 69 | 74 | 77 | 80 | |

| Semi-prepared Surface Corrected SPACI Value Chart | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Deduct Value | q = Number of distresses with deduct values greater than 5 | | | | | | |
| | 0 or 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 51 | 49 | 63 | 69 | 73 | 77 | 79 | |
| 52 | 48 | 62 | 68 | 73 | 76 | 79 | |
| 53 | 47 | 61 | 67 | 72 | 75 | 78 | |
| 54 | 46 | 61 | 67 | 71 | 74 | 78 | |
| 55 | 45 | 60 | 66 | 71 | 74 | 77 | |
| 56 | 44 | 59 | 65 | 70 | 73 | 76 | |
| 57 | 43 | 59 | 65 | 69 | 73 | 76 | |
| 58 | 42 | 58 | 64 | 69 | 72 | 75 | |
| 59 | 41 | 57 | 63 | 68 | 71 | 74 | |
| 60 | 40 | 57 | 63 | 67 | 71 | 74 | |
| 61 | 39 | 56 | 62 | 67 | 70 | 73 | |
| 62 | 38 | 55 | 61 | 66 | 70 | 73 | |
| 63 | 37 | 54 | 61 | 65 | 69 | 72 | |
| 64 | 36 | 54 | 60 | 65 | 69 | 72 | |
| 65 | 35 | 53 | 59 | 64 | 68 | 71 | |
| 66 | 34 | 53 | 59 | 64 | 67 | 71 | |
| 67 | 33 | 52 | 58 | 63 | 67 | 70 | |
| 68 | 32 | 51 | 57 | 62 | 66 | 69 | |
| 69 | 31 | 50 | 57 | 61 | 66 | 69 | |
| 70 | 30 | 49 | 56 | 61 | 65 | 68 | |
| 71 | 29 | 49 | 55 | 60 | 65 | 68 | |
| 72 | 28 | 48 | 54 | 60 | 64 | 67 | |
| 73 | 27 | 47 | 54 | 59 | 63 | 67 | 67 |
| 74 | 26 | 47 | 53 | 58 | 63 | 66 | 66 |
| 75 | 25 | 46 | 52 | 58 | 62 | 65 | 65 |
| 76 | 24 | 45 | 52 | 57 | 62 | 65 | 65 |
| 77 | 23 | 45 | 51 | 56 | 61 | 64 | 64 |
| 78 | 22 | 44 | 50 | 56 | 60 | 64 | 64 |
| 79 | 21 | 43 | 50 | 55 | 60 | 63 | 63 |
| 80 | 20 | 42 | 49 | 54 | 59 | 62 | 62 |
| 81 | 19 | 42 | 49 | 54 | 59 | 62 | 62 |
| 82 | 18 | 41 | 48 | 53 | 58 | 61 | 61 |
| 83 | 17 | 40 | 47 | 53 | 58 | 61 | 61 |
| 84 | 16 | 40 | 47 | 52 | 57 | 60 | 60 |
| 85 | 15 | 39 | 46 | 51 | 57 | 60 | 60 |
| 86 | 14 | 39 | 46 | 51 | 56 | 59 | 59 |
| 87 | 13 | 38 | 45 | 50 | 55 | 59 | 59 |
| 88 | 12 | 37 | 44 | 49 | 55 | 58 | 58 |
| 89 | 11 | 37 | 44 | 49 | 54 | 58 | 58 |
| 90 | 10 | 36 | 43 | 48 | 54 | 57 | 57 |
| 91 | 9 | 36 | 43 | 48 | 53 | 57 | 57 |
| 92 | 8 | 35 | 42 | 47 | 52 | 56 | 56 |
| 93 | 7 | 34 | 41 | 46 | 52 | 55 | 55 |
| 94 | 6 | 34 | 41 | 46 | 51 | 55 | 55 |
| 95 | 5 | 33 | 40 | 45 | 51 | 54 | 54 |
| 96 | 4 | 33 | 40 | 45 | 50 | 54 | 54 |
| 97 | 3 | 32 | 39 | 44 | 50 | 53 | 53 |
| 98 | 2 | 31 | 38 | 43 | 49 | 53 | 53 |
| 99 | 1 | 31 | 38 | 43 | 48 | 52 | 52 |
| 100 | 0 | 30 | 37 | 42 | 48 | 52 | 52 |

# Figure 2-40 Corrected SPACI, 101 to 200 TDV

**Semi-prepared Surface Corrected SPACI Value Chart**

| Total Deduct Value | q = Number of distresses with deduct values greater than 5 | | | | | |
|---|---|---|---|---|---|---|
| | 0 or 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 101 | 0 | 30 | 37 | 42 | 47 | 51 | 51 |
| 102 | 0 | 29 | 36 | 41 | 47 | 51 | 51 |
| 103 | 0 | 29 | 35 | 40 | 46 | 50 | 50 |
| 104 | 0 | 28 | 35 | 40 | 46 | 49 | 49 |
| 105 | 0 | 27 | 34 | 39 | 45 | 49 | 49 |
| 106 | 0 | 27 | 34 | 39 | 45 | 48 | 48 |
| 107 | 0 | 26 | 33 | 38 | 44 | 48 | 48 |
| 108 | 0 | 26 | 33 | 38 | 43 | 47 | 47 |
| 109 | 0 | 25 | 32 | 37 | 43 | 47 | 47 |
| 110 | 0 | 25 | 32 | 36 | 42 | 46 | 46 |
| 111 | 0 | 24 | 31 | 36 | 42 | 46 | 46 |
| 112 | 0 | 24 | 30 | 35 | 41 | 45 | 45 |
| 113 | 0 | 23 | 30 | 35 | 41 | 45 | 45 |
| 114 | 0 | 22 | 29 | 34 | 40 | 44 | 44 |
| 115 | 0 | 22 | 29 | 34 | 40 | 44 | 44 |
| 116 | 0 | 21 | 28 | 33 | 39 | 43 | 43 |
| 117 | 0 | 21 | 28 | 33 | 39 | 43 | 43 |
| 118 | 0 | 20 | 27 | 32 | 38 | 42 | 42 |
| 119 | 0 | 20 | 26 | 31 | 38 | 42 | 42 |
| 120 | 0 | 19 | 26 | 31 | 37 | 41 | 41 |
| 121 | 0 | 19 | 25 | 30 | 37 | 41 | 41 |
| 122 | 0 | 18 | 25 | 30 | 36 | 40 | 40 |
| 123 | 0 | 18 | 24 | 29 | 36 | 40 | 40 |
| 124 | 0 | 17 | 24 | 29 | 35 | 39 | 39 |
| 125 | 0 | 17 | 23 | 28 | 35 | 39 | 39 |
| 126 | 0 | 16 | 23 | 28 | 34 | 38 | 38 |
| 127 | 0 | 16 | 22 | 27 | 34 | 38 | 38 |
| 128 | 0 | 15 | 22 | 27 | 33 | 37 | 37 |
| 129 | 0 | 15 | 21 | 26 | 33 | 37 | 37 |
| 130 | 0 | 14 | 21 | 26 | 32 | 36 | 36 |
| 131 | 0 | 14 | 20 | 25 | 32 | 36 | 36 |
| 132 | 0 | 14 | 20 | 25 | 31 | 35 | 35 |
| 133 | 0 | 13 | 19 | 24 | 31 | 35 | 35 |
| 134 | 0 | 13 | 19 | 24 | 30 | 34 | 35 |
| 135 | 0 | 12 | 18 | 23 | 30 | 34 | 34 |
| 136 | 0 | 12 | 18 | 23 | 29 | 33 | 34 |
| 137 | 0 | 12 | 17 | 22 | 29 | 33 | 34 |
| 138 | 0 | 11 | 17 | 22 | 28 | 32 | 33 |
| 139 | 0 | 11 | 16 | 21 | 28 | 32 | 33 |
| 140 | 0 | 10 | 16 | 21 | 27 | 32 | 33 |
| 141 | 0 | 10 | 16 | 21 | 27 | 31 | 32 |
| 142 | 0 | 9 | 15 | 20 | 26 | 31 | 32 |
| 143 | 0 | 9 | 15 | 20 | 26 | 31 | 31 |
| 144 | 0 | 9 | 14 | 19 | 25 | 30 | 31 |
| 145 | 0 | 8 | 14 | 19 | 25 | 30 | 31 |
| 146 | 0 | 8 | 14 | 18 | 24 | 29 | 30 |
| 147 | 0 | 8 | 13 | 18 | 24 | 29 | 30 |
| 148 | 0 | 7 | 13 | 17 | 23 | 28 | 30 |
| 149 | 0 | 7 | 12 | 17 | 23 | 28 | 29 |
| 150 | 0 | 6 | 12 | 16 | 22 | 27 | 29 |

**Semi-prepared Surface Corrected SPACI Value Chart**

| Total Deduct Value | q = Number of distresses with deduct values greater than 5 | | | | | |
|---|---|---|---|---|---|---|
| | 0 or 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 151 | 0 | 6 | 12 | 16 | 22 | 27 | 29 |
| 152 | 0 | 6 | 11 | 16 | 21 | 27 | 28 |
| 153 | 0 | 5 | 11 | 15 | 21 | 26 | 28 |
| 154 | 0 | 5 | 10 | 15 | 21 | 26 | 28 |
| 155 | 0 | 5 | 10 | 14 | 20 | 25 | 27 |
| 156 | 0 | 4 | 10 | 14 | 20 | 25 | 27 |
| 157 | 0 | 4 | 9 | 14 | 20 | 24 | 27 |
| 158 | 0 | 4 | 9 | 13 | 19 | 24 | 26 |
| 59 | 0 | 3 | 8 | 13 | 19 | 24 | 26 |
| 160 | 0 | 3 | 8 | 13 | 19 | 23 | 26 |
| 161 | 0 | 3 | 8 | 12 | 18 | 23 | 25 |
| 162 | 0 | 2 | 7 | 12 | 18 | 22 | 25 |
| 163 | 0 | 2 | 7 | 12 | 18 | 22 | 25 |
| 164 | 0 | 2 | 7 | 11 | 17 | 22 | 24 |
| 165 | 0 | 1 | 6 | 11 | 17 | 21 | 24 |
| 166 | 0 | 1 | 6 | 11 | 17 | 21 | 24 |
| 167 | 0 | 1 | 6 | 10 | 16 | 21 | 24 |
| 168 | 0 | 1 | 5 | 10 | 16 | 20 | 23 |
| 169 | 0 | 0 | 5 | 10 | 16 | 20 | 23 |
| 170 | 0 | 0 | 5 | 10 | 15 | 20 | 23 |
| 171 | 0 | 0 | 5 | 9 | 15 | 19 | 23 |
| 172 | 0 | 0 | 4 | 9 | 15 | 19 | 22 |
| 173 | 0 | 0 | 4 | 9 | 14 | 19 | 22 |
| 174 | 0 | 0 | 4 | 8 | 14 | 18 | 22 |
| 175 | 0 | 0 | 3 | 8 | 14 | 18 | 22 |
| 176 | 0 | 0 | 3 | 8 | 14 | 18 | 21 |
| 177 | 0 | 0 | 3 | 8 | 13 | 17 | 21 |
| 178 | 0 | 0 | 2 | 7 | 13 | 17 | 21 |
| 179 | 0 | 0 | 2 | 7 | 13 | 17 | 21 |
| 180 | 0 | 0 | 2 | 7 | 12 | 16 | 21 |
| 181 | 0 | 0 | 1 | 7 | 12 | 16 | 21 |
| 182 | 0 | 0 | 1 | 6 | 12 | 16 | 20 |
| 183 | 0 | 0 | 1 | 6 | 11 | 15 | 20 |
| 184 | 0 | 0 | 0 | 6 | 11 | 15 | 20 |
| 185 | 0 | 0 | 0 | 5 | 11 | 15 | 20 |
| 186 | 0 | 0 | 0 | 5 | 11 | 15 | 20 |
| 187 | 0 | 0 | 0 | 5 | 11 | 14 | 20 |
| 188 | 0 | 0 | 0 | 5 | 10 | 14 | 19 |
| 189 | 0 | 0 | 0 | 4 | 10 | 14 | 19 |
| 190 | 0 | 0 | 0 | 4 | 10 | 14 | 19 |
| 191 | 0 | 0 | 0 | 4 | 9 | 13 | 19 |
| 192 | 0 | 0 | 0 | 4 | 9 | 13 | 19 |
| 193 | 0 | 0 | 0 | 3 | 9 | 13 | 19 |
| 194 | 0 | 0 | 0 | 3 | 8 | 13 | 19 |
| 195 | 0 | 0 | 0 | 3 | 8 | 12 | 18 |
| 196 | 0 | 0 | 0 | 3 | 8 | 12 | 18 |
| 197 | 0 | 0 | 0 | 2 | 8 | 12 | 18 |
| 198 | 0 | 0 | 0 | 2 | 7 | 12 | 18 |
| 199 | 0 | 0 | 0 | 2 | 7 | 11 | 18 |
| 200 | 0 | 0 | 0 | 2 | 7 | 11 | 18 |

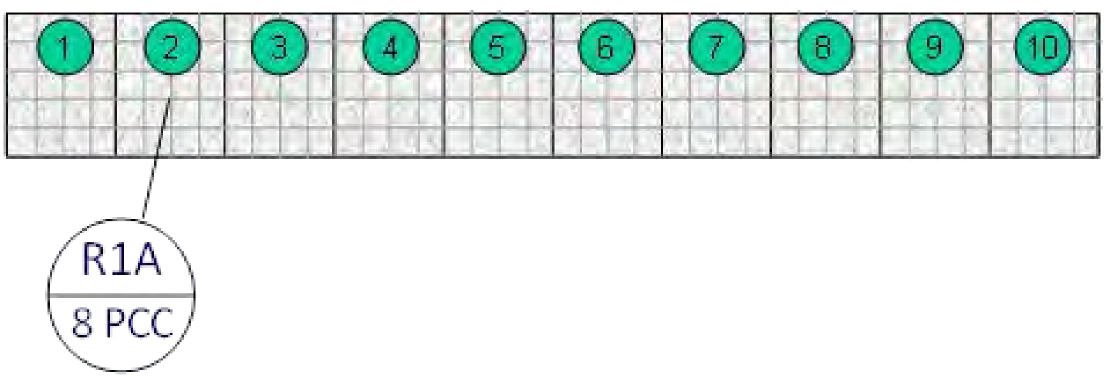
**2-5.2.1.1** A branch is an identifiable part of the pavement network that is a single entity and has a distinct function. For example, runways, named taxiways, and apron areas are all separate branches.

**2-5.2.1.2** A section is a subset of a branch. It is an area of pavement having a uniform pavement type, thickness, and condition, as well as the same pavement use, traffic type, construction history, and subsurface layer structure.

**2-5.2.1.3** The deduct values prescribed in ASTM D5340 are based upon standard sample sizes. If one chooses to use sample sizes other than the standard ASTM sample sizes then adjust the distress densities. The standard sample size for rigid pavements is a 20 contiguous slab area (± eight slabs if the total number of slabs in the section is not evenly divisible by 20). For example, if rigid pavement section R1A in Figure 24 contains 200 slabs, it can be broken into 10 samples as shown, each containing 20 slabs. If the pavement slabs in PCC have joint spacing greater than 25 feet (7.6 m), subdivide each slab into imaginary slabs. Size the imaginary slabs all to be less than or equal to 25 feet (7.6 m) in length and the imaginary joints dividing the slabs are assumed to be in perfect condition. This is needed because the distress deduct values were developed for jointed concrete slabs less than or equal to 25 feet (7.6 m).

**2-5.2.1.4** The standard sample size for flexible pavements is a 5,000 contiguous square foot (465 $m^2$) area (± 2,000 square feet [186 $m^2$] if the total area of the section is not evenly divisible by 5,000).

**Figure 2-41 Semi-prepared Airfield Layout**




**2-5.2.1.5** The sample units chosen to inspect are determined by a systematic random sampling technique. This means the samples are selected so they are evenly distributed throughout the pavement section. Select samples typical of the overall condition of the section being surveyed; don't just look for areas of higher distress. If some areas are significantly better or worse than the overall area then break the original section into multiple sections and give the new sections condition ratings based upon the distresses actually contained in each respective section. A significant difference is a change in the PCI of 15 or more, which results in a different pavement condition rating.

**2-5.2.1.6** No pavement section is entirely consistent. Surfaces in one sample unit may not have all of the types of distresses found in the pavement section. The objective is to rate the condition that represent the majority of the pavement section. Small or isolated conditions typically do not influence the PCI rating, but they may adversely impact operations. It is useful to note these special conditions in the report so this information can be used in planning specific improvement projects. For example, some spot repairs may be required.

**2-5.2.1.7** For contingency evaluations, if the randomly selected sample unit is not typical of the pavement section, choose another sample unit instead. A non-representative sample unit may be one that has an unusual or isolated distress such as a utility cut.

**2-5.2.1.8** Survey a sufficient number of samples in each section to obtain confidence in the PCIs that will ultimately be assigned to the sections. For contingency evaluations, the minimum number of samples to be surveyed is based upon the overall size of the section they represent. The pavement section shown in Figure 2-41 contains ten samples, so a minimum of two randomly selected samples are surveyed. The recommended number of samples to be surveyed based upon various section sizes is as follows:

| Section Size | Samples to Survey |
|---|---|
| 1 to 5 samples | 1 sample |
| 6 to 10 samples | 2 samples |
| 11 to 15 samples | 3 samples |
| 16 to 40 samples | 4 samples |
| > 40 samples | 10% |

**2-5.2.1.9** The second step is to locate the various surface distresses, plot them on the runway layout, and record their severity levels. Continue to track the development and degradation of the distresses through subsequent aircraft operations and determine airfield suitability.

### 2-5.2.2 Distress Types.

There are seven distress types for semi-prepared airfields: potholes, loose aggregate, ruts, rolling resistant material (RRM), dust, jet blast erosion, and stabilized layer failure.

#### 2-5.2.2.1 Potholes.

Potholes are bowl-shaped depressions in the airfield surface. Once potholes have begun to form, they will continue to disintegrate because of loosening surface material or weak spots in the underlying soil. The number and location of potholes can be critical to aircraft operations. To determine the severity, measure the depths and diameters of the largest potholes. Severity levels are shown in Table 2-10. If the potholes have hard, abrupt, vertical sides, refer to stabilized layer failure criteria as described in paragraph 2-5.2.7.7.

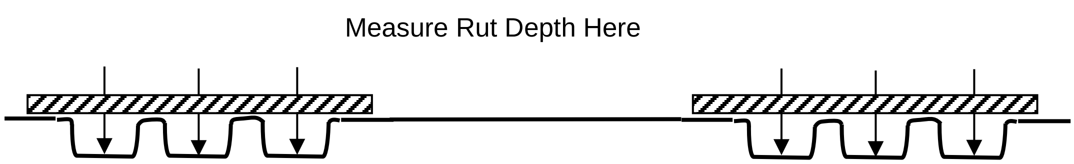
### 2-5.2.2.2 Loose Aggregate.

Loose aggregate is small stones 0.25 inch (6 mm) or larger that have separated from the soil binder. In large enough quantities and sizes, it can create problems. Remove rocks over 4 inches (100 mm) in diameter from the operational surface. If material crushes underfoot it is not considered loose aggregate. To determine the severity, estimate coverage on the airfield. Severity levels are shown in Table 2-10.

### 2-5.2.2.3 Ruts.

Ruts are surface depressions in the wheel paths that generally run parallel with the centerline or direction of traffic. To measure, lay a straightedge across the ruts with both ends resting on the solid runway surface with the loose rolling resistant material (RRM) removed. Measure the depth of the three deepest ruts on each side, from the bottom of the straight edge to the solid ground in the bottom of the rut (see Figure 2-42). Use the maximum depth of the six measurements for that location. Rut width does not affect severity. Generally, check rut depths in the touchdown area, in the primary braking area, at the point of rotation, and in the last 500 feet (150 m) of the runway or in other areas where the ruts are more severe. For a typical 4,000-foot (1200-m) runway, take one set of measurements at approximately 4+00, 10+00, 20+00, and 35+00. The maximum rut depth measured determines the severity. Severity levels are shown in Table 2-10.

**Figure 2-42 Rut Depth Measurements**



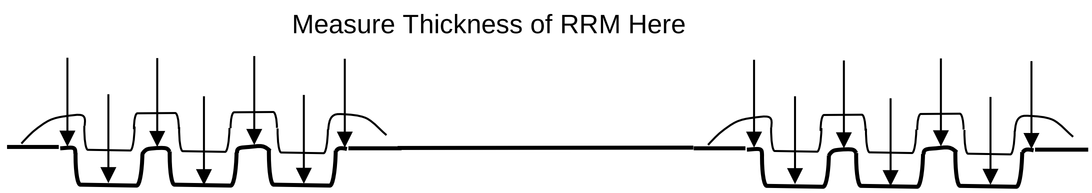

| Location 1 Measurements | Location 2 Measurements | Location 3 Measurements | Location 4 Measurements |
|---|---|---|---|
| 1. ____ 4. ____ | 1. ____ 4. ____ | 1. ____ 4. ____ | 1. ____ 4. ____ |
| 2. ____ 5. ____ | 2. ____ 5. ____ | 2. ____ 5. ____ | 2. ____ 5. ____ |
| 3. ____ 6. ____ | 3. ____ 6. ____ | 3. ____ 6. ____ | 3. ____ 6. ____ |
| Loc 1 Max = ____ | Loc 2 Max = ____ | Loc 3 Max = ____ | Loc 4 Max = ____ |

Runway Maximum Rut Depth = ______

### 2-5.2.2.4 Rolling Resistant Material (RRM).

RRM is any type of loose or unbound material that separates from the solid base and lies on top of the surface and in ruts. In sufficient quantities it increases the rolling resistance, thereby increasing the amount of runway required for takeoffs. It is more prevalent in dry soils and is a byproduct of severe rutting. To measure, stick a ruler into the RRM until you hit solid ground and read the number on the ruler at the top of the RRM to the nearest 0.25 inch (6 mm). Take seven measurements in each main gear path and average those measurements (see Figure 2-43). Determine the average RRM depth by averaging the measurements in the touchdown area, in the primary braking area, at the point of rotation, and in the last 500 feet (150 m) of the runway. For a typical 4,000-foot (1200-m) runway, take one set of measurements at approximately 4+00, 10+00, 20+00, and 35+00 and average those four sets of measurements. Severity levels are shown in Table 2-10.

**Figure 2-43 RRM Depth Measurements**




| Location 1 Measurements | | Location 2 Measurements | | Location 3 Measurements | | Location 4 Measurements | |
|---|---|---|---|---|---|---|---|
| 1. ____ | 8. ____ | 1. ____ | 8. ____ | 1. ____ | 8. ____ | 1. ____ | 8. ____ |
| 2. ____ | 9. ____ | 2. ____ | 9. ____ | 2. ____ | 9. ____ | 2. ____ | 9. ____ |
| 3. ____ | 10. ____ | 3. ____ | 10. ____ | 3. ____ | 10. ____ | 3. ____ | 10. ____ |
| 4. ____ | 11. ____ | 4. ____ | 11. ____ | 4. ____ | 11. ____ | 4. ____ | 11. ____ |
| 5. ____ | 12. ____ | 5. ____ | 12. ____ | 5. ____ | 12. ____ | 5. ____ | 12. ____ |
| 6. ____ | 13. ____ | 6. ____ | 13. ____ | 6. ____ | 13. ____ | 6. ____ | 13. ____ |
| 7. ____ | 14. ____ | 7. ____ | 14. ____ | 7. ____ | 14. ____ | 7. ____ | 14. ____ |
| Loc 1 Avg = ____ | | Loc 2 Avg = ____ | | Loc 3 Avg = ____ | | Loc 4 Avg = ____ | |

Runway RRM Average Depth = ______

### 2-5.2.2.5 Dust.

Dust is fine material that becomes airborne when disturbed. These fines separate from the surface and become a significant problem for personnel, trailing aircraft, and the environment. To determine the severity, drive a ground vehicle quickly down the runway and note the visibility through the trailing dust cloud. Dust is difficult to control; be aware of the problem to adequately phase aircraft operations. Severity levels are shown in Table 2-10.

### 2-5.2.2.6 Jet Blast Erosion.

Jet blast erosion occurs when the top layer of soil is blown or stripped away in areas scoured by engine blast. Jet blast erosion outside of trafficked areas can be ignored. Jet blast erosion is characterized by no evidence of loose aggregate or by a serrated or dimpled surface. To determine the severity, measure the depth of the erosion. Severity levels are shown in Table 2-10.

### 2-5.2.2.7 Stabilized Layer Failure.

Stabilized layer failure occurs in areas of a stabilized surface layer that begin to crack and delaminate; it is a progressive failure. It first appears as cracks that become more prevalent and begin to interconnect and resemble alligator cracking. These pieces then separate from the surface. This creates a dangerous FOD problem and leaves abrupt vertical edges in the surface that may cause gear damage. To determine the severity, measure the depth of the failure. Severity levels are shown in Table 2-10.

### 2-5.2.3 Distress Severities.

Distress severities are coded as green, amber, or red.

- Green indicates a low risk to aircraft operations.
- Amber indicates a medium risk and identifies the need for repairs.
- Red indicates high-risk operations and identifies areas that require repair before subsequent aircraft operations.

Table 2-10 contains the criteria used to determine the impact of surface distresses on C-17 and C-130 operations.

### Table 2-10 Distress Severity Levels for C-17 and C-130 Operations

| C-17 | | | |
|---|---|---|---|
| **Distress Types** | **Green** | **Amber** | **Red** |
| Potholes | < 4 inches deep and/or < 15 inches in diameter | 4 to 9 inches deep and > 15 inches in diameter | > 9 inches deep and > 15 inches in diameter |
| Loose aggregate coverage | Covers < 1/10 of section | Covers between 1/10 and 1/2 of section | Covers > 1/2 of section |
| Loose aggregate size | Max. < ¾ inch diameter, Recommended < ½ inch | Max. = ¾ inch to 1inch diameter | Max. > 1inch diameter |
| Ruts | Exist but < 4 inches deep | 4 to 9 inches deep | > 9 inches deep |
| RRM | Exist but < 3.5 inches deep | 3.5 to 7.75 inches deep | > 7.75 inches deep |
| Dust | Does not obstruct visibility | Partially obstructs visibility | Thick; obstructs visibility |
| Jet blast erosion | Exist but < 1 inch deep | 1 to 3 inches deep | > 3 inches deep |
| Stabilized layer failure | Exist but < 1 inch deep | 1 to 2 inches deep | > 2 inches deep |
| **C-130** | | | |
| **Distress Types** | **Green** | **Amber** | **Red** |
| Potholes | < 4 inches deep and/or < 15 inches in diameter | 4 to 6 inches deep and > 15 inches in diameter | > 6 inches deep and > 15 inches in diameter |
| Loose aggregate coverage | Covers < 1/10 of section | Covers between 1/10 and 1/2 of section | Covers > 1/2 of section |
| Loose aggregate size | Max. < ¾ inch diameter, Recommended < ½ inch | Max. = ¾ inch to 1inch diameter | Max. > 1inch diameter |
| Ruts | Exist but < 3 inches deep | 3 to 6 inches deep | > 6 inches deep |
| RRM | Exist but < 1 inch deep | 1 to 3 inches deep | > 3 inches deep |
| Dust | Does not obstruct visibility | Partially obstructs visibility | Thick; obstructs visibility |
| Jet blast erosion | Exist but < 1 inch deep | 1 to 3 inches deep | > 3 inches deep |
| Stabilized layer failure | Exist but < 1 inch deep | 1 to 2 inches deep | > 2 inches deep |

**Notes:** 1. These limits are based upon tests of soils in arid environments and may be too high for soils in more humid environments.
2. Potholes, ruts, and RRM are considered major distresses. Depending upon actual distress location, any distress types categorized as Red may cause the overall condition of the airfield to be Red.

## 2-6 SURFACE CONDITION OF NONTRADITIONAL AIRFIELD SURFACES.

Accurately identifying what type of surface or wearing course is present is necessary to properly evaluate the structural capacity of the pavement and determine the correct surface condition inspection procedure. Upon cursory examination, surface-treated pavements, penetration macadam, and sand asphalt may appear to be hot mixed asphalt (HMA). Closer examination is needed to distinguish between pavement types**.**

### 2-6.1 Sand Asphalt.

**2-6.2.1** Sand asphalts can be distinguished from HMA by coring the pavement to look at the aggregate structure or by a small test pit. Sand asphalt has minimal coarse aggregates. Sand asphalt is an asphalt paving mixture composed of sand and asphalt binder prepared without the careful grading used for traditional HMA. Sand asphalts are used as the wearing surface for street or road construction in regions where sand is of good quality and abundant or is the only available aggregate.

**2-6.2.2** While sand asphalt mixtures are fine-textured, dense, and relatively impermeable, they are not generally recommended for airfield surfaces because they lack the strength and durability needed for high tire pressures. Sand asphalt surfaces can oxidize and become brittle with age or crack and ravel if constructed with insufficient asphalt binder. They are more susceptible than HMA to cracking from temperature, load, and aging and perform best when subjected to continuous, all-over traffic providing kneading action not typically experienced with airfield pavements.

**2-6.2.3** For visual condition inspection purposes, consider a sand asphalt pavement “surfaced flexible pavement.” Because sand asphalt surfaces will experience deterioration similar to flexible pavement surfaces, visually inspect the sand asphalt following the traditional PCI procedures for flexible pavements, as contained in paragraph 2.5.1.

**2-6.2.4** Sand asphalts will oxidize and crack like HMA pavements and tend to rut and shove under traffic loads, so pay particularly close attention to identify the extent and severity of distresses, including cracking, rutting, shoving, weathering, and raveling.

### 2-6.2 Surface Treatments and Macadam.

**2-6.3.1** Surface treatments can be distinguished from HMA based on their surface, which have small, similar-sized aggregates with binder between aggregates. Additionally, check the pavement thickness. If the surface course is less than 1.5 inches (40 mm) thick, it can be assumed to be a surface treatment for the purposes of a contingency airfield evaluation.

**2-6.3.2** Penetration macadam may be more difficult to identify from the surface; however, under the penetrating asphalt layer(s), the base material is typically gap-graded with layers of larger aggregate filled with small aggregates. This pavement may also be difficult to penetrate with testing equipment due to the use of large stones or aggregates in its construction (possibly wider than 2 inches (50 mm) in diameter). It is often impossible to DCP through and even difficult to drill through because the large stones tend to shift and bind against the drill bit while drilling.

**2-6.3.3** Surface treatments and macadams are often difficult to identify by just looking at the surface or through small diameter drilled holes. For austere locations where one might anticipate the use of such surfaces, dig a small pit adjacent to the pavement to allow inspection of the layer structure and assist in the identification of surface treatments and macadam pavements.

**2-6.3.4** For visual condition inspection purposes, consider surface-treated and macadam pavements a “semi-prepared or unsurfaced pavement” and assessed using the procedures outlined in paragraph 2-5.2, but with different severity level criteria (see Figure 2-44).

**Figure 2-44 Surface Condition Criteria for Surface-Treatment and Macadam Airfields**

| Distress Types | Green (Low) | Amber (Medium) | Red (High) |
|---|---|---|---|
| 91. Potholes | < 1 inch deep and/or < 15 inches in diameter | 1 to 2 inches deep and > 15 inches in diameter | > 2 inches deep and > 15 inches in diameter |
| 92. Ruts | Exist but < 1 inch deep | 1 to 3 inches deep | > 3 inches deep |
| 93. Loose aggregate | Binder is wearing away, causing low FOD potential over < 10% of surface; surface mostly intact | Fine aggregate is missing and larger pieces are dislodged. Moderate FOD potential. Surface is rough and pitted with loose aggregate covering between 10% and 50% of the surface. | High FOD potential. Surface texture is very rough and pitted. Loose aggregate covering > 50% of the surface |
| 94. Dust | Does not obstruct visibility | Partially obstructs visibility | Thick; obstructs visibility |
| 95. Rolling resistant material | Exist but < 1 inch deep | 1 to 3 inches deep | > 3 inches deep |
| 96. Jet blast erosion | Exist but < 1 inch deep | 1 to 3 inches deep | > 3 inches deep |
| 97. Stabilized layer failure | Exist but < 1 inch deep | 1 to 2 inches deep | > 2 inches deep |
| **Note:** If the pavement section is in relatively good condition with only low-severity distresses scattered across the section, which does not require more than routine maintenance to maintain aircraft operations, the pavement is considered in Green (good) condition. However, if medium-severity distresses were present in addition to the low-severity distresses, or the section requires routine to major repair to maintain operations, then rate the section Amber (fair). If high-severity distresses are prevalent and the pavement requires constant maintenance and repairs to maintain operations, then consider the pavement Red (poor). When the condition of the airfield approaches Red, inspect it before and after each aircraft operation. | | | |

**2-6.3.5** Unsurfaced pavements differ from paved surfaces in that unsurfaced pavements do not have a surface-wearing course capable of resisting the abrasive action of the wheel loads. Surface-treated and penetration macadam pavements have thin-wearing surfaces (usually less than 1.5 inches [40 mm] thick) and these thin coverings are likewise not capable of resisting the shearing actions of the aircraft gears expected for contingency airfield operations. These pavement surfaces are expected to experience deterioration similar to semi-prepared surfaces.

**2-6.3.6** In evaluating a surface-treated pavement or macadam, if the binder no longer holds the aggregate in place (usually due to oxidation of the binder), then record the distress as “loose aggregate.”

**2-6.3.7** Identify loose aggregate separately from RRM. RRM is also loose material that has separated from the top surface but is usually the result of severe rutting and is located between and in rut locations. RRM is usually attributed to unsurfaced soil or aggregate airfields; however, this material can be produced through severe rutting of surface-treated surfaces.

**2-6.3.8** Delamination due to aging and cracking of surface-treated surface courses have been identified as problems with these materials. Record these occurrences as “stabilized layer failure.”

### 2-6.3 Stabilized Soil.

**2-6.4.1** Stabilization of soil/aggregate is a construction method used in unsurfaced pavement construction. The process improves the properties of the native soil by adding supplementary materials. Stabilizing the surface of the soil improves its bearing capacity and durability (compared to untreated surfaces) and may be employed to reduce costs associated with PCC or HMA surfacing.

**2-6.4.2** Stabilization can be accomplished by blending additives such as portland cement, lime, fly ash, asphalt binder, polymers, or fibers with the natural soil. In stabilizing soil, strength, durability, cohesion, and reduced swelling properties may be improved.

**2-6.4.3** Cement is the most widely used stabilizing agent, as it enhances tensile and compressive strength, which contribute to increased bearing strength. Cement is generally available throughout the world and is relatively inexpensive to use. High-percentage cement additions can greatly increase the bearing strength of the material but can result in brittle pavement behavior, leading to cracking and reduced structural performance. In addition to cracking, other common distresses that may be encountered in cement- or lime-stabilized surfaces include crushing of the cemented surface, rutting, and delamination.

**2-6.4.4** Lime stabilization reduces plasticity and is desirable when the material being stabilized has a plasticity index greater than 10%; for a plasticity index less than 10%, cement is generally recommended. Often a combination of lime and cement may be used. Similar distresses to those previously described for cement-stabilized materials may be experienced.

**2-6.4.5** While asphalt stabilization does not typically provide as great an increase in strength as cement-stabilized pavements, this stabilization technique is often employed to provide water resistance, increased cohesion, and flexibility to the stabilized layer when compacted. Rutting is a common distress that may be encountered when asphalt-stabilized material is used as a surface course.

**2-6.4.6** For visual condition inspection purposes, consider stabilized soil pavements “semi-prepared or unsurfaced pavement,” using the procedures outlined in paragraph 2-5.2 and the criteria in Table 2-10. Unsurfaced pavements differ from paved surfaces in that unsurfaced pavements do not have a surface-wearing course capable of resisting the abrasive action of the wheel loads. Stabilized surfaces have historically been evaluated as semi-prepared surfaces because these pavement surfaces are expected to experience deterioration similar to semi-prepared surfaces.

**2-6.4.7** Stabilized layer failure is recorded for stabilized surfaces when delamination of the surface layer occurs due to aging, cracking, and the loss of bond with the underlying layer. Over time, pieces or chunks of the surface layer (not just small aggregates) are dislodged and can cause FOD damage. The abrupt edges or changes in elevation caused by stabilized layer failure have a significant impact on aircraft operations due to their aircraft damage potential.

## 2-7 REFINE AIRFIELD LAYOUT/COMPILE SUMMARY OF PHYSICAL PROPERTY DATA (PPD).

**2-7.1** Update the airfield layout based upon aircraft operational requirements, pavement condition assessment, and results of field test data.

**2-7.1.1** For expedient evaluations, because of the limited number of tests, enter each DCP test location on the PPD. The weakest test location on the runway is the controlling test for the runway and will be used to determine the runway load-bearing capability. This is true in any case where multiple tests are performed on a given area (taxiway or apron).

**2-7.1.2** For sustainment or permanent evaluations, distinguish each feature by the characteristics of pavement type, thickness, and condition; subsurface layer types, thicknesses, and strengths; construction history; pavement use; and traffic type (see Figure 2-2). One method to consolidate the cross-section or pavement system profile data obtained from field tests and construction history into specific features is to:

**2-7.1.2.1** Arrange pavement and soil profile data in relation to the actual test locations on the airfield. This will show the range of values and relationship of any given test location data to that at adjacent test locations.

**2-7.1.2.2** Group those containing common characteristics into features.

**2-7.1.2.3** Establish the representative profile for each feature. In most cases, select the CBR values for a feature to be a low average (85% of average but never lower than the lowest measured CBRs) of those collected from all the test locations within the feature, but this is not always true. Conditions are seldom uniform. Use sound engineering judgment.

**2-7.2** Compile the characteristics for test location (expedient evaluation) or section (sustainment or permanent evaluation) into the Summary of PPD. This information will be used to determine the AGLs and/or allowable passes for the airfield (see Figure 2-45). Fill out the PPD as follows**:**

### 2-7.2.1 Facility, Section.

For expedient evaluations, enter the test location number. For sustainment or permanent evaluations, enter the section designation.

### 2-7.2.2 Facility, Ident.

Area designation, e.g., Runway 09/27, Taxiway C, Transient Apron.

### 2-7.2.3 Facility, Cond.

Enter the surface PCI condition rating.

### 2-7.2.4 Pavement, Thick.

Enter the thickness in inches of each layer of pavement.

### 2-7.2.5 Pavement, Descrip.

Enter the pavement type (see paragraph 2-2.2.1) of each layer of pavement. If evaluating a semi-prepared or unsurfaced airfield, do not enter anything in the pavement fields. Enter the surface layer as the base course.

### 2-7.2.6 Pavement, Flex.

If evaluating as a rigid pavement, enter the flexural strength. If evaluating as a flexible pavement, no entry is required.

### 2-7.2.7 Base Course, Thick.

Enter the thickness in inches of each soil layer measured, beginning with the soil layer immediately under the pavement layer and progressing downward to the subgrade.

### 2-7.2.8 Base Course, Descrip.

Enter the USCS soil type (see Appendix A), if known, for each soil layer, beginning with the soil layer immediately under the pavement layer and progressing downward to the subgrade. If uncertain of the USCS soil types, do not use USCS symbols but describe the soils.

### 2-7.2.9 Base Course, K or CBR.

Enter the measured strength of each soil layer. **If a feature or test location is evaluated as a flexible (asphalt) or semi-prepared pavement, CBR values are recorded in this column. If the feature or test location is evaluated as a rigid (concrete) pavement, K-values are recorded in this column.**

### 2-7.2.10 Subgrade Type.

Enter the USCS soil type (see Appendix A), if known, for the subgrade soil. If uncertain of USCS soil type, do not use a USCS symbol but describe the soil.

### 2-7.2.11 Subgrade, K or CBR.

Enter the measured subgrade strength. **If a feature or test location is evaluated as a flexible (asphalt) or semi-prepared pavement, CBR values are recorded in this column. If the feature or test location is evaluated as a rigid (concrete) pavement, K-values are recorded in this column.**

**Figure 2-45 Summary of PPD Sheet**

| Summary of Physical Property Data | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FACILITY | | | PAVEMENT | | | BASE COURSE | | | SUBBASE | | | SUBGRADE | | Eval Eff K |
| **Section** | **Ident** | **Cond** | **Thick (in)** | **Type** | **Flex (psi)** | **Thick (in)** | **Type** | **K or CBR** | **Thick (in)** | **Type** | **K or CBR** | **Type** | **K or CBR** | |
| **R01A** | **Runway 03/21** | **Fair** | **9** | **PCC** | **700** | **10** | **GP** | **400** | **16** | **SM** | **200** | **SM** | **150** | **250** |
| **R02A** | **Runway 03/21** | **Fair** | **4** | **AC** | | **12** | **GP** | **90** | **14** | **SM** | **40** | **SC** | **10** | |
| **R03A** | **Runway 03/21** | **Fair** | **9** | **PCC** | **700** | **10** | **GP** | **400** | **16** | **SM** | **200** | **SC** | **100** | **220** |
| **T01A** | **Taxiway B** | **Fair** | **3.5** | **AC** | | **18** | **Crushed Gravel** | **90** | **5** | **Silty Sand** | **30** | **Soft Clay** | **5** | |
| **A01B** | **North Apron** | **Fair** | **10** | **PCC** | **700** | **12** | **Unk** | | | | | **Unk** | **200** | **200** |

**Note:** Only one K-value is entered on the PPD for a given feature. Once the K-values and, in turn, effective K-values for each layer are computed, the initially computed K-value for the controlling layer or layer that produces the lowest effective K-value is entered on the PPD for that layer.

## 2-8 DETERMINE AGLS/ALLOWABLE PASSES.

### 2-8.1 Semi-prepared (Unsurfaced, Expedient-Surfaced, or Aggregate-Surfaced) Airfields.

Two steps are required to manually evaluate semi-prepared airfields: first, evaluate for the strength of the surface layer; second, evaluate for the thickness of the surface layer and the strengths and thicknesses of underlying layers.

#### 2-8.1.1 Evaluate Surface Layer Strength.

- Select the soil surface strength requirements chart for the desired aircraft from Appendix D.
- Enter the left of the chart at the measured CBR of the surface layer and project a line horizontally to intersect with the appropriate aircraft weight.
- At that point, project a line down vertically to determine the number of passes the surface layer will support.

#### 2-8.1.2 Evaluate Surface Layer Thickness.

- Select the chart from Appendix D for the desired aircraft.
- Using the layer data from the PPD, enter the top of the chart with the thickness of the surface layer. Draw a vertical line (Line 1) downward through the aircraft pass levels. Also enter the bottom of the chart at the desired gross weight; draw a line vertically to the curve depicting the CBR of the layer immediately beneath the surface layer, then horizontally to intersect Line 1. This point of intersection defines the allowable number of passes. If this number is equal to or exceeds the number of passes

computed during the evaluation of the surface layer strength, then the thickness of the surface layer is adequate. If not, use the lower number of passes.

**Note:** This step evaluates the layer immediately beneath the surface layer as well as the thickness of the surface layer.

### 2-8.1.3 Evaluate Remaining Subsurface Layers.

Repeat this procedure for each soil layer. Enter the top of the chart with the thickness above the layer being evaluated and use the CBR of the layer being evaluated. **The layer that produces the lowest allowable number of passes is the controlling layer for the evaluation.**

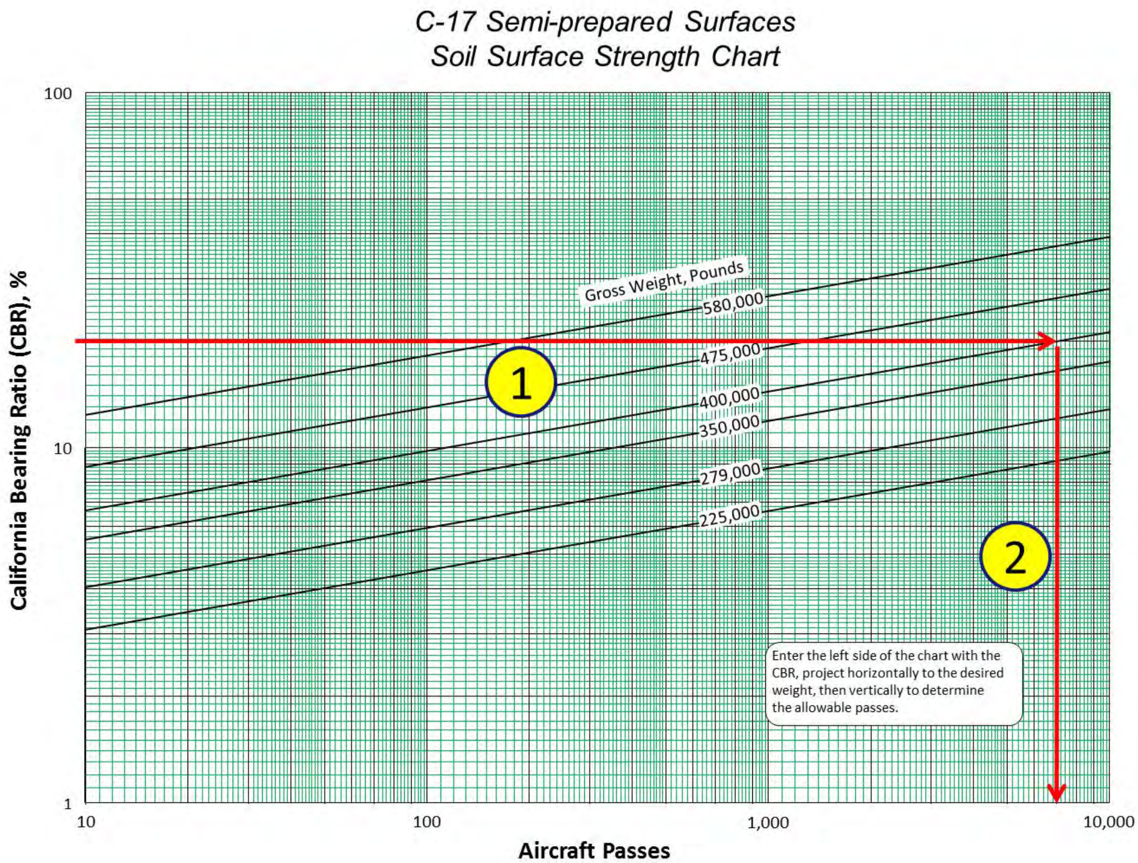
**Example:** Determine the allowable number of passes for a 400,000-pound C-17 aircraft on the following soil cross-section:

- 6-inch aggregate surface course, CBR 20
- 10-inch subbase course, CBR 15
- Subgrade, CBR 5

**Solution:**

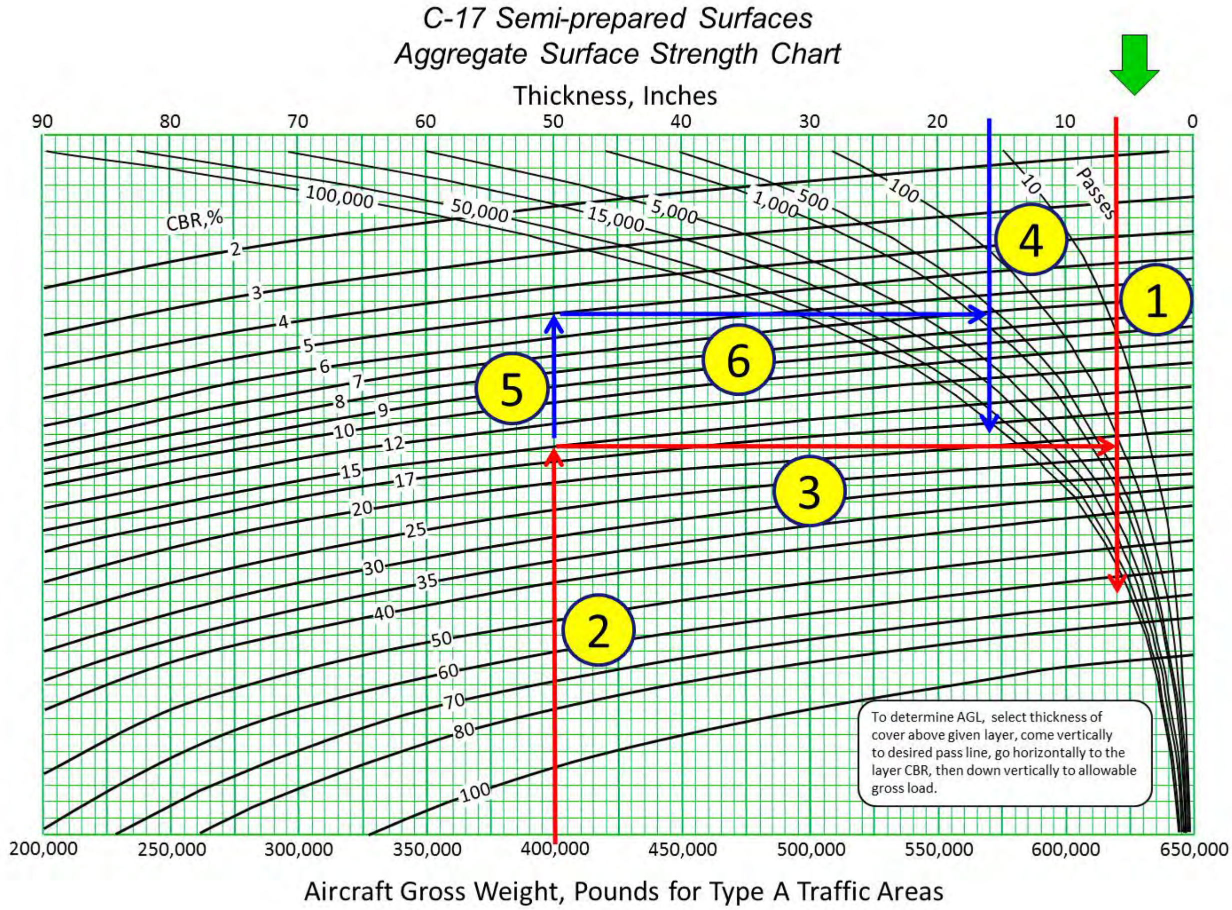
- Step 1. Evaluate surface course strength (see Figure 2-46):
  - Select the soil surface strength requirements chart for the C-17 (Appendix D).
  - Enter the chart at 20 CBR (strength of surface layer) and project a line until it intersects with 400,000 pounds (Line 1).
  - At this point, project a vertical line downward to read approximately 7,000 passes (Line 2).

**Figure 2-46 Example Evaluation of Surface Strength on Semi-prepared Airfield for C-17 Operations**




- Step 2. Evaluate surface layer thickness (see Figure 2-47):
  - o Select the aggregate surfaced evaluation chart for the C-17 (Appendix D).
  - o Enter the top of the chart at 6 inches (thickness of soil layer above the layer being evaluated) drawing a vertical line (Line 1) downward through the aircraft pass curves.
  - o Enter the bottom of the chart at 400,000 pounds and draw a vertical line (Line 2) up to the 15 CBR (strength of the layer being evaluated) curve, then horizontally (Line 3) to intersect with Line 1.
  - o The point of intersection indicates an allowable pass number of approximately 200.

**Figure 2-47 Example Evaluation of Subsurface Layers on Semi-prepared Airfield for C-17 Operations**




- Step 3. Evaluate the subgrade:
  - o Enter the top of the chart at 16 inches (combined thickness of both soil layers above the layer being evaluated) drawing a vertical line (Line 4) downward through the aircraft passes.
  - o Enter the bottom of the chart at 400,000 pounds and draw a vertical line (Line 5) up to the 5 CBR (strength of the layer being evaluated) curve, then horizontally (Line 6) to intersect with Line 4.
  - o The point of intersection indicates an allowable pass number of approximately 700.
- In this example, the subbase layer results in the lowest allowable number of passes. The maximum allowable number of C-17 passes at a gross weight of 400,000 pounds is 200.

**2-8.1.4 PCASE Software.**

Semi-prepared airfields may also be evaluated for various aircraft using the Pavement Computer Aided Structural Engineering (PCASE) software program. Careful analysis of the DCP data is required to ensure the layer data entered in the program represents the data determined in the field.

**2-8.2 Flexible Pavement Surfaced Airfields.**

Flexible pavement systems may be evaluated manually using the flexible pavement evaluation curves in Appendix E.

**2-8.2.1 Evaluation Procedures to Determine Allowable Passes.**

**2-8.2.1.1** Select the chart for the desired aircraft and traffic area from Appendix E.

**2-8.2.1.2** Using the layer data from the PPD, enter the top of the chart with the thickness to the surface above the layer being evaluated. Follow downward to the appropriate gross weight curve, then horizontally to the curve corresponding to the CBR of the layer being evaluated. Then follow downward to determine the allowable number of aircraft passes.

**2-8.2.1.3** Repeat this procedure for each soil layer. **The layer that produces the lowest allowable number of passes is the controlling layer for the evaluation.**

**Example:** Determine the AGL of a C-17 operating for 50,000 passes on an “A” traffic area pavement section with the following pavement profile:

- 3-inch flexible pavement surface layer
- 8-inch base course layer with a CBR of 80
- 13-inch subbase layer with a CBR of 30
- Subgrade layer with a CBR of 6

**Solution:**

- Select Figure 2-48 because the pavement section is located in an “A” traffic area.
- Select the AGL chart for the C-17.
- Determine the limiting stress for each layer in the pavement section.
    - o From Figure 2-48, based upon the C-17 and 50,000 passes, the limiting stress value is 2.56.
    - o Multiply the base course layer CBR (80) by 2.56. The limiting stress for this layer is 204.8.

- o Multiply the subbase layer CBR (30) by 2.56. The limiting stress for this layer is 76.8.
- o Multiply the subbase layer CBR (6) by 2.56. The limiting stress for this layer is 15.4.

**Figure 2-48 Limiting Stress Values for Traffic Area "A" Flexible Pavements**

| TRAFFIC AREA "A" -- LIMITING STRESS (PSI) = (Value from Table) Multiplied by (CBR) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aircraft | Passes | | | | | | | | | | | | | | | |
| | 1 | 5 | 10 | 50 | 100 | 500 | 1,000 | 3,000 | 5,000 | 10,000 | 30,000 | 50,000 | 100,000 | 300,000 | 500,000 | 1,000,000 |
| AF Group 1 | 25.21 | 13.30 | 10.77 | 7.27 | 6.34 | 4.86 | 4.42 | 3.86 | 3.65 | 3.40 | 3.07 | 2.94 | 2.78 | 2.57 | 2.49 | 2.38 |
| AF Group 2 | 23.92 | 12.83 | 10.44 | 7.11 | 6.21 | 4.78 | 4.35 | 3.81 | 3.60 | 3.36 | 3.04 | 2.91 | 2.76 | 2.55 | 2.47 | 2.36 |
| AF Group 3 | 17.12 | 10.17 | 8.52 | 6.11 | 5.42 | 4.30 | 3.95 | 3.50 | 3.33 | 3.12 | 2.85 | 2.74 | 2.61 | 2.43 | 2.35 | 2.26 |
| AF Group 4 | 14.56 | 9.06 | 7.70 | 5.65 | 5.06 | 4.07 | 3.76 | 3.35 | 3.19 | 3.01 | 2.75 | 2.65 | 2.53 | 2.36 | 2.29 | 2.21 |
| AF Group 5 | 18.37 | 10.69 | 8.90 | 6.31 | 5.58 | 4.40 | 4.03 | 3.57 | 3.39 | 3.17 | 2.89 | 2.78 | 2.64 | 2.45 | 2.38 | 2.28 |
| AF Group 6 | 17.11 | 10.17 | 8.52 | 6.10 | 5.42 | 4.30 | 3.95 | 3.50 | 3.33 | 3.12 | 2.85 | 2.74 | 2.61 | 2.43 | 2.35 | 2.26 |
| AF Group 7 | 15.89 | 9.65 | 8.14 | 5.89 | 5.25 | 4.19 | 3.86 | 3.43 | 3.27 | 3.07 | 2.81 | 2.70 | 2.57 | 2.40 | 2.32 | 2.23 |
| AF Group 8 | 13.03 | 8.36 | 7.18 | 5.35 | 4.82 | 3.91 | 3.62 | 3.25 | 3.10 | 2.92 | 2.69 | 2.59 | 2.48 | 2.32 | 2.25 | 2.17 |
| AF Group 9 | 13.21 | 8.45 | 7.24 | 5.39 | 4.85 | 3.93 | 3.64 | 3.26 | 3.11 | 2.93 | 2.70 | 2.60 | 2.48 | 2.32 | 2.26 | 2.17 |
| AF Group10 | 12.27 | 8.01 | 6.91 | 5.20 | 4.69 | 3.83 | 3.55 | 3.19 | 3.05 | 2.88 | 2.65 | 2.56 | 2.45 | 2.29 | 2.23 | 2.15 |
| AF Group 11 | 10.49 | 7.13 | 6.23 | 4.80 | 4.36 | 3.61 | 3.37 | 3.04 | 2.92 | 2.76 | 2.56 | 2.47 | 2.37 | 2.22 | 2.16 | 2.09 |
| AF Group 12 | 13.09 | 8.39 | 7.20 | 5.37 | 4.83 | 3.92 | 3.63 | 3.25 | 3.11 | 2.93 | 2.69 | 2.60 | 2.48 | 2.32 | 2.25 | 2.17 |
| AF Group 13 | 12.75 | 8.23 | 7.08 | 5.30 | 4.77 | 3.88 | 3.60 | 3.23 | 3.08 | 2.91 | 2.68 | 2.58 | 2.47 | 2.31 | 2.24 | 2.16 |
| AF Group 14 | 13.05 | 8.37 | 7.18 | 5.36 | 4.82 | 3.91 | 3.62 | 3.25 | 3.10 | 2.93 | 2.69 | 2.59 | 2.48 | 2.32 | 2.25 | 2.17 |
| A-10 | 23.87 | 12.82 | 10.43 | 7.10 | 6.21 | 4.78 | 4.35 | 3.81 | 3.60 | 3.36 | 3.04 | 2.91 | 2.76 | 2.55 | 2.47 | 2.36 |
| C-5 | 10.49 | 7.13 | 6.23 | 4.80 | 4.36 | 3.61 | 3.37 | 3.04 | 2.92 | 2.76 | 2.56 | 2.47 | 2.37 | 2.22 | 2.16 | 2.09 |
| C-12J | 22.79 | 12.41 | 10.14 | 6.96 | 6.09 | 4.71 | 4.29 | 3.77 | 3.57 | 3.33 | 3.01 | 2.89 | 2.74 | 2.53 | 2.45 | 2.35 |
| C-17 | 12.27 | 8.01 | 6.91 | 5.20 | 4.69 | 3.83 | 3.55 | 3.19 | 3.05 | 2.88 | 2.65 | 2.56 | 2.45 | 2.29 | 2.23 | 2.15 |
| C-130H | 14.30 | 8.94 | 7.61 | 5.60 | 5.02 | 4.04 | 3.73 | 3.33 | 3.18 | 2.99 | 2.74 | 2.64 | 2.52 | 2.35 | 2.28 | 2.20 |
| C-130J | 14.59 | 9.07 | 7.71 | 5.66 | 5.06 | 4.07 | 3.76 | 3.35 | 3.20 | 3.01 | 2.76 | 2.65 | 2.53 | 2.36 | 2.29 | 2.21 |
| CH-47 | 18.46 | 10.72 | 8.93 | 6.32 | 5.60 | 4.41 | 4.04 | 3.57 | 3.39 | 3.18 | 2.89 | 2.78 | 2.64 | 2.45 | 2.38 | 2.28 |
| CV-22 | 19.61 | 11.19 | 9.27 | 6.50 | 5.74 | 4.50 | 4.11 | 3.63 | 3.44 | 3.22 | 2.93 | 2.81 | 2.67 | 2.48 | 2.40 | 2.30 |
| E-3 | 13.46 | 8.56 | 7.33 | 5.44 | 4.89 | 3.96 | 3.66 | 3.28 | 3.13 | 2.95 | 2.71 | 2.61 | 2.49 | 2.33 | 2.26 | 2.18 |
| F-14 | 23.70 | 12.75 | 10.38 | 7.08 | 6.19 | 4.77 | 4.34 | 3.80 | 3.60 | 3.35 | 3.03 | 2.91 | 2.76 | 2.55 | 2.47 | 2.36 |
| F-15D | 25.82 | 13.52 | 10.92 | 7.35 | 6.40 | 4.90 | 4.45 | 3.88 | 3.67 | 3.41 | 3.08 | 2.95 | 2.79 | 2.58 | 2.49 | 2.39 |
| F-15E | 24.14 | 12.91 | 10.49 | 7.13 | 6.23 | 4.80 | 4.36 | 3.82 | 3.61 | 3.37 | 3.05 | 2.92 | 2.76 | 2.56 | 2.47 | 2.37 |
| F-16 | 28.99 | 14.61 | 11.67 | 7.71 | 6.68 | 5.07 | 4.58 | 3.98 | 3.75 | 3.49 | 3.14 | 3.01 | 2.84 | 2.62 | 2.53 | 2.42 |
| KC-10 | 13.57 | 8.61 | 7.36 | 5.46 | 4.90 | 3.97 | 3.67 | 3.29 | 3.14 | 2.95 | 2.71 | 2.61 | 2.50 | 2.33 | 2.26 | 2.18 |
| KC-46 | 13.51 | 8.58 | 7.34 | 5.44 | 4.93 | 3.97 | 3.66 | 3.28 | 3.13 | 2.95 | 2.71 | 2.61 | 2.50 | 2.33 | 2.26 | 2.18 |
| KC-135 | 13.21 | 8.45 | 7.24 | 5.39 | 4.85 | 3.93 | 3.64 | 3.26 | 3.11 | 2.93 | 2.70 | 2.60 | 2.48 | 2.32 | 2.25 | 2.17 |
| OV-1 | 25.62 | 13.45 | 10.87 | 7.32 | 6.38 | 4.89 | 4.44 | 3.87 | 3.66 | 3.41 | 3.08 | 2.95 | 2.79 | 2.58 | 2.49 | 2.39 |
| P-3C | 17.02 | 10.13 | 8.49 | 6.09 | 5.41 | 4.29 | 3.94 | 3.50 | 3.32 | 3.12 | 2.85 | 2.74 | 2.60 | 2.42 | 2.35 | 2.26 |
| UH-60 | 29.31 | 14.73 | 11.76 | 7.76 | 6.72 | 5.08 | 4.60 | 4.00 | 3.77 | 3.50 | 3.15 | 3.01 | 2.85 | 2.63 | 2.53 | 2.42 |
| Note: Values in the table represent the limiting stress for a CBR=1.0. To determine the limiting stress for other values of CBR, multiply the chart value by the CBR. Example for CBR=6: For 50,000 passes of the C-17 the value from the table = 2.56. Limiting stress = 2.56 x 6 = 15.36 psi. | | | | | | | | | | | | | | | | |

## Figure 2-49 Limiting Stress Values for Traffic Area "B," "C," "D" Flexible Pavements

TRAFFIC AREA "B, C, D" -- LIMITING STRESS (PSI) = (Value from Table) Multiplied by (CBR)

| Aircraft | Passes | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 5 | 10 | 50 | 100 | 500 | 1,000 | 3,000 | 5,000 | 10,000 | 30,000 | 50,000 | 100,000 | 300,000 | 500,000 | 1,000,000 |
| AF Group 1 | 31.24 | 15.37 | 12.20 | 7.97 | 6.88 | 5.18 | 4.68 | 4.05 | 3.82 | 3.54 | 3.19 | 3.05 | 2.88 | 2.65 | 2.56 | 2.44 |
| AF Group 2 | 29.01 | 14.63 | 11.69 | 7.72 | 6.69 | 5.07 | 4.59 | 3.99 | 3.76 | 3.49 | 3.15 | 3.01 | 2.84 | 2.62 | 2.53 | 2.42 |
| AF Group 3 | 22.25 | 12.21 | 10.00 | 6.88 | 6.04 | 4.68 | 4.26 | 3.74 | 3.55 | 3.31 | 3.00 | 2.88 | 2.73 | 2.53 | 2.44 | 2.34 |
| AF Group 4 | 18.68 | 10.81 | 9.00 | 6.36 | 5.62 | 4.43 | 4.05 | 3.58 | 3.40 | 3.19 | 2.90 | 2.79 | 2.65 | 2.46 | 2.38 | 2.29 |
| AF Group 5 | 24.20 | 12.93 | 10.51 | 7.14 | 6.24 | 4.80 | 4.37 | 3.82 | 3.61 | 3.37 | 3.05 | 2.92 | 2.77 | 2.56 | 2.47 | 2.37 |
| AF Group 6 | 22.06 | 12.14 | 9.95 | 6.86 | 6.02 | 4.67 | 4.26 | 3.74 | 3.54 | 3.30 | 2.99 | 2.87 | 2.72 | 2.52 | 2.44 | 2.34 |
| AF Group 7 | 20.31 | 11.46 | 9.46 | 6.60 | 5.82 | 4.55 | 4.15 | 3.66 | 3.47 | 3.25 | 2.95 | 2.83 | 2.69 | 2.49 | 2.41 | 2.31 |
| AF Group 8 | 15.87 | 9.64 | 8.13 | 5.89 | 5.25 | 4.19 | 3.86 | 3.43 | 3.27 | 3.07 | 2.81 | 2.70 | 2.57 | 2.40 | 2.32 | 2.23 |
| AF Group 9 | 15.58 | 9.51 | 8.04 | 5.84 | 5.21 | 4.16 | 3.84 | 3.41 | 3.25 | 3.06 | 2.79 | 2.69 | 2.56 | 2.39 | 2.32 | 2.23 |
| AF Group10 | 13.60 | 8.63 | 7.38 | 5.47 | 4.91 | 3.97 | 3.67 | 3.29 | 3.14 | 2.96 | 2.71 | 2.62 | 2.50 | 2.33 | 2.27 | 2.18 |
| AF Group 11 | 11.25 | 7.51 | 6.52 | 4.97 | 4.51 | 3.71 | 3.45 | 3.11 | 2.98 | 2.82 | 2.60 | 2.51 | 2.40 | 2.25 | 2.19 | 2.11 |
| AF Group 12 | 14.97 | 9.24 | 7.84 | 5.73 | 5.12 | 4.11 | 3.79 | 3.38 | 3.22 | 3.03 | 2.77 | 2.67 | 2.54 | 2.37 | 2.30 | 2.21 |
| AF Group 13 | 14.28 | 8.93 | 7.61 | 5.60 | 5.02 | 4.04 | 3.73 | 3.33 | 3.18 | 2.99 | 2.74 | 2.64 | 2.52 | 2.35 | 2.28 | 2.20 |
| AF Group 14 | 13.72 | 8.68 | 7.42 | 5.49 | 4.93 | 3.98 | 3.68 | 3.30 | 3.14 | 2.96 | 2.72 | 2.62 | 2.50 | 2.34 | 2.27 | 2.18 |
| A-10 | 33.95 | 16.24 | 12.79 | 8.25 | 7.09 | 5.30 | 4.78 | 4.13 | 3.89 | 3.60 | 3.23 | 3.09 | 2.91 | 2.68 | 2.58 | 2.47 |
| C-5 | 11.24 | 7.31 | 6.52 | 4.97 | 4.51 | 3.71 | 3.45 | 3.11 | 2.98 | 2.82 | 2.60 | 2.51 | 2.40 | 2.25 | 2.19 | 2.11 |
| C-12J | 31.87 | 15.58 | 12.34 | 8.04 | 6.93 | 5.21 | 4.70 | 4.07 | 3.84 | 3.56 | 3.20 | 3.06 | 2.88 | 2.65 | 2.56 | 2.45 |
| C-17 | 13.60 | 8.63 | 7.38 | 5.47 | 4.91 | 3.97 | 3.67 | 3.29 | 3.14 | 2.96 | 2.71 | 2.62 | 2.50 | 2.33 | 2.27 | 2.18 |
| C-130H | 18.29 | 10.65 | 8.88 | 6.30 | 5.57 | 4.39 | 4.03 | 3.56 | 3.38 | 3.17 | 2.89 | 2.78 | 2.64 | 2.45 | 2.37 | 2.28 |
| C-130J | 18.72 | 10.83 | 9.01 | 6.36 | 5.63 | 4.43 | 4.06 | 3.59 | 3.40 | 3.19 | 2.90 | 2.79 | 2.65 | 2.46 | 2.38 | 2.29 |
| CH-47 | 22.89 | 12.45 | 10.17 | 6.97 | 6.10 | 4.72 | 4.30 | 3.77 | 3.57 | 3.33 | 3.02 | 2.89 | 2.74 | 2.54 | 2.45 | 2.35 |
| CV-22 | 20.28 | 11.45 | 9.46 | 6.60 | 5.82 | 4.54 | 4.15 | 3.66 | 3.47 | 3.24 | 2.95 | 2.83 | 2.69 | 2.49 | 2.41 | 2.31 |
| E-3 | 16.45 | 9.89 | 8.32 | 5.99 | 5.33 | 4.24 | 3.90 | 3.47 | 3.30 | 3.09 | 2.83 | 2.72 | 2.59 | 2.41 | 2.34 | 2.25 |
| F-14 | 33.58 | 16.13 | 12.71 | 8.21 | 7.06 | 5.29 | 4.76 | 4.12 | 3.88 | 3.59 | 3.22 | 3.08 | 2.91 | 2.67 | 2.58 | 2.46 |
| F-15D | 31.60 | 15.49 | 12.28 | 8.01 | 6.91 | 5.20 | 4.69 | 4.06 | 3.83 | 3.55 | 3.19 | 3.05 | 2.88 | 2.65 | 2.56 | 2.45 |
| F-15E | 29.31 | 14.73 | 11.76 | 7.76 | 6.71 | 5.08 | 4.60 | 4.00 | 3.77 | 3.80 | 3.15 | 3.01 | 2.85 | 2.63 | 2.54 | 2.42 |
| F-16 | 34.20 | 16.31 | 12.83 | 8.27 | 7.11 | 5.31 | 4.78 | 4.13 | 3.89 | 3.60 | 3.23 | 3.08 | 2.91 | 2.67 | 2.58 | 2.47 |
| KC-10 | 15.56 | 9.50 | 8.03 | 5.84 | 5.21 | 4.16 | 3.83 | 3.41 | 3.25 | 3.05 | 2.79 | 2.69 | 2.56 | 2.39 | 2.32 | 2.23 |
| KC-46 | 16.00 | 9.70 | 8.17 | 5.92 | 5.27 | 4.20 | 3.87 | 3.44 | 3.27 | 3.07 | 2.81 | 2.70 | 2.57 | 2.40 | 2.33 | 2.24 |
| KC-135 | 16.10 | 9.73 | 8.20 | 5.93 | 5.28 | 4.21 | 3.88 | 3.44 | 3.28 | 3.08 | 2.81 | 2.71 | 2.58 | 2.40 | 2.33 | 2.24 |
| OV-1 | 31.56 | 15.48 | 12.27 | 8.00 | 6.90 | 5.19 | 4.69 | 4.06 | 3.83 | 3.55 | 3.19 | 3.05 | 2.88 | 2.65 | 2.56 | 2.45 |
| P-3C | 22.00 | 12.11 | 9.93 | 6.85 | 6.01 | 4.66 | 4.25 | 3.73 | 3.54 | 3.30 | 2.99 | 2.87 | 2.72 | 2.52 | 2.44 | 2.34 |
| UH-60 | 36.07 | 16.91 | 13.23 | 8.46 | 7.25 | 5.39 | 4.85 | 4.18 | 3.93 | 3.64 | 3.26 | 3.11 | 2.94 | 2.70 | 2.60 | 2.48 |

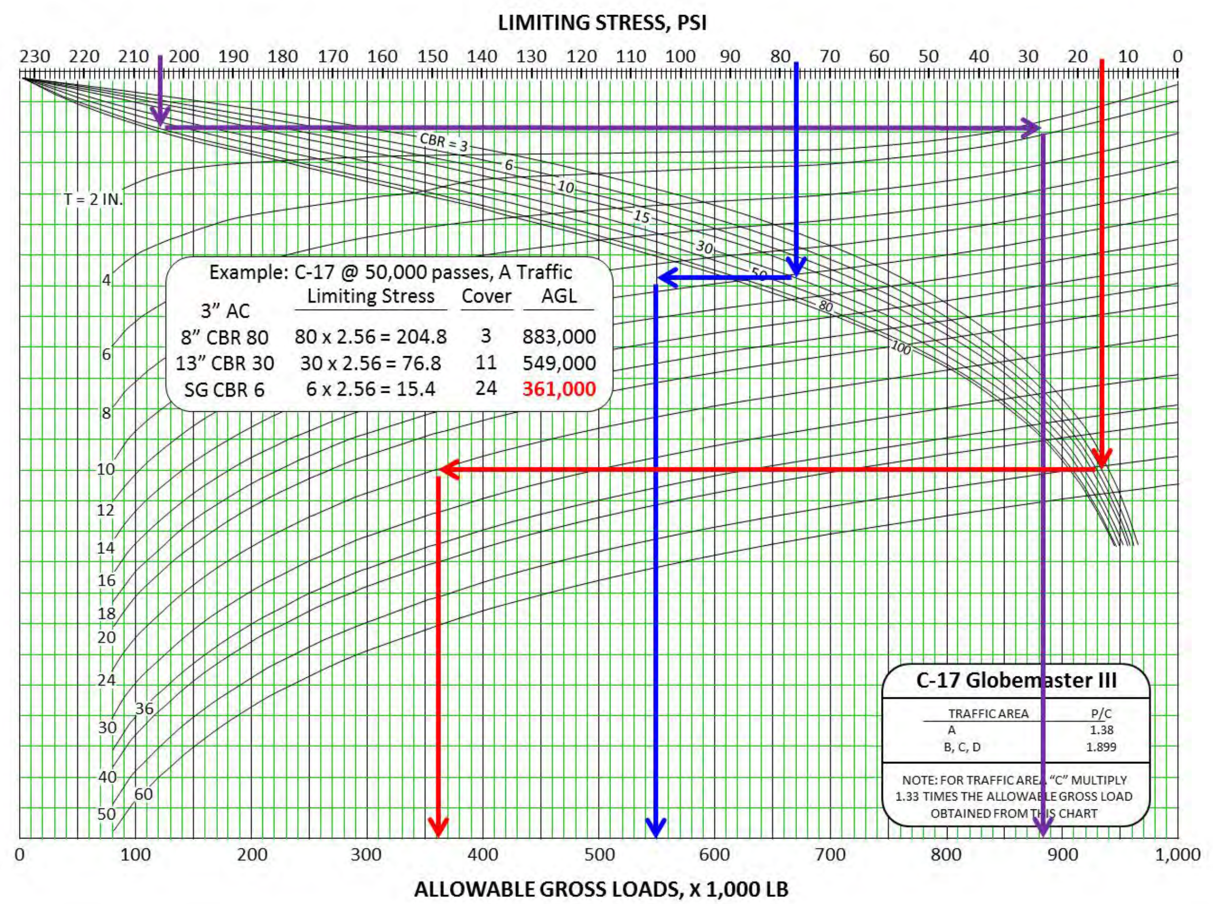
Notes: 1. Values in the table represent the limiting stress for a CBR=1.0. To determine the limiting stress for other values of CBR, multiply the chart value by the CBR. Example for CBR=6: For 50,000 passes of the C-17 the value from the table = 2.62. Limiting stress = 2.62 x 6 = 15.72 psi.

2. Multiply "B" traffic area AGL x 1.33 to obtain "C" traffic area AGL.

- Evaluate the base course layer. Enter the top of the chart (Figure 2-50) with the limiting stress (204.8) and project a line downward to the CBR (80), then horizontally until it intersects the 3 inch (the cover above the CBR 80) curve. Then project a line downward to determine an AGL of approximately 883,000 pounds for this layer.

- Evaluate the subbase layer. Enter the top of the chart (Figure 2-50) with the limiting stress (76.8) and project a line downward to the CBR (30), then horizontally until it intersects the 11 inch (the total cover above the CBR 30) curve. Then project a line downward to determine an AGL of approximately 549,000 pounds for this layer.
- Evaluate the subgrade layer. Enter the top of the chart (Figure 2-50) with the limiting stress (15.4) and project a line downward to the CBR (6), then horizontally until it intersects the 24 inch (the total cover above the CBR 6) curve. Then project a line downward to determine an AGL of approximately 361,000 pounds for this layer.
- In this example, the subgrade layer results in the lowest AGL rating. The C-17 can operate for 50,000 passes on this pavement section at an AGL of 361,000 pounds.

**Figure 2-50 Example AGL Determination for C-17 Operations on Flexible Pavements**



**2-8.2.2 Evaluation Procedures to Determine Allowable Passes.**

**2-8.2.2.1** Select the appropriate tables and charts for the desired aircraft and traffic area from Appendix E.

**2-8.2.2.2** Determine the limiting stress for each layer in the pavement structure using the aircraft-specific Allowable Gross Load chart. Enter the bottom of the chart with the AGL of the aircraft. If evaluating for type “C” traffic areas, multiply the AGL of the aircraft by 0.75 to determine the correct AGL for a “C” traffic area. Project a line from the AGL upward until it intersects the thickness of total cover above the layer being evaluated, then horizontally to intersect the appropriate CBR curve. At this intersection, extend a line upward to determine the limiting stress for that particular layer.

**2-8.2.2.3** Repeat this procedure for each identified soil layer.

**2-8.2.2.4** Divide the limiting stress values of each layer by the respective layer CBRs to determine the correct values to use on the aircraft-specific Allowable Passes Chart. Enter the allowable passes chart on the left side with the value determined by dividing the limiting stress by the CBR and project a line horizontally until it intersects the correct traffic type curve. At this point project a line downward to determine the allowable passes for that layer.

**2-8.2.2.5** Repeat this procedure for each layer in the pavement structure. The layer that produces the lowest number of allowable passes is the controlling layer in the evaluation.

**Example:** Determine the allowable passes of a C-17 aircraft with an operating weight of 585,000 pounds on an “A” traffic area with the following flexible pavement profile:

- 3-inch flexible pavement surface layer
- 8-inch base course layer with a CBR of 80
- 13-inch subbase layer with a CBR of 30
- Subgrade layer with a CBR of 6

**Solution:**

- Select the AGL chart (Figure 2-51) for the C-17.
- Select the Allowable Pass chart for the C-17.
- Determine the limiting stress for each layer in the pavement section using the AGL chart.
    - o Enter the bottom of the chart (Figure 2-51) at 585,000 pounds and project a line upward to 24 inches, the total cover above the subgrade layer. Then extend a line horizontally to the CBR 6 curve. At this intersection, extend a line upward to determine the limiting stress (23.7) of the subgrade layer.

   - Enter the bottom of the chart (Figure 2-51) at 585,000 pounds and project a line upward to 11 inches, the total cover above the subbase layer. Then extend a line horizontally to the CBR 30 curve. At this intersection, extend a line upward to determine the limiting stress (80) of the subbase layer.
   - Enter the bottom of the chart (Figure 2-51) at 585,000 pounds and project a line upward to 3 inches, the total cover above the base course layer. Then extend a line horizontally to the CBR 80 curve. At this intersection, extend a line upward to determine the limiting stress (178.7) of the base course layer.

- Determine the values to use in the Allowable Pass Chart.
   - Divide the limiting stress (178.7) of the base course layer by the CBR (80) to obtain a value of 2.34.
   - Divide the limiting stress (80) of the subbase layer by the CBR (30) to obtain a value of 2.67.
   - Divide the limiting stress (23.7) of the subgrade layer by the CBR (6) to obtain a value of 3.95.
- Determine the allowable passes for each layer in the pavement section using the Allowable Pass Chart.
   - Enter the left side of the chart (Figure 2-52) with the base course layer stress/CBR (2.34). Project a line horizontally to the “A” traffic curve, then downward to determine the allowable passes for this layer, approximately 200,000.
   - Enter the left side of the chart (Figure 2-52) with the subbase layer stress/CBR (2.67). Project a line horizontally to the “A” traffic curve, then downward to determine the allowable passes for this layer, approximately 27,500.
   - Enter the left side of the chart (Figure 2-52) with the subgrade layer stress/CBR (3.95). Project a line horizontally to the “A” traffic curve, then downward to determine the allowable passes for this layer, approximately 370.
- In this example, the subgrade layer results in the lowest number of allowable passes. The C-17 can operate for 370 passes on this pavement section at an AGL of 585,000 pounds.

## Figure 2-51 Example Pass Level Determination for C-17 Operations on Flexible Pavements

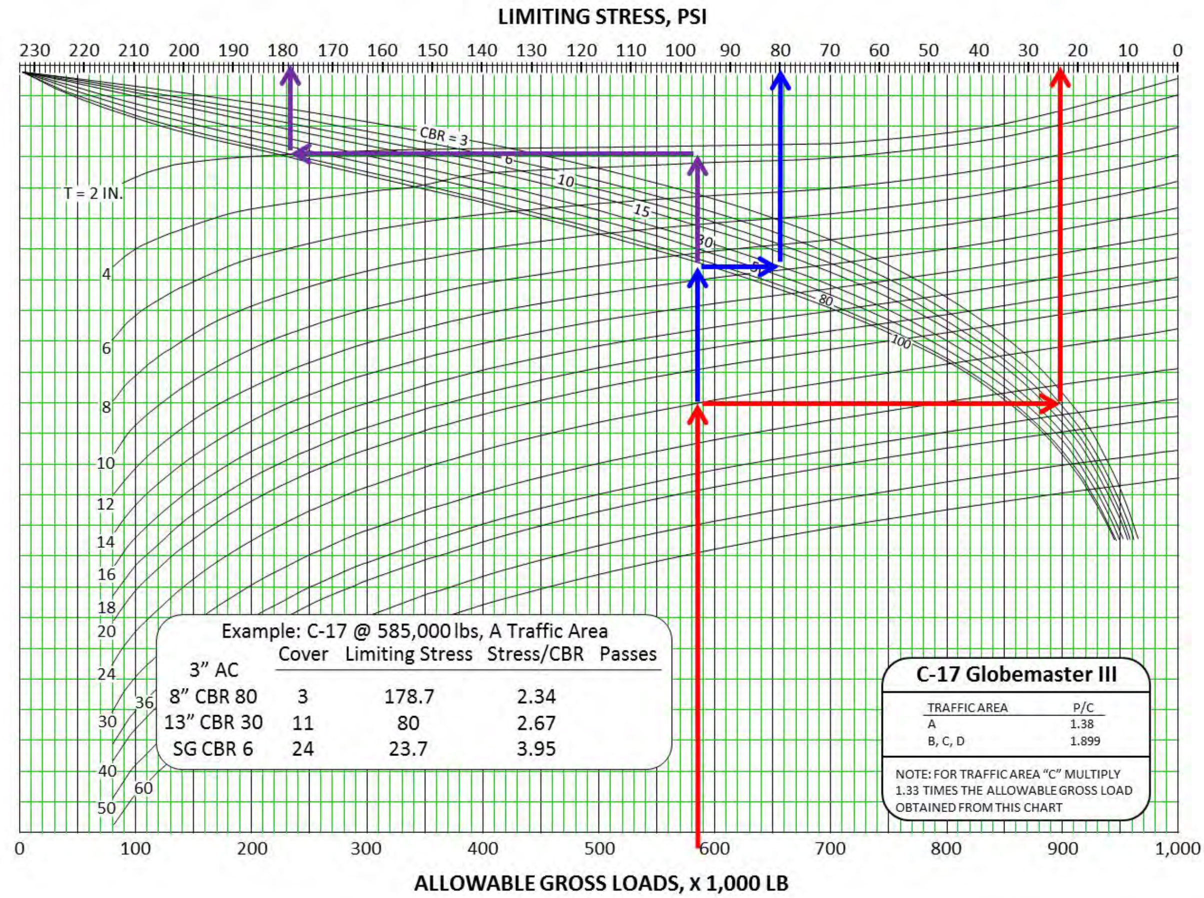
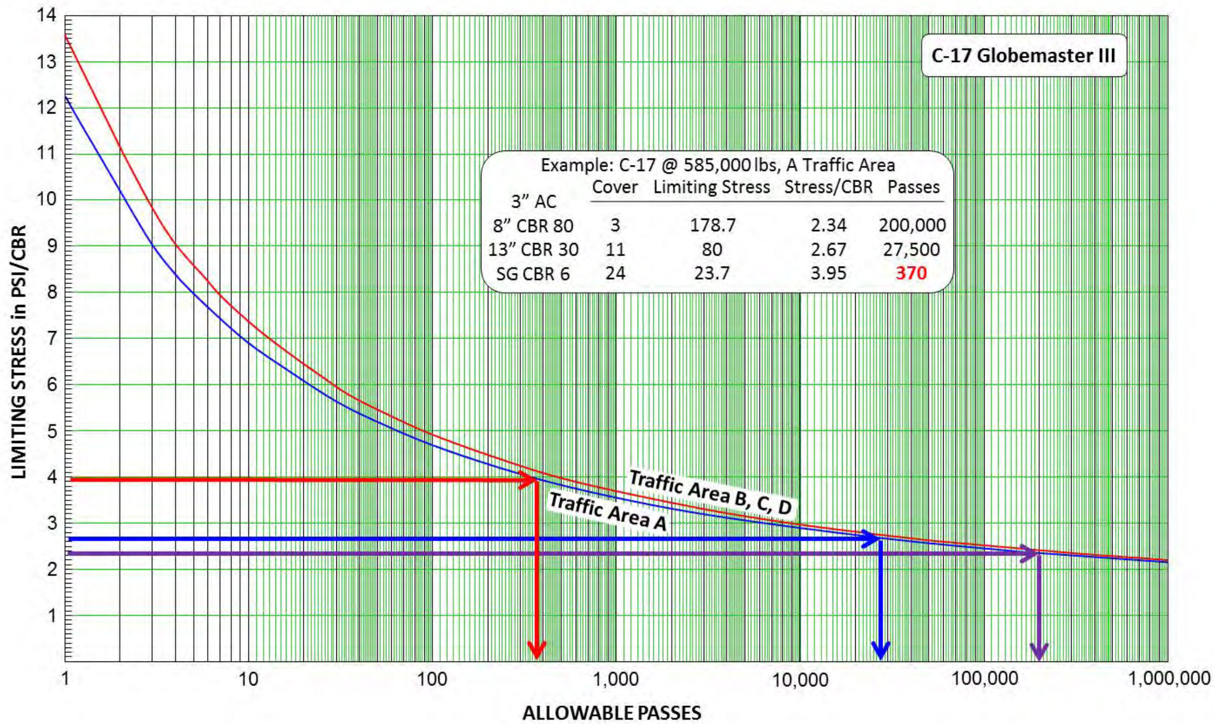


**Figure 2-52 Example Pass Level Determination for C-17 Operations on Flexible Pavements**




### 2-8.2.3 Thickness Adjustments.

**2-8.2.3.1** All of the evaluation curves for flexible pavement that reflect cover or thickness requirements are based upon having a minimum thickness surface layer of very-high-quality material (bituminous surface course), a minimum thickness of strong material (80 or 100 CBR base course) (see Table 2-11), and the remainder of the soil structure being composed of lesser quality subbase material. If the actual layers exceed the thicknesses the curves are based upon, the curves will underestimate the load-bearing potential of the pavement section, so the measured thicknesses are adjusted when evaluating lower pavement layers to take advantage of any excess high-strength materials located above them.

**2-8.2.3.2** If a pavement system has a bituminous surface thickness that exceeds minimum design thickness requirements (Table 2-11) and a base course strength that meets or exceeds the minimum design requirement, the excess thickness of asphalt is converted to an equivalent thickness of base course using the equivalency factors in Table 2-12 and added to the existing thickness of base when evaluating the subbase. If the base course material meets the minimum strength requirements, any resulting excess thickness of base is then converted to an equivalent thickness of subbase material, which is added to the subbase thickness for evaluation of the subgrade.

**2-8.2.3.3** If a pavement system has a bituminous surface thickness that meets minimum design thickness requirements (Table 2-11) and a base course thickness and strength that exceeds minimum design thickness' chart requirements, the excess thickness of base is converted to an equivalent thickness of subbase using the equivalency factors in Table 2-12 and added to the existing thickness of subbase for evaluation of the subgrade. This can only be done if the base course material meets the minimum strength requirements as well.

**Table 2-11 Minimum Design Thicknesses for Flexible Pavements**

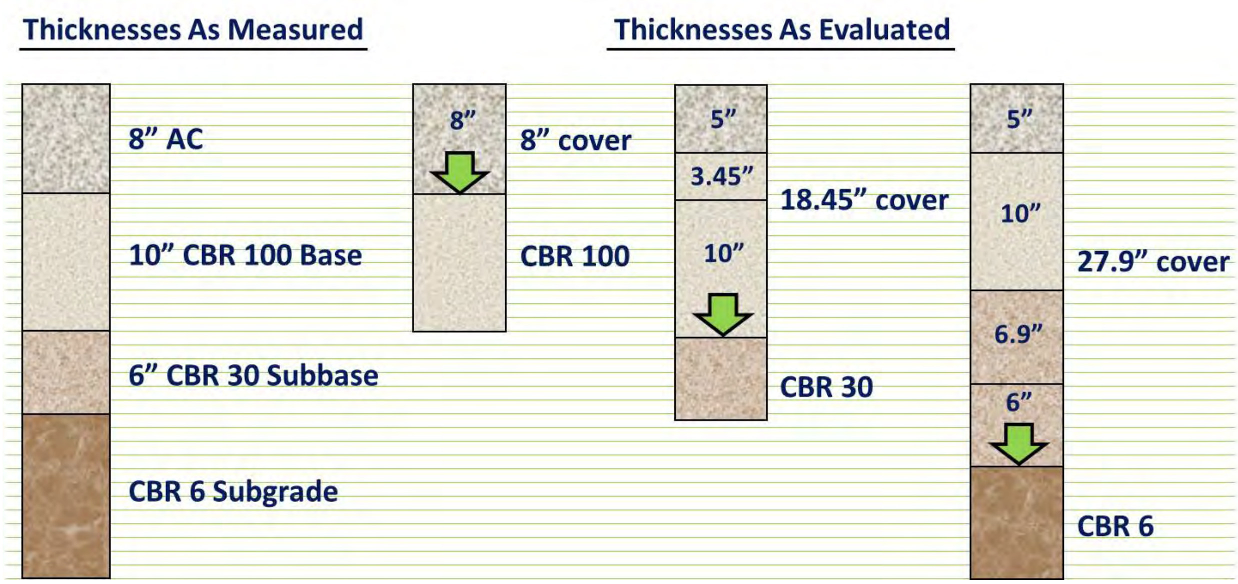
| Airfield Type | Traffic Area | 100 CBR Base | | | 80 CBR Base | | |
|---|---|---|---|---|---|---|---|
| | | Surface | Base | Total | Surface | Base | Total |
| Light load (fighters & trainers) | A/B | 4 | 6 | 10 | 5 | 6 | 11 |
| | C | 3 | 6 | 9 | 4 | 6 | 10 |
| Medium load (C-5, C-17, C-141, KC-135) | A/B | 4 | 6 | 10 | 5 | 6 | 11 |
| | C | 3 | 6 | 9 | 4 | 6 | 10 |
| Heavy load (B-52) | A | 5 | 10 | 15 | 6 | 9 | 15 |
| | B | 4 | 9 | 13 | 6 | 8 | 14 |
| | C | 4 | 9 | 13 | 5 | 8 | 13 |
| Modified heavy load (B-1, KC-10) | A/B | 5 | 8 | 13 | 6 | 8 | 14 |
| | C | 4 | 8 | 12 | 5 | 8 | 13 |
| Shortfield (C-130) | A | 4 | 6 | 10 | 5 | 6 | 11 |
| Auxiliary (F-15, C-27) | A/B/C | 3 | 6 | 9 | 3 | 6 | 9 |
| | All Shoulders | 2 | 6 | 8 | 2 | 6 | 8 |

**Table 2-12 Equivalency Factors for Thickness Adjustments**

| Material | Equivalency Factors | |
|---|---|---|
| | Base | Subbase |
| Unbound crushed stone | 1.00 | 2.00 |
| Unbound subbase | * | 1.00 |
| Asphalt-Stabilized | | |
| All-bituminous concrete | 1.15 | 2.30 |
| GW, GP, GM, GC | 1.00 | 2.00 |
| SW, SP, SM, SC | * | 1.50 |
| Cement-stabilized | | |
| GW, GP, SW, SP | 1.15 | 2.30 |
| GC, GM | 1.00 | 2.00 |
| ML, MH, CL, CH | * | 1.70 |
| SC, SM | * | 1.50 |
| Lime-stabilized | | |
| ML, MH, CL, CH | * | 1.00 |
| SC, SM, GC, GM | * | 1.10 |
| Lime, cement, fly ash stabilized | | |
| ML, MH, CL, CH | * | 1.30 |
| SC, SM, GC, GM | * | 1.40 |

**2-8.2.3.4** These adjusted thicknesses are used to enter the appropriate evaluation charts. For example, a heavy load pavement with 8 inches of asphalt surface, 10 inches of CBR 100 base, and a 6-inch subbase has 3 inches more asphalt than required (Figure 2-53). Consider the excess thickness of the surface course when calculating the depth of the subgrade. Evaluate the subgrade with a 5-inch surface, 10-inch base, and 12.9-inch subbase (3-inch excess surface x 2.3 = 6.9 inches) or a 27.9-inch depth of cover in lieu of the measured 24 inches.

**Figure 2-53 Minimum Thickness Adjustments**




**2-8.2.3.5** In contingency evaluations, the pavement thickness is often less than the minimum thickness prescribed in Table 2-11. In this case, evaluate the pavement cross-section as measured. This thinner pavement thickness will produce a reduced load-bearing capability but, depending upon the intended mission, that capability may be sufficient. When very thin pavements are encountered, such as chip seal or DBST surfaces, and the concern is to facilitate the aircraft mission in lieu of preventing pavement damage, consider evaluating the pavement as unsurfaced and treating the surface as just a FOD sealer. The failure criteria used to evaluate unsurfaced pavement is less stringent than that for flexible surfaces and will often permit higher loads or more passes. If the concern is to prevent pavement damage, evaluate the structure as measured.

**2-8.2.4 Pavement Condition Adjustments.**

**If the cursory Pavement Condition Survey results in a feature condition rating of poor or lower, further reduce the maximum AGLs computed for that feature by 25%.** If evaluating to determine allowable passes, multiply the gross weight by 1.33 to establish the correct gross aircraft weight curve to use in the chart.

**2-8.2.5 PCASE.**

Flexible pavement surfaced airfields may also be evaluated for various aircraft using the PCASE software program.

**2-8.3 Rigid Pavement Evaluation.**

Rigid or PCC-surfaced airfields may be evaluated manually using the rigid pavement evaluation and design factor curves in Appendix F. The curves can be used to determine AGLs or passes for a standard (first crack criteria) evaluation or extended life (shattered slab criteria) evaluation***.*** **The extended life curves (shattered slab) are used for all Air Force pavement evaluation reports.**

**2-8.3.1 Standard Evaluation.**

The standard evaluation is based upon criteria where 50% of the slabs are cracked into two or three pieces at the end of traffic (sometimes referred to as initial failure or first crack failure).

**2-8.3.2 Extended Life Evaluation.**

The extended life evaluation is based upon a criterion where 50% of the slabs are cracked into approximately six pieces at the end of traffic (sometimes referred to as shattered slab failure). A slab cracked into four pieces is considered shattered if cracks are medium or high severity.

**2-8.3.3 Evaluation Procedures to Determine AGLs.**

**2-8.3.3.1** Based upon the PCC thickness and lowest effective K-value of the supporting soil, determine the radius of relative stiffness (L) from Table 2-13.

**2-8.3.3.2** Based upon the PCC thickness and lowest effective K-value of the supporting soil, determine the radius of relative stiffness/thickness (L/T) from Table 2-14.

**2-8.3.3.3** Determine the design factor (DF) and the evaluation number (EN) using curves in Appendix F. These curves are not aircraft specific but are used to evaluate all aircraft.

**2-8.3.3.4** Determine the AGL using an aircraft-specific rigid pavement evaluation curve. Curves are included in Appendix F for some selected aircraft typically used in contingency scenarios.

**2-8.3.3.5** When solving for the AGL of an aircraft operating on a “C” traffic area, multiply the AGL obtained from the rigid pavement evaluation curve by 1.33.

**2-8.3.3.6** When evaluating a pavement with a pavement condition rating/index of “very poor” or “PCI = 40” or below, reduce the AGL obtained from the rigid pavement evaluation curve by 25%.

## Table 2-13 Radius of Relative Stiffness (L)

| T (in) | Radius of Relative Stiffness (L) for E = 4,000,000 psi and v = 0.15 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | K-Value (pci) | | | | | | | | | | | | | | | | | | | |
| | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 325 | 350 | 375 | 400 | 425 | 450 | 475 | 500 |
| 1 | 10.81 | 9.09 | 8.21 | 7.64 | 7.23 | 6.91 | 6.64 | 6.43 | 6.24 | 6.08 | 5.93 | 5.81 | 5.69 | 5.59 | 5.49 | 5.40 | 5.32 | 5.25 | 5.18 | 5.11 |
| 2 | 18.18 | 15.28 | 13.81 | 12.85 | 12.15 | 11.61 | 11.17 | 10.81 | 10.49 | 10.22 | 9.98 | 9.77 | 9.57 | 9.40 | 9.24 | 9.09 | 8.95 | 8.82 | 8.71 | 8.59 |
| 3 | 24.63 | 20.72 | 18.72 | 17.42 | 16.47 | 15.74 | 15.15 | 14.65 | 14.22 | 13.85 | 13.53 | 13.24 | 12.97 | 12.74 | 12.52 | 12.32 | 12.13 | 11.96 | 11.80 | 11.65 |
| 4 | 30.57 | 25.70 | 23.23 | 21.61 | 20.44 | 19.53 | 18.79 | 18.18 | 17.65 | 17.19 | 16.78 | 16.42 | 16.10 | 15.80 | 15.53 | 15.28 | 15.05 | 14.84 | 14.64 | 14.45 |
| 5 | 36.14 | 30.39 | 27.46 | 25.55 | 24.17 | 23.09 | 22.22 | 21.49 | 20.86 | 20.32 | 19.84 | 19.42 | 19.03 | 18.68 | 18.36 | 18.07 | 17.80 | 17.54 | 17.31 | 17.09 |
| 6 | 41.43 | 34.84 | 31.48 | 29.30 | 27.71 | 26.47 | 25.47 | 24.63 | 23.92 | 23.30 | 22.75 | 22.26 | 21.82 | 21.42 | 21.05 | 20.72 | 20.40 | 20.11 | 19.84 | 19.59 |
| 7 | 46.51 | 39.11 | 35.34 | 32.89 | 31.10 | 29.72 | 28.59 | 27.65 | 26.85 | 26.15 | 25.54 | 24.99 | 24.49 | 24.04 | 23.63 | 23.25 | 22.90 | 22.58 | 22.28 | 21.99 |
| 8 | 51.41 | 43.23 | 39.06 | 36.35 | 34.38 | 32.85 | 31.60 | 30.57 | 29.68 | 28.91 | 28.23 | 27.62 | 27.07 | 26.58 | 26.12 | 25.70 | 25.32 | 24.96 | 24.62 | 24.31 |
| 9 | 56.15 | 47.22 | 42.67 | 39.71 | 37.55 | 35.88 | 34.52 | 33.39 | 32.42 | 31.58 | 30.83 | 30.17 | 29.57 | 29.03 | 28.53 | 28.08 | 27.66 | 27.26 | 26.90 | 26.55 |
| 10 | 60.77 | 51.10 | 46.18 | 42.97 | 40.64 | 38.83 | 37.36 | 36.14 | 35.09 | 34.17 | 33.37 | 32.65 | 32.01 | 31.42 | 30.88 | 30.39 | 29.93 | 29.50 | 29.11 | 28.74 |
| 11 | 65.28 | 54.89 | 49.60 | 46.16 | 43.65 | 41.71 | 40.13 | 38.81 | 37.69 | 36.71 | 35.84 | 35.07 | 34.38 | 33.75 | 33.17 | 32.64 | 32.15 | 31.69 | 31.27 | 30.87 |
| 12 | 69.68 | 58.59 | 52.94 | 49.27 | 46.60 | 44.52 | 42.84 | 41.43 | 40.23 | 39.18 | 38.26 | 37.44 | 36.69 | 36.02 | 35.41 | 34.84 | 34.31 | 33.83 | 33.37 | 32.95 |
| 13 | 73.99 | 62.22 | 56.22 | 52.32 | 49.48 | 47.27 | 45.49 | 43.99 | 42.72 | 41.61 | 40.63 | 39.75 | 38.97 | 38.25 | 37.60 | 36.99 | 36.44 | 35.92 | 35.44 | 34.99 |
| 14 | 78.22 | 65.77 | 59.43 | 55.31 | 52.31 | 49.98 | 48.09 | 46.51 | 45.16 | 43.98 | 42.95 | 42.02 | 41.19 | 40.44 | 39.74 | 39.11 | 38.52 | 37.97 | 37.46 | 36.99 |
| 15 | 82.37 | 69.27 | 62.59 | 58.25 | 55.08 | 52.63 | 50.64 | 48.98 | 47.56 | 46.32 | 45.23 | 44.26 | 43.38 | 42.58 | 41.86 | 41.19 | 40.57 | 39.99 | 39.45 | 38.95 |
| 16 | 86.46 | 72.70 | 65.69 | 61.13 | 57.82 | 55.24 | 53.15 | 51.41 | 49.92 | 48.62 | 47.47 | 46.45 | 45.53 | 44.70 | 43.93 | 43.23 | 42.58 | 41.97 | 41.41 | 40.88 |
| 17 | 90.48 | 76.08 | 68.75 | 63.98 | 60.51 | 57.81 | 55.62 | 53.80 | 52.24 | 50.88 | 49.68 | 48.61 | 47.65 | 46.77 | 45.97 | 45.24 | 44.56 | 43.93 | 43.34 | 42.78 |
| 18 | 94.44 | 79.41 | 71.76 | 66.78 | 63.16 | 60.34 | 58.06 | 56.15 | 54.53 | 53.11 | 51.86 | 50.74 | 49.74 | 48.82 | 47.99 | 47.22 | 46.51 | 45.85 | 45.23 | 44.66 |
| 19 | 98.35 | 82.70 | 74.73 | 69.54 | 65.77 | 62.84 | 60.46 | 58.48 | 56.78 | 55.31 | 54.00 | 52.84 | 51.79 | 50.84 | 49.97 | 49.17 | 48.43 | 47.75 | 47.11 | 46.51 |
| 20 | 102.21 | 85.94 | 77.66 | 72.27 | 68.35 | 65.30 | 62.84 | 60.77 | 59.01 | 57.47 | 56.12 | 54.91 | 53.83 | 52.84 | 51.93 | 51.10 | 50.33 | 49.62 | 48.95 | 48.33 |
| 21 | 106.02 | 89.15 | 80.55 | 74.96 | 70.90 | 67.74 | 65.18 | 63.04 | 61.21 | 59.62 | 58.21 | 56.96 | 55.83 | 54.81 | 53.87 | 53.01 | 52.21 | 51.47 | 50.78 | 50.13 |
| 22 | 109.78 | 92.31 | 83.41 | 77.63 | 73.41 | 70.14 | 67.49 | 65.28 | 63.38 | 61.73 | 60.28 | 58.98 | 57.81 | 56.75 | 55.78 | 54.89 | 54.06 | 53.30 | 52.58 | 51.91 |
| 23 | 113.50 | 95.44 | 86.24 | 80.26 | 75.90 | 72.52 | 69.78 | 67.49 | 65.53 | 63.83 | 62.32 | 60.98 | 59.77 | 58.68 | 57.67 | 56.75 | 55.90 | 55.10 | 54.36 | 53.67 |
| 24 | 117.18 | 98.54 | 89.04 | 82.86 | 78.36 | 74.87 | 72.04 | 69.68 | 67.66 | 65.90 | 64.35 | 62.96 | 61.71 | 60.58 | 59.54 | 58.59 | 57.71 | 56.89 | 56.13 | 55.41 |
| 25 | 120.83 | 101.60 | 91.81 | 85.44 | 80.80 | 77.20 | 74.28 | 71.84 | 69.76 | 67.95 | 66.35 | 64.92 | 63.63 | 62.46 | 61.40 | 60.41 | 59.50 | 58.66 | 57.87 | 57.14 |
| 26 | 124.43 | 104.64 | 94.55 | 87.99 | 83.21 | 79.51 | 76.50 | 73.99 | 71.84 | 69.97 | 68.33 | 66.86 | 65.53 | 64.33 | 63.23 | 62.22 | 61.28 | 60.41 | 59.60 | 58.84 |
| 27 | 128.01 | 107.64 | 97.26 | 90.51 | 85.60 | 81.79 | 78.70 | 76.11 | 73.90 | 71.98 | 70.29 | 68.78 | 67.41 | 66.18 | 65.04 | 64.00 | 63.04 | 62.15 | 61.31 | 60.53 |
| 28 | 131.54 | 110.62 | 99.95 | 93.02 | 87.97 | 84.05 | 80.87 | 78.22 | 75.95 | 73.97 | 72.23 | 70.68 | 69.28 | 68.01 | 66.84 | 65.77 | 64.78 | 63.86 | 63.01 | 62.20 |
| 29 | 135.05 | 113.57 | 102.62 | 95.50 | 90.32 | 86.29 | 83.03 | 80.30 | 77.97 | 75.95 | 74.16 | 72.56 | 71.12 | 69.82 | 68.62 | 67.53 | 66.51 | 65.57 | 64.69 | 63.86 |
| 30 | 138.53 | 116.49 | 105.26 | 97.96 | 92.64 | 88.51 | 85.17 | 82.37 | 79.98 | 77.90 | 76.07 | 74.43 | 72.96 | 71.62 | 70.39 | 69.27 | 68.22 | 67.26 | 66.35 | 65.51 |

## Table 2-14 Radius of Relative Stiffness / Thickness (L/T)

| T (in) | Radius of Relative Stiffness (L) to Thickness (T) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | K-Value (pci) | | | | | | | | | | | | | | | | | | | |
| | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 325 | 350 | 375 | 400 | 425 | 450 | 475 | 500 |
| 1 | 10.807 | 9.088 | 8.212 | 7.642 | 7.227 | 6.905 | 6.644 | 6.426 | 6.239 | 6.077 | 5.934 | 5.806 | 5.691 | 5.587 | 5.491 | 5.404 | 5.322 | 5.247 | 5.176 | 5.110 |
| 2 | 9.088 | 7.642 | 6.905 | 6.426 | 6.077 | 5.806 | 5.587 | 5.404 | 5.247 | 5.110 | 4.990 | 4.883 | 4.786 | 4.698 | 4.618 | 4.544 | 4.475 | 4.412 | 4.353 | 4.297 |
| 3 | 8.212 | 6.905 | 6.239 | 5.806 | 5.491 | 5.247 | 5.048 | 4.883 | 4.741 | 4.618 | 4.509 | 4.412 | 4.325 | 4.245 | 4.173 | 4.106 | 4.044 | 3.987 | 3.933 | 3.883 |
| 4 | 7.642 | 6.426 | 5.806 | 5.404 | 5.110 | 4.883 | 4.698 | 4.544 | 4.412 | 4.297 | 4.196 | 4.106 | 4.024 | 3.951 | 3.883 | 3.821 | 3.763 | 3.710 | 3.660 | 3.614 |
| 5 | 7.227 | 6.077 | 5.491 | 5.110 | 4.833 | 4.618 | 4.443 | 4.297 | 4.173 | 4.064 | 3.968 | 3.883 | 3.806 | 3.736 | 3.672 | 3.614 | 3.559 | 3.509 | 3.462 | 3.417 |
| 6 | 6.905 | 5.806 | 5.247 | 4.883 | 4.618 | 4.412 | 4.245 | 4.106 | 3.987 | 3.883 | 3.792 | 3.710 | 3.636 | 3.570 | 3.509 | 3.453 | 3.401 | 3.352 | 3.307 | 3.265 |
| 7 | 6.644 | 5.587 | 5.048 | 4.698 | 4.443 | 4.245 | 4.085 | 3.951 | 3.836 | 3.736 | 3.648 | 3.570 | 3.499 | 3.435 | 3.376 | 3.322 | 3.272 | 3.226 | 3.182 | 3.142 |
| 8 | 6.426 | 5.404 | 4.883 | 4.544 | 4.297 | 4.106 | 3.951 | 3.821 | 3.710 | 3.614 | 3.528 | 3.453 | 3.384 | 3.322 | 3.265 | 3.213 | 3.165 | 3.120 | 3.078 | 3.039 |
| 9 | 6.239 | 5.247 | 4.741 | 4.412 | 4.173 | 3.987 | 3.836 | 3.710 | 3.602 | 3.509 | 3.426 | 3.352 | 3.286 | 3.226 | 3.170 | 3.120 | 3.073 | 3.029 | 2.989 | 2.950 |
| 10 | 6.077 | 5.110 | 4.618 | 4.297 | 4.064 | 3.883 | 3.736 | 3.614 | 3.509 | 3.417 | 3.337 | 3.265 | 3.201 | 3.142 | 3.088 | 3.039 | 2.993 | 2.950 | 2.911 | 2.874 |
| 11 | 5.934 | 4.990 | 4.509 | 4.196 | 3.968 | 3.792 | 3.648 | 3.528 | 3.426 | 3.337 | 3.258 | 3.188 | 3.125 | 3.068 | 3.015 | 2.967 | 2.922 | 2.881 | 2.842 | 2.806 |
| 12 | 5.806 | 4.883 | 4.412 | 4.106 | 3.883 | 3.710 | 3.570 | 3.453 | 3.352 | 3.265 | 3.188 | 3.120 | 3.058 | 3.002 | 2.950 | 2.903 | 2.860 | 2.819 | 2.781 | 2.746 |
| 13 | 5.691 | 4.786 | 4.325 | 4.024 | 3.806 | 3.636 | 3.499 | 3.384 | 3.286 | 3.201 | 3.125 | 3.058 | 2.997 | 2.942 | 2.892 | 2.846 | 2.803 | 2.763 | 2.726 | 2.691 |
| 14 | 5.587 | 4.698 | 4.245 | 3.951 | 3.736 | 3.570 | 3.435 | 3.322 | 3.226 | 3.142 | 3.068 | 3.002 | 2.942 | 2.888 | 2.839 | 2.793 | 2.751 | 2.712 | 2.676 | 2.642 |
| 15 | 5.491 | 4.618 | 4.173 | 3.883 | 3.672 | 3.509 | 3.376 | 3.265 | 3.170 | 3.088 | 3.015 | 2.950 | 2.892 | 2.839 | 2.790 | 2.746 | 2.704 | 2.666 | 2.630 | 2.597 |
| 16 | 5.404 | 4.544 | 4.106 | 3.821 | 3.614 | 3.453 | 3.322 | 3.213 | 3.120 | 3.039 | 2.967 | 2.903 | 2.846 | 2.793 | 2.746 | 2.702 | 2.661 | 2.623 | 2.588 | 2.555 |
| 17 | 5.322 | 4.475 | 4.044 | 3.763 | 3.559 | 3.401 | 3.272 | 3.165 | 3.073 | 2.993 | 2.922 | 2.860 | 2.803 | 2.751 | 2.704 | 2.661 | 2.621 | 2.584 | 2.549 | 2.517 |
| 18 | 5.247 | 4.412 | 3.987 | 3.710 | 3.509 | 3.352 | 3.226 | 3.120 | 3.029 | 2.950 | 2.881 | 2.819 | 2.763 | 2.712 | 2.666 | 2.623 | 2.584 | 2.547 | 2.513 | 2.481 |
| 19 | 5.176 | 4.353 | 3.933 | 3.660 | 3.462 | 3.307 | 3.182 | 3.078 | 2.989 | 2.911 | 2.842 | 2.781 | 2.726 | 2.676 | 2.630 | 2.588 | 2.549 | 2.513 | 2.479 | 2.448 |
| 20 | 5.110 | 4.297 | 3.883 | 3.614 | 3.417 | 3.265 | 3.142 | 3.039 | 2.950 | 2.874 | 2.806 | 2.746 | 2.691 | 2.642 | 2.597 | 2.555 | 2.517 | 2.481 | 2.448 | 2.417 |
| 21 | 5.048 | 4.245 | 3.836 | 3.570 | 3.376 | 3.226 | 3.104 | 3.002 | 2.915 | 2.839 | 2.772 | 2.712 | 2.659 | 2.610 | 2.565 | 2.524 | 2.486 | 2.451 | 2.418 | 2.387 |
| 22 | 4.990 | 4.196 | 3.792 | 3.528 | 3.337 | 3.188 | 3.068 | 2.967 | 2.881 | 2.806 | 2.740 | 2.681 | 2.628 | 2.580 | 2.536 | 2.495 | 2.457 | 2.423 | 2.390 | 2.360 |
| 23 | 4.935 | 4.150 | 3.750 | 3.489 | 3.300 | 3.153 | 3.034 | 2.934 | 2.849 | 2.775 | 2.710 | 2.651 | 2.599 | 2.551 | 2.508 | 2.467 | 2.430 | 2.396 | 2.364 | 2.334 |
| 24 | 4.883 | 4.106 | 3.710 | 3.453 | 3.265 | 3.120 | 3.002 | 2.903 | 2.819 | 2.746 | 2.681 | 2.623 | 2.571 | 2.524 | 2.481 | 2.441 | 2.405 | 2.370 | 2.339 | 2.309 |
| 25 | 4.833 | 4.064 | 3.672 | 3.417 | 3.232 | 3.088 | 2.971 | 2.874 | 2.790 | 2.718 | 2.654 | 2.597 | 2.545 | 2.499 | 2.456 | 2.417 | 2.380 | 2.346 | 2.315 | 2.285 |
| 26 | 4.786 | 4.024 | 3.636 | 3.384 | 3.201 | 3.058 | 2.942 | 2.846 | 2.763 | 2.691 | 2.628 | 2.571 | 2.520 | 2.474 | 2.432 | 2.393 | 2.357 | 2.324 | 2.292 | 2.263 |
| 27 | 4.741 | 3.987 | 3.602 | 3.352 | 3.170 | 3.029 | 2.915 | 2.819 | 2.737 | 2.666 | 2.603 | 2.547 | 2.497 | 2.451 | 2.409 | 2.370 | 2.335 | 2.302 | 2.271 | 2.242 |
| 28 | 4.698 | 3.951 | 3.570 | 3.322 | 3.142 | 3.002 | 2.888 | 2.793 | 2.712 | 2.642 | 2.580 | 2.524 | 2.474 | 2.429 | 2.387 | 2.349 | 2.314 | 2.281 | 2.250 | 2.222 |
| 29 | 4.657 | 3.916 | 3.539 | 3.293 | 3.114 | 2.976 | 2.863 | 2.769 | 2.689 | 2.619 | 2.557 | 2.502 | 2.453 | 2.408 | 2.366 | 2.328 | 2.293 | 2.261 | 2.231 | 2.202 |
| 30 | 4.618 | 3.883 | 3.509 | 3.265 | 3.088 | 2.950 | 2.839 | 2.746 | 2.666 | 2.597 | 2.536 | 2.481 | 2.432 | 2.387 | 2.346 | 2.309 | 2.274 | 2.242 | 2.212 | 2.184 |

**Example:** Determine the AGL of a C-17 operating for 1,000 passes on an “A” traffic area using extended-life criteria for a rigid pavement section with the following pavement profile:

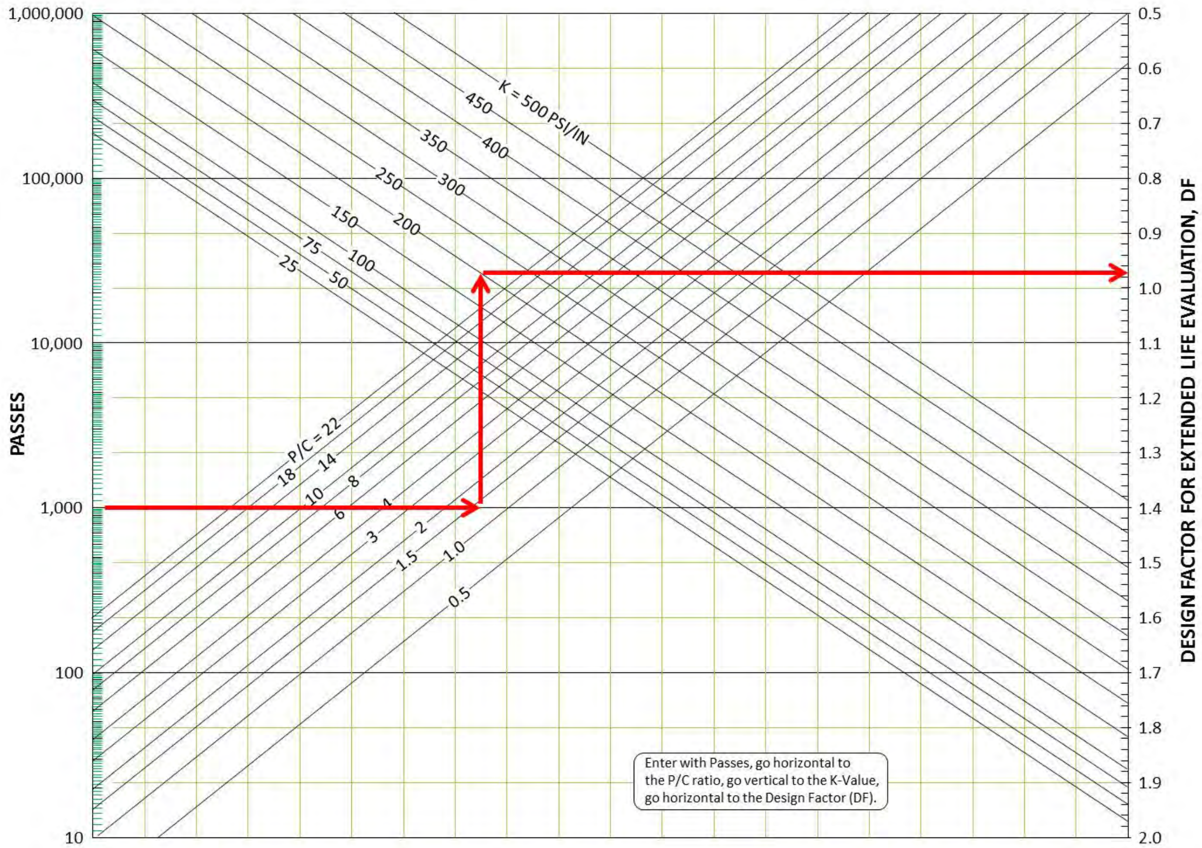
- 10-inch PCC pavement surface layer with a 600 psi flexural strength
- 200 PCI (lowest effective K-value) soil strength

**Solution:**

- Select the Design Factor for Extended Life, DF graph and the Evaluation Number, EN graph in Appendix F.
- Select the C-17 Rigid Pavement Evaluation graph from Appendix F.
- From Table 2-13, based upon the 10-inch PCC thickness and 200 lowest effective K-value, the radius of relative stiffness (L) is 36.14.
- From Table 2-14, based upon the 10-inch PCC thickness and 200 lowest effective K-value, the radius of relative stiffness/thickness (L/T) is 3.614.
- From the C-17 Rigid Pavement Evaluation curve, the pass/coverage (P/C) ratio for an “A” traffic pavement is 1.380.
- Determine the DF. See Figure 2-54.
  - o Enter the Design Factor for Extended Life, DF curve on the left side with 1,000 passes and extend a line horizontally until it intersects the P/C of 1.380.
  - o From this point, extend a line vertically until it intersects the 200 (lowest effective K-value) line.
  - o From this point extend a line horizontally to the right side of the graph to determine a DF of 0.97.
- Determine the EN. See Figure 2-55.
  - o Enter the Evaluation Number, EN curve on the left side with the L/T of 3.614 and extend a line horizontally until it intersects the PCC flexural strength of 600 psi.
  - o From this point, extend a line vertically until it intersects the DF of 0.97.
  - o From this point, extend a line horizontally to the right side of the graph to determine an EN of 63.
- Determine the AGL of the C-17 operating for 1,000 passes. See Figure 2-56.
  - o Enter the C-17 Rigid Pavement Evaluation curve at the bottom with an EN of 63 and project a line vertically until it intersects the L of 36.14.

- o From this point, extend a line horizontally to the left side of the graph to determine an AGL of 550,000 pounds.

**Figure 2-54 Determination of DF for C-17 Example**



## Figure 2-55 Determination of EN for C-17 Example

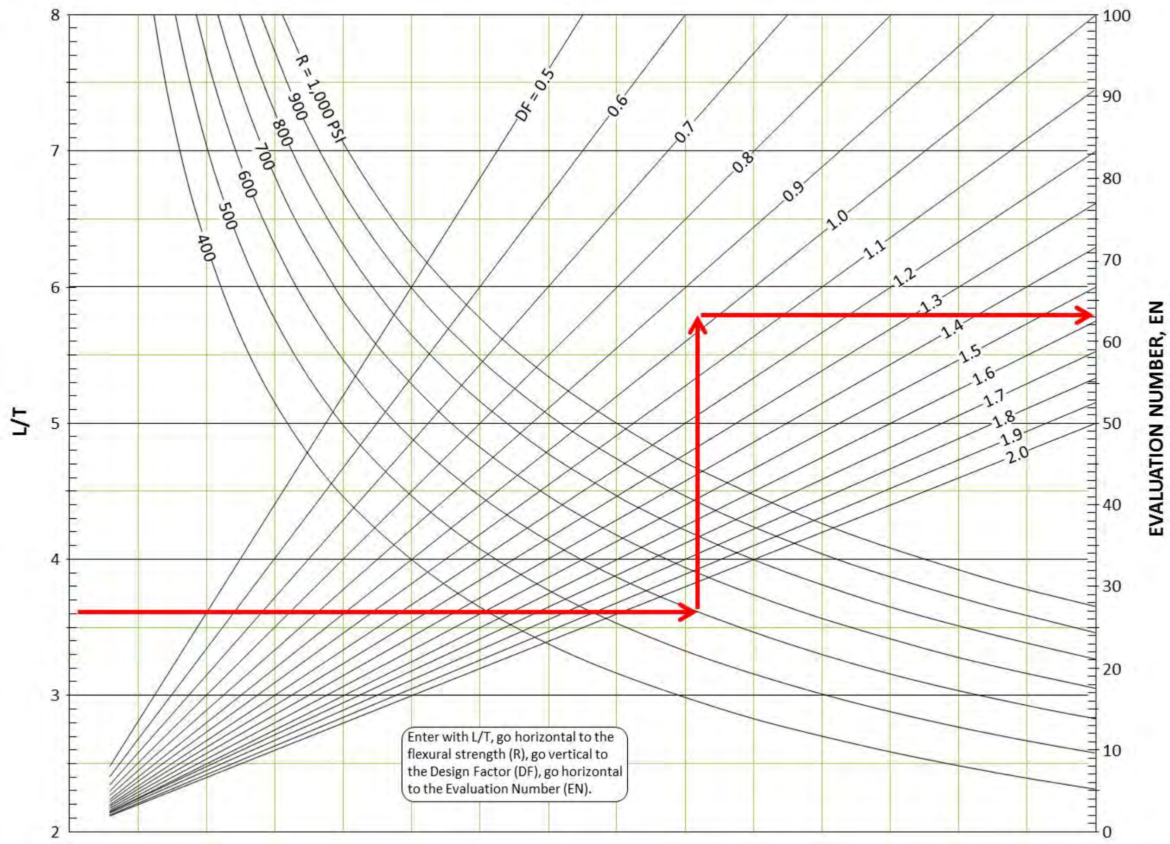
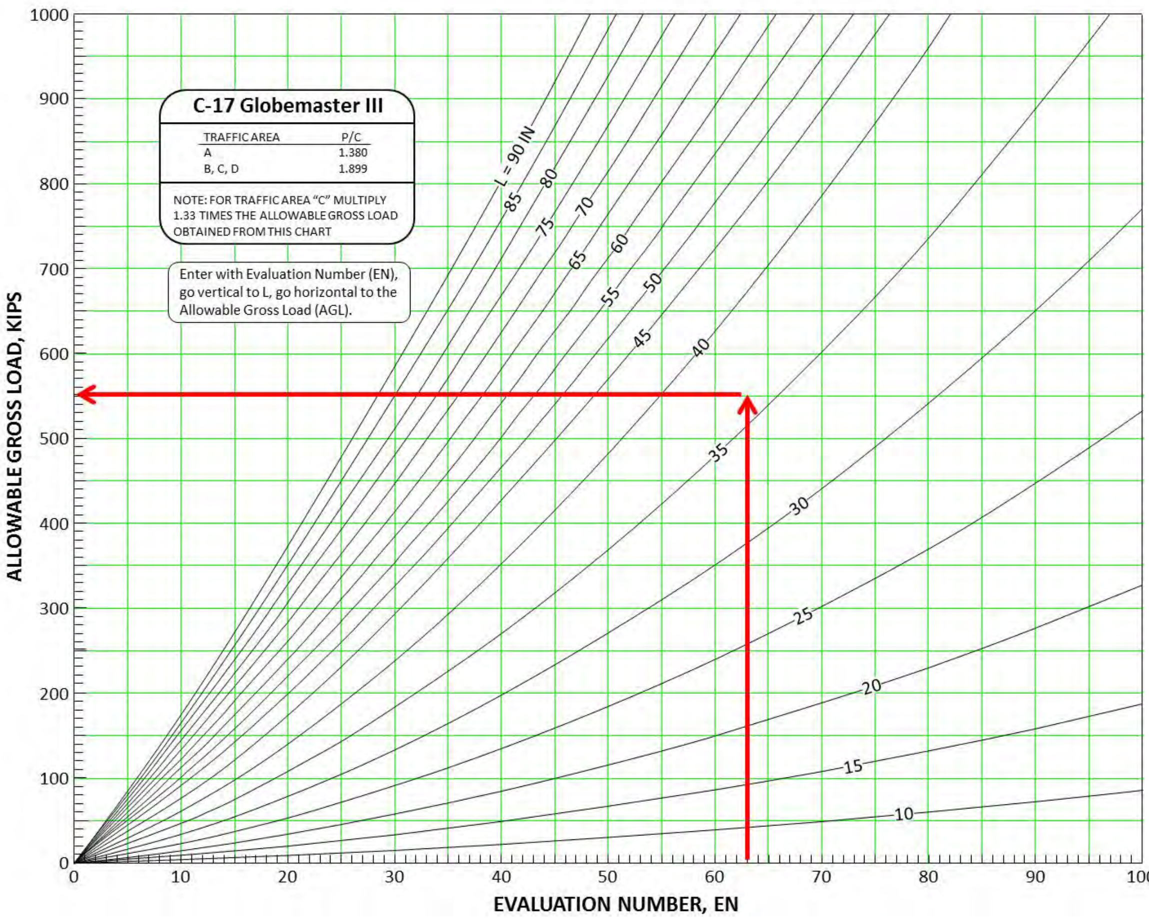


**Figure 2-56 Determination of AGL for C-17 Example**




## 2-8.3.4 Evaluation Procedures to Determine Allowable Passes.

**2-8.3.4.1** Based upon the PCC thickness and lowest effective K-value of the supporting soil, determine the radius of relative stiffness (L) from Table 2-13.

**2-8.3.4.2.** Based upon the PCC thickness and lowest effective K-value of the supporting soil, determine the radius of relative stiffness/thickness (L/T) from Table 2-14.

**2-8.3.4.3.** Determine the EN using the aircraft-specific rigid pavement evaluation curve. If the aircraft is operating on a "C" traffic area, the operating aircraft AGL is reduced by 25% to determine the appropriate AGL to enter with into this curve. When evaluating a pavement that has a pavement condition rating/index of "very poor" or "PCI = 40" or below, the operating aircraft AGL is multiplied by 1.33 to determine the appropriate AGL to enter with into this curve.

**2-8.3.4.4.** Determine the DF using the EN curve in Appendix F. This curve is not aircraft specific, but is used to evaluate all aircraft.

**2-8.3.4.5.** Determine the allowable passes using the appropriate DF curve.

**Example:** Determine the allowable passes of a C-130J operating at 155,000 pounds on an "A" traffic area using extended-life criteria for a rigid pavement section with the following pavement profile:

- 9-inch PCC pavement surface layer with a 600 psi flexural strength
- 200 PCI (lowest effective K-value) soil strength

**Solution:**

- Select the Design Factor for Extended Life, DF curve and the Evaluation Number, EN curve in Appendix F.
- Select the C-130J Rigid Pavement Evaluation graph from Appendix F.
- From Table 2-13, based upon the 9-inch PCC thickness and 200 lowest effective K-value, the radius of relative stiffness (L) is 33.39.
- From Table 2-14, based upon the 9-inch PCC thickness and 200 lowest effective K-value, the radius of relative stiffness/thickness (L/T) is 3.710.
- From the C-130J Rigid Pavement Evaluation curve, the P/C ratio for an "A" traffic pavement is 4.667.
- Determine the EN. See Figure 2-57.
    - o Enter the C-130J Rigid Pavement Evaluation curve on the left side with the AGL of 155,000 pounds and extend a line horizontally until it intersects an L of 33.39.
    - o From this point extend a line vertically to the bottom of the curve to determine an EN of 60.5.
- Determine a DF. See Figure 2-58.
    - o Enter the EN curve on the right side with an EN of 60.5 and extend a line horizontally to the left.
    - o Enter the EN curve on the left side with an L/T of 3.710 and extend a line horizontally until it intersects the flexural strength of 600 psi.
    - o From the intersection of 3.710 L/T and 600 psi flexural strength, extend a line vertically until it intersects the horizontal line extended from the EN of 60.5. The intersection of these two lines indicates a DF of 0.96.
- Determine the allowable passes. See Figure 2-59.
    - o Enter the Design Factor for Extended Life Evaluation curve on the right side at a DF of 0.96 and extend a line horizontally until it intersects the lowest effective K-value of 200 PCI.
    - o From this point, extend a line vertically until it intersects the P/C ratio of 4.667.

- o From this point, extend a line horizontally to the left side of the curve to determine an allowable pass level of approximately 3,000 passes.

**Figure 2-57 Determination of EN for C-130J Example**

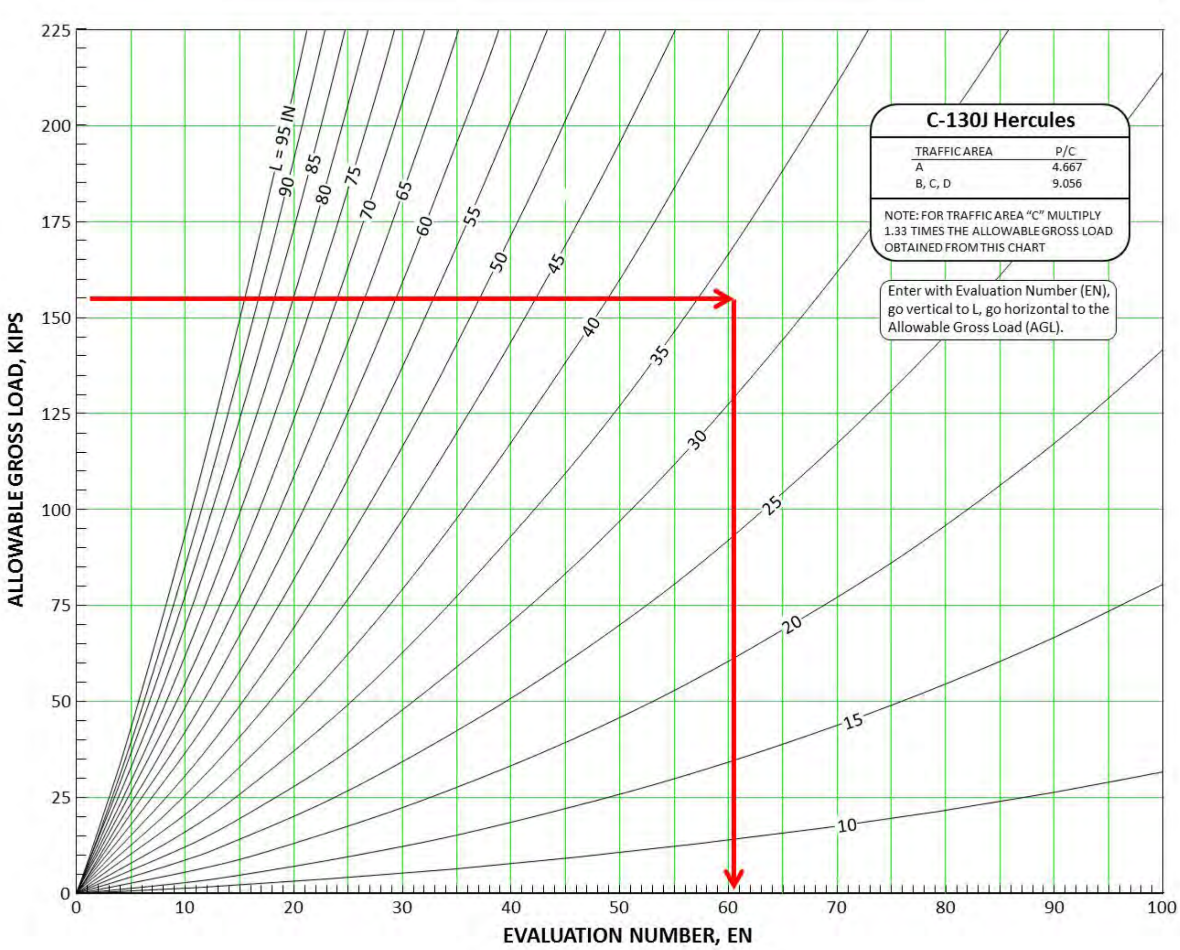


**Figure 2-58 Determination of DF for C-130J Example**

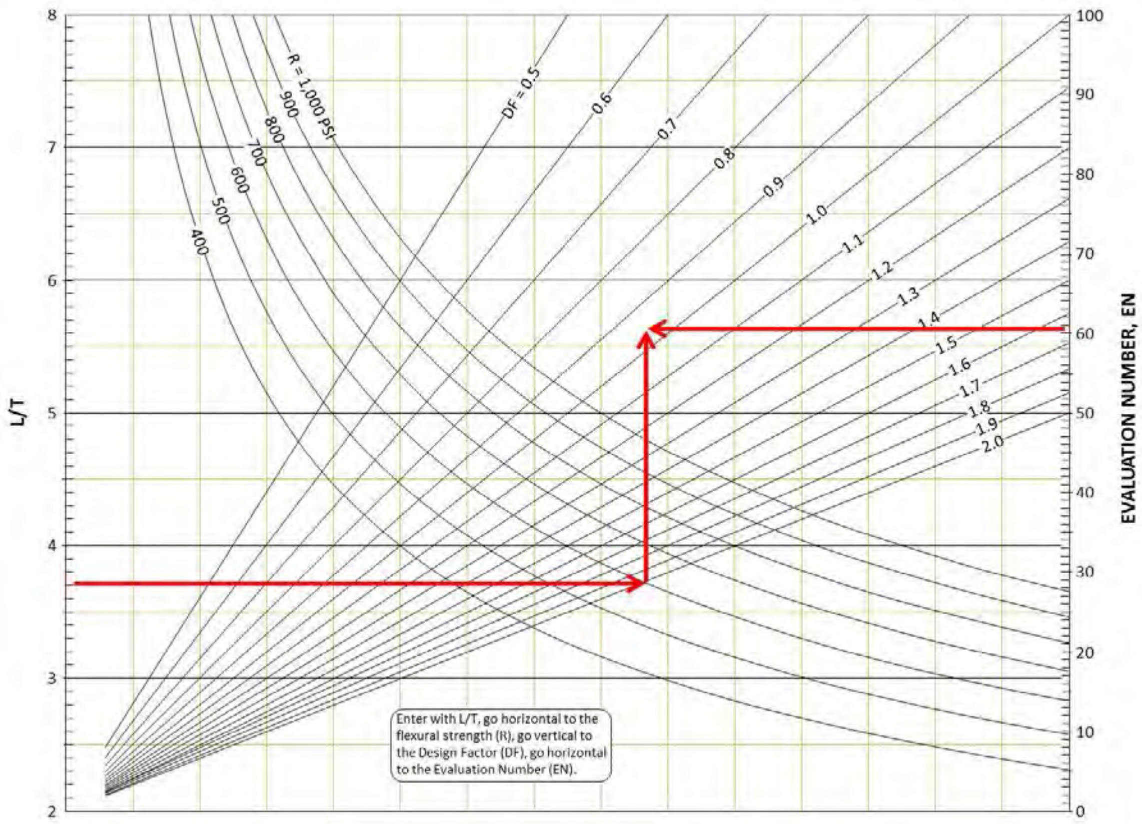
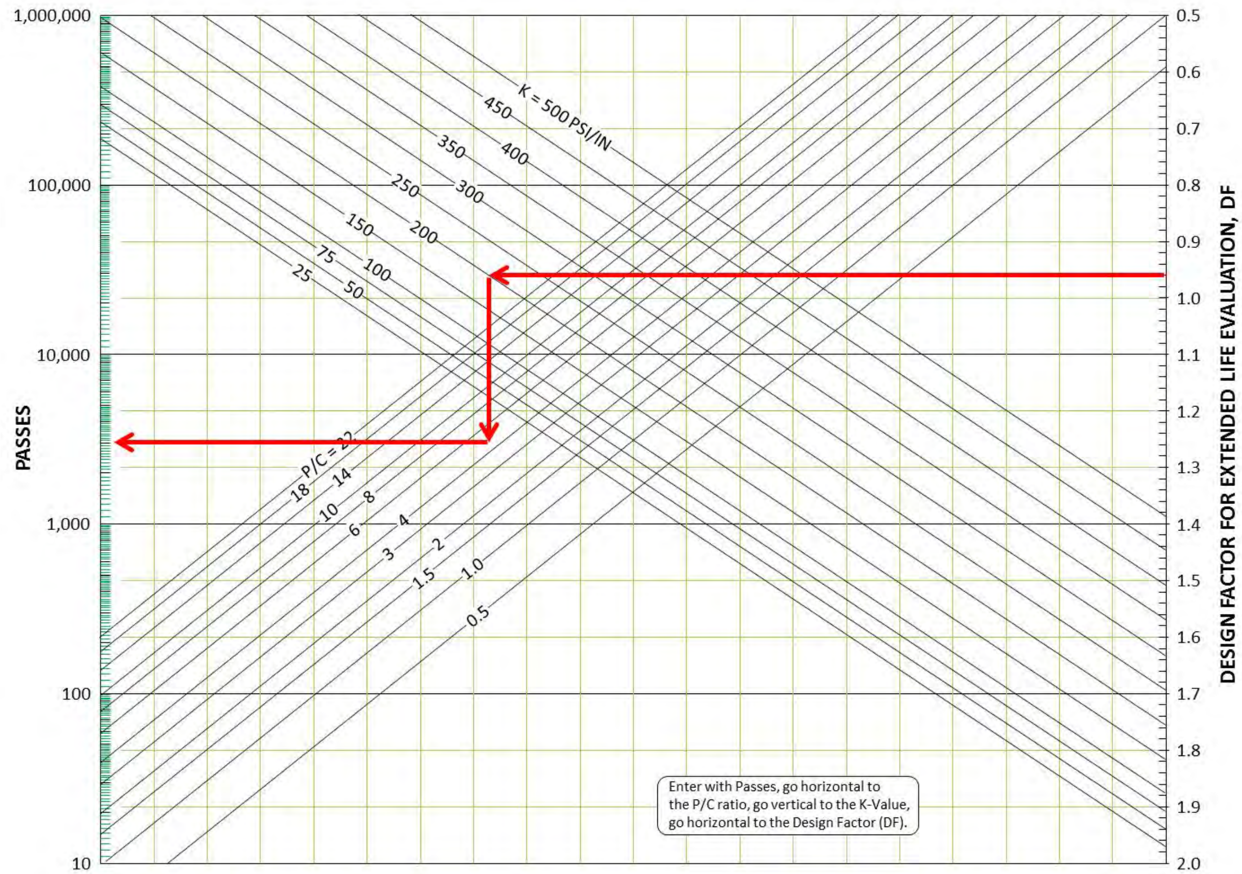


**Figure 2-59 Determination of Allowable Passes for C-130J Example**




### 2-8.3.5 Load Transfer.

Rigid pavements are designed to act like a beam and use the bending strength of the slabs to carry the load. Therefore, load transfer across cracks and joints is important, especially on pavements with heavy traffic loading. Because wide cracks and widely spaced joints open up, they cannot transfer loads and therefore take higher edge loads. These higher edge loads can cause further cracking and deterioration along the joint or crack edges. If there are obviously open gapped joints or if the PCI results in ratings ≤ 40 due primarily to structurally related distresses, one can assume the load transfer between slabs is inadequate and AGLs are reduced by 25%. Do not, however, take double deductions in load calculations, e.g., do not reduce AGLs by 25% because of the lack of load transfer and also reduce the AGLs by 25% because of very poor surface condition.

### 2-8.3.6 Reinforced Concrete Pavement.

For evaluation of rigid pavements, do not assume the existence of reinforcing if you do not see it. Evaluate it as plain PCC pavement. If you know the pavement is reinforced, use the following steps to evaluate it.

**2-8.3.6.1** Determine percent steel in a cross-section of rigid pavement. Compute the percent steel in both directions by looking at the end area both transversely and longitudinally. If these are different, use the lowest percentage calculated.

$$\%\,Steel = \left(\frac{AS}{AP}\right) \times 100$$

Where:

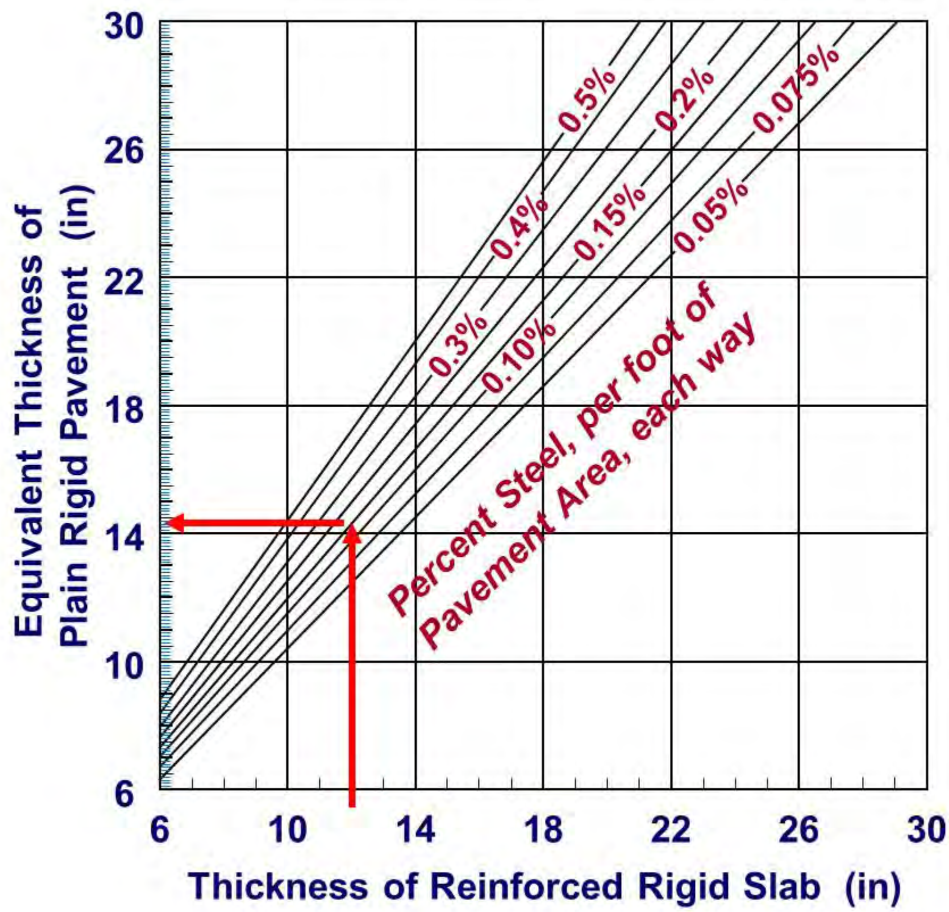
*AS* = Cross-sectional area of steel/foot of pavement width or length, expressed in square inches (**Note:** Table 2-15 presents the cross-sectional areas of steel bars for standard bar sizes in the United States, Canada, and Europe.)

*AP* = Cross-sectional area of pavement/foot of pavement width or length, expressed in square inches

**2-8.3.6.2** Enter the bottom of Figure 2-60 with the thickness of the reinforced concrete, project a line vertically to intersect the calculated percent steel, then project the line horizontally to determine the equivalent thickness of plain concrete pavement.

**2-8.3.6.3** Using this equivalent thickness, evaluate the pavement as plain or unreinforced rigid pavement.

**Figure 2-60 Reinforced to Plain Concrete, Equivalent Thickness**




**Example:** Determine the equivalent thickness of plain PCC pavement to be used in lieu of 12-inch PCC pavement reinforced with 0.375-inch-diameter bars both ways, spaced 6 inches apart.

**Solution:**

- Compute percent steel:

$$\left(\frac{AS}{AP}\right) \times 100 = \left(\frac{.221}{144}\right) \times 100 = 0.153\%$$

- Enter Figure 2-60 at 12 inches, project vertically to the 0.15% line, then horizontally to determine an equivalent thickness of 14.3 inches.

**Table 2-15 Standard Reinforcing Bar Nominal Dimensions**

| ASTM Standard Reinforcing Bars | | |
|---|---|---|
| **Bar Size #** | **Bar Diameter, mm (in)** | **Bar End Area, $mm^2$ ($in^2$)** |
| 3 | 9.5250 (0.375) | 70.9676 (0.110) |
| 4 | 12.7000 (0.500) | 126.4514 (0.196) |
| 5 | 15.8750 (0.625) | 198.0641 (0.307) |
| 6 | 19.0500 (0.750) | 285.1607 (0.442) |
| 7 | 22.2250 (0.875) | 387.7412 (0.601) |
| 8 | 25.4000 (1.000) | 506.4506 (0.785) |
| 9 | 28.6512 (1.128) | 644.5148 (0.999) |
| 10 | 32.2580 (1.270) | 817.4177 (1.267) |
| 11 | 35.8140 (1.410) | 1007.0950 (1.561) |
| 14 | 43.0022 (1.693) | 1452.2550 (2.251) |
| 18 | 57.3278 (2.257) | 2581.2850 (4.001) |
| **Canadian Metric Standard Reinforcing Bars** | | |
| **Bar Size #** | **Bar Diameter, mm (in)** | **Bar End Area, $mm^2$ ($in^2$)** |
| 10 | 11.3 (0.4449) | 100 (0.155) |
| 15 | 16.0 (0.6299) | 200 (0.310) |
| 20 | 19.5 (0.7677) | 300 (0.465) |
| 25 | 25.2 (0.9921) | 500 (0.775) |
| 30 | 29.9 (1.1772) | 700 (1.085) |
| 35 | 35.7 (1.4055) | 1000 (1.550) |
| 45 | 43.7 (1.7205) | 1500 (2.325) |
| 55 | 56.4 (2.2205) | 2500 (3.875) |
| **European Metric Standard Reinforcing Bars** | | |
| **Bar Size #** | **Bar Diameter, mm (in)** | **Bar End Area, $mm^2$ ($in^2$)** |
| 6 | 6 (0.2362) | 28.3 (0.0439) |
| 8 | 8 (0.3150) | 50.3 (0.0780) |
| 10 | 10 (0.3937) | 78.5 (0.1217) |
| 12 | 12 (0.4724) | 113 (0.1752) |
| 14 | 14 (0.5512) | 154 (0.2387) |
| 16 | 16 (0.6299) | 201 (0.3116) |
| 20 | 20 (0.7874) | 314 (0.4867) |
| 25 | 25 (0.9843) | 491 (0.7611) |
| 28 | 28 (1.1024) | 616 (0.9548) |
| 32 | 32 (1.2598) | 804 (1.2462) |
| 40 | 40 (1.5748) | 1257 (1.9484) |
| 50 | 50 (1.9685) | 1963 (3.0427) |

Nominal dimensions of a deformed bar are equivalent to those of a plain round bar with the same kg/m (lb/ft) as the deformed bar.

### 2-8.3.7 Other PCC Pavement Sections.

If uncommon pavement sections such as concrete pavers or precast slabs are encountered on the airfield, contact AFCEC for assistance.

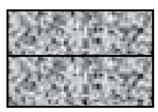
## 2-8.4 Evaluating Overlays and Composite Pavements.

### 2-8.4.1 Rigid Overlay on Rigid Pavement.

#### 2-8.4.1.1 Partially Bonded.

If the rigid overlay was cast directly on the base slab with no sand, asphalt, or other material to break the bond with the base pavement, evaluate it as partially bonded (see Figure 2-61).

**Figure 2-61 Rigid Overlay on Rigid Pavement**




**2-8.4.1.1.1** Compute the equivalent thickness (*$H_E$*) of the combined overlay section using the following equation:

$$H_E = \sqrt[1.4]{(H_O)^{1.4} + C_R(H_B)^{1.4}}$$

Where:

$H_O$ = Thickness of rigid pavement overlay, inches

$C_R$= Coefficient representing condition of rigid base pavement

$H_B$ = Thickness of rigid base pavement, inches

Recommended values for $C_R$:

$C_R$ = 1.00 for base pavement in good condition

$C_R$ = 0.75 for base pavement having a few initial cracks due to loading, but no progressive cracks

$C_R$ = 0.35 for badly cracked base pavement

**2-8.4.1.1.2** In the design process where one is determining the required thickness of a new overlay, a structural condition index (SCI) survey is performed to establish the condition rating to apply to the existing base pavement. In the evaluation process, the base pavement is already covered by an overlay and the base pavement condition cannot easily be visually determined. To determine the condition rating of the base concrete, consider the purpose of the overlay. **In most cases where concrete is placed directly over existing concrete with no bond breaker, it is safe to assume the base concrete was in fairly good condition, provided that no structural distresses are noted on the surface. Use a $C_R$ of 0.75. If structural distresses are evident in the surface, use a value of 0.5.**

**2-8.4.1.1.3** Evaluate as rigid pavement using the appropriate rigid pavement evaluation curve from Appendix F and entering the chart with the computed equivalent thickness, $H_E$.

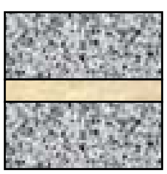
**2-8.4.1.1.4** Compute the weighted average flexural strength for the evaluation using the following equation:

$$R = \frac{(H_O)(R_O) + (H_B)(R_B)}{H_O + H_B}$$

Where $H_O$ = Thickness of rigid overlay
$H_B$ = Thickness of rigid base slab
$R_O$ = Flexural strength of rigid overlay
$R_B$ = Flexural strength of rigid base slab

**2-8.4.1.2 Unbonded, Bond Breaker Less Than 4 Inches.**

**Figure 2-62 Unbonded Rigid Overlay on Rigid Pavement, Bond Breaker Less than 4 Inches**




**2-8.4.1.2.1** Compute the equivalent thickness, $H_E$, of the combined overlay section using the following equation:

$$H_E = \sqrt{(H_O)^2 + C_R(H_B)^2}$$

$H_o$ = Thickness of rigid pavement overlay, inches

$C_R$ = Coefficient representing condition of rigid base pavement

$H_B$ = Thickness of rigid base pavement, inches

Recommended values for $C_R$:

$C_R$ = 1.00 for base pavement in good condition

$C_R$ = 0.75 for base pavement having a few initial cracks due to loading but no progressive cracks

$C_R$ = 0.35 for badly cracked base pavement

**2-8.4.1.2.2** To determine the condition rating of the base concrete, consider the purpose of the overlay. **Was the base concrete overlaid due to a mission change, which required increased pavement strength, or to correct surface distresses, such as those that produce FOD? If so, a $C_R$ of 0.75 can be assumed. If the concrete was overlaid due to failure of the base pavement or the reason is unknown, use a lower $C_R$ of 0.50.**

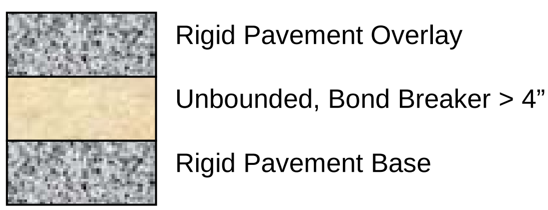
**2-8.4.1.2.3** Compute the weighted average flexural strength for the evaluation using the equation in paragraph 2-8.4.1.1.4.

**2-8.4.1.2.4** Evaluate as rigid pavement.

### 2-8.4.1.3 Unbonded, Bond Breaker Greater Than 4 Inches.

Evaluate as composite pavement (paragraph 2-8.4.3).

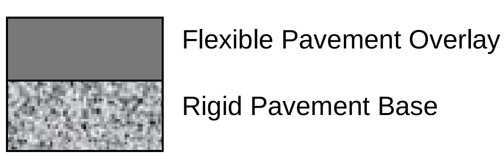
**Figure 2-63 Unbonded Rigid Overlay on Rigid Pavement, Bond Breaker Greater than 4 Inches**




### 2-8.4.2 Non-Rigid Overlay on Rigid Pavements.

Evaluate as a rigid pavement system and as a flexible pavement system to determine which yields the higher AGLs or allowable passes. Report the higher AGLs or allowable passes in the evaluation.

**Figure 2-64 Flexible Overlay on Rigid Pavement**



**2-8.4.2.1 Evaluate as Rigid Pavement.**

**2-8.4.2.1.1** Compute the equivalent thickness ($H_E$) of the combined overlay section using the following equation:

$$H_E = \frac{1}{F}\left(0.33t + C_B(H_B)\right)$$

Where $t$ = Thickness of nonrigid overlay pavement, inches
$H_B$ = Thickness of rigid base pavement, inches
$F$ = Factor which controls the degree of cracking in the rigid base pavement (see Appendix G)

**2-8.4.2.1.2** For certain values of $F$, the equation will yield a $H_E$ greater than the combined thickness of $H_B + t$. When this occurs, use the value of $H_B + t$ for $H_E$.

**2-8.4.2.1.3** If a condition factor ($C_B$) for the base pavement is known, the thickness $H_B$ is multiplied by the condition factor to determine the equivalent thickness.

**2-8.4.2.1.4** To determine the condition rating of the base concrete, consider the purpose of the overlay and the condition of the surface. In all cases of AC overlays over concrete base materials, look for reflective cracking or other evidence of distresses in the base concrete. **If there are no reflective cracks (other than joint reflective cracks), use a $C_B$ of 0.80. If there are reflective cracks (other than joint reflective cracks), use a $C_B$ of 0.50.**

**2-8.4.2.1.5** Evaluate as rigid pavement. If evaluating for the allowable number of passes, the process becomes interactive because the $F$ factor is dependent on traffic level. **For expedient evaluations, assign an F factor of 0.80.**

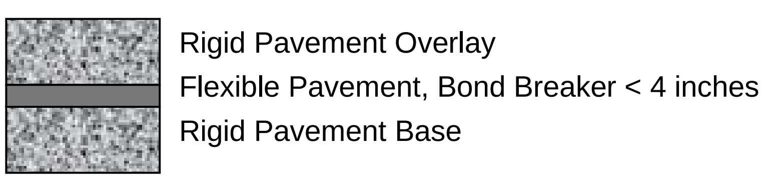
**2-8.4.2.2 Evaluate as Flexible Pavement.**

- Assume the nonrigid overlay is a flexible pavement
- Assume the rigid base pavement is a high-quality base course material with a CBR of 100
- Evaluate as flexible pavement

**2-8.4.3 Composite Pavements.**

**2-8.4.3.1 Bond Breaker Less Than 4 Inches.**

**Figure 2-65 Rigid Overlay on Flexible Overlay on Rigid Pavement, Bond Breaker Less than 4 Inches**



**2-8.4.3.1.1** Evaluate as rigid overlay on a rigid pavement, with the thickness of the non-rigid material assumed to be a bond-breaking course.

**2-8.4.3.1.2** Compute the equivalent thickness (*$H_E$*) of the combined overlay section using the following equation:

$$H_E = \sqrt{(H_O)^2 + C_R(H_B)^2}$$

$H_o$ = Thickness of rigid pavement overlay, inches

$C_R$= Coefficient representing condition of rigid base pavement

$H_B$ = Thickness of rigid base pavement, inches

Recommended values for $C_R$:

$C_R$ = 1.00 for base pavement in good condition

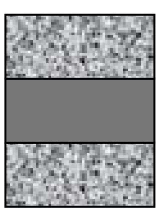
$C_R$ = 0.75 for base pavement having a few initial cracks due to loading but no progressive cracks

$C_R$ = 0.35 for badly cracked base pavement

**2-8.4.3.1.3** Compute the weighted average flexural strength for the evaluation using the equation found in paragraph 2-8.4.1.1.4.

**2-8.4.3.2 Bond Breaker Greater Than 4 Inches.**

**Figure 2-66 Rigid Overlay on Flexible Overlay on Rigid Pavement, Bond Breaker Greater than 4 Inches**




**2-8.4.3.2.1** Evaluate as rigid pavement, with the non-rigid material and the rigid base pavement assumed to be a base course.

**2-8.4.3.2.2** The thickness of the rigid overlay and the flexural strength of the rigid overlay will be used in the evaluation.

**2-8.4.3.2.3** In a normal evaluation a plate-bearing test is performed on top of the non-rigid bond-breaker to establish the K-value. For contingency evaluations, estimate this value based upon the thickness, confinement, and material type of the non-rigid bond-breaker. **If there are no surface structural distresses and the bond-breaker is**

**gravel or a bituminous material, assign a 500 K-value. If there are no surface structural distresses and the bond-breaker is sand, assign a 400 K-value. If there are surface structural distresses, assign a 300 K-value.** This assigned K-value represents the strength of the total underlying support structure, i.e., bond breaker, base slab, and all soil layers.

**2-8.4.4 Stabilized Layers.**

**2-8.4.4.1** The use of stabilized base course layers under rigid pavements is common. When encountered, evaluate the pavement structure in two ways and the results of the method that provides the higher number of allowable passes or higher allowable gross weights is reported.

**2-8.4.4.1.1** Evaluate the pavement as a rigid pavement system. Use the thickness of the PCC pavement as the total pavement thickness. Consider the stabilized layer to be a high-quality aggregate base course and use its thickness to adjust the effective K-value of the underlying soil.

**2-8.4.4.1.2** Evaluate the pavement as a rigid pavement system. Use the computed equivalent thickness of the combined PCC and stabilized layers as the total pavement thickness. Use the effective K-value of the underlying soil structure, computed from the bottom of the stabilized layer.

**2-8.4.4.1.2.1** Compute the equivalent thickness of the combined PCC and stabilized layers using the following formula:

$$h_E = \sqrt[1.4]{{h_e}^{1.4} + \left[\sqrt[3]{\frac{E_S}{E_C}} \times h_S\right]^{1.4}}$$

Where: $h_E$ = Equivalent thickness of combined slab and stabilized layers
$he$ = Thickness of slab
$h_S$ = Thickness of stabilized layer
$E_S$ = Modulus of elasticity of stabilized layer
$E_C$ = Modulus of elasticity of slab

**2-8.4.4.1.2.2** Use 4,000,000 as the modulus of elasticity of the PCC slab. This is the number used in pavement design.

**2-8.4.4.1.2.3** The modulus of elasticity of the stabilized layer is more difficult to determine. If the stabilized layer is a high-quality lean concrete or cement-stabilized layer, assign it a modulus value of 1,200,000. If the stabilized layer is lower quality, such as a lime or asphalt stabilized layer, assign it a modulus value of 500,000.

## 2-9 DETERMINE AIRCRAFT CLASSIFICATION NUMBER/PAVEMENT CLASSIFICATION NUMBER (ACN/PCN).

In 1983, the International Civil Aviation Organization (ICAO) developed and adopted a standardized method of reporting the load-bearing capacity of airfield pavements designed to support aircraft weighing more than 12,500 pounds. This procedure is known as the Aircraft Classification Number/Pavement Classification Number (ACN/PCN) method. The ACN is a number that expresses the relative effect an aircraft will have on a pavement system. The PCN is a number that expresses the capability of a pavement to support aircraft. Once AGLs are computed for each section using the procedures in paragraph 2-8, convert them to PCNs. PCNs for a given section will vary depending on which aircraft and number of passes they are based upon. All routine reports generated by AFCEC base the PCNs on the AGLs for the C-17 aircraft at 50,000 passes. This facilitates pavement strength comparisons of bases throughout the Air Force. **For all evaluations, performed by or for Air Force organizations, report PCNs for the C-17 aircraft at 50,000 passes.** To further explain, regardless of the mission or aircraft type an airfield pavement section is being evaluated for, the evaluator will also determine the allowable weight of a C-17 operating at 50,000 passes on the pavement section. The resulting allowable weight will be used on the appropriate (flexible or rigid) C-17 ACN chart to determine the reportable PCN of the pavement section being evaluated.

### 2-9.1 ACN/PCN Code.

In the ACN/PCN method, the PCN, pavement type, subgrade strength category, tire pressure category, and evaluation method are reported together in a code system (see Table 2-16).

The ACN/PCN method of reporting airfield structural capability is not as accurate as the methods previously presented in this manual to determine allowable passes or weights of mission aircraft. Use the ACN/PCN ratio as a “first look” to determine suitability for operations. If the ACN/PCN ratio suggests the operations can be allowed then the evaluator does not have to look any further. If the ACN/PCN ratio suggests the operations not be allowed then use the methods described in this manual to determine the allowable passes or weights of the proposed mission aircraft. Never limit operations based solely upon ACN/PCN ratios.

**Table 2-16 ACN/PCN Code System**

| PCN | Pavement Type | Subgrade Strength | Tire Pressure | Method of PCN Determination |
|---|---|---|---|---|
| Numerical Value | R = Rigid | A = High | W = Unlimited | |
| | | B = Medium | X = High | T = Technical Evaluation |
| | F = Flexible | C = Low | Y = Medium | U = Using Aircraft |
| | | D = Ultra Low | Z = Low | |

| Subgrade Strength Code | Flexible Pavement (CBR) | Rigid Pavement (K) |
|---|---|---|
| A | CBR ≥ 13 | K ≥ 442 |
| B | 8 > CBR > 13 | 221 > K > 442 |
| C | 4 > CBR ≥ 8 | 92 > K ≥ 221 |
| D | CBR ≤ 4 | K ≤ 92 |

| Tire Pressure | |
|---|---|
| **Code** | **PSI** |
| W | No Limit |
| X | Limit to 254 |
| Y | Limit to181 |
| Z | Limit to 73 |

**Example:** If the reported PCN for a feature is **42/R/C/W/T**, "**42**" indicates the PCN number, "**R**" indicates that it is a rigid or PCC surface, "**C**" indicates a low subgrade strength, "**W**" indicates that high tire pressures are allowed, and "**T**" indicates a technical evaluation was performed to determine the PCN. Each part of the code is important. The number "**42**" cannot be used properly without the letters that follow.

**2-9.1.1** **The pavement type reported is determined by the method of evaluation, not the surface type.** For example, if a rigid (concrete) pavement with a flexible (asphalt) overlay was evaluated as a rigid pavement, report the pavement type in the PCN as R. An evaluator is not permitted to get creative in the coding used to report PCNs. Aircrews have only two charts to use in considering suitability of operations based upon the ACN/PCN system: one for operations on flexible pavements and one for operations on rigid pavements.

**2-9.1.2** When determining the subgrade code to be used, the term "subgrade" refers to all soil beneath the pavement, not just the in situ soil at the bottom of a typical flexible pavement cross-section. **When reporting the subgrade strength code, use the strength of the critical or controlling layer in the evaluation.** For flexible pavements, base this upon the CBR of the controlling layer. For rigid pavements, base it upon the lowest effective K-value used in the evaluation.

**2-9.1.3** As a general rule, tire pressure has little effect on pavements with PCC surfaces. These pavements are inherently strong enough to resist high tire pressures and can usually be rated as code "W." If, however, the rigid pavement is very thin (less than 4 inches [100 mm]) or is thoroughly shattered (pieces less than about 2 feet [0.5 m] wide), do not rate the pavement above 100 psi. In cases of thinly bonded overlays, such as surface scaling repairs when one suspects poor bonding between the repair material and the original concrete surface, reduce the tire pressure code to eliminate high tire pressure aircraft.

**2-9.1.4** Tire pressures may be restricted on flexible pavement, depending on the quality of the asphalt mixture, climatic conditions, or the thickness and condition of the surface. Tire pressure effects on an asphalt layer relate to the stability of the mix in resisting shearing or densification. A properly prepared and placed mixture that conforms to DOD specifications can withstand tire pressures in excess of 254 psi. Do not rate pavements that are thinner than the minimum required by UFC 3-260-02, *Pavement Design for Airfields* (medium load criteria for the Air Force), higher than code "Y." Do not rate pavements constructed of poorer quality asphalt or aged or severely cracked pavements above 100 psi.

**2-9.1.5** When using PCASE software to calculate PCNs, remember the software always displays a "W" as the subgrade strength part of the PCN code. Change this code manually in the report to reflect any desired tire pressure limitations.

### 2-9.2 Determining ACN Values.

ACN values for particular aircraft are determined the same way as PCN values because they are relative to the aircraft load, pavement type, and subgrade strength. An ACN may be determined for any combination of pavement type, subgrade category, and aircraft weight using the ACN/PCN charts in Appendix H. The ACN numbers for a given aircraft vary with the pavement type and subgrade strength category, as shown by the eight possible ACN values for a 750,000-pound C-5 aircraft:

| Rigid Pavement | Flexible Pavement |
|---|---|
| 26/R/A/W/T | 25/F/A/W/T |
| 30/R/B/W/T | 28/F/B/W/T |
| 39/R/C/W/T | 33/F/C/W/T |
| 48/R/D/W/T | 45/F/D/W/T |

The ACN of a 750,000-pound C-5 varies on flexible pavement from 25 to 45, depending upon the subgrade strength and similarly varies on flexible pavement. For lower aircraft weights, the ACNs are lower. When analyzing the effect of an aircraft on a specific pavement feature, select the appropriate ACN. For example, if the PCN of a given feature is 74/F/C/W/T, to determine the effect of a 750,000-pound C-5 on the feature, the correct ACN to compare with the PCN is 33/F/C (the one considering similar pavement type and subgrade strength).

### 2-9.3 ACN/PCN System.

**2-9.3.1** The ACN/PCN system is structured so a pavement with a particular PCN value can support an aircraft with an ACN value equal to or less than the PCN. If the ACN is more than the PCN, the pavement will be overloaded and pavement life reduced. Except for massive overloading, pavements are not subject to a limiting load above which they suddenly or catastrophically fail. As a general guide:

**2-9.3.1.1** Overloading of pavements can result from loads too large or a substantially increased application rate, or both. Loads larger than the defined design or evaluation load shorten the design life whilst smaller loads extend it. With the exception of massive overloading, pavements are not subject to a particular limiting load above which they suddenly or catastrophically fail. The structural behavior of pavements is such that a pavement can sustain a definable load for an expected number of repetitions during its design life. As a result, occasional overloading is acceptable, when expedient, with only a limited loss in pavement life expectancy and a relatively small acceleration of anticipated pavement deterioration.

**2-9.3.1.2** Examples of situations where operators may decide it is acceptable to overload a pavement are emergency landings, short-term contingencies, exercises, and air shows. In the ACN/PCN methodology, a pavement can support operations of an aircraft if the PCN is equal to or greater than the ACN (i.e., ACN/PCN ≤ 1.0). For those operations in which the magnitude of load and/or the frequency of use do not justify a detailed analysis using the AGL/pass level methodology presented previously, ICAO suggests the following criteria as a “quick” approach:

**2-9.3.1.2.1** For flexible pavements, occasional movements by aircraft with ACNs not exceeding the reported PCN by more than 10% (i.e., 1.0 ≤ ACN/PCN ≤ 1.1) do not adversely affect the pavement.

**2-9.3.1.2.2** For rigid or composite pavements, in which a rigid pavement layer provides a primary element of the structure, occasional movements by aircraft with ACNs not exceeding the reported PCN by more than 5% (i.e., 1.0 ≤ ACN/PCN ≤ 1.05) do not adversely affect the pavement.

**2-9.3.1.2.3** If the pavement structure details are unknown, the 5% limitation applies (i.e., 1.0 ≤ ACN/PCN ≤ 1.05).

**2-9.3.1.2.4** The annual number of movements by aircraft exceeding an ACN/PCN ratio of 1.0 is not to exceed 5% of the total annual aircraft movements.

**Note:** Movements by aircraft exceeding an ACN/PCN ratio of 1.0 are not be permitted on pavements exhibiting substantial signs of distress or failure or risk plunging failure through the pavement. Furthermore, during any periods of thaw-weakening following frost penetration or when the strength of the pavement or its subgrade is weakened by the presence of water, perform analysis using PCNs determined based on the reduced subgrade strength.

For expedient evaluations, and sustainment evaluations where aircraft missions are the primary concern, do not restrict aircraft operations just because the ACN/PCN ratio exceeds 1.1. The ACN/PCN ratio gives a good first-look at the pavement. If the ratio is okay then operations can proceed. If the ratio is questionable then evaluate the allowable gross weights and/or allowable pass calculations to determine structural suitability for operations. Evaluate the airfield capability based upon mission requirements and computed allowable pass levels.

### 2-9.4 A Word of Caution.

The ACN/PCN system was developed to compare the impact of various aircraft operations on a given pavement structure, **but the aircraft used to determine the pavement PCN has an impact on the PCN value. Using different aircraft and pass levels to determine the PCNs will result in different PCN values.** Not all evaluations in DOD produce PCNs based upon 50,000 passes of a C-17. Other agencies, foreign and domestic, base the PCNs on the using aircraft type and traffic. **In situations where the basis for a reported PCN is not known, make an effort to perform the necessary field tests to determine AGLs or allowable passes before making a decision on mission capability.**

### 2-9.5 Assuming the PCN.

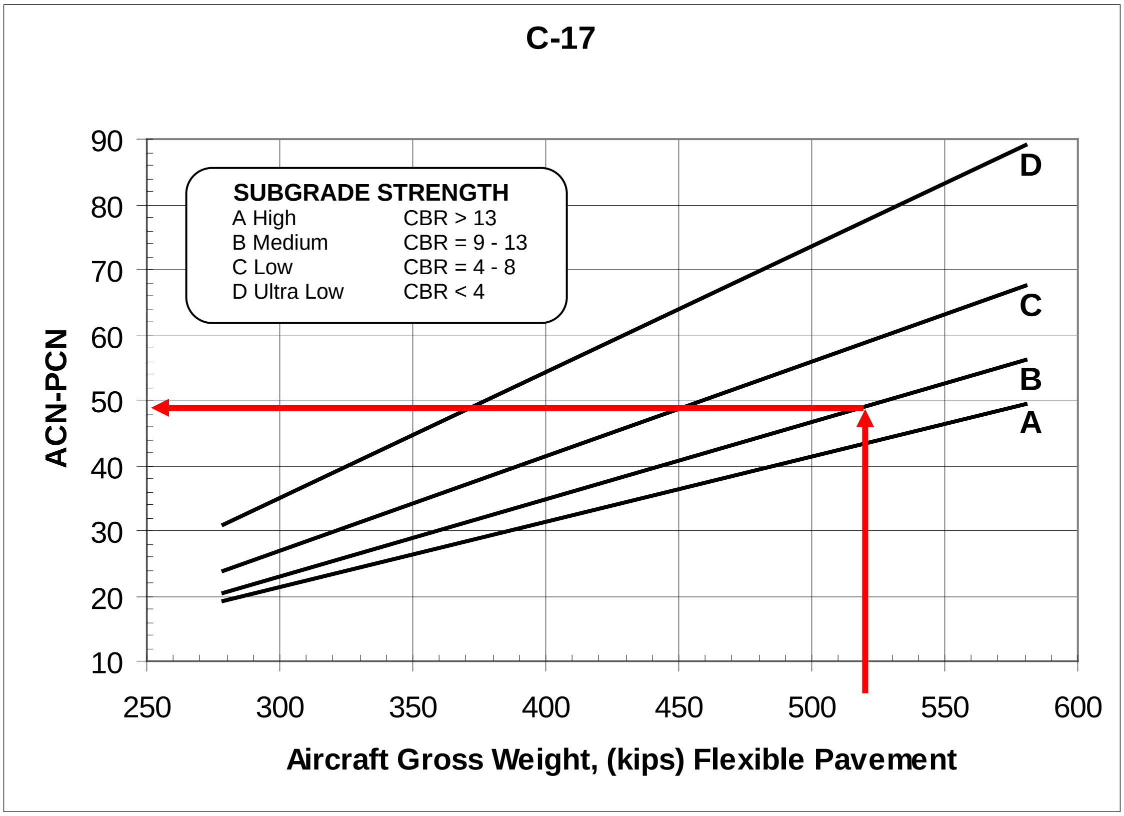
If means are not available to measure soil strength and assign an appropriate subgrade strength code to the PCN, the following assumptions can be used if soil classification is known:

| Subgrade Strength Code | Unified Classification |
|---|---|
| A – High | GW, GP, GM |
| B – Medium | GC, SW, SP, SM |
| C – Low | SC, OL, CL, ML |
| D – Ultra Low | OH, CH, MH |

### 2-9.6 Determining the PCN.

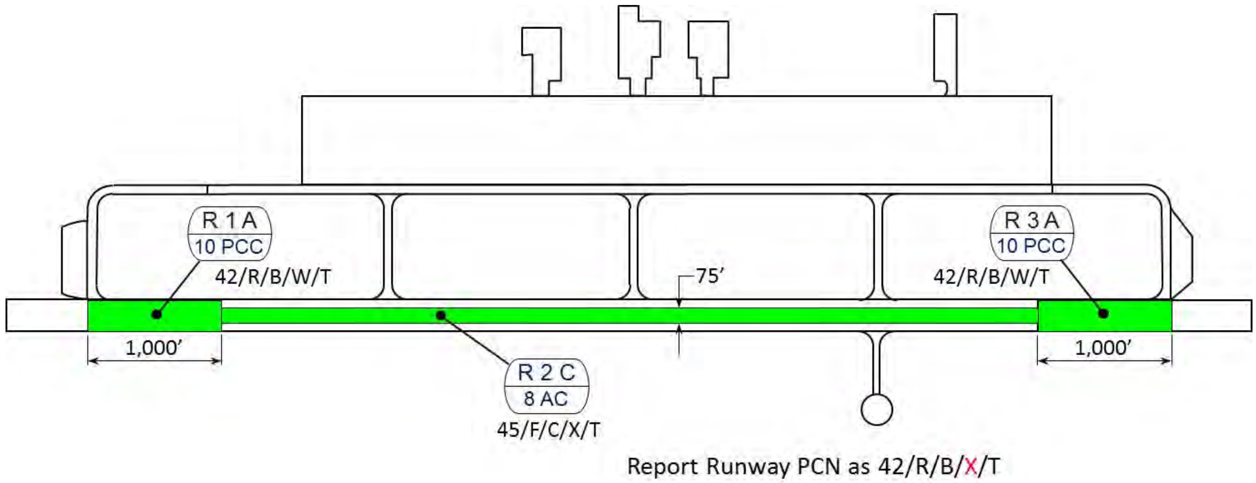
To determine the reportable PCN for a given section, select the C-17 ACN/PCN chart for the type pavement surface being evaluated (Appendix H), enter the chart at the allowable gross weight calculated for the C-17 at 50,000 passes, project vertically to intersect the subgrade strength category line corresponding to the CBR of the controlling layer when evaluating flexible pavement or the lowest effective K-value when evaluating rigid pavement, then horizontally to read the resulting PCN. For example, if the allowable weight for the C-17 at 50,000 passes on a flexible pavement having a controlling subgrade strength of 10 CBR is calculated at 520,000 pounds, the reported PCN is 38/F/B/W/T. See Figure 2-67.

**Figure 2-67 Determining the PCN**




**2-9.6.1** When a runway is composed of more than one pavement section, the reported PCN for that runway is usually based on the most weight-restrictive section (the section that produces the lowest AGL for the C-17 operating for 50,000 passes) located in the center 75-foot (23-m) -wide keel section of the runway, threshold to threshold, extended to the full runway width for the 1,000-foot (305-m) -long areas located at each end. See Figure 2-68.

**Figure 2-68 Reporting Runway PCN**




**2-9.6.2** When there is another section on the runway that cannot be avoided during operations, with a higher allowable gross load but a more restrictive tire pressure code, report the lower tire pressure code. For example, a given runway has PCC ends (sections R01A and R03A) and a flexible interior (section R02C). The PCN of sections R01A and R03A is 42/R/B/W/T, with an AGL of 500,000 pounds. The PCN of section R02C is 45/F/C/X/T (tire pressure restriction), with an AGL of 511,000 pounds. The reported PCN of the runway is 42/R/B/X/T, with an explanation of the reduced tire pressure code. See Figure 2-68.

**2-9.6.3** Many nations continue to use the load classification number (LCN) method to report pavement capability. This was a standard method used before the adoption of the ACN/PCN system. The Air Force operational community is familiar with the LCN system and uses it. Most reported airfield LCNs are based upon satellite imagery, using aircraft, or on information provided by airfield mangers or in Airfield Information Pamphlets (AIPs). Less than 1% of the LCNs reported by the National Geospatial Intelligence Agency (NGA) in Flight information Pamphlets (FLIPs) is based upon actual engineering data such as as-built drawings and specifications or evaluation reports.  Basically, if the pavement LCN is greater than the aircraft LCN, the pavement will support that aircraft for unlimited operations.

**2-9.6.4** Aircraft that impose similar stress levels on pavements have been grouped together into Load Classification Groups (LCG). LCG I includes LCNs 101 to 120, LCG II includes LCNs 76 to 100, LCG III includes LCNs 51 to 75, LCG IV includes LCNs 31 to 50, LCG V includes LCNs 16 to 30, LCG VI includes LCNs 11 to 15, and LCG VII includes LCNs of 10 and below.

**2-9.6.5** The published LCG of a pavement permits its unlimited use by all aircraft with LCNs within that LCG or lower LCGs. If the pavement is rated as LCG IV, it will support all aircraft in LCGs IV, V, VI, and VII.

**2-9.6.6** It is possible to allow the occasional use of a pavement by aircraft falling within the LCG category one above the published pavement LCG on an infrequent basis (can occasionally operate LCG I aircraft on LCG II pavement).

**2-9.6.7** An aircraft with an LCN that places it in an LCG category two higher than the published pavement LCG is only allowed to operate in emergency conditions (can operate LCG I aircraft on LCG III pavement in an emergency).

**2-9.6.8** **Use LCNs for evaluation purposes only when more detailed information is not available.** Figures 2-69 and 2-70 contain approximate conversions from LCNs to PCNs. LCNs were based upon the stress developed in several standard PCC slab/base course structures and do not correlate well for all pavement types. When comparing LCNs to AGL computations for various pavements, consider the following:

- Single-wheel aircraft on rigid pavement – compares fairly well.
- Multi-wheel aircraft on rigid pavement – results are variable, depending upon how the actual pavement structure compares to the standard LCN structures.
- Single-wheel aircraft on flexible pavement – results are more variable because the rigid pavement criterion was used to compute the flexible pavement stresses.
- Multi-wheel aircraft on flexible pavement – results will vary considerably.
- The LCN system assumes that all base course materials in the flexible pavement structure met and still meet the original design specifications (e.g., CBRs, gradations).

**Figure 2-69 LCN to PCN Conversion, Rigid Pavement**

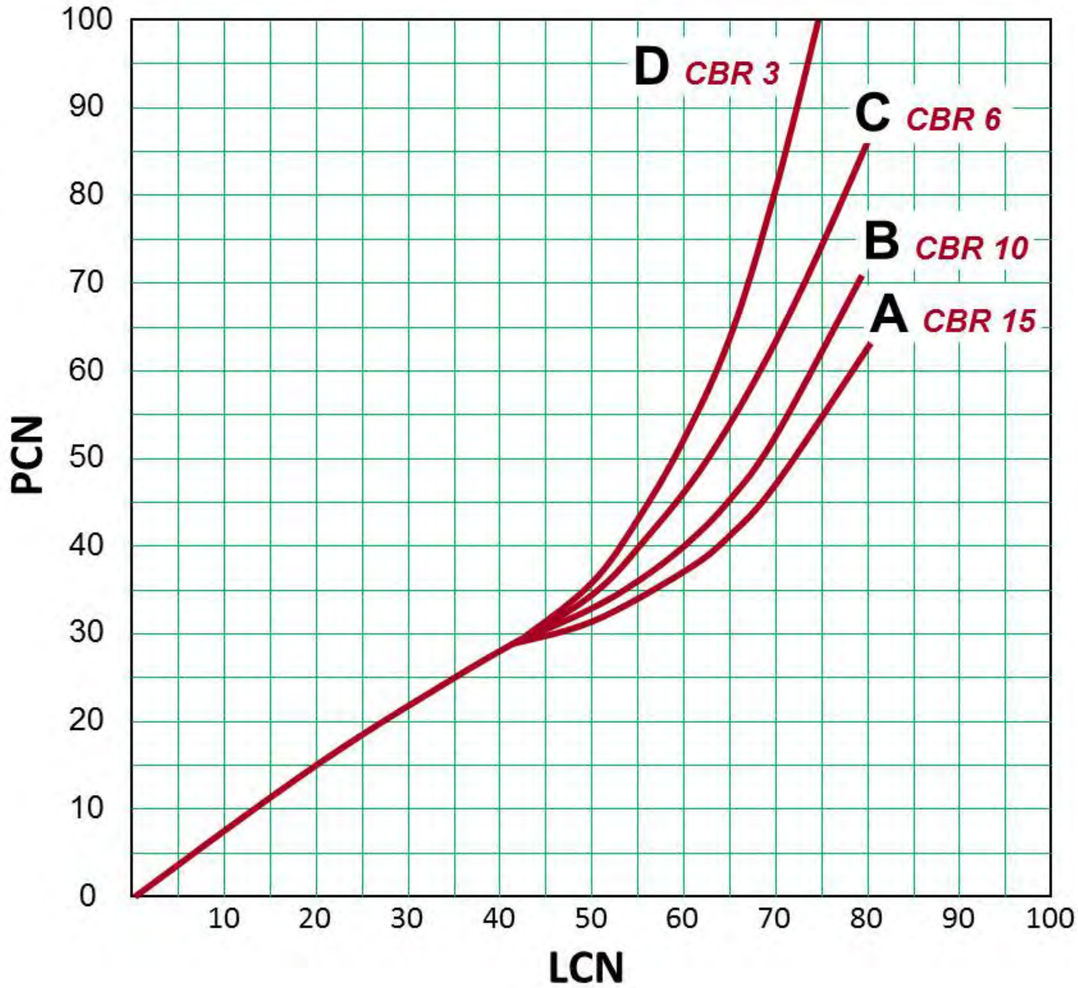
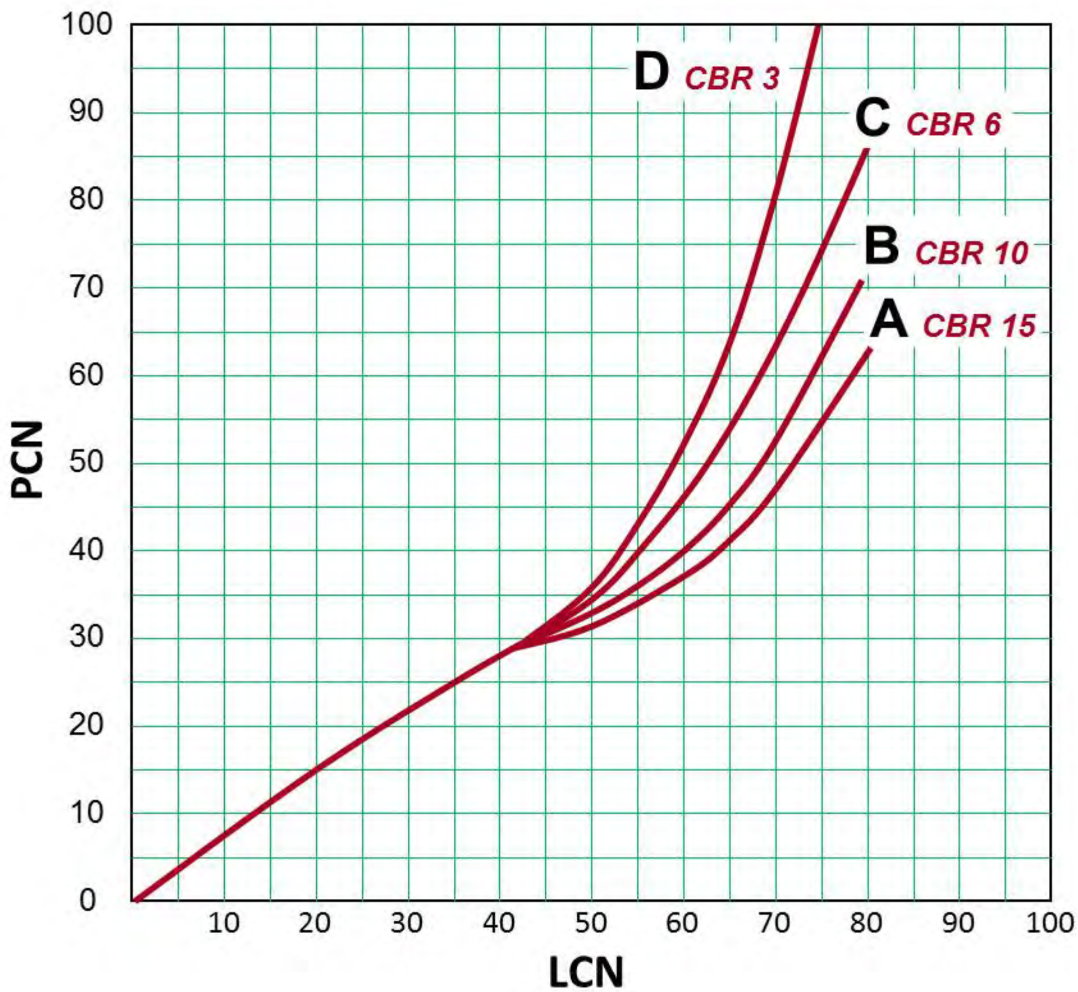


**Figure 2-70 LCN to PCN Conversion, Flexible Pavement**




## 2-10 EVALUATION REPORT.

**2-10.1** Once the field testing and data analysis are complete, publish the results in a format that is easily understood.

**2-10.1.1** Expedient evaluation reports contain the following minimum information:

**2-10.1.1.1 Summary.**

Include the following:

- Location and dates of evaluation
- Requester
- Answers to the questions that prompted the evaluation

- Mission capability. Provide text or tables as needed to summarize report findings on structural load-bearing capability (allowable aircraft operations or allowable gross weight limitations). At a minimum, provide the allowable passes for the mission aircraft at its maximum weight, along with allowable passes or AGLs for other aircraft as requested by the tasking agency/agencies.
- Provide PCNs for each area evaluated based upon 50,000 passes of the C-17 at 585,000 pounds. **Note the governing or controlling PCN, which is defined as the weakest feature along the central portion (75-foot keel) of a runway from threshold to threshold. It also includes the entire width of the touch-down zones.** Overruns and the non-keel pavements of the runway interior are excluded under this definition.

#### 2-10.1.1.2 Observations.

Include the following:

- Description of pavement surface condition, including PCI rating and discussion of major distresses. **Document the condition ratings with photographs.**
- Description of any limiting factors that may impact aircraft operations, such as craters, high-severity distresses, obvious obstructions, or weak areas.
- Explanation of areas that are closed to or restrict aircraft ground operations.

#### 2-10.1.1.3 Analysis.

Include the following:

- PPD sheet listing all the test locations shown on the scaled drawing, with the cross-sectional data that was used to evaluate that location. Document the sources of the reported data as notes on this sheet.
- Explanation of data included in the PPD, as required.
- **Document all assumptions used in the evaluation process and the rationale for any deviations from the recommended assumptions in this publication.**

#### 2-10.1.1.4 Airfield Layout.

Include a scaled drawing of the airfield showing:

- Runway length and width and directional designation
- Names for other operational surfaces (e.g., Taxiway C, North Apron)
- Highlighted areas that are closed to or restrict aircraft ground operations

- Test locations
- Areas of major repair, weak areas, and crater repairs
- Pavement surface types

**2-10.1.1.5 Evaluation Team Members.**

Include the following:

- Name of certified team chief and names of all team members
- Organization(s)
- Phone number(s)
- E-mail address(es)

**2-10.1.2** Attach the DCP data plots for each test location to the report. Show the soil layer breaks and CBRs for each soil layer in the DCP data plots.

**2-10.1.3** Distribute copies of all expedient evaluation reports to AFCEC and the tasking agency/agencies as required.

**2-10.1.4** Appendix I is an example expedient evaluation report that may be useful as “boiler plate” for expedient evaluation reports.

**2-10.2** Sustainment and permanent evaluation reports contain the same information as an expedient evaluation, but in greater detail. Provide information for each evaluated feature. Much of the information, because of quantity, is best summarized in tables as well as descriptions located in the text of the report; plans are also more detailed.

# APPENDIX A SOIL CHARACTERISTICS

## A-1 SOIL PROPERTIES.

The physical properties of a soil help determine the soil's engineering characteristics. These properties are the basis for the system of soil classification used in engineering identification of soil types. Physical characteristics of soil particles are size and shape. The proportions of particles of different sizes determine the gradation of the aggregate. Compactness refers to the closeness of packing of the soil particles—the closer the packing, the greater the compactness, and the larger the weight of the soil per unit of volume. Plasticity characteristics of fine-grained soil components influence bearing capacity. The presence of organic matter is important to the engineering use of soils. Color, texture, odor, structure, and consistency are readily observed factors that aid in soil description.

### A-1.1 Grain-Size Groups.

Soils are divided into groups based on the size of the particle grains in the soil mass. Size groups in the USCS are shown in Table A-1. Coarse-grained soil particles that fall into the gravel or sand groups are individually discernible to the naked eye—fine-grained soil particles are not. In the fine particle group, particles passing the No. 200 sieve, but larger than 0.002 to 0.005 millimeter are called silt. Those finer are called clay.

**Table A-1 Soil Grain Size Groups**

| Size Group | Passing | Retained On | Example |
|---|---|---|---|
| Boulders | No maximum size | 12 inch | |
| Cobbles | 12 inch | 3 inch | |
| Gravels | 3 inch | No. 4 | Lemon to pea |
| (Coarse) | 3 inch | 0.75 inch | Lemon to walnut |
| (Fine) | 0.75 inch | No. 4 | Walnut to pea |
| Sands | No. 4 | No. 200 | Pea to powdered sugar |
| (Coarse) | No. 4 | No. 10 | Pea to rock salt |
| (Medium) | No. 10 | No. 40 | Rock salt to table salt |
| (Fine) | No. 40 | No. 200 | Table salt to powdered sugar |
| Fines | No. 200 | No minimum size | |

### A-1.2 Particle Shape.

The shape of particles influences the strength and stability of a soil. Two general shapes are typically recognized: bulky and platy. The bulky shapes include particles that are relatively equal in all three dimensions. In platy shapes, one dimension is very small compared to the other two. Bulky shapes are subdivided depending on the amount of weathering that has acted on them. They may be angular, subangular, subrounded, or rounded. The angular shape shows flat surfaces, jagged projections, and sharp ridges. The rounded shape has smooth, curved surfaces and is almost spherical. Cobbles, gravels, sand, and silt fall into the bulky shape group. Particles of clay soil exhibit a platy shape, though too small to be seen with the naked eye.

### A-1.3 Soil Gradation.

The size and shape of the soil particles deal with properties of the individual grains in a soil mass. Gradation describes the distribution of the different size groups within a soil sample. The soil may be well graded or poorly graded.

**A.1.3.1** Well-graded soils have a good range of all representative particle sizes between the largest and the smallest. All sizes are represented and no one size is either overabundant or missing.

**A.1.3.2** Poorly graded soils are either those containing a narrow range of particle sizes or those lacking some intermediate sizes. Soils with a limited range of particle sizes are called uniformly graded. Soils which have some intermediate size or sizes not well represented or missing are called gap graded, step graded, or skip graded.

### A-1.4 Compactness.

The structure of the aggregate of soil particles may be dense (closely packed) or loose (lacking compactness). A dense structure provides interlocking of particles with smaller grains filling the voids between the larger particles. When each particle is closely surrounded by other particles, the grain-to-grain contacts are increased, the tendency for displacement of individual grains under load is lessened, and the soil is capable of supporting heavier loads. Coarse materials that are well graded are usually dense and have strength and stability under load. Loose, open structures have large voids and will compact under load, leading to settlement or disintegration under foundation or traffic loads. The shape of the grains also affects the bearing capacity. Angular particles tend to interlock and form a dense mass and are more stable than the rounded particles that can roll or slide past one another.

### A-1.5 Moisture.

The moisture content of a soil mass is often the most important factor affecting the engineering behavior of the soil. The water may enter from the surface or may move through the subsurface layers either by gravitational pull, capillary action, or hygroscopic action. This moisture influences various soils differently and usually has its greatest effect on the behavior of fine-grained soils such as silts and clays. The term “moisture content” (w) is used to define the amount of water present in a soil sample. It is the proportion of the weight of water to the weight of the solid mineral grains (weight of dry soil) expressed as a percentage.

$$\%W = \frac{wt\ of\ water}{wt\ of\ dry\ soil} \times 100$$

Grain size affects soil moisture. Coarse-grained soils with larger voids permit easy drainage of water. They are less susceptible to capillary action. The amount of water held in these soils is less than in fine-grained soils since the surface area is smaller and excess water will tend to drain off whenever possible. The fine grains and their small voids retard the movement of water and also tend to hold the water by surface tension. Clay soil properties may vary from essentially liquid to almost brick-hard with different amounts of moisture. Furthermore, clays are basically impervious to the passage of free or capillary moisture.

### A-1.6 Cohesive Soils.

A cohesive soil has considerable strength when air-dried but has low strength when its moisture content is high. These soils are composed of fine-grained particles of clay minerals. Clay particles are capable of holding a film of adsorbed water on their surfaces. Adsorbed water is held by physiochemical forces and has properties substantially different from ordinary or chemically combined water. The attraction exerted by clay particles for water molecules gives these materials plasticity. Plasticity is a property of the fine-grained portion of a soil that allows it to be deformed beyond the point of recovery without cracking or appreciable volume change. This property permits clay to be rolled into thin threads at some moisture contents without crumbling. Only clay minerals possess this property; thus, the degree of plasticity is a general index to the clay content of a soil. The terms “fat” and “lean” are sometimes used to distinguish between highly plastic and moderately plastic soils.

**A.1.6.1** Soil plasticity is determined by observing the different physical states that a plastic soil passes through as the moisture content changes. The boundaries between the different states as described by the moisture content at the time of changes are called “consistency” or “Atterberg limits.”

**A.1.6.2** The liquid limit (LL) is the moisture content at an arbitrary limit between the liquid and plastic states of a soil. Above this value, the soil is presumed to be a liquid and flows freely under its own weight. Below this value, it will deform under pressure without crumbling, provided the soil exhibits a plastic state.

**A.1.6.3** The plastic limit (PL) is the moisture content at an arbitrary limit between the plastic and brittle states. As the sample is dried, the semisolid state is reached when the soil is no longer pliable and crumbles under pressure.

**A.1.6.4** Between the liquid and plastic limits is the plastic range. The numerical difference in moisture contents between the two limits is called the plasticity index (PI). It defines the range of moisture content of the soil in a plastic state.

$$(PI = LL - PL)$$

### A-1.7 Organic Soils.

Soils having a high content of organic material are described as organic soils. They usually are very compressible and have poor load-maintaining properties.

**Table A-2 Soil Characteristics Pertinent to Roads and Airfields – Part 1**

| Soil Type | | Letter Symbol | | Value as Subbase or Subgrade | Value as Base Course | Potential Frost Action | Compressibility and Expansion |
|---|---|---|---|---|---|---|---|
| Coarse Grained Soils | Gravel and Gravelly Soils | GW | | Excellent | Good | None to Very Slight | Almost None |
| | | GP | | Good to Excellent | Poor to Fair | None to Very Slight | Almost None |
| | | GM | d | Good to Excellent | Fair to Good | Slight to Medium | Very Slight |
| | | | u | Good | Poor | Slight to Medium | Slight |
| | | GC | | Fair to Good | Poor | Slight to Medium | Slight |
| | Sands and Sandy Soils | SW | | Good | Poor | None to Very Slight | Almost None |
| | | SP | | Fair to Good | Poor to Not Suitable | None to Very Slight | Almost None |
| | | SM | d | Good | Poor | Slight to High | Very Slight |
| | | | u | Fair to Good | Not Suitable | Slight to High | Slight to Medium |
| | | SC | | Fair to Good | Not Suitable | Slight to High | Slight to Medium |
| Fine Grained Soils | Silts and Clays LL < 50 | ML | | Fair to Poor | Not Suitable | Medium to Very High | Slight to Medium |
| | | CL | | Fair to Poor | Not Suitable | Medium to High | Medium |
| | | OL | | Poor | Not Suitable | Medium to High | Medium to High |
| | Silts and Clays LL > 50 | MH | | Poor | Not Suitable | Medium to Very High | High |
| | | CH | | Poor to Very Poor | Not Suitable | Medium | High |
| | | OH | | Poor to Very Poor | Not Suitable | Medium | High |
| Highly Organic Soils | | Pt | | Not Suitable | Not Suitable | Slight | Very High |

**Notes:** Division of GM and SM groups into subdivisions of d and u are for roads and airfields. Suffix d is used when the liquid limit is 28 or less and the plasticity index is 6 or more. Suffix u is used when the liquid limit is greater than 28.

**Table A-3 Soil Characteristics Pertinent to Roads and Airfields – Part 2**

| Soil Type | | Letter Symbol | | Drainage Characteristics | Unit Dry Weight (lb/ft$^3$) | Field CBR | Subgrade Modulus (lb/ft$^3$) |
|---|---|---|---|---|---|---|---|
| Coarse Grained Soils | Gravel and Gravelly Soils | GW | | Excellent | 125 – 140 | 60 - 80 | 300 or More |
| | | GP | | Excellent | 110 – 130 | 25 - 60 | 300 or More |
| | | GM | d | Fair to Poor | 130 – 145 | 40 - 80 | 300 or More |
| | | | u | Poor to Impervious | 120 - 140 | 20 - 40 | 200 to 300 |
| | | GC | | Poor to Impervious | 120 - 140 | 20 - 40 | 200 to 300 |
| | Sands and Sandy Soils | SW | | Excellent | 110 – 130 | 20 - 40 | 200 to 300 |
| | | SP | | Excellent | 100 – 120 | 10 - 25 | 200 to 300 |
| | | SM | d | Fair to Poor | 120 - 135 | 20 - 40 | 200 to 300 |
| | | | u | Poor to Impervious | 105 - 130 | 10 - 20 | 200 to 300 |
| | | SC | | Poor to Impervious | 105 - 130 | 10 - 20 | 200 to 300 |
| Fine Grained Soils | Silts and Clays LL < 50 | ML | | Fair to Poor | 100 - 125 | 5 - 15 | 100 to 200 |
| | | CL | | Impervious | 100 – 125 | 5 - 15 | 100 to 200 |
| | | OL | | Poor | 90 – 105 | 4 - 8 | 100 to 200 |
| | Silts and Clays LL > 50 | MH | | Fair to Poor | 80 – 100 | 4 - 8 | 100 to 200 |
| | | CH | | Impervious | 90 - 110 | 3 - 5 | 50 to 100 |
| | | OH | | Impervious | 80 - 105 | 3 - 5 | 50 to 100 |
| Highly Organic Soils | | Pt | | Fair to Poor | -- | -- | -- |

**Notes:** Division of GM and SM groups into subdivisions of d and u are for roads and airfields.
Suffix d is used when the liquid limit is 28 or less and the plasticity index is 6 or more.
Suffix u is used when the liquid limit is greater than 28.

## A-2 SOIL CLASSIFICATION.

Soils seldom exist separately as sand, gravel, or any other single component in nature. They are usually mixtures with varying proportions of different sized particles. Each component contributes to the characteristics of the mixture. The USCS is based on the characteristics that indicate how a soil will behave as a construction material. The physical properties determined by appropriate tests and calculations are used to classify the soil. The criteria for identifying the different soil types are described in Table A-4 and the following paragraphs.

**Table A-4 USCS**

| Major Divisions | | | Symbol | Field Identification Procedures | | |
|---|---|---|---|---|---|---|
| Coarse-Grained Soils (More than half of the material is larger than No. 200 sieve) | Gravels (More than half of coarse fraction is larger than No. 4 sieve) | Gravels < 5% Fines | GW | Wide range in grain sizes, all intermediate sizes substantially represented | | |
| | | | GP | Predominantly one size or some intermediate sizes missing | | |
| | | Gravels > 12% Fines | GM | Nonplastic fines or fines with little plasticity (see ML below) | | |
| | | | GC | Plastic fines (see CL below) | | |
| | Sands (More than half of coarse fraction is smaller than No. 4 sieve) | Sands < 5% Fines | SW | Wide range in grain sizes, all intermediate sizes substantially represented | | |
| | | | SP | Predominantly one size or some intermediate sizes missing | | |
| | | Sands > 12% Fines | SM | Nonplastic fines or fines with little plasticity (see ML below) | | |
| | | | SC | Plastic fines (see CL below) | | |
| Fine-Grained Soils (More than half of the material is smaller than No. 200 sieve) | | | | Identification Procedure on Fraction Smaller than No. 40 Sieve | | |
| | | | | Dry Strength | Wet Shake | Thread or Ribbon |
| | Silts and Clays LL < 50 | | ML | None to Slight | Quick to Slow | None |
| | | | CL | Medium to High | None to Very Slow | Medium |
| | | | OL | Slight to Medium | Slow | Slight |
| | Silts and Clays LL > 50 | | MH | Slight to Medium | Slow to None | Slight to Medium |
| | | | CH | High to Very High | None | High |
| | | | OH | Medium to High | None to Very Slow | Slight to Medium |
| Highly Organic Soils | | | Pt | Readily identified by color, odor, spongy feel, and frequently by fibrous texture | | |

### A-2.1 Categories.

In the USCS, all soils are divided into three major categories: coarse grained, fine grained, and peat. The first two are differentiated by grain size, whereas the third is identified by the presence of large amounts of organic material.

### A-2.2 Groups.

Each of the major categories is subdivided into groups and a letter symbol is assigned to each group.

| Soil Groups | Symbol | Soil Characteristics | Symbol |
|---|---|---|---|
| Gravel | G | Well-graded | W |
| Sand | S | Poorly graded | P |
| Silt | M | High compressibility | H |
| Clay | C | Low compressibility | L |
| | | Organic (peat) | Pt |
| | | Organic (silts and clays) | O |
| | | Liquid limits less than 50 | L |
| | | Liquid limits over 50 | H |

### A-2.3 Coarse-Grained Soils.

Coarse-grained soils are defined as those in which at least half the material by weight is larger than a No. 200 sieve. They are divided into two major divisions: gravels and sands. A coarse-grained soil is classified as gravel if more than half the coarse fraction by weight is larger than a No. 4 sieve. It is sand if more than half the coarse fraction by weight is smaller than a No. 4 sieve.

#### A-2.3.1 Coarse-Grained Soils with Less than 5% Nonplastic Fines.

The first letter of the symbol indicates a gravel or sand. The second letter is determined by the grain size distribution curve.

- **GW** Well-graded gravels or gravel-sand mixtures
- **GP** Poorly graded gravels or gravel-sand mixtures
- **SW** Well-graded sands or gravelly sands
- **SP** Poorly graded sands or gravelly sands

#### A-2.3.2 Coarse-Grained Soils Containing more than 12% Fines.

The first letter of the symbol indicates a gravel or sand. The second letter is based upon the plasticity characteristics of the portion of the material passing the No. 40 sieve. The symbol M usually designates a fine-grained soil of little or no plasticity. The symbol C is used to indicate that the binder soil is predominantly clayey in nature.

- **GM** Silty gravels or gravel-sand-silt mixtures. The Atterberg limits plot below the A-line on the plasticity chart or the plastic index is less than 4.
- **GC** Clayey gravels or gravel-sand-clay mixtures. The Atterberg limits plot above the A-line with a plastic index of more than 7.
- **SM** Silty sands or sand-silt mixtures. The Atterberg limits plot below the A-line or the plastic index is less than 4.

- **SC** Clayey sands or sand-clay mixtures. The Atterberg limits plot above the A-line with a plastic index of more than 7.

### A-2.3.3 Borderline Coarse-Grained Soils.

Coarse-grained soils that contain between 5 and 12% of material passing the No. 200 sieve are classified as borderline and are given a dual symbol (for example, GW-GM). Select the two that are believed to be the most representative of the probable behavior of the soil. In cases of doubt, use the symbol representing the poorer of the possible groupings, depending upon the judgment of the engineer, from the standpoint of the climatic region.

## A-2.4 Fine-Grained Soils.

Fine-grained soils are those in which more than half the material by weight passes a No. 200 sieve. Fine-grained soils are not classified on the basis of grain-size distribution, but according to plasticity and compressibility.

### A-2.4.1 Silts.

- **ML** Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity. The plastic index plots below the A-line and the liquid limit is less than 50.
- **MH** Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, plastic silts. The plastic index plots below the A-line and the liquid limit is more than 50.
- **OL** Organic silts and organic silt-clays of low plasticity. The plastic index plots below the A-line and the liquid limit is less than 50.

### A-2.4.2 Clays.

- **CL** Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, and lean clays. The plastic index plots above the A-line and the liquid limit is less than 50.
- **CH** Inorganic clays of high plasticity (fat clays). The plastic index plots above the A-line and the liquid limit is more than 50.
- **OH** Organic clays of medium to high plasticity. The plastic index plots below the A-line and the liquid limit is more than 50.

### A-2.4.3 Borderline Fine-Grained Soils.

Fine-grained soils that plot in the shaded portion of the plasticity chart are borderline cases and are given dual symbols (for example, CL-ML).

### A-2.5 Highly Organic Soils.

A special classification (Pt) is reserved for the highly organic soils, such as peat, which have many characteristics undesirable for use as foundations and construction materials. No laboratory criteria are established for these soils as they can be identified in the field by their distinctive color, odor, spongy feel, and fibrous textures. Particles of leaves, grass, branches, or other fibrous vegetable matter are common components of these soils.

## A-3 FIELD IDENTIFICATION OF SOIL.

Lack of time and facilities often make laboratory testing impossible in contingency evaluations. Even where laboratory tests are to follow, field identification tests can reduce the number of required laboratory test samples. In expedient evaluations where the DCP is the primary instrument used to determine soil strength, proper identification of soil type is required to determine the correct correlation factor to be used in computing CBRs. The correlations for CL and CH soils vary significantly from other materials (see Tables A-2 and A-3). Experience is the greatest asset in field identification and this is gained by getting the feel of soils during laboratory testing. If expedient field tests to identify clay soils are inconclusive, conduct testing using laboratory Atterberg limits equipment and procedures.

### A-3.1 Equipment Required.

Field tests may be performed with little or no equipment other than a small amount of water; however, accuracy and uniformity of results will be increased by the proper use of available equipment. The following is a suggested list:

- Sieves:
  - No. 40. All tests used to identify the fine-grained portions of any soil are performed on the portion of the material that passes the No. 40 sieve. If this sieve is not available, spreading the material on a flat surface and removing the gravel and larger sand particles may make a rough separation.
  - No. 4. This sieve defines the limit between gravels and sands.
  - No. 200. This sieve defines the limit between sands and fines. The sedimentation test may also be used to separate the sands and fines. This test requires a transparent cup or jar.
- Pan and oven or other heating device
- Mixing bowl and pestle
- Scales or balances
- Knife or small spatula

**Figure A-1 Field Identification Equipment**

### A-3.2 Tests for Field Identification.

The USCS considers three soil properties: the percentage of gravel, sand, or fines; the shape of the grain-size distribution curve; and the plasticity. The purpose of field tests is to get the best possible identification and classification in the field. Make tests appropriate to a given soil sample. When a simple visual examination will define the soil type, only the tests needed to verify this are necessary. When results from a test are inconclusive, try some of the similar tests to establish the best identification.

#### A-3.2.1 Visual Examination.

This test establishes the color, grain sizes, grain shapes of the coarse-grained portion, approximate gradation, and some properties of the undisturbed soil.

##### A-3.2.1.1 Color.

Color helps distinguish between soil types and identify soil types. It may also indicate the presence of certain chemicals, minerals, or impurities. Color often varies with moisture content; therefore, include the moisture content at the time of identification. Colors generally become darker as the moisture content increases and lighter as the soil dries. Some fine-grained soils (OH, OL) with dark, drab shades of brown or gray, including almost black, contain organic material. In contrast, clean, bright shades of gray, olive green, brown, red, yellow, and white are associated with inorganic soils. Gray-blue or gray-and-yellow mottled colors frequently result from poor drainage. Red, yellow, and yellowish-brown result from the presence of iron oxides. White to pink may indicate considerable silica, calcium carbonate, or aluminum compounds.

### A-3.2.1.2 Grain Size.

Establish the maximum particle size of each sample to determine the upper limit of the gradation curve. Gravels range down to the size of peas; sands start just below this size and decrease until the individual grains are just distinguishable by the naked eye. **Silt and clay particles are indistinguishable as individual particles.**

### A-3.2.1.3 Grain Shape.

Determine the shapes of the visible particles. They may vary from sharp and angular to smooth and rounded.

### A-3.2.1.4 Grain Size Distribution.

Examining a dry sample spread on a flat surface can make an approximate identification. Pulverize all lumps until individual grains are exposed, but not broken. A rubber-faced or wooden pestle and a mixing bowl are recommended, but mashing the sample underfoot on a smooth surface will suffice for an approximate identification. Separate the larger grains (gravels and some sands) by picking them out individually. Examine the remainder of the soil and estimate the proportions of visible individual particles and fines. Convert these estimates into percentages by weight of the total sample. If the fines exceed 50%, the soil is considered fine-grained (M, C, or O). If the coarse material exceeds 50%, the soil is coarse-grained (G or S). Examine coarse-grained soil for gradation of the particle sizes from the largest to the smallest. A good distribution of all sizes means the soil is well-graded (W). Overabundance or lack of any size means the material is poorly graded (P). Estimate the percentage of the fine-grained portion of the coarse-grained soil for further classification. Fine-grained soils and fine-grained portions of coarse-grained soils require other tests for identification.

**Figure A-2 Grain Size Distribution**

### A-3.2.1.5 Undisturbed Soil Properties.

Characteristics of the soil in the undisturbed state may be helpful in identification. The compactness of gravels or sands may be loose, medium, or dense. Clays may be hard, stiff, or soft. Record the ease or difficulty of sample removal. The moisture content of the soil influences the in-place characteristics. It is helpful to know the weather just prior to and during the field evaluation to determine how the soil has reacted or will react to weather changes. The presence of decayed roots, leaves, grasses, and other vegetable matter in organic soils produces soil that is usually dark when moist, having a soft, spongy feel and a distinctive odor of rotting organic matter. The odor may be musky and slightly offensive. The odor is especially apparent in undisturbed conditions or in fresh samples. It is less pronounced as the sample is exposed to air. The odor can be made stronger by heating a wet sample.

### A-3.2.2 Sedimentation Test.

From visual examination it is relatively easy to approximate the proportions of gravels and sands in a soil sample. Determining the proportion of fine-grained particles is more difficult but just as important. In the laboratory and in some field-testing situations, the fines may be separated from the sample using the No. 200 sieve. The sedimentation test provides an alternate field method to separate fines from the sand particles in a soil sample.

**Figure A-3 Sedimentation Test**

Larger particles settle more quickly than fines

Smaller particles will settle through water at a slower rate than large particles. Placing a small amount of the fine fraction of a soil (such as a heaping teaspoon) in a transparent cup or jar, covering it with about 5 inches (125 mm) of water, and agitating it by stirring or shaking will completely suspend the soil in water. With cohesive soils, it will be necessary to break up all lumps of soil before adding the water. After the soil particles have been dispersed in the water and then left, they will start to settle to the bottom, beginning with the larger sized particles, in time periods indicated in Table A-5.

**Table A-5 Sedimentation Test**

| Approximate Time of Settlement in 5 in. (125 mm) of Water | Grain Diameter | Differentiates |
|---|---|---|
| 2 seconds | 0.4 mm | Coarse sand - fine sand |
| 30 seconds | 0.072 mm (No. 200 sieve) | Sand - fines |
| 10 minutes | 0.03 mm | Coarse silt - fine silt |
| 1 hour | 0.01 mm | Silt - clay |

Since all of the particles of soil larger than the No. 200 sieve will have settled to the bottom of the cup or jar 30 seconds after the mixture has been agitated, it follows that the particles still remaining in suspension are fines. Carefully pour the water containing the suspended fines into another container 30 seconds after agitation, more water added to the cup or jar containing the coarse fraction, and the procedure repeated until the water-soil mixture becomes clear 30 seconds after mixing. The cup or jar will contain the coarse fraction of the soil and the other container will hold the fines. The water is then wicked or evaporated off and the relative amounts of fines and sands determined fairly accurately. In clay soils the clay particles will often form small lumps (flocculate) that will not break up in water. If after several repetitions of the test substantial amounts of clay are still present in the coarse material, the sand will feel slippery. Further mixing and grinding with a stick will be necessary to help break up these lumps.

### A-3.2.3 Plasticity Tests.

Fine-grained soil particles (those passing the No. 200 sieve) are generally not classified using gradation criteria but identified primarily by characteristics related to plasticity. In the laboratory, Atterberg tests are used to define the liquid and plastic limits of the soil and classify it. Expedient field tests have been developed to determine the cohesive and plastic characteristics of soil. **These field tests are performed only on material passing the No. 40 sieve**, the same fraction used in the laboratory tests.

#### A-3.2.3.1 Breaking or Dry Strength Test.

##### A.3.2.3.1.1 Pat Test.

###### A.3.2.3.1.1.1 Procedure.

Prepare a pat of soil about 2 inches (50 mm) in diameter and 0.5 inch (10 mm) thick by molding it in a wet, plastic state. Allow the pat to dry completely (in the sun, in an oven, or inside the engine compartment) then grasp the pat between the thumbs and forefingers of both hands and attempt to break it. If the pat breaks, try to powder it by rubbing it between the thumb and forefinger of one hand.

**A.3.2.3.1.1.2 Results.**

- Pat cannot be broken nor powdered by finger pressure: very highly plastic soil (CH).
- Pat can be broken with great effort, but cannot be powdered: highly plastic soil (CL).
- Pat can be broken and powdered, but with some effort: medium plastic soil (CL).
- Pat breaks easily and powders readily: slightly plastic soil (ML, MH, or CL).
- Pat has little or no dry strength and crumbles or powders when picked up: nonplastic soil (ML or MH) or (OL or OH).

**Figure A-4 Dry Strength Pat Test**

**Note:** Dry pats of highly plastic clays often display shrinkage cracks. Breaking the pat along such a crack may not give a true indication of the strength. It is important to distinguish between a break along such a crack and a clean, fresh break that indicates the true dry strength of the soil.

**A.3.2.3.1.2 Ball Test (Alternative to Pat Test).**

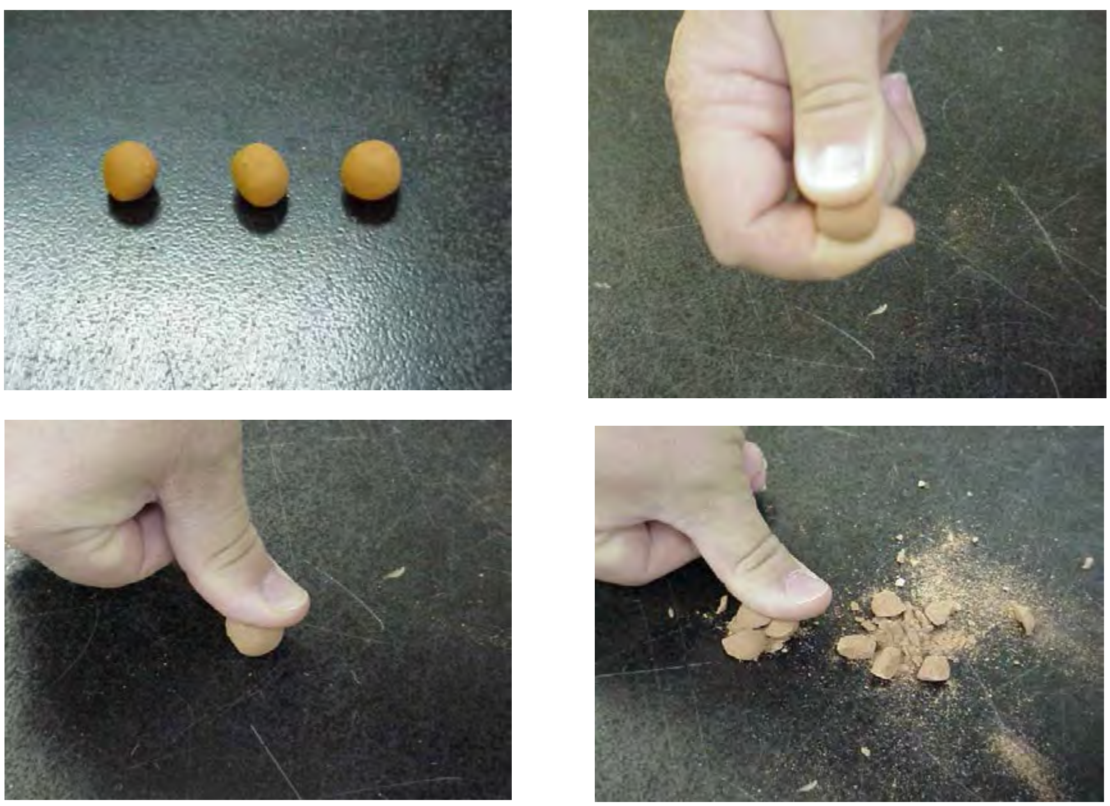
**A.3.2.3.1.2.1 Procedure.**

Select enough material to mold into a ball about 1 inch (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water as necessary. From the molded material, make at least three 0.5-inch (10-mm) -diameter balls as test specimens. Allow the test specimens to dry in the air, sun or by artificial means, as long as the temperature does not exceed 140 °F (60 °C) then test the strength of the material by crushing it between the fingers.

**A.3.2.3.1.2.2 Results.**

- No strength: The dry specimen crumbles into powder with mere finger pressure of handling (ML).
- Low strength: The dry specimen crumbles into powder with some finger pressure (ML or MH).
- Medium strength: The dry specimen breaks into pieces or crumbles with considerable finger pressure (MH or CL).
- High strength: The dry specimen cannot be broken with finger pressure but will break into pieces between the thumb and a hard surface (CL or CH).
- Very high strength: The dry specimen cannot be broken between the thumb and a hard surface (CH).

**Figure A-5 Dry Strength Ball Test**



**Note:** Natural dry lumps about 0.5 inch (10 mm) in diameter may be used, but do not use the results if any of the lumps contain particles of coarse sand. The presence of highly cementitious materials in the soil such as calcium carbonate may produce exceptionally high strengths.

**A-3.2.3.2 Roll or Thread Test.**

**A.3.2.3.2.1 Procedure.**

A representative portion of the sample is mixed with water until it can be molded or shaped without sticking to the fingers. This moisture content is described as being just below the sticky limit. Prepare a nonabsorbent rolling surface by placing a sheet of glass or heavy wax paper on a flat or level support then shape the sample into an elongated cylinder and rapidly roll the prepared soil cylinder on the surface into a thread approximately 0.125 inch (3 mm) in diameter. If the moist soil rolls into a thread, it has some plasticity. The number of times it can be rolled into a thread without crumbling is a measure of the degree of plasticity. Soils that cannot be rolled are nonplastic.

**A.3.2.3.2.2 Results.**

- Soil may be molded into a ball or cylinder and deformed under very firm finger pressure without crumbling or cracking: high plasticity (CH).
- Soil may be molded, but it cracks or crumbles under finger pressure: medium plasticity (CL).
- Soil cannot be lumped into a ball or cylinder without breaking up: low plasticity (CL, ML, or MH).
- Soil forms a soft, spongy ball or thread when molded: organic material (OL or OH).
- Soil cannot be rolled into a thread at any moisture content: nonplastic soil (ML or MH).
- The higher the soil is on the plasticity chart, the stiffer the threads are as they dry out and the tougher the lumps are if the soil is remolded after rolling.

**Figure A-6 Roll or Thread Test**

Roll soil to 0.125-in. (3-mm) -diameter thread

**Note:** Micaceous silts and sands can be rolled due to the flaky nature of the mica. The wet shaking test is the only way to distinguish this property.

### A-3.2.3.3 Ribbon Test.

#### A.3.2.3.3.1 Procedure.

Prepare a soil sample as in the roll or thread test. Form a roll of soil about 0.5 to 0.75 inch (10 to 20 mm) in diameter and 3 to 5 inches (75 to 125 mm) long. Lay the roll across the palm of one hand (palm up) and, starting at one end, squeeze the roll between the thumb and forefinger over the edge of the hand to form a flat unbroken ribbon about 0.125 to 0.25 inch (3 to 6 mm) thick. Allow the ribbon as formed to hang free and unsupported. Continue squeezing and handling the roll carefully to form the maximum length of ribbon that can be supported only by the cohesive properties of the soil.

#### A.3.2.3.3.2 Results.

- Sample holds together for a length of 8 to 10 inches (200 to 250 mm) without breaking: highly plastic and highly compressive (CH).
- Soil can be ribboned only with difficulty to 3- to 8-inch (75- to 200-mm) lengths: low plasticity (CL).

**Figure A-7 Ribbon Test**

### A-3.2.3.4 Wet Shaking Test.

### A.3.2.3.4.1 Procedure.

- Form a ball of soil about 0.75 inch (20 mm) in diameter, moistened with water to just below the sticky limit. Smooth the soil pat in the palm of the hand with a knife blade or small spatula, shake it horizontally, and strike the back of the hand vigorously against the other hand. When shaking, water comes to the surface of the sample, producing a smooth, shiny, or livery appearance.
- Squeeze the sample between the thumb and forefinger of the other hand. The surface water will disappear. The surface will become dull and the sample will become firm, resisting deformation. Cracks will occur as pressure is continued and the sample will crumble.
- If the water content is still adequate, shaking the broken pieces will cause them to liquefy again and flow together.

### A.3.2.3.4.2 Results.

This process can only occur when the soil grains are bulky and noncohesive. Very fine sands and silts are readily identified by this test. Even small amounts of clay will tend to retard the reaction to this test.

- A rapid reaction is typical of nonplastic fine sands and silts.
- A sluggish reaction indicates slight plasticity, indicating the silt has small amounts of clay or organic silts.
- No reaction at all does not indicate a complete absence of silt or fine sand.

**Figure A-8 Wet Shaking Test**

### A-3.2.3.5 Cast Test.

#### A.3.2.3.5.1 Procedure.

Compress a handful of damp (not sticky) soil into a cylinder and observe its ability to be formed and handled.

#### A.3.2.3.5.2 Results.

- Soil crumbles when touched: GP, SP, SW, GW.
- Soil cast withstands careful handling: SM, SC.
- Soil cast can be handled freely: ML, MH.
- Soil cast withstands rough handling: CL, CH.

**Figure A-9 Cast Test**

### A-3.2.3.6 Wash Test.

#### A.3.2.3.6.1 Procedure.

Place a small, dry sample of soil into the palm of the hand and cover with water. Note how quickly the water discolors and how long the fines are suspended. One variation is to look for mud puddles or create them, disturb the soil surface and note how the water discolors and how long the fines are suspended.

#### A.3.2.3.6.2 Results.

If the water becomes completely discolored and hides the sand particles, there is evidence of greater than 5% silt content.

**Figure A-10 Wash Test**

Note discoloration of water with fines

### A-3.2.3.7 Bite or Grit Test.

#### A.3.2.3.7.1 Procedure.

Grind a small pinch of soil lightly between the teeth.

#### A.3.2.3.7.2 Results.

- Sandy soils. The sharp hard particles of even fine sands will grate very harshly between the teeth and will be highly objectionable.
- Silty soils. Silt grains are not particularly gritty, but their presence is still quite unpleasant and easily detected.
- Clayey soils. Clay grains feel smooth and powdery like flour. Dry lumps will stick when lightly touched with the tongue.

#### A-3.2.3.8 Shine Test.

##### A.3.2.3.8.1 Procedure.

Rub a clay sample with a fingernail or smooth metal surface such as a knife blade.

##### A.3.2.3.8.2 Results.

- Highly plastic clay will produce a definite shine.
- Lean clays will remain dull.

#### A-3.2.3.9 Feel Test.

##### A.3.2.3.9.1 Consistency.

Squeeze a piece of undisturbed soil between the thumb and forefinger. It may be hard, stiff, brittle, friable, sticky, plastic, or soft. Remold the soil by working it between the hands. This can indicate the natural water content. Clays which become fluid on remolding are probably near their liquid limit. If they remain stiff and crumble, they are probably below their liquid limit.

##### A.3.2.3.9.2 Texture.

Rub a portion of fine-grained soil between the fingers or on a more sensitive area such as the inside of the wrist. Results are similar to the bite or grit test.

#### A-3.2.3.10 Track Field Identification Tests.

Use Table A-6 as a convenient way to track field identification tests. As tests are completed, mark the results on the chart. The results from the different tests may vary, but as the test results are plotted you will have a general indication of the soil type.

**Table A-6 Summary of Field Identification Test Results**

<table>
<tr><th colspan="7">Field Identification of Soils</th></tr>
<tr><th rowspan="2">Test</th><th rowspan="2">Material</th><th colspan="5">Soil Types</th></tr>
<tr><th>ML</th><th>MH</th><th>CL</th><th>CH</th><th>OL/OH</th></tr>
<tr><td>Dry strength</td><td>< 40 sieve (wet)</td><td>No to low</td><td>Low to medium</td><td>Medium to high</td><td>Very high</td><td>Low</td></tr>
<tr><td>Roll/thread</td><td>< 40 sieve (sticky)</td><td>Low</td><td>Low to medium</td><td>Medium</td><td>High</td><td>Spongy</td></tr>
<tr><td>Ribbon</td><td>< 40 sieve (sticky)</td><td>No cohesion</td><td>Little cohesion</td><td>3 to 8 inches</td><td>8 to 10 inches</td><td rowspan="5"></td></tr>
<tr><td>Wet shake</td><td>< 40 sieve (sticky)</td><td>Slow to rapid</td><td>No to slow</td><td>No to slow</td><td>No</td></tr>
<tr><td>Cast</td><td>Damp</td><td colspan="2">Handle freely</td><td colspan="2">Handle roughly</td></tr>
<tr><td>Bite/feel</td><td>< 40 (< 200) sieve</td><td colspan="2">Unpleasant</td><td colspan="2">Smooth</td></tr>
<tr><td>Shine</td><td rowspan="4"></td><td colspan="3">Dull</td><td>Shine</td></tr>
<tr><td>Wash</td><td colspan="5">Discolors quickly, > 5% silt</td></tr>
<tr><td>Dust</td><td colspan="2">> 10% silt</td><td colspan="3"></td></tr>
<tr><td>Sedimentation</td><td colspan="2">30 seconds</td><td colspan="2">1 hour</td><td></td></tr>
</table>

**A-3.2.3.11 Steps for Field Identification of Soils.**

**A.3.2.3.11.1** Select representative sample of soil (approximately 1 pint [0.5 liter]).

**A.3.2.3.11.2** Separate gravel size particles from remainder of soil (approximately 0.125 to 0.1875 inch [3 to 5 mm] and above).

- Gravel > 50% = GW, GP, GM, GC
- Gravel < 50% = SW, SP, SM, SC, or fine-grained ML, MH, CL, CH, OL, OH

**A.3.2.3.11.3** Estimate percent fines (< 200 sieve) in original sample (sedimentation test may be helpful).

- For gravels:
  - o If < 10% fines = GW or GP
  - o If > 10% fines = GM or GC
- For sands:
  - o If < 10% fines = SW or SP

    - If > 10% fines = SM or SC

- If > 50% of entire sample < 200 sieve = ML, MH, CL, CH, OL, OH

**A.3.2.3.11.4** For gravels and sands with < 10% fines (GW, GP, SW, SP), check gradation to determine if well-graded or poorly graded.

- Wide range in grain sizes, with all intermediate sizes substantially represented = GW or SW
- Predominantly one size or some intermediate size missing (uniform or gap graded) = GP or SP

**A.3.2.3.11.5** For fine-grained soils (ML, MH, CL, CH, OL, OH), test for organic matter:

- If distinctive color, odor, spongy feel, or fibrous texture (particles of vegetation) = OL or OH
- If not, then = ML, MH, CL, CH

**A.3.2.3.11.6** For fine-grained soils (ML, MH, CL, CH, OL, OH) and coarse-grained soils with > 10% fines (GM, GC, SM, SC):

- Remove all material > 40 sieve.
- Perform field plasticity tests on portion < 40 sieve to determine cohesive and plastic characteristics.
- Plot results on summary of field identification test results (Table A-6).
- Perform tests, as required, until results are conclusive.

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# APPENDIX B FLEXIBLE PAVEMENT DISTRESSES

## B-1 INTRODUCTION.

When performing a PCI in a contingency situation, place an emphasis on structural- or FOD-related distresses. The following is a list of common distresses associated with flexible pavement. List all of the distresses included in determining the PCI. Only consider those that are structurally related in determining an SCI of the pavement.

## B-2 FLEXIBLE (AC) PAVEMENT DISTRESSES.

| Distress | PCI | SCI | FOD |
|---|---|---|---|
| 41. Alligator or Fatigue Crack | LMH | LMH | LMH (x 0.6) |
| 42. Bleeding | N/A | | |
| 43. Block Crack | LMH | | LMH |
| 44. Corrugation | LMH | | |
| 45. Depression | LMH | LMH | |
| 46. Jet Blast Erosion | N/A | | N/A |
| 47. Joint Reflection Crack | LMH | | LMH |
| 48. Long./Trans. Crack | LMH | H | LMH |
| 49. Oil Spillage | N/A | | N/A |
| 50. Patch/Utility Cut | LMH | MH | MH |
| 51. Polished Aggregate | LMH | | |
| 52. Raveling | LMH | | LMH |
| 53. Rutting | LMH | LMH | |
| 54. Shoving | LMH | | MH |
| 55. Slippage Crack | N/A | N/A | N/A |
| 56. Swell | LMH | | |
| 57. Weathering | LMH | | LMH |

## B-3 DISTRESS DESCRIPTIONS.

### B-3.1 Alligator or Fatigue Cracking (Distress #41).

#### B-3.1.1 Description.

Alligator or fatigue cracking is a series of interconnecting cracks caused by fatigue failure of the asphalt surface under repeated traffic loading. The cracking initiates at the bottom of the asphalt surface (or stabilized base) where tensile stress and strain is highest under a wheel load. The cracks propagate to the surface initially as a series of parallel cracks.

After repeated traffic loading, the cracks connect and form multi-sided, sharp-angled pieces that develop a pattern resembling chicken wire or the skin of an alligator. The pieces are less than 2 feet (0.6 m) on the longest side. Alligator cracking occurs only in areas subjected to repeated traffic loadings, such as wheel paths. Therefore, it does not occur over an entire area unless the entire area was subjected to traffic loading. (Pattern-type cracking, which occurs over an entire area that is not subject to loading, is rated as block cracking, which is not a load-associated distress.) Alligator cracking is considered a major structural distress.

### B-3.1.2 Severity Levels.

#### B-3.1.2.1 Low.

Fine, longitudinal hairline cracks running parallel to each other with no or only a few interconnecting cracks. The cracks are not spalled.

#### B-3.1.2.2 Medium.

Further development of light alligator cracking into a pattern or network of cracks that may be lightly spalled. Medium-severity alligator cracking is defined by a well-defined pattern of interconnecting cracks where all pieces are securely held in place (good aggregate interlock between pieces).

#### B-3.1.2.3 High.

Network or pattern cracking progressed so pieces are well-defined and spalled at the edges; some of the pieces rock under traffic and may cause FOD potential.

### B-3.1.3 How to Measure.

Alligator cracking is measured in square feet (square meters) of surface area. The major difficulty in measuring this type of distress is that many times two or three levels of severity exist within one distressed area. If these portions can be easily distinguished from each other, measure and record separately. However, if the different levels of severity cannot be easily divided, rate the entire area at the highest severity level present. If alligator cracking and rutting occur in the same area, each is recorded separately at its respective severity level.

**Figure B-1 Alligator Cracking Severity Levels**

**Low** **Medium** **High**

## B-3.2 Bleeding (Distress #42).

### B-3.2.1 Description.

Bleeding is a film of bituminous material on the pavement surface that creates a shiny, glass-like, reflecting surface that usually becomes quite sticky. Bleeding is caused by excessive amounts of asphalt cement or tars in the mix and/or low air-void content. It occurs when asphalt fills the voids of the mix during hot weather and then expands onto the surface of the pavement. Since the bleeding process is not reversible during cold weather, asphalt or tar will accumulate on the surface.

### B-3.2.2 Severity Levels.

No degrees of severity are defined. Note bleeding when it is extensive enough to cause a reduction in skid resistance.

### B-3.2.3 How to Measure.

Bleeding is measured in square feet (square meters) of surface area. If bleeding is counted, polished aggregate is not counted in the same area

**Figure B-2 Bleeding**

## B-3.3 Block Cracking (Distress #43).

### B-3.3.1 Description.

Block cracks are interconnected cracks that divide the pavement into approximately rectangular pieces. The blocks may range in size from approximately 1 by 1 foot to 10 by 10 feet (0.3 by 0.3 m to 3 by 3 m). Block cracking is caused mainly by shrinkage of the AC and daily temperature cycling (which results in daily stress/strain cycling). It is not load-associated. The occurrence of block cracking usually indicates the asphalt has significantly hardened. Block cracking typically occurs over a large proportion of pavement area but sometimes will occur in non-traffic areas. This type of distress differs from alligator cracking in that alligator cracks form smaller, many-sided pieces with sharp angles. Also, unlike block cracks, alligator cracks are caused by repeated traffic loadings and, therefore, are located only in traffic areas (i.e., wheel paths).

### B-3.3.2 Severity Levels.

#### B-3.3.2.1 Low.

Blocks are defined by cracks that are non-spalled (sides of the crack are vertical) or only lightly spalled, causing no FOD potential. Non-filled cracks have 0.25 inch (6 mm) or less mean width and filled cracks have filler in satisfactory condition.

#### B-3.3.2.2 Medium.

Blocks are defined by either: (1) filled or non-filled cracks that are moderately spalled (some FOD potential); (2) non-filled cracks that are not spalled or have only minor spalling (some FOD potential), but have a mean width greater than approximately 0.25 inch (6 mm); or (3) filled cracks that are not spalled or have only minor spalling (some FOD potential), but have filler in unsatisfactory condition

#### B-3.3.2.3 High.

Blocks are well defined by cracks that are severely spalled, causing a definite FOD potential.

### B-3.3.3 How to Measure.

Block cracking is measured in square feet (square meters) of surface area. It usually occurs at one severity level in a given pavement section; however, measure and record separately any areas of the pavement section having distinctly different levels of severity. For asphalt pavements, not including AC over PCC, if block cracking is recorded, do not record longitudinal and transverse cracking in the same area. For asphalt overlay over concrete, record separately block cracking, joint reflection cracking, and longitudinal and transverse cracking reflected from old concrete.

**Figure B-3 Block Cracking Severity Levels**

Low Medium High

## B-3.4 Corrugation (Distress #44).

### B-3.4.1 Description.

Corrugation is a series of closely spaced ridges and valleys (ripples) occurring at fairly regular intervals, usually less than 5 feet (1.5 m) along the pavement. The ridges are perpendicular to the traffic direction. Traffic action combined with an unstable pavement surface or base usually causes this type of distress.

### B-3.4.2 Severity Levels.

#### B-3.4.2.1 Low.

Corrugations are minor and do not significantly affect ride quality (see Table B-1 measurement criteria).

#### B-3.4.2.2 Medium.

Corrugations are noticeable and significantly affect ride quality (see Table B-1 measurement criteria).

#### B-3.4.2.3 High.

Corrugations are easily noticed and severely affect ride quality (see Table B-1 measurement criteria).

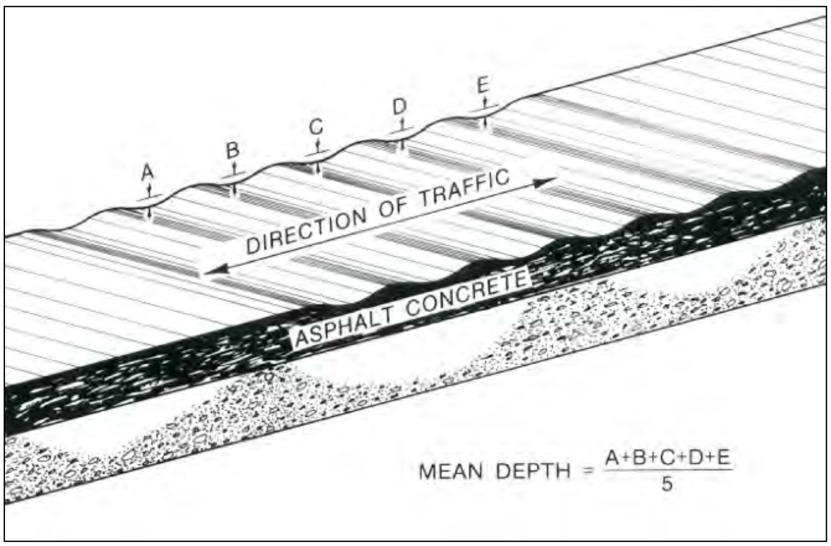
### B-3.4.3 How to Measure.

Corrugation is measured in square feet (square meters) of surface area. The mean elevation difference between the ridges and valleys of the corrugations indicates the level of severity. To determine the mean elevation difference, place a 10-foot (3-m) straightedge perpendicular to the corrugations so the depth of the valleys can be measured in inches (millimeters). The mean depth is calculated from five such measurements.

**Table B-1 Corrugation Measurement Criteria**

| Severity | Runways & High-Speed Taxiways | Taxiways & Aprons |
|---|---|---|
| Low | < 0.25 in. (< 6 mm) | < 0.5 in. (< 13 mm) |
| Medium | 0.25 to 0.5 in. (6 to 13 mm) | 0.5 to 1 in. (13 to 25 mm) |
| High | > 0.5 in. (> 13 mm) | > 1 in. (> 25 mm) |

**Figure B-4 Corrugation Measurements**




## B-3.5 Depression (Distress #45).

### B-3.5.1 Description.

Depressions are localized pavement surface areas having elevations slightly lower than those of the surrounding pavement. In many instances, light depressions are not noticeable until after a rain when ponding water creates “birdbath” areas, but the depressions can also be located without rain because of stains created by ponding water.

Depressions can be caused by settlement of the foundation soil or can be “built up” during construction. Depressions cause roughness and, when filled with water of sufficient depth, can cause hydroplaning of aircraft.

### B-3.5.2 Severity Levels.

#### B-3.5.2.1 Low.

Depression can be observed or located by stained areas, only slightly affects pavement riding quality, and may cause hydroplaning potential on runways (see Table B-2 measurement criteria).

#### B-3.5.2.2 Medium.

The depression can be observed, moderately affects pavement riding quality, and causes hydroplaning potential on runways (see Table B-2 measurement criteria).

#### B-3.5.2.3 High.

The depression can be readily observed, severely affects pavement riding quality, and causes definite hydroplaning potential (see Table B-2 measurement criteria).

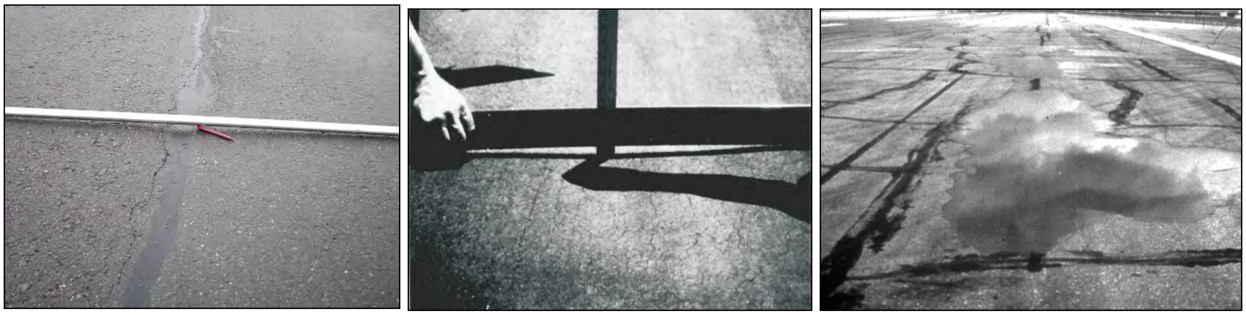
### B-3.5.3 How to Measure.

Depressions are measured in square feet (square meters) of surface area. The maximum depth of the depression determines the level of severity. This depth can be measured by placing a 10-foot (3-m) straightedge across the depressed area and measuring the maximum depth in millimeters (inches). Measure depressions larger than 10 feet (3 m) across by either visual estimation or direct measurement when filled with water.

**Table B-2 Maximum Depth of Depression**

| Severity | Runways & High-Speed Taxiways | Taxiways & Aprons |
|---|---|---|
| Low | 0.125 to 0.5 in. (3 to 13 mm) | 0.5 to 1 in. (13 to 25 mm) |
| Medium | 0.5 to 1 in. (13 to 25 mm) | 1 to 2 in. (25 to 51 mm) |
| High | > 1 in. (> 25 mm) | > 2 in. (> 51 mm) |

**Figure B-5 Depression Severity Levels**



Low Medium High

## B-3.6 Jet Blast Erosion (Distress #46).

### B-3.6.1 Description.

Jet blast erosion causes darkened areas on the pavement surface when bituminous binder has been burned or carbonized. Localized burned areas may vary in depth up to approximately 0.5 inch (13 mm).

### B-3.6.2 Severity Levels.

No degrees of severity are defined. It is sufficient to indicate that jet blast erosion exists.

### B-3.6.3 How to Measure.

Jet blast erosion is measured in square feet (square meters) of surface area.

**Figure B-6 Jet Blast Erosion**

## B-3.7 Joint Reflection Cracking from PCC (Distress #47).

### B-3.7.1 Description.

This distress occurs only on pavements having an asphalt or tar surface over a PCC slab. This category does not include reflection cracking from any other type of base (i.e., cement stabilized, lime stabilized); such cracks are listed as longitudinal and transverse cracks. Joint reflection cracking is caused mainly by movement of the PCC slab beneath the AC surface because of thermal and moisture changes; it is not load related. However, traffic loading may cause a breakdown of the AC near the crack, resulting in spalling and FOD potential. If the pavement is fragmented along a crack, the crack is said to be spalled. A knowledge of slab dimensions beneath the AC surface will help identify these cracks.

### B-3.7.2 Severity Levels.

#### B-3.7.2.1 Low.

Cracks have only light spalling (little or no FOD potential) or no spalling and can be filled or non-filled. If non-filled, the cracks have a mean width of 0.25 inch (6 mm) or less. Filled cracks are of any width but their filler material is in satisfactory condition

#### B-3.7.2.2 Medium.

One of the following conditions exists: (1) cracks are moderately spalled (some FOD potential) and can be either filled or non-filled of any width; (2) filled cracks are not spalled or are only lightly spalled but the filler is in unsatisfactory condition; (3) non-filled cracks are not spalled or are only lightly spalled but the mean crack width is greater than 0.25 inch (6 mm); or (4) light random cracking exists near the crack or at the corner of intersecting cracks.

#### B-3.7.2.3 High.

Cracks are severely spalled (definite FOD potential) and can be either filled or non-filled of any width.

### B-3.7.3 How to Measure.

Joint reflection cracking is measured in linear feet (linear meters). Identify and record the length and severity level of each crack. If the crack does not have the same severity level along its entire length, record each portion separately. For example, a crack that is 50 feet (15 m) long may have 10 feet (3 m) of high severity, 20 feet (6 m) of medium severity, and 20 feet (6 m) of light severity; these are all recorded separately. If the different levels of severity in a portion of a crack cannot be easily divided, rate that portion at the highest severity present.

**Figure B-7 Joint Reflection Cracking Severity Levels**

Low Medium High

## B-3.8 Longitudinal and Transverse Cracking (Non-PCC Joint Reflective) (Distress #48).

### B-3.8.1 Description.

Longitudinal cracks are parallel to the pavement's centerline or laydown direction. They may be caused by (1) a poorly constructed paving lane joint, (2) shrinkage of the AC surface due to low temperatures or hardening of the asphalt, or (3) a reflective crack caused by cracks beneath the surface course, including cracks in PCC slabs (but not at PCC joints). Transverse cracks extend across the pavement at approximately right angles to the pavement centerline or direction of laydown. They may be caused by items 2 or 3 above. These types of cracks are not usually load-associated. If the pavement is fragmented along a crack, the crack is said to be spalled.

### B-3.8.2 Severity Levels.

#### B-3.8.2.1 Low.

Cracks have either minor spalling (little or no FOD potential) or no spalling. The cracks can be filled or non-filled. Non-filled cracks have a mean width of 0.25 inch (6 mm) or less; filled cracks are of any width but their filler material is in satisfactory condition.

#### B-3.8.2.2 Medium.

One of the following conditions exists: (1) cracks are moderately spalled (some FOD potential) and can be either filled or non-filled of any width; (2) filled cracks are not spalled or are only lightly spalled but the filler is in unsatisfactory condition; (3) non-filled cracks are not spalled or are only lightly spalled but mean crack width is greater than 0.25 inch (6 mm); or (4) lightly random cracking exists near the crack or at the corners of intersecting cracks.

#### B-3.8.2.3 High.

Cracks are severely spalled, causing definite FOD potential. They can be either filled or non-filled of any width.

**Figure B-8 Longitudinal and Transverse Cracking Severity Levels**

**Low** **Medium** **High**

### B-3.8.3 Porous Friction Course Severity Levels.

These severity levels are in addition to the existing definitions.

#### B-3.8.3.1 Low.

Average raveled area around the crack is less than 0.25 inch (6 mm) wide.

#### B-3.8.3.2 Medium.

Average raveled area around the crack is 0.25 to 1 inch (6 to 25 mm) wide.

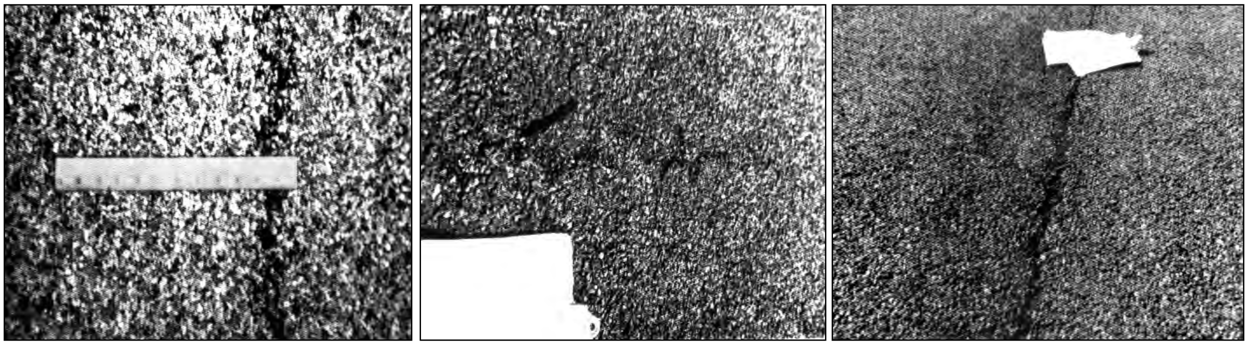
#### B-3.8.3.3 High.

Average raveled area around the crack is greater than 1 inch (25 mm) wide.

### B-3.8.4 How to Measure.

Longitudinal and transverse cracks are measured in linear feet (linear meters). Identify and record the length and severity of each crack. If the crack does not have the same severity level along its entire length, separately record each portion of the crack having a different severity level. For an example, see the discussion on measuring joint reflection cracking in paragraph B-3.7.3. If block cracking is recorded, longitudinal and transverse cracking is not recorded in the same area.

**Figure B-9 Longitudinal and Transverse Cracking Severity Levels, Porous Friction Course**



Low Medium High

### B-3.9 Oil Spillage (Distress #49).

#### B-3.9.1 Description.

Oil spillage is the deterioration or softening of the pavement surface caused by the spilling of oil, fuel, or other solvents.

#### B-3.9.2 Severity Levels.

No degrees of severity are defined. It is sufficient to indicate that oil spillage exists.

#### B-3.9.3 How to Measure.

Oil spillage is measured in square feet (square meters) of surface area.

**Figure B-10 Oil Spillage**

### B-3.10 Patching and Utility Cut Patch (Distress #50).

#### B-3.10.1 Description.

A patch is considered a defect, regardless of how well it is performing.

#### B-3.10.2 Severity Levels.

##### B-3.10.2.1 Low.

Patch is in good condition and performing satisfactorily. There is little or no FOD potential.

##### B-3.10.2.2 Medium.

Patch is somewhat deteriorated and affects riding quality to some extent. There is some FOD potential.

#### B-3.10.3 High.

Patch is badly deteriorated and affects riding quality significantly or has high FOD potential. Patch needs replacement.

#### B-3.10.4 Porous Friction Courses.

The use of dense-graded AC patches in PCC surfaces causes a water damming effect at the patch that contributes to differential skid resistance of the surface. Rate low-severity, dense-graded patches as medium severity because of the differential friction problem. Medium- and high-severity patches are rated the same as above.

#### B-3.10.5 How to Measure.

Patching is measured in square feet (square meters) of surface area. However, if a single patch has areas of differing severity levels, separately measure and record these areas. For example, a 25-square-foot (2.5-$m^2$) patch may have 10 square feet (1 $m^2$) of medium severity and 15 square feet (1.5 $m^2$) of light severity. Record these areas separately. Any distress found in a patched area will not be recorded; however, its effects on the patch will be considered when determining the patch’s severity level. A very large patch (area > 2500 square feet [230 $m^2$]), or feathered-edge pavement, may qualify as an additional sample unit or a separate section.

**Figure B-11 Patching and Utility Cut Patch Severity Levels**

**Low** **Medium** **High**

## B-3.11 Polished Aggregate (Distress #51).

### B-3.11.1 Description.

Aggregate polishing is caused by repeated traffic applications. Polished aggregate is present when close examination of a pavement reveals that the portion of aggregate extending above the asphalt is either very small or there are no rough or angular aggregate particles to provide good skid resistance. Existence of this type of distress is also indicated when the number on a skid resistance rating test is low or has dropped significantly from previous ratings.

### B-3.11.2 Severity Levels.

Before it is included in the condition survey and rated as a defect, polished aggregate has to be very pervasive and wide-spread; however, no degrees of severity are defined.

### B-3.11.3 How to Measure.

Polished aggregate is measured in square feet (square meters) of surface area. If bleeding is counted, polished aggregate is not counted in the same area.

**Figure B-12 Polished Aggregate**

### B-3.12 Raveling (Distress #52).

### B-3.12.1 Description.

Raveling is the dislodging of coarse aggregate particles from the pavement surface.

### B-3.12.2 Dense Mix Severity Levels.

As used herein, coarse aggregate refers to predominant coarse aggregate sizes of the asphalt mix. Aggregate clusters refer to when more than one adjoining coarse aggregate piece is missing. If in doubt about a severity level, examine three representative square yards (square meters) and count the number of missing coarse aggregate particles.

### B-3.12.2.1 Low.

Low severity occurs if any one of these conditions exist. (1) In a square yard (square meter) representative area, the number of coarse aggregate pieces missing is between 21 and 40. (2) Missing aggregate clusters is less than 2% of the examined square yard (square meter) area. In low-severity raveling, there is little or no FOD potential.

### B-3.12.2.2 Medium.

Medium severity occurs if any one of these conditions exist: (1) In a square yard (square meter) representative area, the number of coarse aggregate pieces missing is between 5 and 20. (2) Missing aggregate clusters is between 2% and 10% of the examined square yard (square meter) area. In medium-severity raveling, there is some FOD potential.

#### B-3.12.2.3 High.

High severity occurs if any one of these conditions exist. (1) In a square yard (square meter) representative area, the number of coarse aggregate pieces missing is over 40. (2) Missing aggregate clusters is more than 10% of the examined square yard (square meter) area. In high-severity raveling, there is significant FOD potential.

**Figure B-13 Raveling, Dense Mix Severity Levels**


**Low** **Medium** **High**

### B-3.12.3 Slurry Seal/Coal Tar Over Dense Mix Severity Levels.

#### B-3.12.3.1 Low.

(1) Scaled area is less than 1%. (2) In case of coal tar where pattern cracking has developed, the tar surface cracks are less than 0.25 inch (6 mm) wide.

#### B-3.12.3.2 Medium.

(1) Scaled area is between 1% and 10% (2) In case of coal tar where pattern cracking has developed, the cracks are 0.25 inch (6 mm) wide or greater.

#### B-3.12.3.3 High.

(1) Scaled area is over 10%. (2) In case of coal tar, the surface is peeling off.

**Figure B-14 Raveling, Slurry Seal/Coal Tar Over Dense Mix Severity Levels**


**Low** **Medium** **High**

### B-3.12.4 Porous Friction Course Severity Levels.

#### B-3.12.4.1 Low.

In a square yard (square meter) representative sample, the number of aggregate pieces missing is between 5 and 20 and/or the number of missing aggregate clusters (when more than one adjoining aggregate piece is missing) does not exceed 1.

#### B-3.12.4.2 Medium.

In a square yard (square meter) representative sample, the number of aggregate pieces missing is between 21 and 40 and/or the number of missing aggregate clusters is greater than 1 but does not exceed 25% of the square yard (square meter) area.

#### B-3.12.4.3 High.

In a square yard (square meter) representative sample, the number of aggregate pieces missing is over 40 and/or the number of missing aggregate clusters is greater than 25% of the square yard (square meter) area.

### B-3.12.5 How to Measure.

Raveling is measured in square feet (square meters) of surface area. Mechanical damage caused by hook drags, tire rims, or snowplows is counted as areas of high-severity raveling.

**Figure B-15 Raveling, Porous Friction Course Severity Levels**

**Low** **Medium** **High**

### B-3.13 Rutting (Distress #53).

### B-3.13.1 Description.

A rut is a surface depression in the wheel path. Pavement uplift may occur along the sides of the rut; however, in many instances, ruts are noticeable only after a rainfall when the wheel paths are filled with water. Rutting stems from a permanent deformation in any of the pavement layers or subgrade. It is usually caused by consolidation or lateral movement of the materials due to traffic loads. Significant rutting can lead to major structural failure of the pavement.

### B-3.13.2 Severity Levels.

**Table B-3 Maximum Depth of Depression**

| Severity | All Pavement Sections |
|---|---|
| Low | 0.25 to 0.5 in.<br>(6 to 13 mm) |
| Medium | 0.5 to 1 in.<br>(13 to 25 mm) |
| High | > 1 in.<br>(> 25 mm) |

### B-3.13.3 How to Measure.

Rutting is measured in square feet (square meters) of surface area and its severity is determined by the depth of the rut. To determine the rut depth, lay a straightedge across the rut and the maximum depth measured. Compute the mean depth in inches (mm) from measurements taken along the length of the rut. If alligator cracking and rutting occur in the same area, each is recorded at its respective severity level.

**Figure B-16 Rutting Severity Levels**

**Low** **Medium** **High**

## B-3.14 Shoving of Asphalt Pavement by PCC Slabs (Distress #54).

### B-3.14.1 Description.

PCC pavements occasionally increase in length at ends where they adjoin flexible pavements (commonly referred to as “pavement growth”). This “growth” shoves the asphalt- or tar-surfaced pavements, causing them to swell and crack. The PCC slab “growth” is caused by a gradual opening of the joints as they are filled with incompressible materials that prevent them from reclosing.

### B-3.14.2 Severity Levels.

#### B-3.14.2.1 Low.

A slight amount of shoving has occurred, with little effect on ride quality and no break-up of the asphalt pavement.

#### B-3.14.2.2 Medium.

A significant amount of shoving has occurred, causing moderate roughness or break-up of the asphalt pavement.

#### B-3.14.2.3 High.

A large amount of shoving has occurred, causing severe roughness or break-up of the asphalt pavement.

#### B-3.14.2.4 Shoving Criteria.

As a guide, the criteria in Table B-4 may be used to determine the severity levels of shoving. At the present time, no significant research has been conducted to quantify levels of severity of shoving.

**Table B-4 Shoving Criteria**

| Severity | All Pavement Sections |
|---|---|
| Low | < 0.75 in.<br>(< 19 mm) |
| Medium | 0.75 to 1.5 in.<br>(19 to 38 mm) |
| High | > 1.5 in.<br>(> 38 mm) |

### B-3.14.3 How to Measure.

Shoving is measured by determining the area in square feet (square meters) of the swell caused by shoving.

**Figure B-17 Shoving Severity Levels**

Low Medium High

### B-3.15 Slippage Cracking (Distress #55).

#### B-3.15.1 Description.

Slippage cracks are crescent- or half-moon-shaped cracks having two ends pointed away from the direction of traffic. They are produced when braking or turning wheels cause the pavement surface to slide and deform. This usually occurs when there is a low-strength surface mix or poor bond between the surface and next layer of pavement structure.

#### B-3.15.2 Severity Levels.

No degrees of severity are defined. It is sufficient to indicate that a slippage crack exists.

#### B-3.15.3 How to Measure.

Slippage cracking is measured in square feet (square meters) of surface area.

**Figure B-1 Slippage Cracking**

## B-3.16 Swell (Distress #56).

### B-3.16.1 Description.

A swell is characterized by an upward bulge in the pavement's surface. A swell may occur sharply over a small area or as a longer, gradual wave. Either type of swell can be accompanied by surface cracking. A swell is usually caused by frost action in the subgrade or by swelling soil, but a small swell can also occur on the surface of an asphalt overlay (over PCC) as a result of a blow-up in the PCC slab.

### B-3.16.2 Severity Levels.

#### B-3.16.2.1 Low.

Swell is barely visible and has a minor effect on the pavement's ride quality as determined at the normal aircraft speed for the pavement section under consideration. (Low-severity swells may not always be observable, but their existence can be confirmed by driving a vehicle over the section at the normal aircraft speed. An upward acceleration will occur if the swell is present.)

#### B-3.16.2.2 Medium.

Swell can be observed without difficulty and has a significant effect on the pavement's ride quality as determined at the normal aircraft speed for the pavement section under consideration.

#### B-3.16.2.3 High.

Swell can be readily observed and severely affects the pavement's ride quality at the normal aircraft speed for the pavement section under consideration.

#### B-3.16.2.4 Swell Criteria.

The swell criteria in Table B-5 is provided for runways.

**Table B-5 Swell Criteria**

| Severity | All Pavement Sections |
|---|---|
| Low | < 0.75 in.<br>(< 19 mm) |
| Medium | 0.75 to 1.5 in.<br>(19 to 38 mm) |
| High | > 1.5 in.<br>(> 38 mm) |

### B-3.16.3 How to Measure.

The surface area of the swell is measured in square feet (square meters). Consider the type of pavement section when considering the severity rating (i.e., runway, taxiway, or apron). For example, a swell of sufficient magnitude to cause considerable roughness on a runway at high speeds are rated as more severe than the same swell located on the apron or taxiway where the normal aircraft operating speeds are much lower.

**Figure B-19 Swell**

## B-3.17 Weathering (Surface Wear) – Dense Mix Asphalt (Distress #57).

### B-3.17.1 Description.

Weathering is the wearing away of the asphalt binder and fine aggregate matrix from the pavement surface.

### B-3.17.2 Severity Levels.

#### B-3.17.2.1 Low.

The asphalt surface is beginning to show signs of aging, which may be accelerated by climatic conditions. Loss in the fine aggregate matrix is noticeable and may be accompanied by fading of the asphalt color. Edges of the coarse aggregates are beginning to be exposed (less than 0.05 inch [1 mm]). Pavement may be relatively new (as new as six months old.)

#### B-3.17.2.2 Medium.

Loss of fine aggregate matrix is noticeable and edges of coarse aggregate have been exposed up to one-quarter of the width (of the longest side) of the coarse aggregate due to the loss of fine aggregate matrix.

**B-3.17.2.3 High.**

Edges of coarse aggregate have been exposed greater than one-quarter of the width (of the longest side) of the coarse aggregate. There is considerable loss of fine aggregate matrix, leading to potential, or some, loss of coarse aggregate.

**B-3.17.3 How to Measure.**

Surface wear is measured in square feet (square meters) of surface area. Surface wear is not recorded if medium- or high-severity raveling is recorded.

**Figure B-20 Weathering Severity Levels**


**Low** **Medium** **High**

## B-4 FREQUENTLY OCCURRING PROBLEMS IN FLEXIBLE PAVEMENT DISTRESS IDENTIFICATION.

| | Situation | Action | Remarks |
|---|---|---|---|
| 1 | Alligator cracking and rutting in the same area | Record each separately at respective severity level | |
| 2 | Bleeding counted in area | Polished aggregate is not counted in same area | |
| 3 | Polished aggregate in very small amount | Do not count | Polished aggregate is only counted when there is a significant amount |
| 4 | Any distress (including cracking) in a patched area | Do not record | Effect of distress is considered in the patch severity level |
| 5 | Block cracking is recorded | Record neither longitudinal nor transverse cracking | |
| 6 | Asphalt overlay over concrete | Block cracking and joint reflection cracking are recorded separately | AC over PCC could have, for example, 100% block cracking and 100 feet (30 m) of joint reflection cracking |

## B-5 POTHOLES.

Although they are not generally encountered when surveying the pavement condition of operational airfields and are not included in ASTM D5340, potholes are occasionally found on asphalt pavements on contingency airfields. Potholes differ from depressions in that they usually cover a smaller area and generally have abrupt or sharp edges and vertical sides near the top of the hole. Potholes are produced when traffic abrades small pieces of the pavement surface. The pavement then continues to disintegrate because of poor pavement surface mixtures or weak spots in the supporting soil structure. Their growth is accelerated by free moisture collection inside the hole. Potholes are considered a structural distress and, depending upon the location on the airfield, repair those of medium to high severity prior to aircraft operations. Severity levels are determined by both the diameter and depth of the pothole. If potholes or other abrupt changes in elevation in the pavement surface exist, include their impact on aircraft operations in the report.

**Table B-6 Pothole Severity Levels**

| Potholes, Severity Levels | | | |
|---|---|---|---|
| **Maximum Depth of Hole** | **Average Diameter in. (mm)** | | |
| | **4 to 8 in. (100 to 200 mm)** | **> 8 to 18 in. (200 to 450 mm)** | **> 18 in. (450 mm)** |
| 0.5 to 1 in. (15 to 25 mm) | L | L | M |
| > 1 to 2 in. (25 to 50 mm) | L | M | H |
| > 2 in. (50 mm) | M | M | H |

## B-6 DISTRESS DEDUCT VALUE CHARTS.

**Figure B-21 Deduct Values for Distress #41, Alligator Cracking**

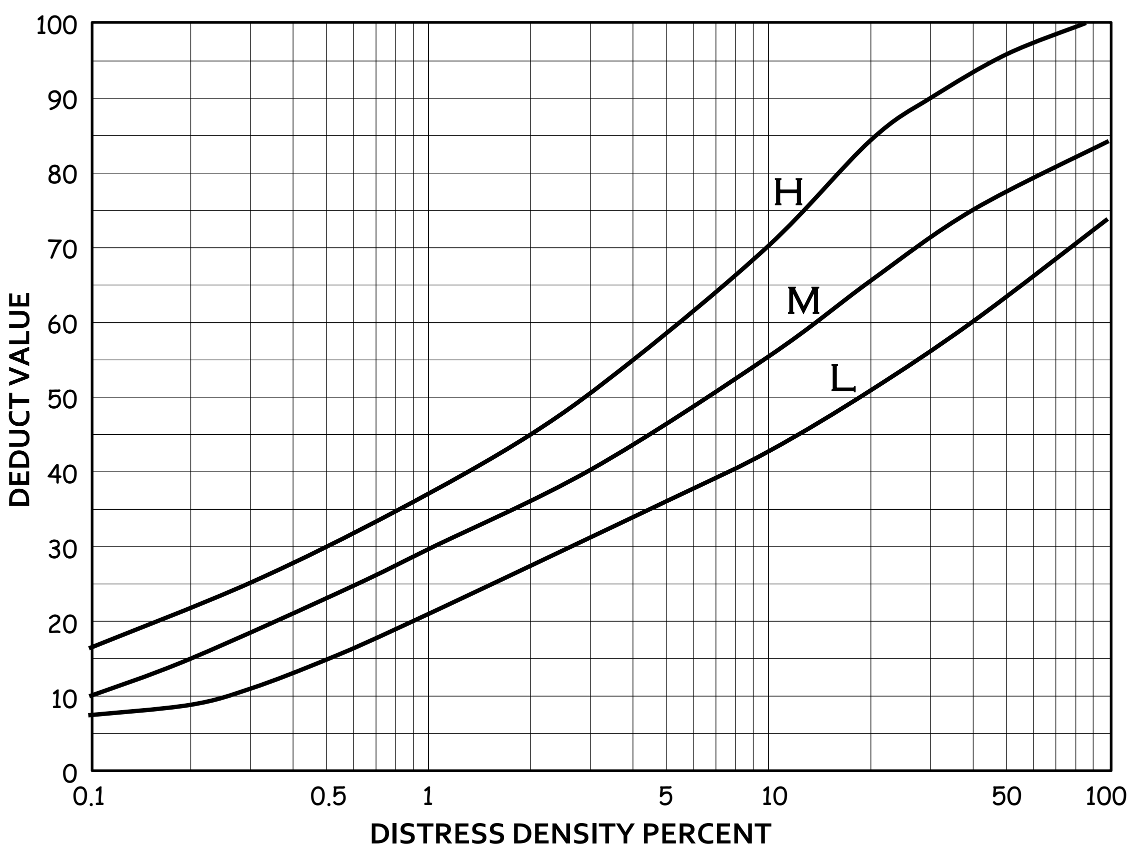


**Figure B-22 Deduct Values for Distress #42, Bleeding**

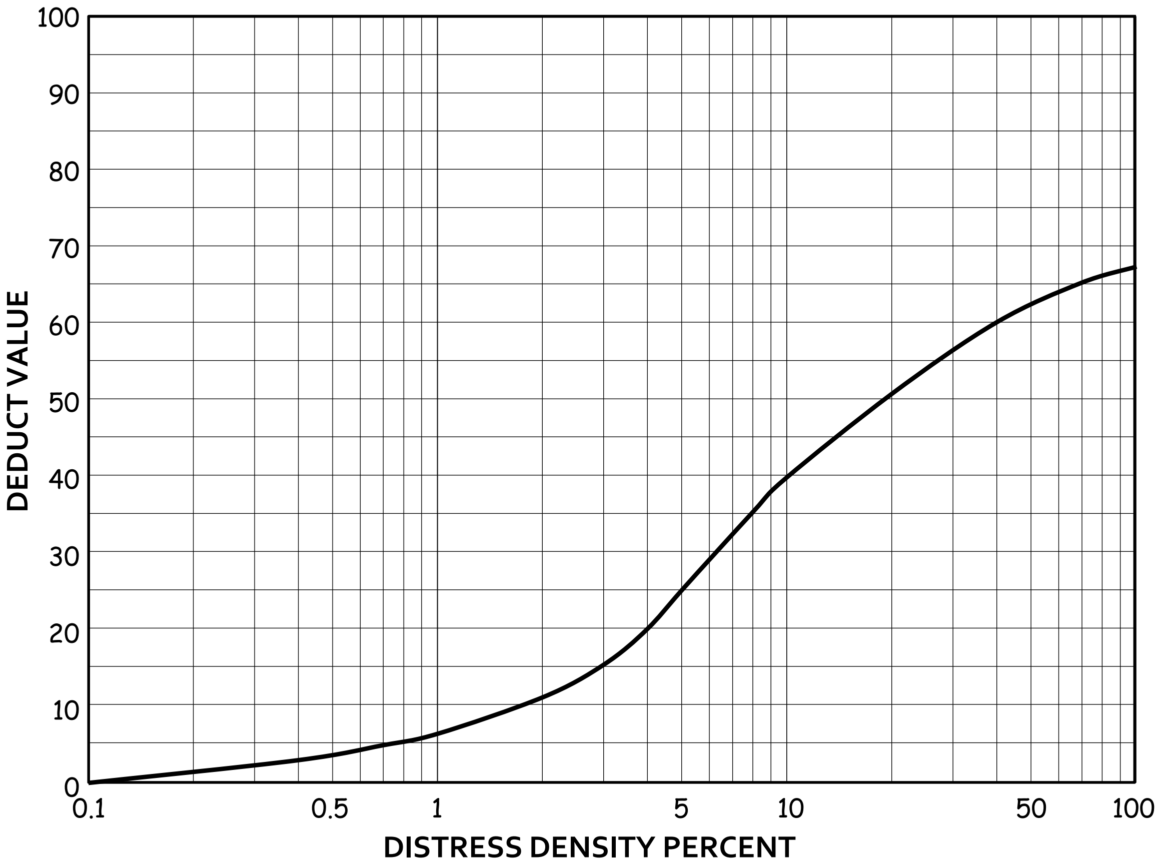


**Figure B-23 Deduct Values for Distress #43, Block Cracking**

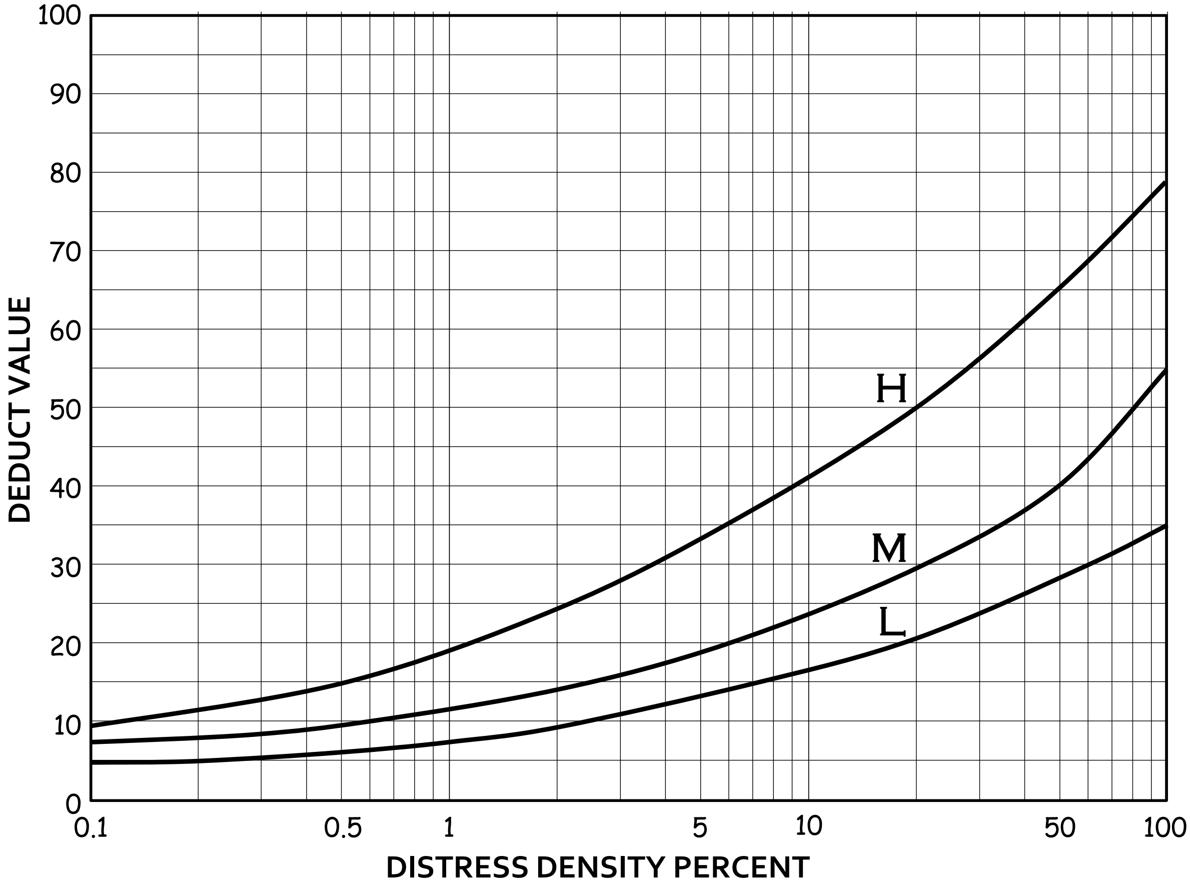


**Figure B-24 Deduct Values for Distress #44, Corrugation**

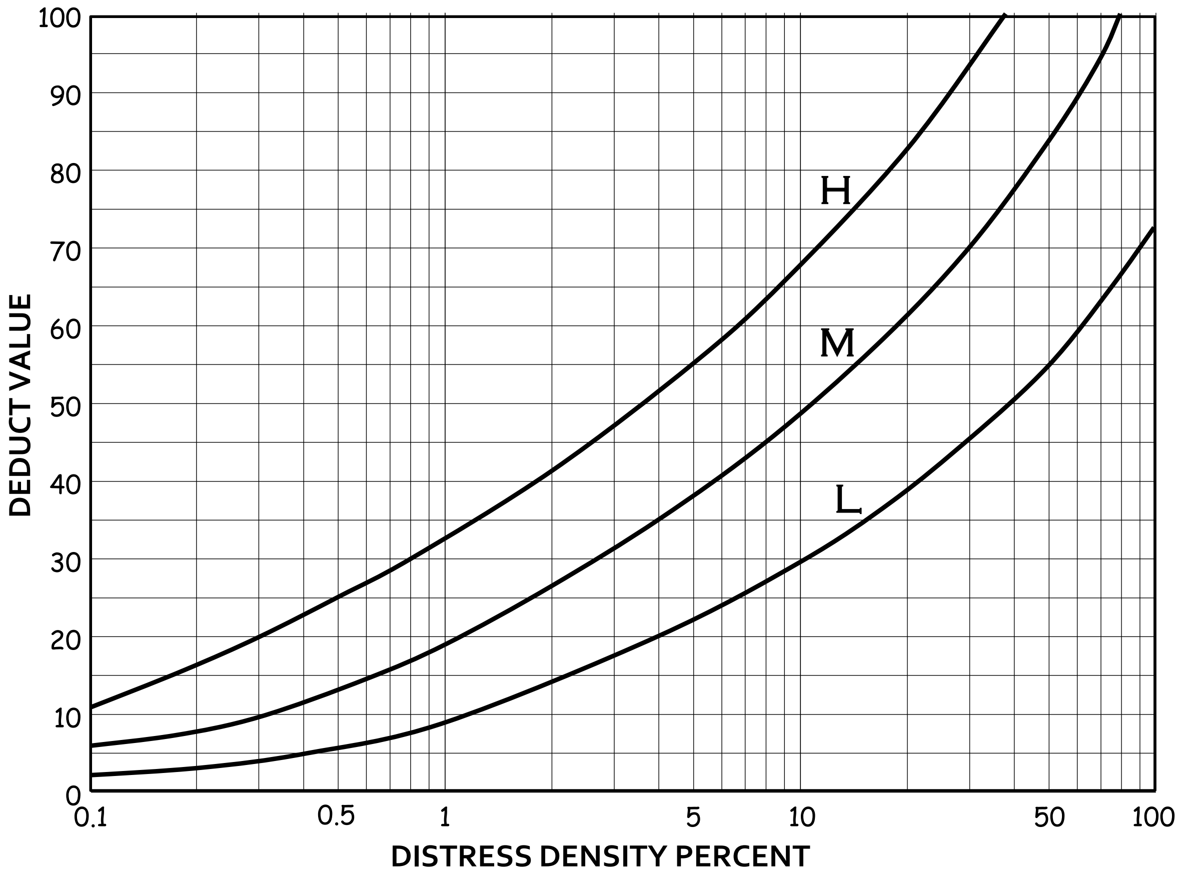


**Figure B-25 Deduct Values for Distress #45, Depression**

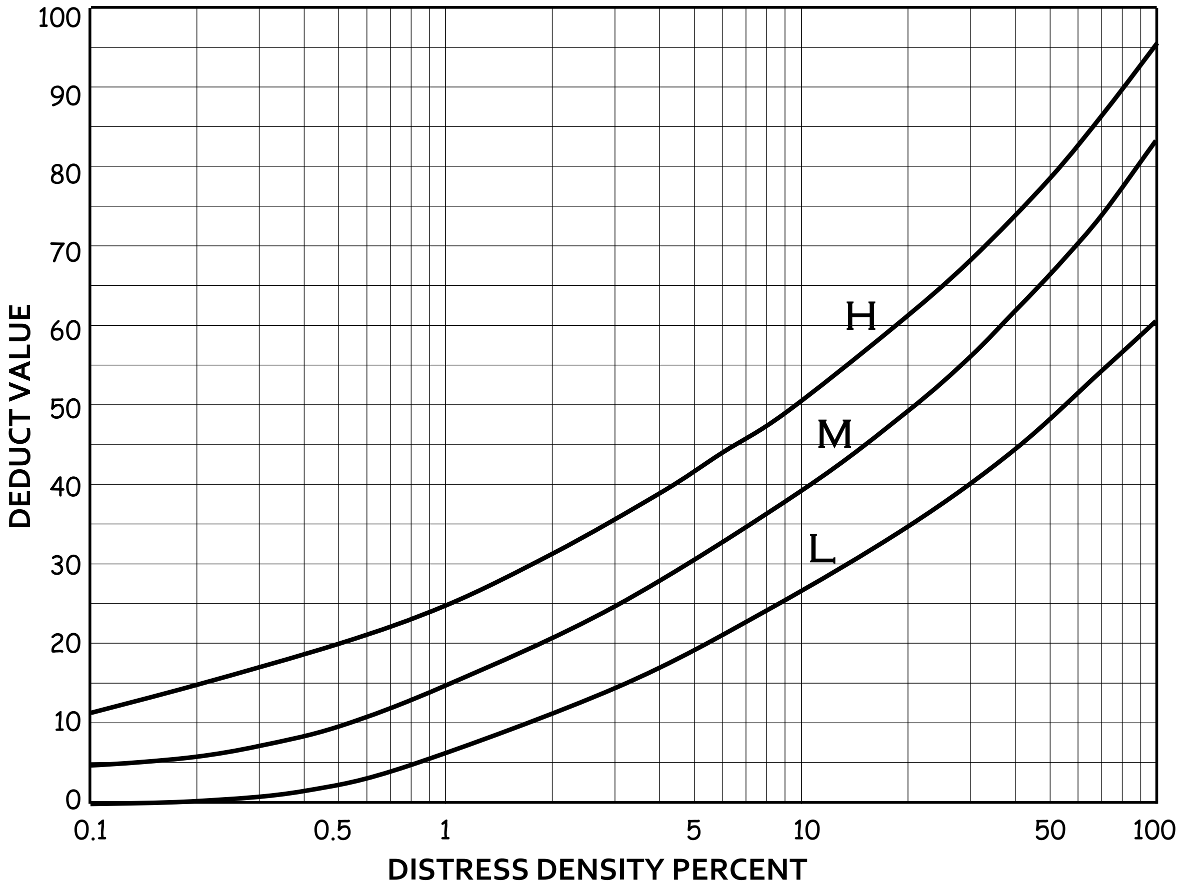


**Figure B-26 Deduct Values for Distress #46, Jet Blast Erosion**

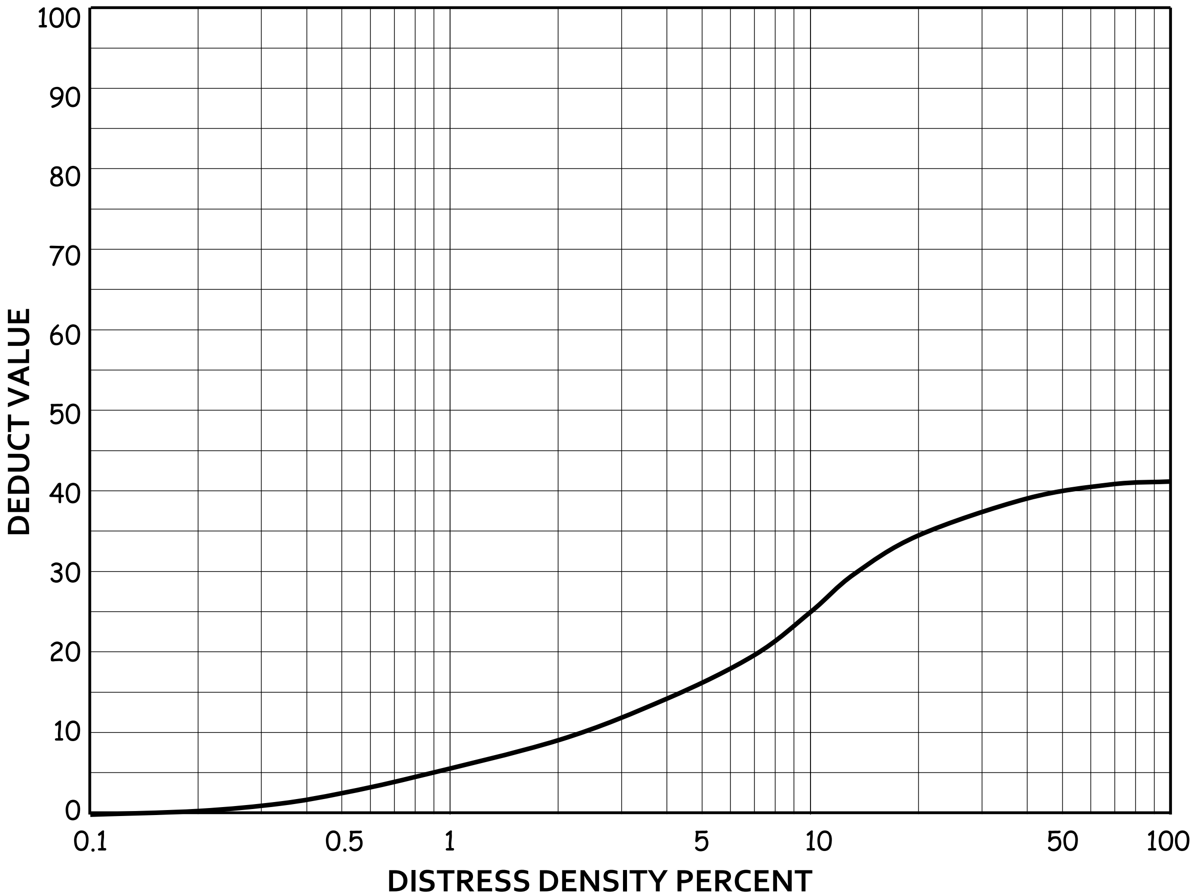


**Figure B-27 Deduct Values for Distress #47, Joint Reflection Cracking**

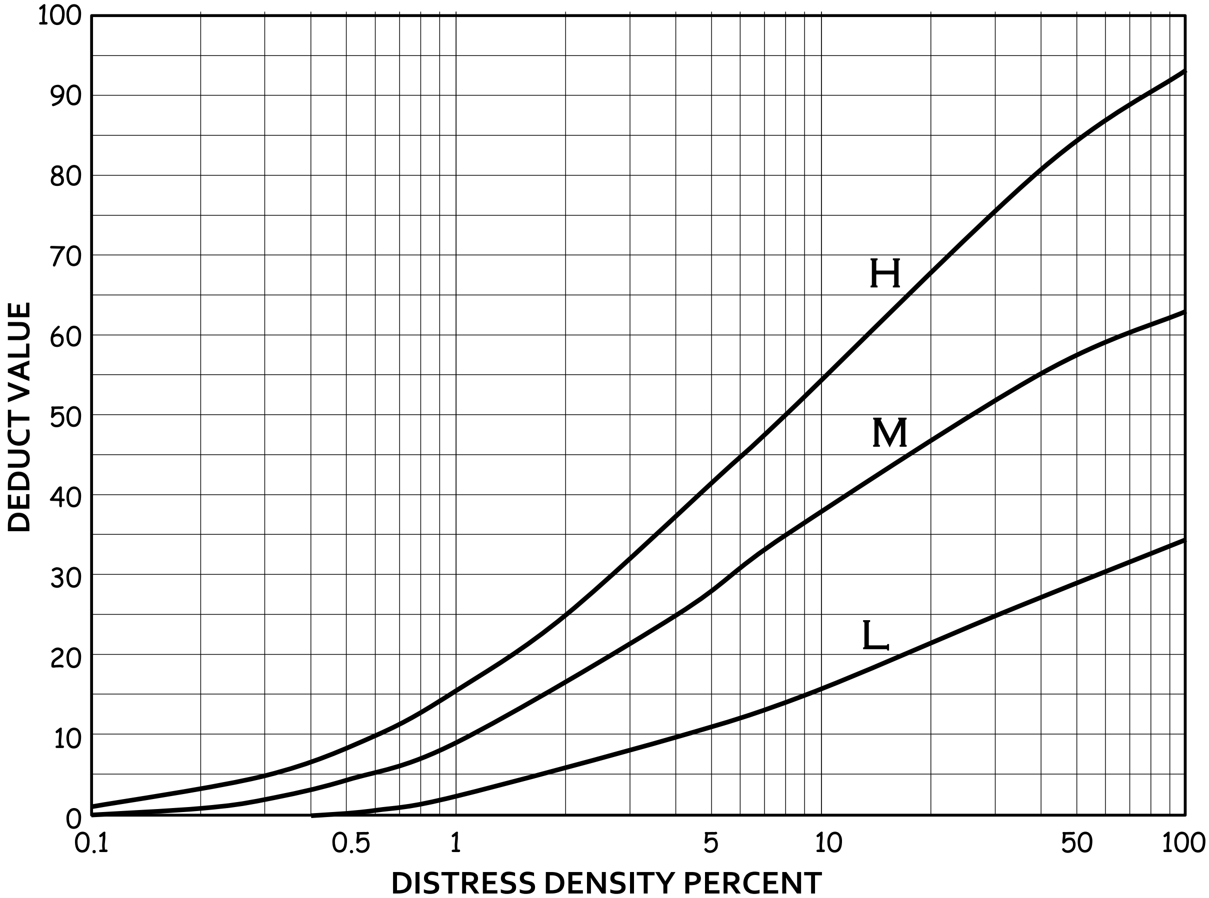


**Figure B-28 Deduct Values for Distress #48, Longitudinal and Transverse Cracking**

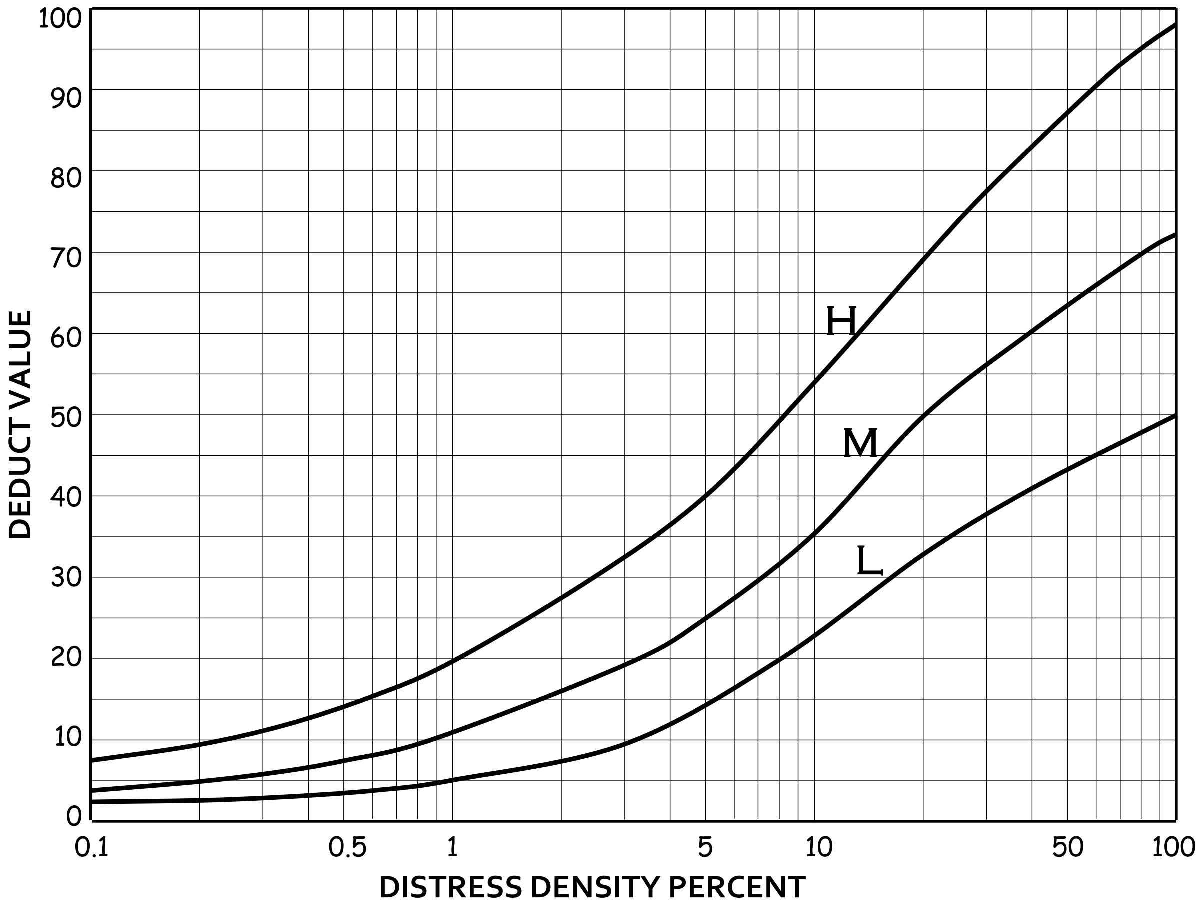


**Figure B-29 Deduct Values for Distress #49, Oil Spillage**

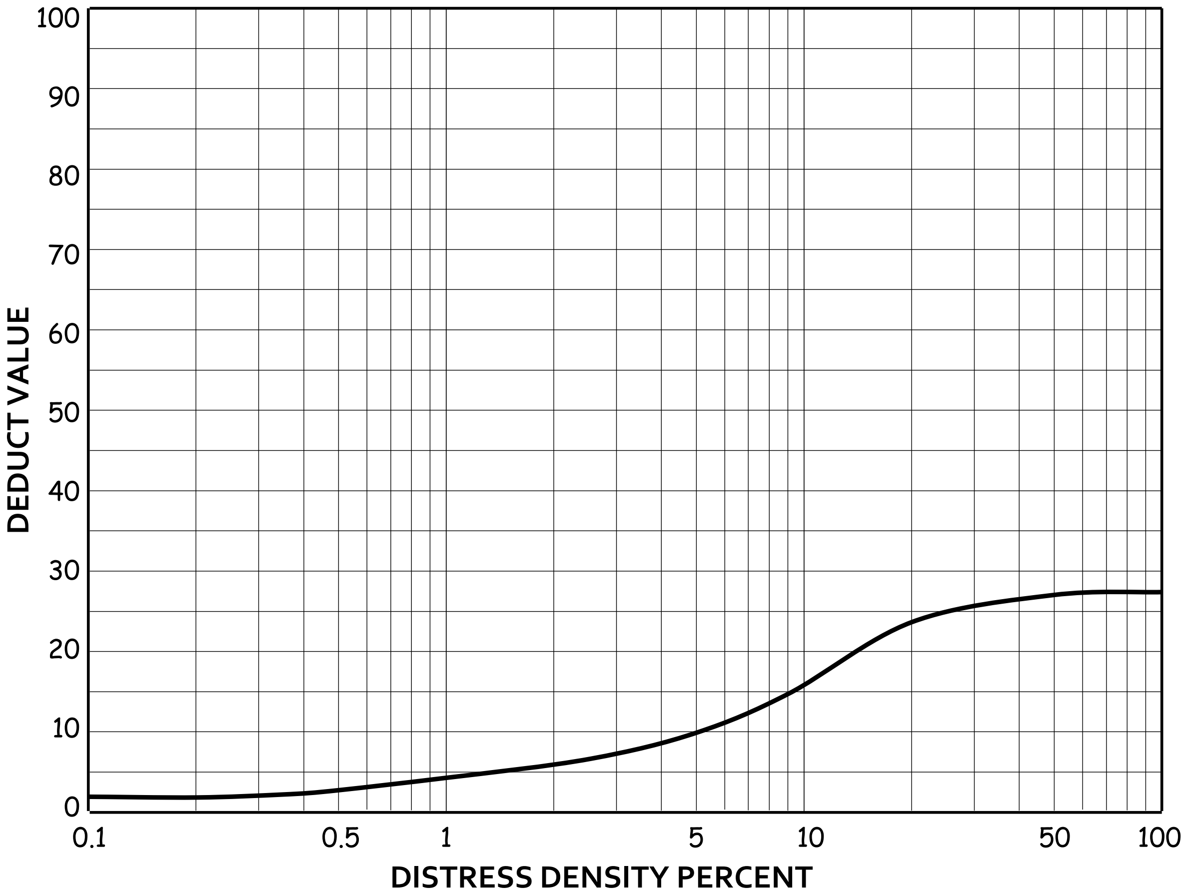


**Figure B-30 Deduct Values for Distress #50, Patching and Utility Cut Patch**

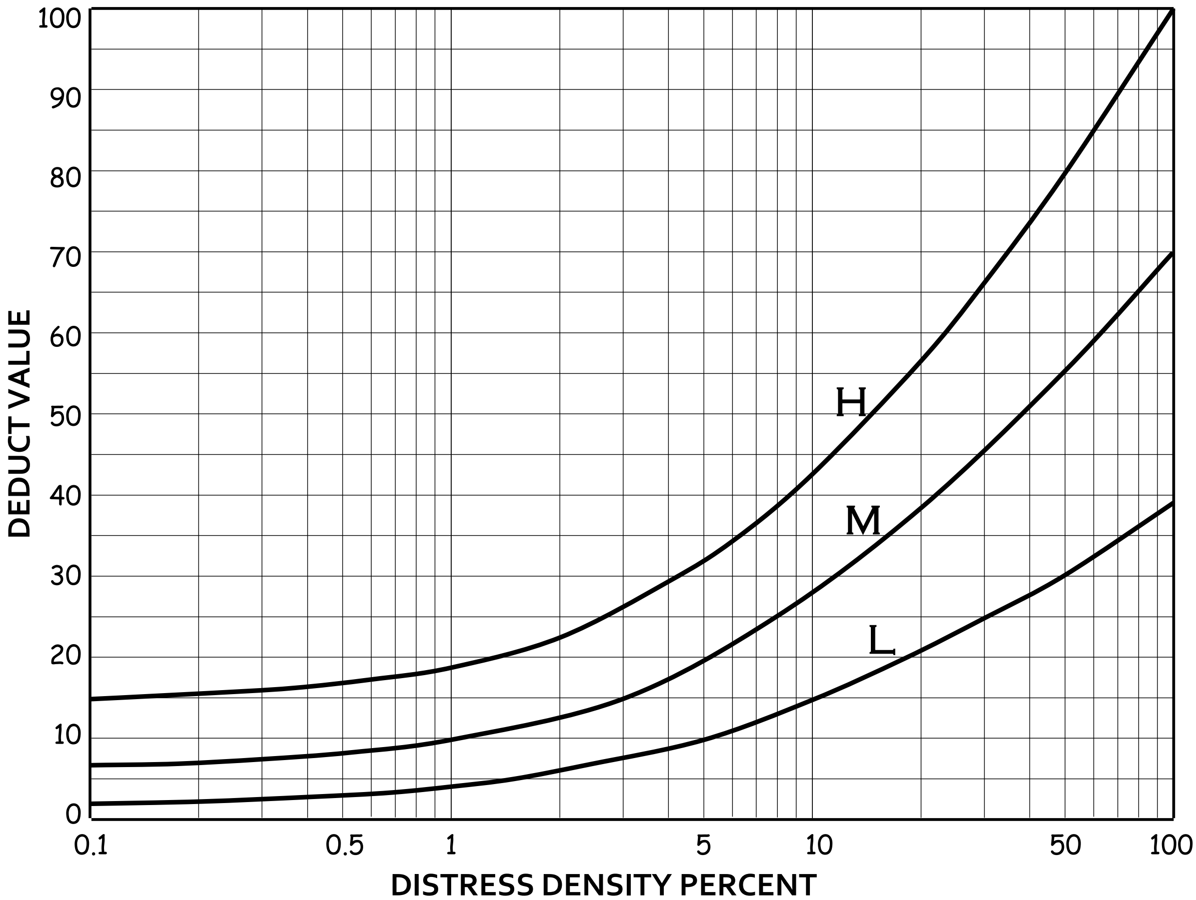


**Figure B-31 Deduct Values for Distress #51, Polished Aggregate**

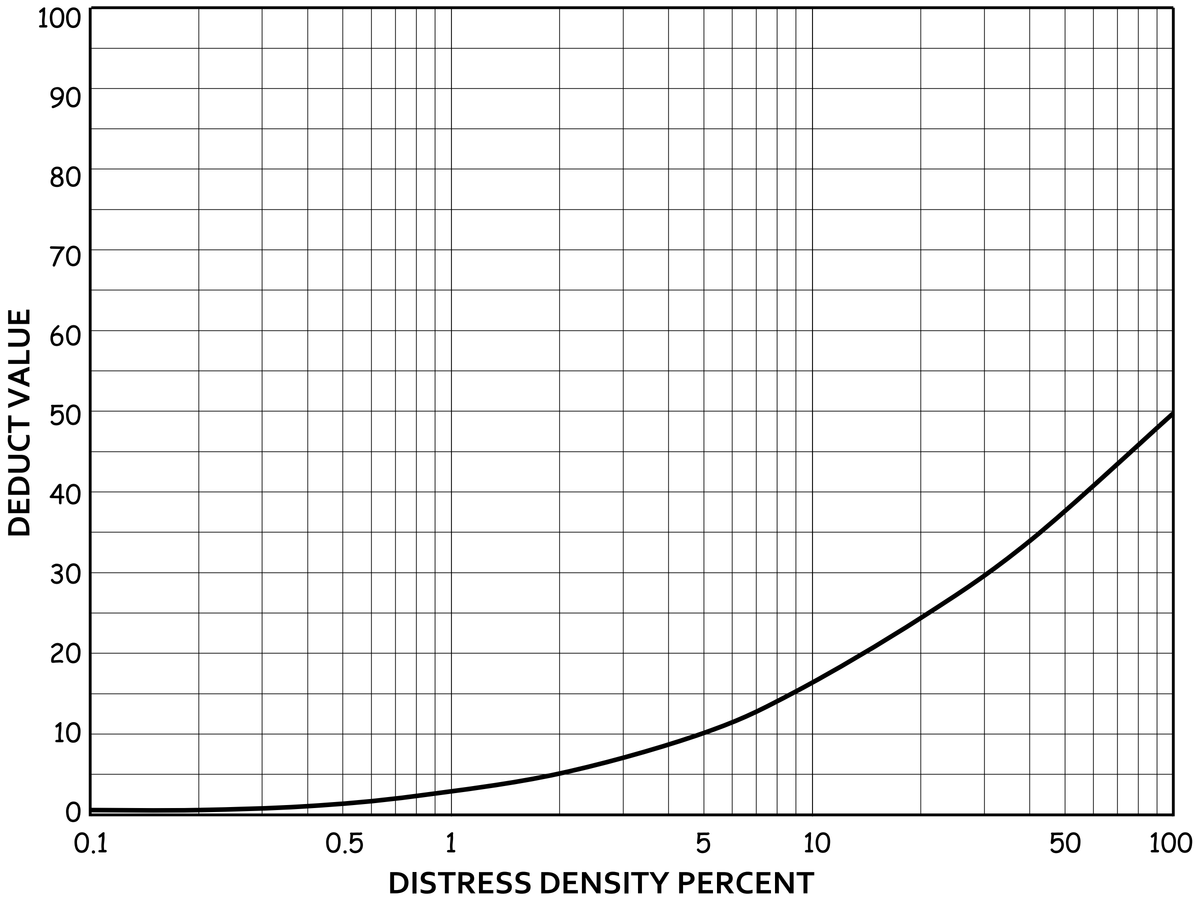


**Figure B-32 Deduct Values for Distress #52, Raveling**

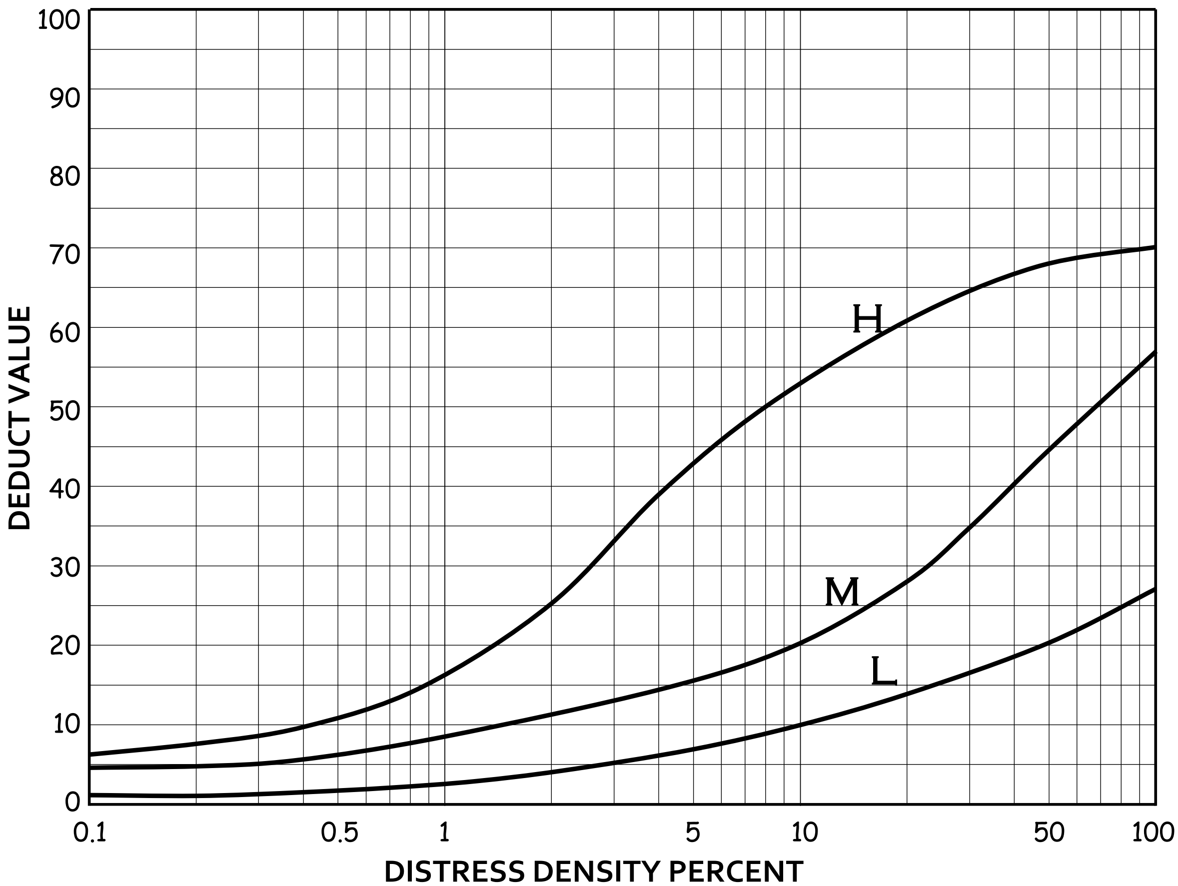


**Figure B-33 Deduct Values for Distress #53, Rutting**

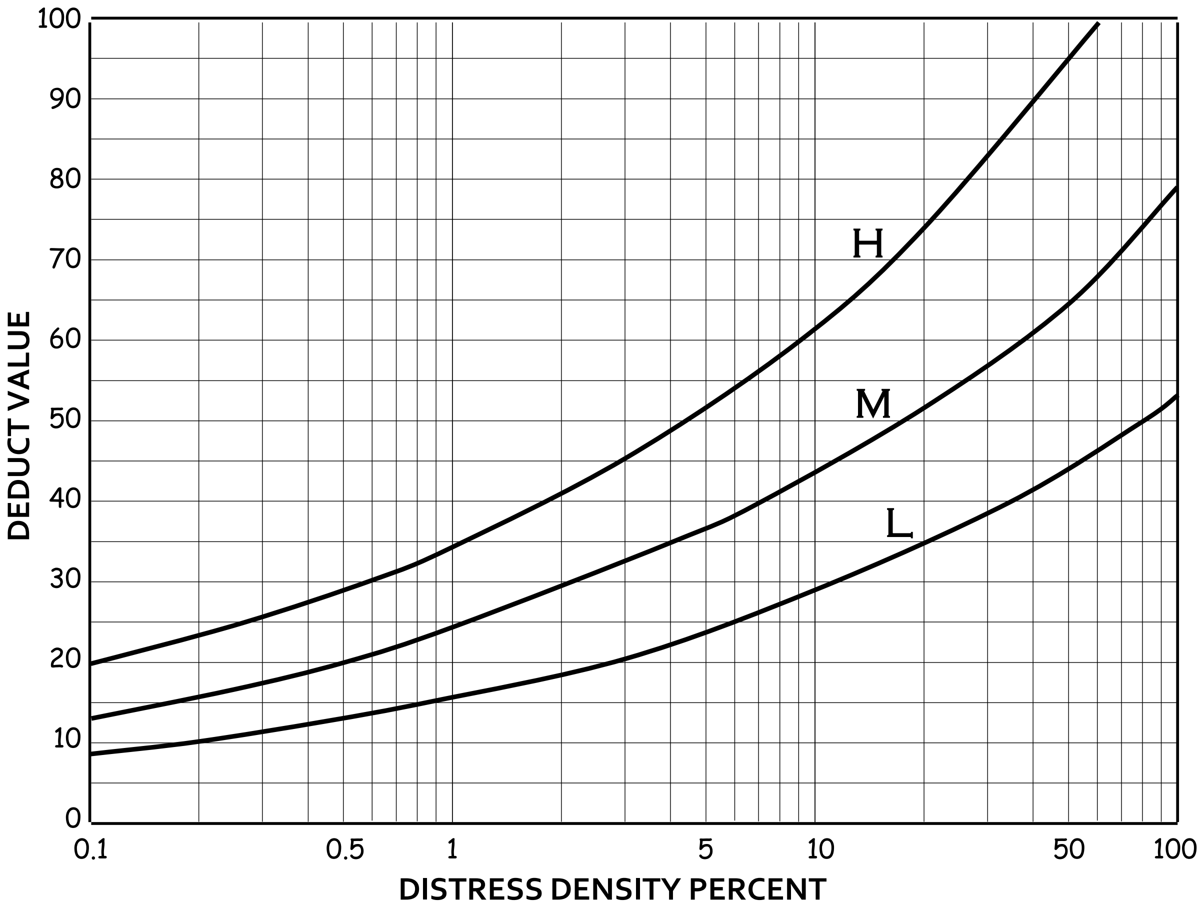


**Figure B-34 Deduct Values for Distress #54, Shoving**

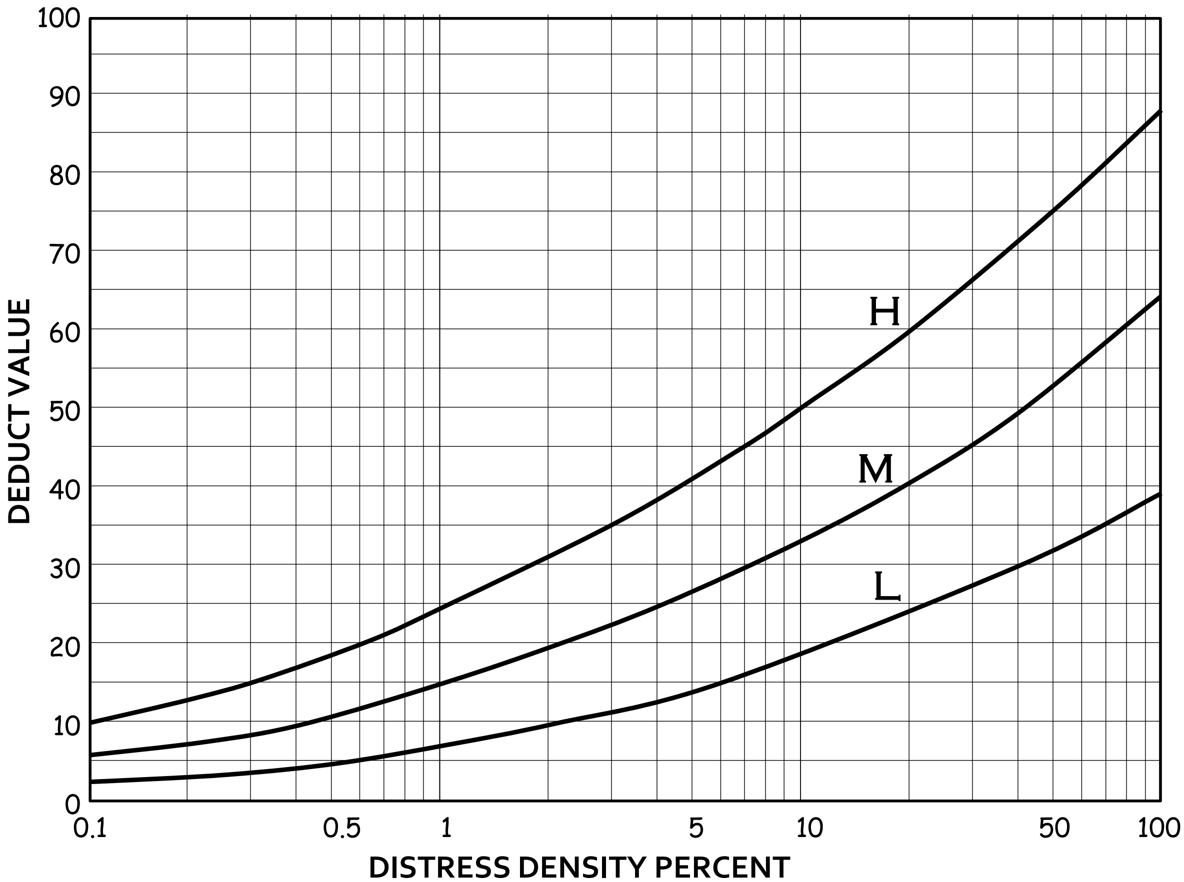


**Figure B-35 Deduct Values for Distress #55, Slippage Cracking**

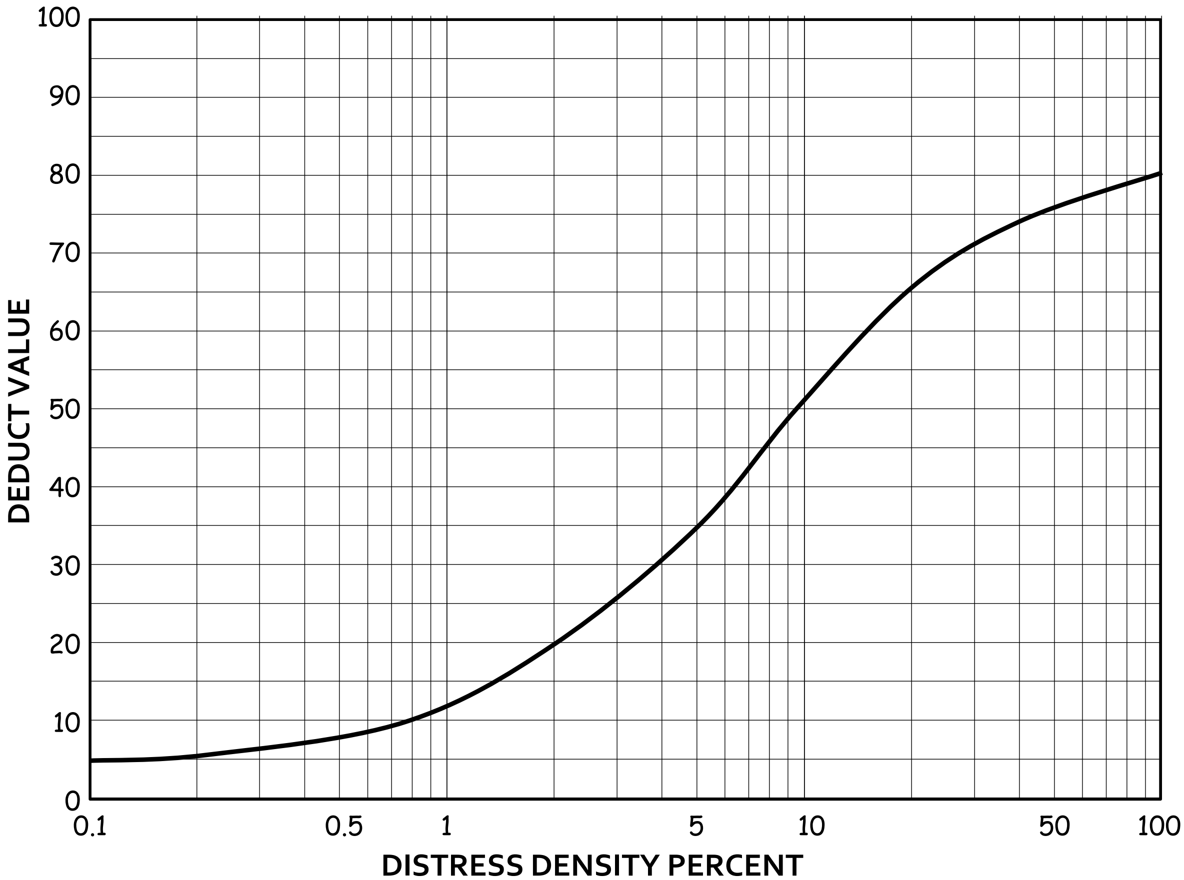


**Figure B-36 Deduct Values for Distress #56, Swell**

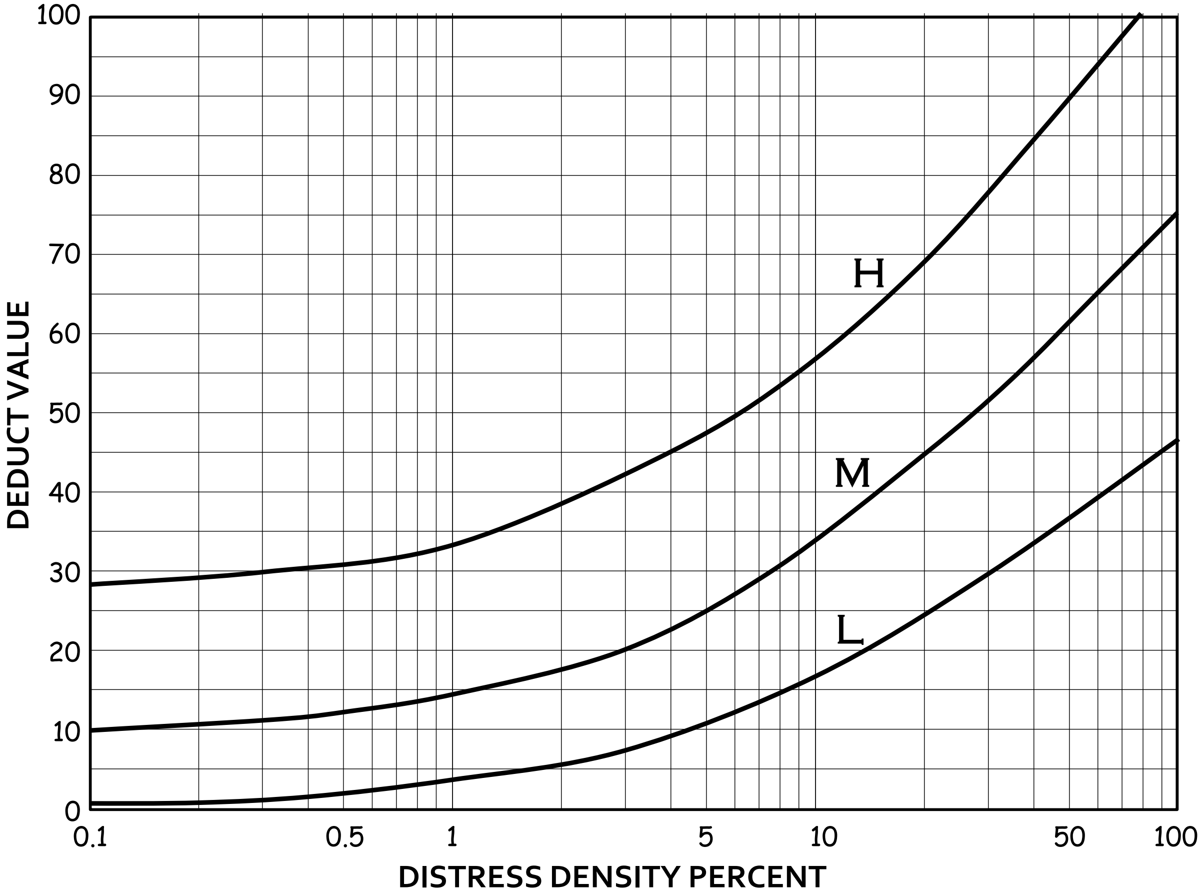


**Figure B-37 Deduct Values for Distress #57, Weathering**

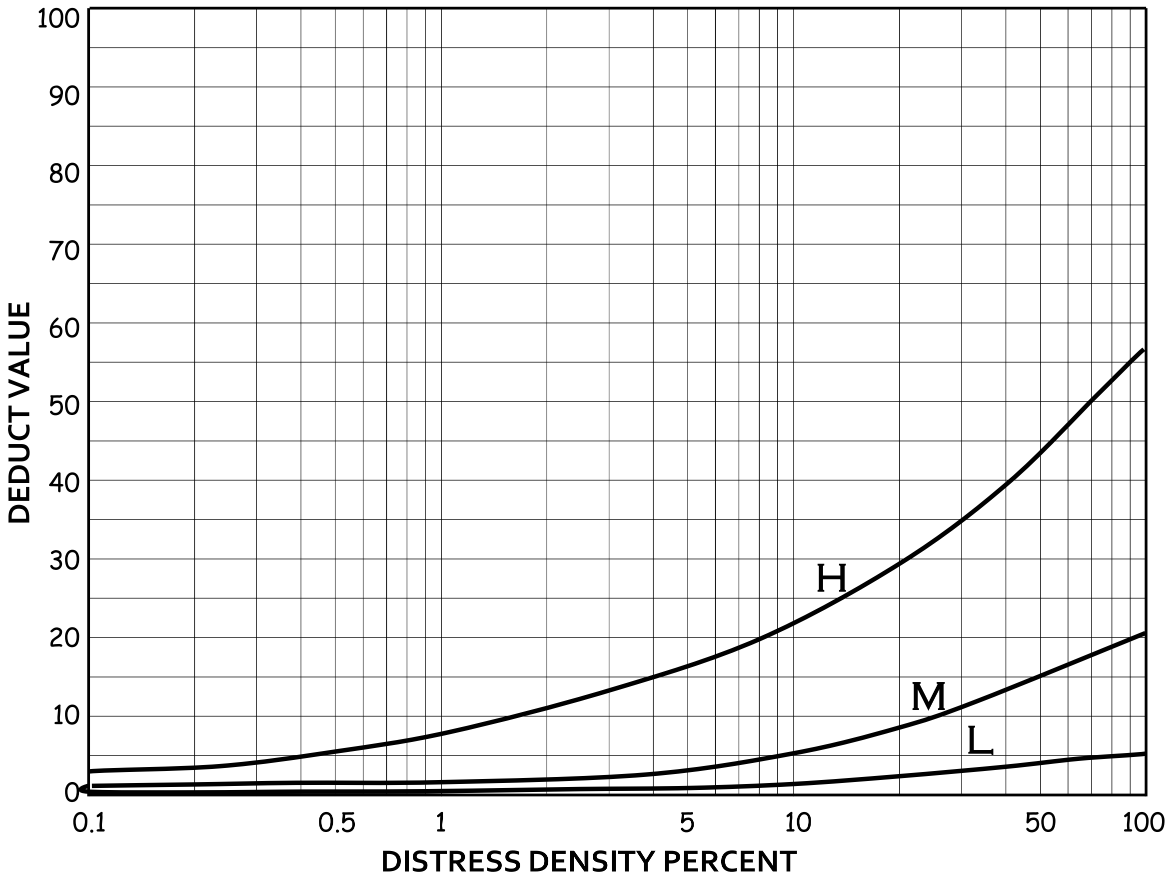
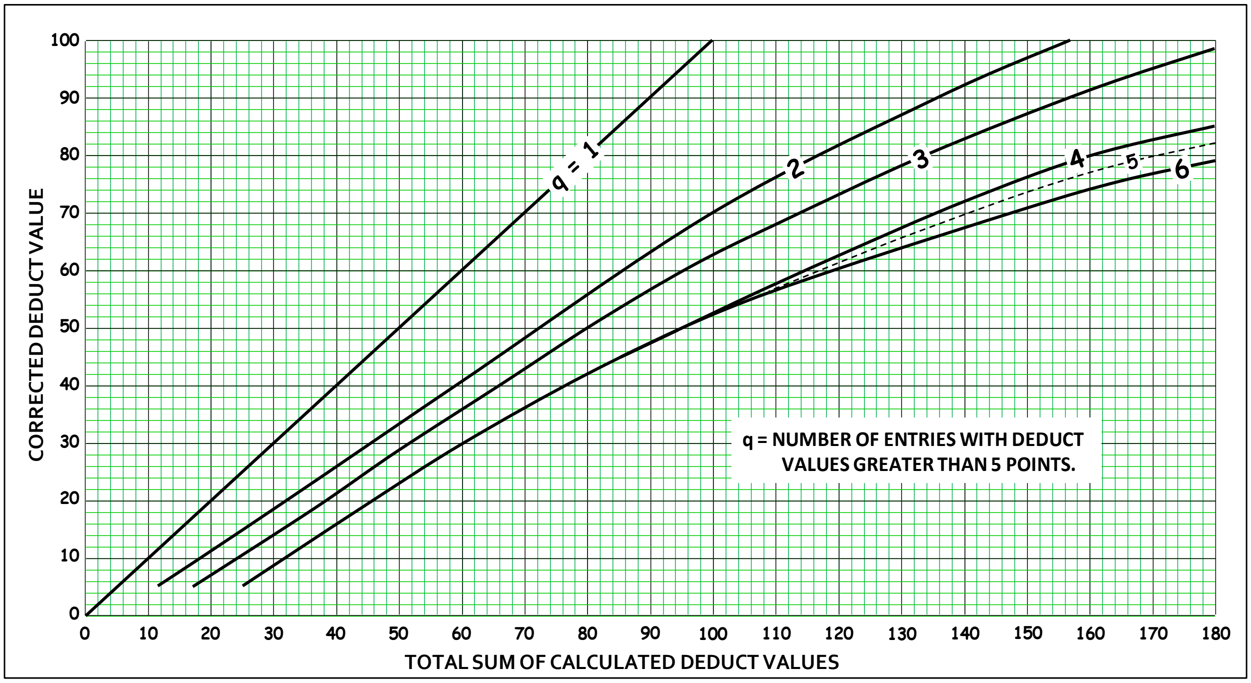



**Figure B-38 Corrected Deduct Values for Flexible (AC) Pavements**



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# APPENDIX C RIGID PAVEMENT DISTRESSES

## C-1 INTRODUCTION.

When performing a PCI in a contingency situation, place an emphasis on structural- or FOD-related distresses. The following is a list of common distresses associated with jointed rigid pavement. Include all of the listed distresses in determining the PCI. Consider only those that are structurally related in determining an SCI of the pavement.

## C-2 C.1. RIGID (PCC) PAVEMENT DISTRESSES:

| Distress | PCI | SCI | FOD |
|---|---|---|---|
| 61. Blow-up | LMH | | LMH |
| 62. Corner Break | LMH | LMH | LMH |
| 63. Long./Trans./Diag. Crack | LMH | MH | LMH |
| 64. “D” Crack | LMH | | LMH |
| 65. Joint Seal Damage | LMH | | LMH (x 4.0) |
| 66. Patch < 5 $ft^2$ | LMH | | LMH |
| 67. Patching/Utility Cut | LMH | MH | LMH |
| 68. Popouts | N/A | | |
| 69. Pumping | N/A | N/A | N/A |
| 70. Scaling/Map Cracking | LMH | | LMH |
| 71. Settlement/Fault | LMH | LMH | |
| 72. Shattered Slab | LMH | LMH | LMH |
| 73. Shrinkage Crack | N/A | | |
| 74. Spalling – Joints | LMH | | LMH |
| 75. Spalling – Corner | LMH | | LMH |
| 76. Alkali Silica Reaction | LMH | | LMH |

## C-3 DISTRESS DESCRIPTIONS.

### C-3.1 Blowup (Distress #61).

#### C-3.1.1 Description.

Blowups occur in hot weather, usually at a transverse crack or joint that is not wide enough to permit expansion by the concrete slabs. The insufficient width is usually caused by infiltration of incompressible materials into the joint space. When expansion cannot relieve enough pressure, a localized upward movement of the slab edges (buckling) or shattering will occur in the vicinity of the joint. Blowups can also occur at utility cuts and drainage inlets. This type of distress is almost always repaired immediately because of severe damage potential to aircraft. Blowups are included for reference when closed sections are being evaluated for reopening.

### C-3.1.2 Severity Levels.

#### C-3.1.2.1 Low.

Buckling or shattering has not rendered the pavement inoperative and only a slight amount of roughness exists.

#### C-3.1.2.2 Medium.

Buckling or shattering has not rendered the pavement inoperative, but a significant amount of roughness exists.

#### C-3.1.2.3 High.

Buckling or shattering has rendered the pavement inoperative.

#### C-3.1.2.4 Foreign Material.

For pavements to be operational, remove all foreign material from blowups.

### C-3.1.3 How to Count.

A blowup usually occurs at a transverse crack or joint. At a crack, it is counted as being in one slab, but at a joint, two slabs are affected and the distress recorded as occurring in two slabs.

**Figure C-1 Blowup Severity Levels**

**Low** **Medium** **High**

## C-3.2 Corner Break (Distress #62).

### C-3.2.1 Description.

A corner break is a crack that intersects the joints at a distance less than or equal to one-half the slab length on both sides, measured from the corner of the slab. For example, a slab with dimensions of 25 by 25 feet (7.5 by 7.5 m) that has a crack intersecting the joint 5 feet (1.5 m) from the corner on one side and 17 feet (5 m) on the other side is not considered a corner break—it is a diagonal crack. However, a crack that intersects 7 feet (2.1 m) on one side and 10 feet (3 m) on the other is considered a corner break. A corner break differs from a corner spall in that the crack extends vertically through the entire slab thickness while a corner spall intersects the joint at an angle. Load repetition combined with loss of support and curling stresses usually causes corner breaks.

### C-3.2.2 Severity Levels.

#### C-3.2.2.1 Low.

Crack has either no spalling or minor spalling (no FOD potential). If non-filled, it has a mean width less than approximately 0.125 inch (3 mm); a filled crack can be of any width, provided the filler material is in satisfactory condition. The area between the corner break and the joints is not cracked.

#### C-3.2.2.2 Medium.

One of the following conditions exists: (1) filled or non-filled crack is moderately spalled (some FOD potential); (2) a non-filled crack has a mean width between 0.125 inch (3 mm) and 1 inch (25 mm); (3) a filled crack is not spalled or only lightly spalled, but the filler is in unsatisfactory condition; (4) the area between the corner break and the joints is lightly cracked. Lightly cracked means one low-severity crack dividing the corner into two pieces.

#### C-3.2.2.3 High.

One of the following conditions exists: (1) filled or non-filled crack is severely spalled, causing definite FOD potential; (2) a non-filled crack has a mean width greater than approximately 1 inch (35 mm), creating a tire damage potential; or (3) the area between the corner break and the joints is severely cracked.

### C-3.2.3 How to Count.

A distressed slab is recorded as one slab if it (1) contains a single corner break, (2) contains more than one break of a particular severity, or (3) contains two or more breaks of different severities. For two or more breaks, record the highest level of severity. For example, count a slab containing both low- and medium-severity corner breaks as one slab with a medium-severity corner break. Measure crack widths between vertical walls, not in spalled areas of the crack. If the corner break is faulted 0.125 inch (3 mm) or more, increase severity to the next higher level. If the corner is faulted more than 0.5 inch (13 mm), rate the corner break at high severity. If faulting in the corner is incidental to faulting in the slab, rate faulting separately. The angle of crack into the slab is usually not evident at low severity. Unless the crack angle can be determined, use the following criteria to differentiate between the corner break and corner spall. If the crack intersects both joints more than 2 feet (600 mm) from the corner, it is a corner break. If it is less than 2 feet (600 mm), unless you can verify the crack is vertical, call it a spall.

**Figure C-2 Corner Break Severity Levels**

**Low** **Medium** **High**

## C-3.3 Longitudinal, Transverse, and Diagonal Cracks (Distress #63).

### C-3.3.1 Description.

These cracks, which divide the slab into two or three pieces, are usually caused by a combination of load repetition, curling stresses, and shrinkage stresses. (For slabs divided into four or more pieces, see paragraph C-3.12, “Shattered Slab/Intersecting Cracks.”) Low-severity cracks are usually warping- or friction-related and not considered major structural distresses. Medium- or high-severity cracks are usually working cracks and considered major structural distresses. Hairline cracks that are only a few feet long and do not extend across the entire slab are rated as shrinkage cracks.

### C-3.3.2 Non-reinforced PCC.

#### C-3.3.2.1 Severity Levels.

##### C.2.3.2.1.1 Low.

Crack has no spalling or minor spalling (no FOD potential). If non-filled, it is less than 0.125 inch (3 mm) wide. A filled crack can be of any width, provided the filler material is in satisfactory condition or the slab is divided into three pieces by low-severity cracks.

##### C.2.3.2.1.2 Medium.

One of the following conditions exists: (1) a filled or non-filled crack is moderately spalled (some FOD potential); (2) a non-filled crack has a mean width between 0.125 inch (3 mm) and 1 inch (25 mm); (3) a filled crack has no spalling or minor spalling but the filler is in unsatisfactory condition; or (4) the slab is divided into three pieces by two or more cracks, one of which is at least medium severity.

##### C.2.3.2.1.3 High.

One of the following conditions exists: (1) a filled or non-filled crack is severely spalled (definite FOD potential); (2) a non-filled crack has a mean width approximately greater than 1 inch (25 mm), creating tire damage potential, or (3) the slab is divided into three pieces by two or more cracks, one of which is at least high severity.

#### C-3.3.2.2 How to Count.

Once the severity has been identified, the distress is recorded as one slab. If a crack is repaired by a narrow patch (e.g., 4 to 10 inches wide [100 to 250 mm]), only record the crack and not the patch at the appropriate severity level. Cracks used to define and rate corner breaks, “D” cracks, patches, shrinkage cracks, and spalls are not recorded as L/T/D cracks.

**Figure C-3 Longitudinal, Transverse, and Diagonal Cracks Severity Levels**

**Low** **Medium** **High**

### C-3.3.3 Reinforced PCC.

#### C-3.3.3.1 Severity Levels.

##### C.2.3.3.1.1 Low.

(1) Non-filled crack, 0.125 inch (3 mm) to 0.5 inch (13 mm) wide, with no faulting or spalling; (2) filled or non-filled cracks of any width < 0.5 inch (13 mm), with low- severity spalling; or (3) filled cracks of any width (filler satisfactory), with no faulting or spalling. (**Note:** Count a crack(s) less than 0.125 inch [3 mm] wide with no spalling or faulting as shrinkage cracking.)

##### C.2.3.3.1.2 Medium.

(1) Non-filled cracks, 0.5 inch (13 mm) to 1 inch (25 mm) wide, no faulting or spalling; (2) filled cracks of any width, with faulting < 3/8 inch (10 mm) or medium-severity spalling; or (3) non-filled cracks of width < 1 inch (25 mm) with faulting < 3/8 inch (10 mm) or medium-severity spalling.

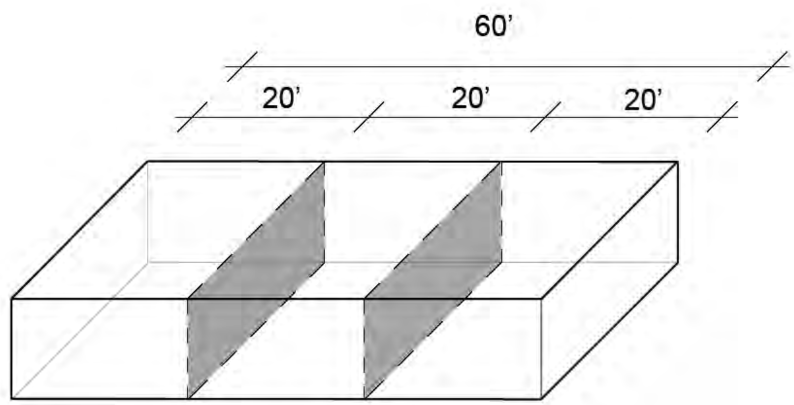
##### C.2.3.3.1.3 High.

(1) Non-filled cracks of width > 1 inch (25 mm); (2) non-filled cracks of any width, with faulting > 3/8 inch (10 mm) or medium-severity spalling; or (3) filled cracks of any width, with faulting > 3/8 inch (10 mm) or high-severity spalling.

**C-3.3.3.2 How to Count.**

Once the severity has been identified, the distress is recorded as one slab. If a crack is repaired by a narrow patch (e.g., 4 to 10 inches wide [100 to 250 mm]), only record the crack and not the patch at the appropriate severity level. Slabs longer than 30 feet (9 m) are divided into approximately equal length “slabs” having imaginary joints assumed to be in perfect condition.

**Figure C-4 Dividing a Large Reinforced Slab into Smaller Imaginary Slabs**




**C-3.4 Durability “D” Cracking (Distress #64).**

**C-3.4.1 Description.**

Durability cracking is caused by the inability of the concrete to withstand environmental factors such as freeze-thaw cycles. It usually appears as a pattern of cracks running parallel to a joint or linear crack. A dark coloring can usually be seen around the fine durability cracks. This type of cracking may eventually lead to disintegration of the concrete within 1 to 2 feet (300 to 600 mm) of the joint or crack.

**C-3.4.2 Severity Levels.**

**C-3.4.2.1 Low.**

“D” cracking is defined by hairline cracks occurring in a limited area of the slab, such as one or two corners or along one joint. Little or no disintegration has occurred. No FOD potential.

**C-3.4.2.2 Medium.**

(1) “D” cracking has developed over a considerable amount of slab area with little or no disintegration or FOD potential; or (2) “D” cracking has occurred in a limited area of the slab, such as in one or two corners or along one joint, but pieces are missing and disintegration has occurred. Some FOD potential.

#### C-3.4.2.3 High.

"D" cracking has developed over a considerable amount of slab area with disintegration of FOD potential.

### C-3.4.3 How to Count.

When the distress is located and rated at one severity, it is counted as one slab. If more than one severity level is found, the slab is counted as having the higher severity distress. If "D" cracking is counted, do not record scaling on the same slab.

**Figure C-5 Durability "D" Cracking Severity Levels**

**Low** **Medium** **High**

## C-3.5 Joint Seal Damage (Distress #65).

### C-3.5.1 Description.

Joint seal damage is any condition that enables soil or rocks to accumulate in the joints or allows significant water infiltration. Accumulation of incompressible materials prevents the slabs from expanding and may result in buckling, shattering, or spalling. A pliable joint filler bonded to the edges of the slabs protects the joints from accumulating materials and also prevents water from seeping down and softening the foundation supporting the slab. Typical types of joint seal damage are (a) stripping of joint sealant, (b) extrusion of joint sealant, (c) weed growth, (d) hardening of the filler (oxidation), (e) loss of bond to the slab edges, and (f) lack or absence of sealant in the joint.

### C-3.5.2 Severity Levels.

#### C-3.5.2.1 Low.

Joint sealer is in generally good condition throughout the section. Sealant is performing well, with only a minor amount of any of the above types of damage present. Joint seal damage is at low severity if a few of the joints have sealer that has debonded from, but is still in contact with, the joint edge. The condition exists if a knife blade can be inserted between the sealer and the joint face without resistance.

#### C-3.5.2.2 Medium.

Joint sealer is in generally fair condition over the entire surveyed section, with one or more of the above types of damage occurring to a moderate degree. Sealant needs replacement within two years. Joint seal damage is at medium severity if a few of the joints have any of the following conditions: (1) joint sealer is in place, but water access is possible through visible openings no more than 0.125 inch (3 mm) wide. (If a knife blade cannot be inserted easily between the sealer and the joint face, this condition does not exist.); (2) pumping debris are evident at the joint; (3) joint sealer is oxidized and “lifeless” but pliable (like a rope) and generally fills the joint opening; or (4) vegetation in the joint is obvious but does not obscure the joint opening.

#### C-3.5.2.3 High.

Joint sealer is in generally poor condition over the entire surveyed section, with one or more of the above types of damage occurring to a severe degree. Sealant needs immediate replacement. Joint seal damage is at high severity if 10% or more of the joint sealer exceeds limiting criteria listed above or if 10% or more of the sealer is missing.

### C-3.5.3 How to Count.

Joint seal damage is not counted on a slab-by-slab basis but is rated based on the overall condition of the sealant in the sample unit. Joint sealer is in satisfactory condition if it prevents entry of water into the joint, it has some elasticity, and if there is no vegetation growing between the sealer and the joint face. Premolded sealer is rated using the same criteria as above except as follows: (1) premolded sealer is elastic and firmly pressed against the joint walls; and (2) premolded sealer is below the joint edge. If it extends above the surface, it can be caught by moving equipment such as snowplows or brooms and be pulled out of the joint. Premolded sealer is recorded at low severity if any part is visible above the joint edge. It is at medium severity if 10% or more of the length is above the joint edge or if any part is more than 0.5 inch (12 mm) above the joint edge. It is high severity if 20% or more is above the joint edge, or if any part is more than 1 inch (25 mm) above the joint edge, or if 10% or more is missing. Rate joint sealer by joint segment. The sample unit rating is the same as the most severe rating held by at least 20% of segments rated. In rating oxidation, do not rate on appearance. Rate on resilience. Some joint sealer will have a very dull surface and may even show surface cracks in the oxidized layer. If the sealer is performing satisfactorily and has good characteristics beneath the surface, it is satisfactory.

**Figure C-6 Joint Seal Damage Severity Levels**

Low Medium High

### C-3.6 Patching, Small (less than 5.5 ft$^2$ [0.5 m$^2$]) (Distress #66).

#### C-3.6.1 Description.

A patch is an area where the original pavement has been removed and replaced by a filler material. For condition evaluation, patching is divided into two types: small (less than 5 square feet [0.5 m$^2$]) and large (over 5 square feet [0.5 m$^2$]). Large patches are described in the next section.

#### C-3.6.2 Severity Levels.

##### C-3.6.2.1 Low.

Patch is functioning well, with little or no deterioration.

##### C-3.6.2.2 Medium.

Patch has deteriorated and/or moderate spalling can be seen around the edges. Patch material can be dislodged with considerable effort (minor FOD potential).

##### C-3.6.2.3 High.

Patch has deteriorated, either by spalling around the patch or cracking within the patch, to a state that warrants replacement.

#### C-3.6.3 How to Count.

If one or more small patches with the same severity level are located in a slab, it is counted as one slab containing that distress. If more than one severity level occurs, it is counted as one slab with the higher severity level being recorded. If a crack is repaired by a narrow patch (e.g., 4 to 10 inches [100 to 250 mm]) wide), record only the crack and not the patch at the appropriate severity level. If the original distress of a patch is more severe than the patch itself, record the original distress type.

**Figure C-7 Patching, Small (less than 5.5 $ft^2$ [0.5 $m^2$]) Severity Levels**

Low Medium High

## C-3.7 Patching, Large (over 5.5 $ft^2$ [0.5 $m^2$]) (Distress #67).

### C-3.7.1 Description.

Patching is the same as defined in the previous section. A utility cut is a patch that has replaced the original pavement because of placement of underground utilities. The severity levels of a utility cut are the same as those for regular patching.

### C-3.7.2 Severity Levels.

#### C-3.7.2.1 Low.

Patch is functioning well, with little or no deterioration.

#### C-3.7.2.2 Medium.

Patch has deteriorated and/or moderate spalling can be seen around the edges. Patch material can be dislodged with considerable effort, causing some FOD potential.

#### C-3.7.2.3 High.

Patch has deteriorated to a state that causes considerable roughness and/or high FOD potential. The extent of the deterioration warrants replacing the patch.

### C-3.7.3 How to Count.

If one or more small patches having the same severity level are located in a slab, it is counted as one slab containing that distress. If more than one severity level occurs, it is counted as one slab with the higher severity level being recorded. If a crack is repaired by a narrow patch (e.g., 4 to 10 inches [100 to 250 mm]) wide), record only the crack and not the patch at the appropriate severity level. If the original distress of a patch is more severe than the patch itself, record the original distress type.

**Figure C-8 Patching, Large (over 5.5 ft$^2$ [0.5 m$^2$]) Severity Levels**

Low Medium High

## C-3.8 Popouts (Distress #68).

### C-3.8.1 Description.

A popout is a small piece of pavement that breaks loose from the surface due to freeze-thaw action in combination with expansive aggregates. Popouts usually range from approximately 1 inch (25 mm) to 4 inches (100 mm) in diameter and from 0.5 inch (13 mm) to 2 inches (50 mm) deep.

### C-3.8.2 Severity Levels.

No degrees of severity are defined for popouts; however, popouts are required to be extensive before they are counted as a distress, i.e., average popout density is required to exceed approximately three popouts per square yard (square meter) over the entire slab area.

### C-3.8.3 How to Count.

Measure the density of the distress. If there is any doubt about the average being greater than three popouts per square yard (per square meter), check at least three, random, 1 square yard (1 square meter) areas. When the average is greater than this density, the slab is counted.

**Figure C-9 Popouts**

## C-3.9 Pumping (Distress #69).

### C-3.9.1 Description.

Pumping is the ejection of material by water through joints or cracks caused by deflection of the slab under passing loads. As the water is ejected, it carries particles of gravel, sand, clay, or silt and results in a progressive loss of pavement support. Surface staining and base or subgrade material on the pavement close to joints or cracks are evidence of pumping. Pumping near joints indicates poor joint sealer and loss of support which will lead to cracking under repeated loads. Identify the joint seal as defective before pumping can be said to exist. Pumping can occur at cracks as well as joints.

### C-3.9.2 Severity Levels.

No degrees of severity are defined. It is sufficient to indicate that pumping exists.

### C-3.9.3 How to Count.

Slabs are counted as follows: one pumping joint between two slabs is counted as two slabs. However, if the remaining joints around the slab are also pumping, one slab is added per additional pumping joint.

**Figure C-10 Pumping**

## C-3.10 Map Cracking, Crazing, Scaling (Distress #70).

### C-3.10.1 Description.

Map cracking, crazing, and scaling is surface deterioration caused by construction defects, material defects, and environmental factors. Map cracking or crazing refers to a network of shallow, fine, or hairline cracks that extend only through the upper surface of the concrete. The cracks tend to intersect at angles of 120 degrees. Generally, scaling is exhibited by delamination or disintegration of the slab surface to the depth of the defect. Scaling is the breakdown of the slab surface to a depth of approximately 0.25 to 0.5 inch (6 to 13 mm).

**C.3.10.3.1** Construction defects include over-finishing, addition of water to the pavement surface during finishing, lack of curing, and attempted surface repairs of fresh concrete with mortar. Generally, this occurs over a portion of a slab.

**C.3.10.3.2** Material defects include inadequate air entrainment for the climate. Generally, this occurs over several slabs affected by the concrete batches.

**C.3.10.3.3** Environmental factors include freezing of concrete before adequate strength is gained or thermal cycles from certain aircraft. Generally, this occurs over a large area for freezing effects and isolated areas for thermal effects.

**C.3.10.3.4** Typically, the FOD from scaling is removed by sweeping but the concrete will continue to scale until the affected depth is removed or expended.

### C-3.10.2 Severity Levels.

#### C-3.10.2.1 Low.

Crazing or map cracking exists over most of the slab area; the surface is in good condition with no scaling. (**Note:** The low-severity level is an indicator that scaling may develop in the future. Only count a slab if, in the judgment of the pavement inspector, future scaling is likely to occur within two to three years.). There is minimal loss of surface paste that poses no FOD hazard.

#### C-3.10.2.2 Medium.

The loss of surface paste that poses some FOD potential, including isolated fragments of loose mortar, exposure of the sides of coarse aggregate (less than one-quarter of the width of coarse aggregate), or evidence of coarse aggregate coming loose from the surface.

#### C-3.10.2.3 High.

High severity is associated with low-durability concrete that will continue to pose a high FOD hazard. Typically, the layer of surface mortar is observable at the perimeter of the scaled area and is likely to continue to scale due to environmental or other factors. Indication of high-severity FOD is that routine sweeping is not sufficient to avoid FOD issues.

### C-3.10.3 How to Count.

If two or more levels of severity exist on a slab, the slab is counted as one slab having the maximum level of severity. If “D” cracking or ASR is counted, scaling is not counted.

**Figure C-11 Map Cracking, Crazing, Scaling Severity Levels**


**Low** **Medium** **High**

## C-3.11 Settlement or Faulting (Distress #71).

### C-3.11.1 Description.

Settlement or faulting is a difference of elevation at a joint or crack caused by upheaval or consolidation.

### C-3.11.2 Severity Levels.

Severity levels are defined by the difference in elevation across the fault and the associated decrease in ride quality and safety as severity increases.

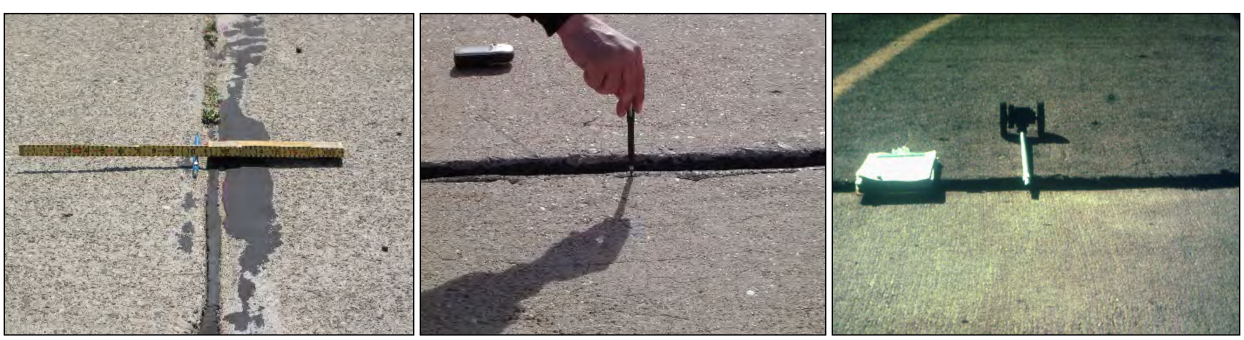
**Table C-1 Difference in Elevation**

| Severity | Runways & Taxiways | Aprons |
|---|---|---|
| Low | < 0.25 in.<br>(< 6 mm) | 0.125 to 0.5 in.<br>(3 to 13 mm) |
| Medium | 0.25 to 0.5 in.<br>(6 to 13 mm) | 0.5 to 1 in.<br>(13 to 25 mm) |
| High | > 0.5 in.<br>(> 13 mm) | > 1 in.<br>(> 25 mm) |

### C-3.11.3 How to Count.

In counting settlement, a fault between two slabs is counted as one slab. Use a straightedge or level to measure the difference in elevation between the two slabs. Construction-induced elevation differential is not rated in PCI procedures. Where construction differential exists, it can often be identified by the way the high side of the joint was rolled down by finishers (usually within 6 inches [150 mm] of the joint) to meet the low-slab elevation.

**Figure C-12 Settlement or Faulting Severity Levels**



**Low** **Medium** **High**

### C-3.12 Shattered Slab/Intersecting Cracks (Distress #72).

#### C-3.12.1 Description.

Intersecting cracks are cracks that break into four or more pieces because of overloading and/or inadequate support. The high-severity level of this distress type, as defined below, is referred to as a shattered slab. If all pieces or cracks are contained within a corner break, the distress is categorized as a severe corner break.

#### C-3.12.2 Severity Levels.

##### C-3.12.2.1 Low.

The slab is broken into four or five pieces predominantly defined by low-severity cracks.

##### C-3.12.2.2 Medium.

(1) The slab is broken into four or five pieces with over 15% of the cracks of medium severity (no high-severity cracks); or (2) slab is broken into six or more pieces with over 85% of the cracks of low severity.

##### C-3.12.2.3 High.

At this level of severity, the slab is called shattered: (1) slab is broken into four or five pieces with some or all of the cracks of high severity; (2) slab is broken into six or more pieces with over 15% of the cracks of medium or high severity.

#### C-3.12.3 How to Count.

No other distress such as scaling, spalling, or durability record cracking if the slab is medium or high severity level since the severity of this distress substantially affects the slab's rating. Do not count shrinkage cracks to determine whether or not the slab is broken into four or more pieces.

**Figure C-13 Shattered Slab/Intersecting Cracks Severity Levels**

**Low** **Medium** **High**

### C-3.13 Shrinkage Cracks (Distress #73).

#### C-3.13.1 Description.

Shrinkage cracks are hairline cracks that are usually only a few feet long and do not extend across the entire slab. They are formed during the setting and curing of the concrete and usually do not extend through the depth of the slab.

#### C-3.13.2 Severity Levels.

No degrees of severity are defined. It is sufficient to indicate that shrinkage cracks exist.

#### C-3.13.3 How to Count.

If one or more shrinkage cracks exist on one particular slab, the slab is counted as one slab with shrinkage cracks.

**Figure C-14 Shrinkage Cracks**

### C-3.14 Spalling (Transverse and Longitudinal Joints) (Distress #74).

#### C-3.14.1 Description.

Joint spalling is the breakdown of the slab edges within 2 feet (600 mm) of the side of the joint. A joint spall usually does not extend vertically through the slab but intersects the joint at an angle. Spalling results from excessive stresses at the joint or crack caused by infiltration of incompressible materials or traffic loads. Weak concrete at the joint (caused by overworking) combined with traffic loads also causes spalling. Frayed condition as used in this test method indicates material is no longer in place along a joint or crack. Spalling indicates material may or may not be missing along a joint or crack.

#### C-3.14.2 Severity Levels.

Severity levels are set out in Table C-2.

**Table C-2 Spalling Severity Levels**

| | Spall Length | Description |
|---|---|---|
| Low | < 2 feet (600 mm) | Spall is broken into pieces or fragmented; little FOD or tire damage potential exists |
| | > 2 feet (600 mm) | (a) Spall is broken into no more than three pieces defined by low- or medium-severity cracks; little or no FOD potential exists; or (b) joint is lightly frayed; little or no FOD potential exists |
| Medium | < 2 feet (600 mm) | Spall is broken into pieces or fragmented, with some of the pieces loose or absent, causing considerable FOD or tire damage potential |
| | > 2 feet (600 mm) | (a) Spall is broken into more than three pieces defined by light or medium cracks; (b) spall is broken into no more than three pieces with one or more of the cracks being severe, with some FOD potential existing; or (c) joint is moderately frayed, with some FOD potential |
| High | > 2 feet (600 mm) | (1) Spall is broken into more than three pieces defined by one or more high-severity cracks with high FOD potential; or (2) joint is severely frayed, with high FOD potential |

#### C-3.14.3 How to Count.

If the joint spall is located along the edge of one slab, it is counted as one slab with joint spalling. If spalling is located on more than one edge of the same slab, the edge having the highest severity is counted and recorded as one slab. Joint spalling can also occur along the edges of two adjacent slabs. If this is the case, each slab is counted as having joint spalling. Do not record a joint spall if the joint spall is small enough to be filled during a joint seal repair.

**Figure C-15 Spalling (Transverse and Longitudinal Joints) Severity Levels**

Low Medium High

### C-3.15 Spalling (Corner) (Distress #75).

#### C-3.15.1 Description.

Corner spalling is the raveling or breakdown of the slab within approximately 2 feet (600 mm) of the corner. A corner spall differs from the corner break in that the spall angles downward to intersect the joint, while a break extends vertically through the slab.

#### C-3.15.2 Severity Levels.

##### C-3.15.2.1 Low.

One of the following conditions exists: (1) spall is broken into one or two pieces defined by low-severity cracks (little or no FOD potential); (2) spall is defined by one medium-severity crack (little or no FOD potential).

##### C-3.15.2.2 Medium.

One of the following conditions exists: (1) spall is broken into two or more pieces defined by medium-severity crack(s) and a few small fragments may be absent or loose; (2) spall is defined by one severe, fragmented crack that may be accompanied by a few hairline cracks; or (3) spall has deteriorated to the point where loose material is causing some FOD potential.

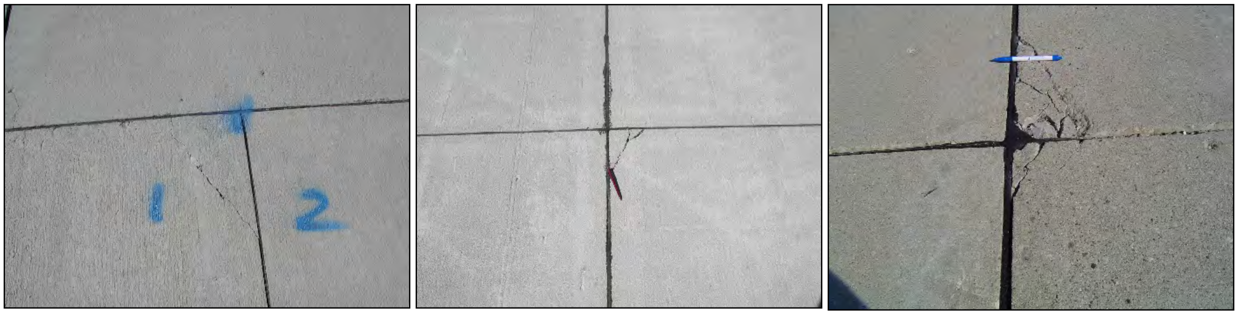
##### C-3.15.2.3 High.

One of the following conditions exists: (1) spall is broken into two or more pieces defined by high-severity fragmented crack(s), with loose or absent fragments; (2) pieces of the spall have been displaced to the extent that a tire damage hazard exists; or (3) spall has deteriorated to the point where loose material is causing high FOD potential.

#### C-3.15.3 How to Count.

If one or more corner spalls having the same severity level are located in a slab, the slab is counted as one slab with corner spalling. If more than one severity level occurs, it is counted as one slab having the higher severity level. A corner spall smaller than 3 inches (76 mm) wide, measured from the edge of the slab and filled with sealant, is not recorded.

**Figure C-16 Spalling (Corner) Severity Levels**



**Low** **Medium** **High**

### C-3.16 Alkali-Silica Reaction (ASR) (Distress #76).

### C-3.16.1 Description.

ASR is caused by chemical reaction between alkalis and certain reactive silica minerals, which forms a gel. The gel absorbs water, causing expansion, which may damage the concrete and adjacent structures. Alkalis are most often introduced by the portland cement within the pavement. ASR cracking may be accelerated by chemical pavement deicers.

**C-3.16.1.1** Visual indicators that ASR may be present include: (1) cracking of the concrete pavement (often in a map pattern); (2) white, brown, gray or other colored gel or staining may be present at the crack surface; (3) aggregate popouts; and/or (4) increase in concrete volume (expansion) that may result in distortion of adjacent or integral structures or physical elements. Examples of expansion include shoving of asphalt pavements, light can tilting, slab faulting, joint misalignment, and extrusion of joint seals or expansion joint fillers.

**C-3.16.1.2** Because ASR is material-dependent, ASR is generally present throughout the pavement section. Coring and concrete petrographic analysis is the only definitive method to confirm the presence of ASR. Keep the following in mind when identifying the presence of ASR through visual inspection:

**C-3.16.1.2.1** Generally, ASR distresses are not observed in the first few years after construction. In contrast, plastic shrinkage cracking can occur the day of construction and is apparent within the first year.

**C-3.16.1.2.2** ASR is differentiated from D-cracking by the presence of cracking perpendicular to the joint face. D-cracking predominantly develops as a series of parallel cracks to joint faces and linear cracking within the slab.

**C-3.16.1.2.3** ASR is differentiated from map cracking/scaling by the presence of visual signs of expansion.

### C-3.16.2 Severity Levels.

#### C-3.16.2.1 Low.

Minimal to no FOD potential from cracks, joints, or ASR-related popouts; cracks at the surface are tight (predominantly 0.04 inch [1 mm] or less). Little to no evidence of movement in pavement or surrounding structures or elements.

#### C-3.16.2.2 Medium.

Some FOD potential; increased sweeping or other FOD removal methods may be required. There may be evidence of slab movement and/or some damage to adjacent structures or elements. Medium ASR distress is differentiated from low by having one or more of the following: increased FOD potential, increased cracking of the slab, some fragments along cracks or at crack intersections present, surface popouts of concrete may occur, pattern of wider cracks (predominantly 0.04 inch [1 mm] or wider) that may be subdivided by tighter cracks.

#### C-3.16.2.3 High.

One or both of the following exist: 1) loose or missing concrete fragments that pose high FOD potential; 2) slab surface integrity and function significantly degraded and pavement requires immediate repair; may also require repairs to adjacent structures or elements.

### C-3.16.3 How to Count.

Do not record other distresses if high-severity ASR is recorded.

**Figure C-17 Alkali-Silica Reaction (ASR) Severity Levels**

**Low** **Medium** **High**

**Table C-3 Frequently Occurring Problems in Rigid Pavement Distress Identification.**

| Situation | Action | Remarks |
|---|---|---|
| Low-severity scaling (i.e., crazing) | Count only if possible future scaling will occur within 2 to 3 years | |
| Joint seal damage | This is not counted on a slab-by-slab basis | A severity level based on the overall condition of the joint seal in the sample unit is assigned |
| Joint spall small enough to be filled during a joint seal repair | Do not record | |
| Medium- or high-severity intersecting crack (shattered slab) | Do not count other distress | |
| Corner or joint spalling caused by “D” cracking | Record only “D” cracking | If spalls are caused by factors other than “D” cracking, record each factor separately |
| Crack repaired by a narrow patch (e.g., 4 to 10 in. [100 to 250 mm] wide) | Record only crack and not patch at appropriate severity level | |
| Original distress of patch more severe than patch itself | Record original distress type | If, for example, patch material is present on scaled area of slab, only the scaling is counted |
| Hairline cracks that are only a few feet long and do not extend across the entire slab | Rated as shrinkage cracks | |

## C-4 DISTRESS DEDUCT VALUE CHARTS.

**Figure C-18 Deduct Values for Distress #61, Blowup**

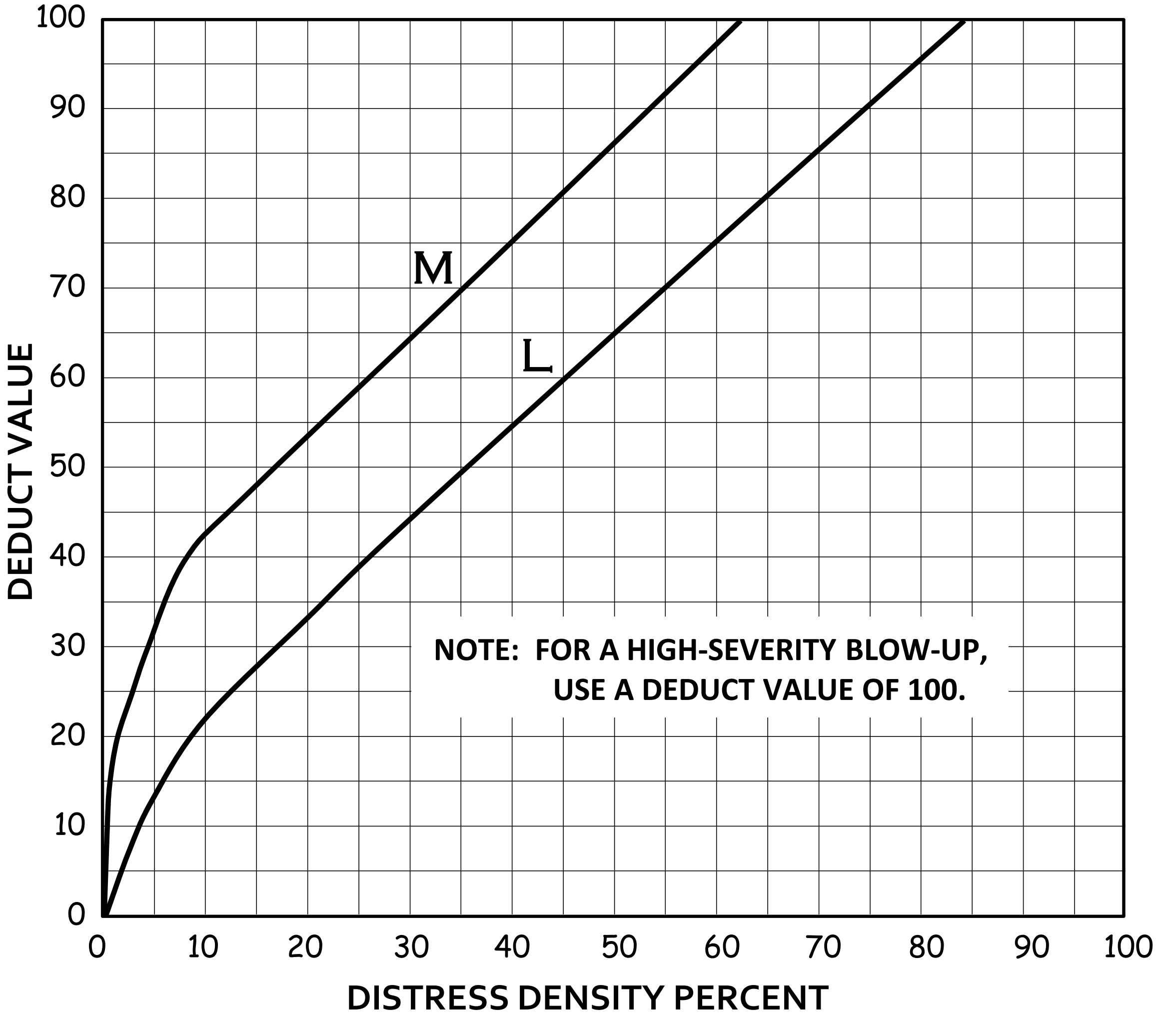


**Figure C-19 Deduct Values for Distress #62, Corner Break**

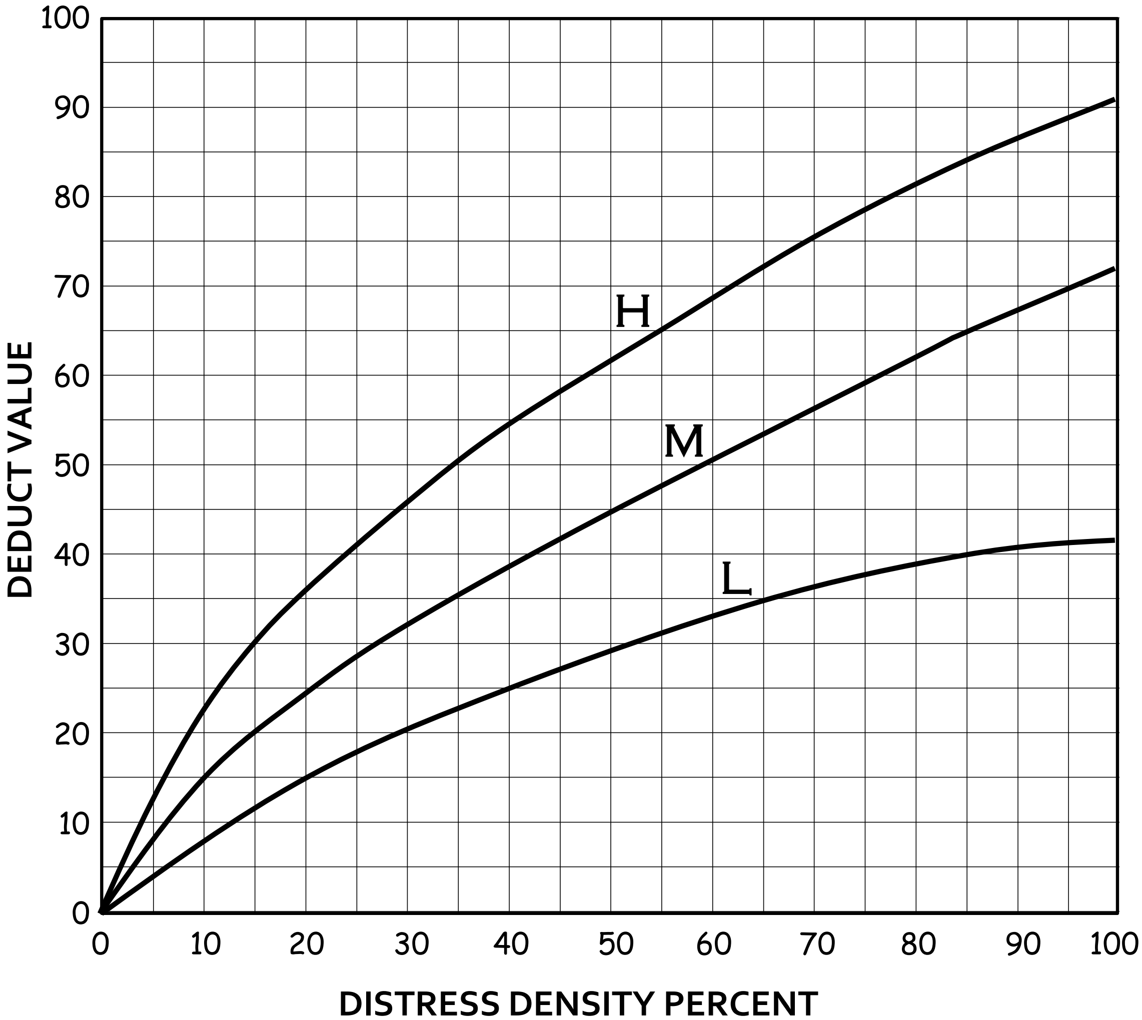


**Figure C-20 Deduct Values for Distress #63, Long./Trans./Diag. Cracks**

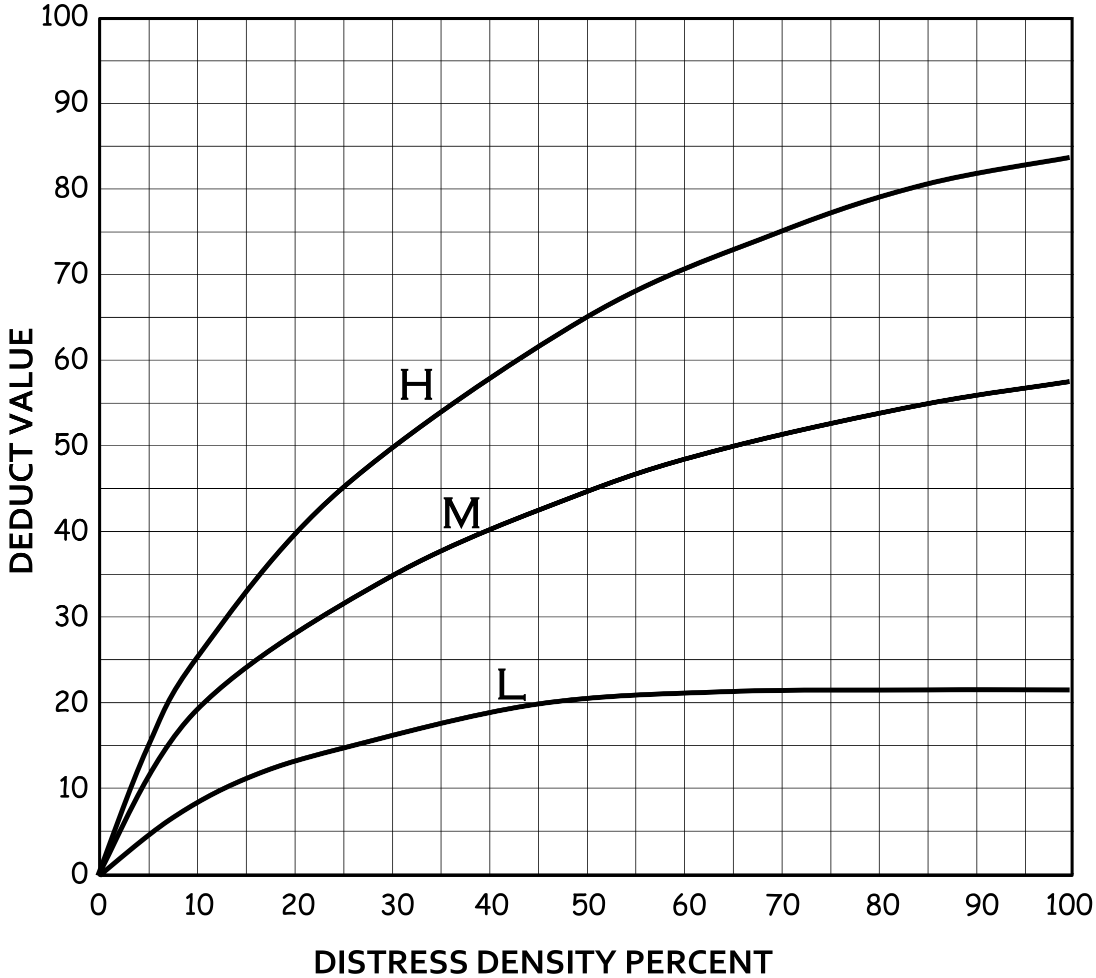


**Figure C-21 Deduct Values for Distress #64, Durability "D" Cracking**

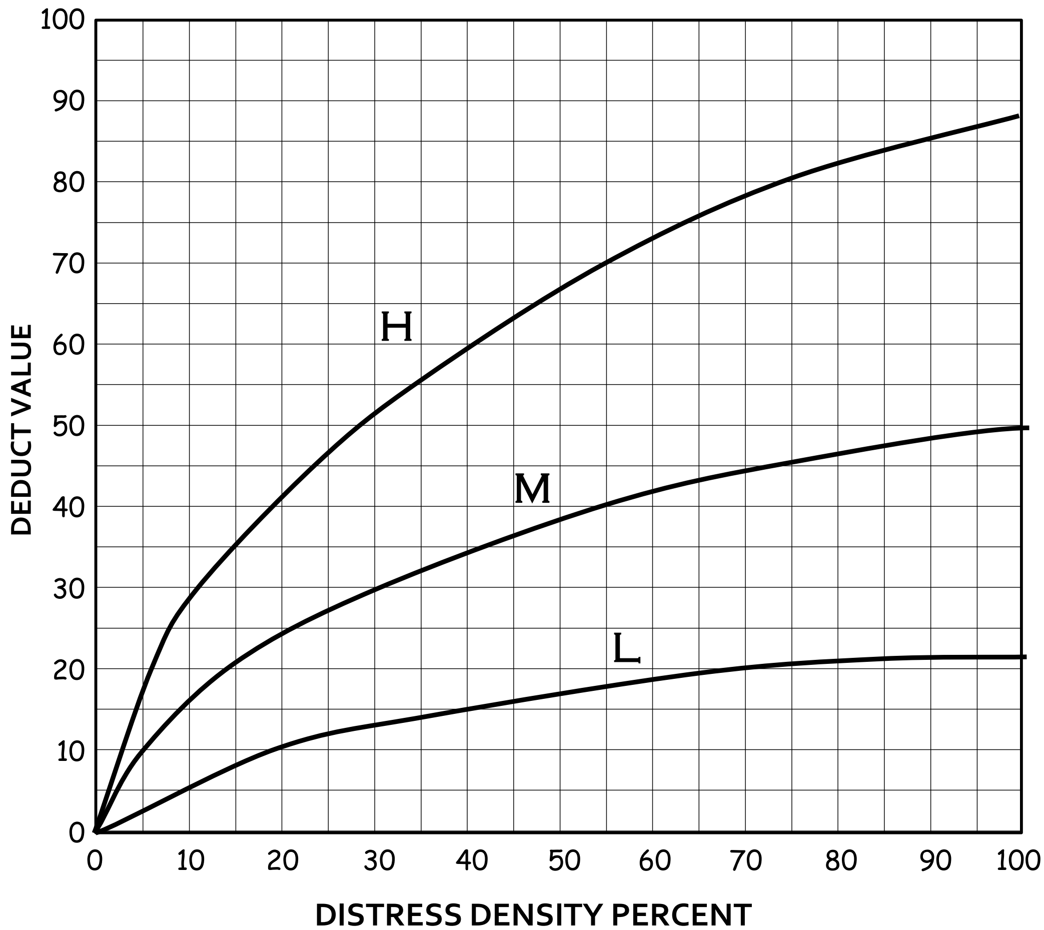



**Figure C-22 Deduct Values for Distress #65, Joint Seal Damage**

Joint seal damage is not rated by density. The severity of the distress is determined by the sealant's overall condition for a particular section.

The deduct values for the three levels of severity are as follows:

| | |
|---|---|
| 1. High severity | 12 points |
| 2. Medium severity | 7 points |
| 3. Low severity | 2 points |

**Figure C-23 Deduct Values for Distress #66, Patching, Small**

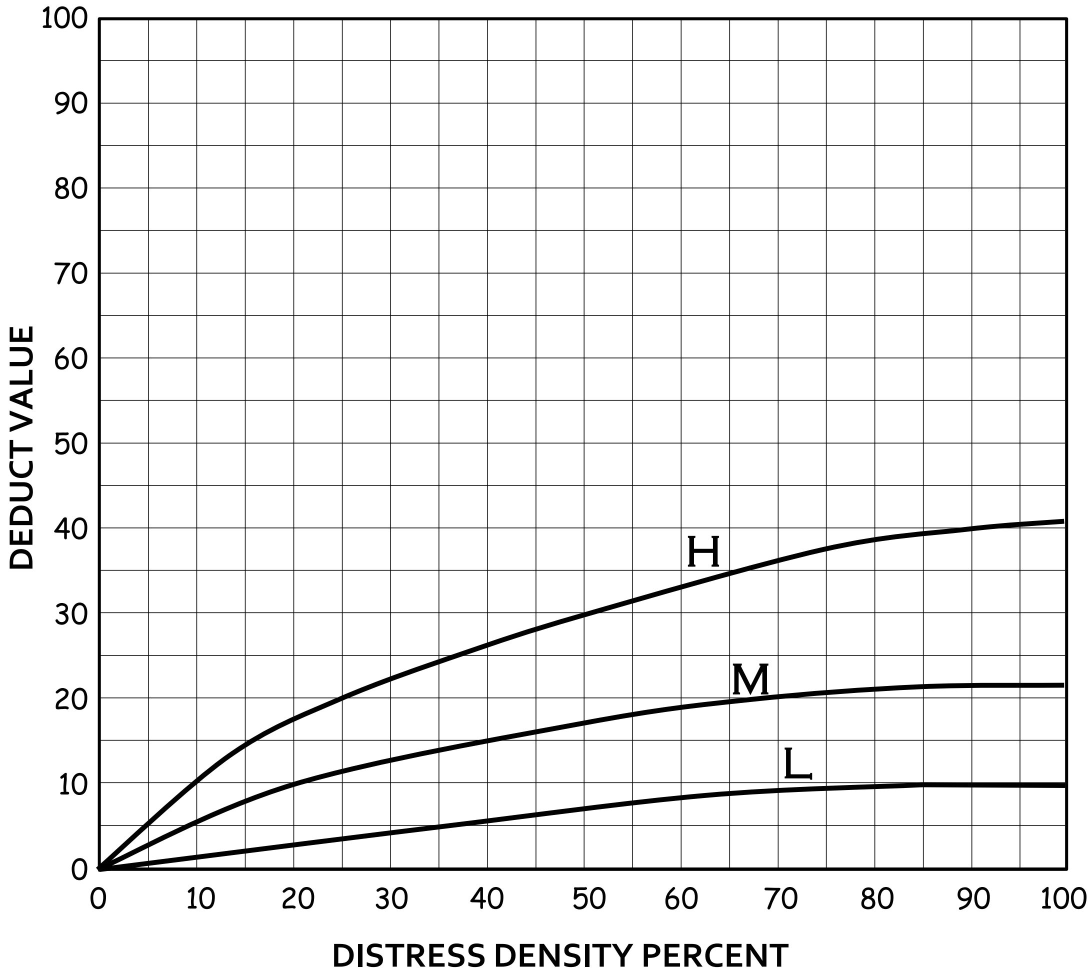


**Figure C-24 Deduct Values for Distress #67, Patching, Large**

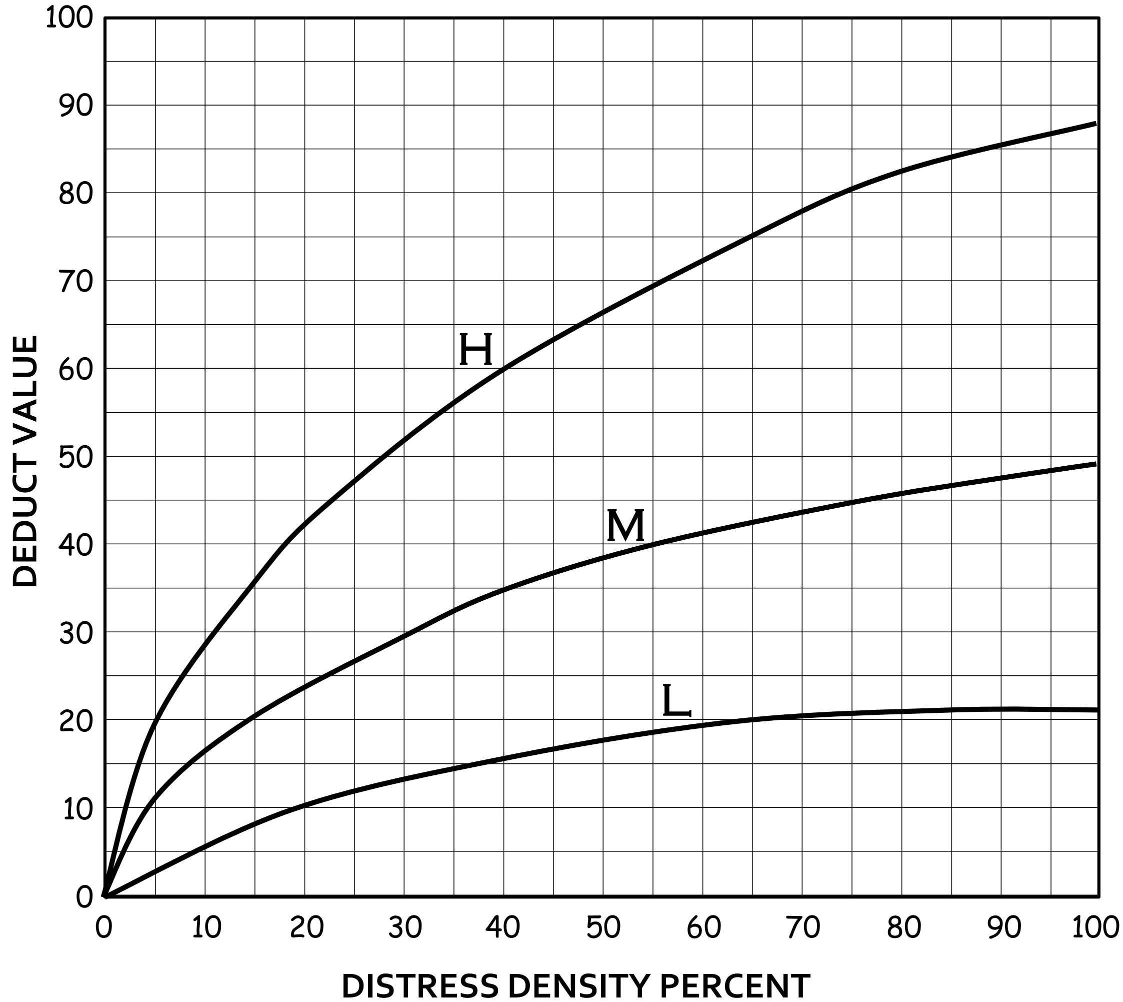


**Figure C-25 Deduct Values for Distress #68, Popouts**

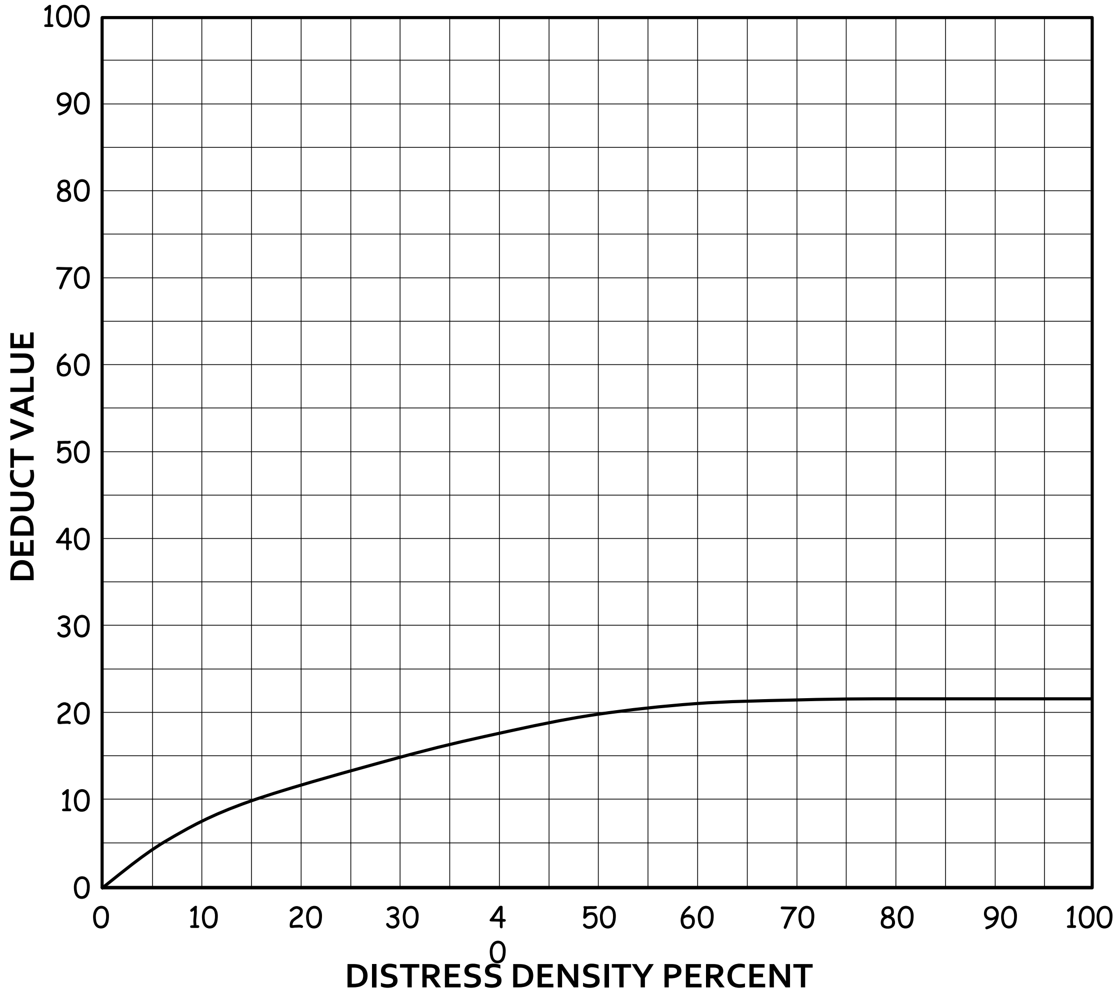


**Figure C-26 Deduct Values for Distress #69, Pumping**

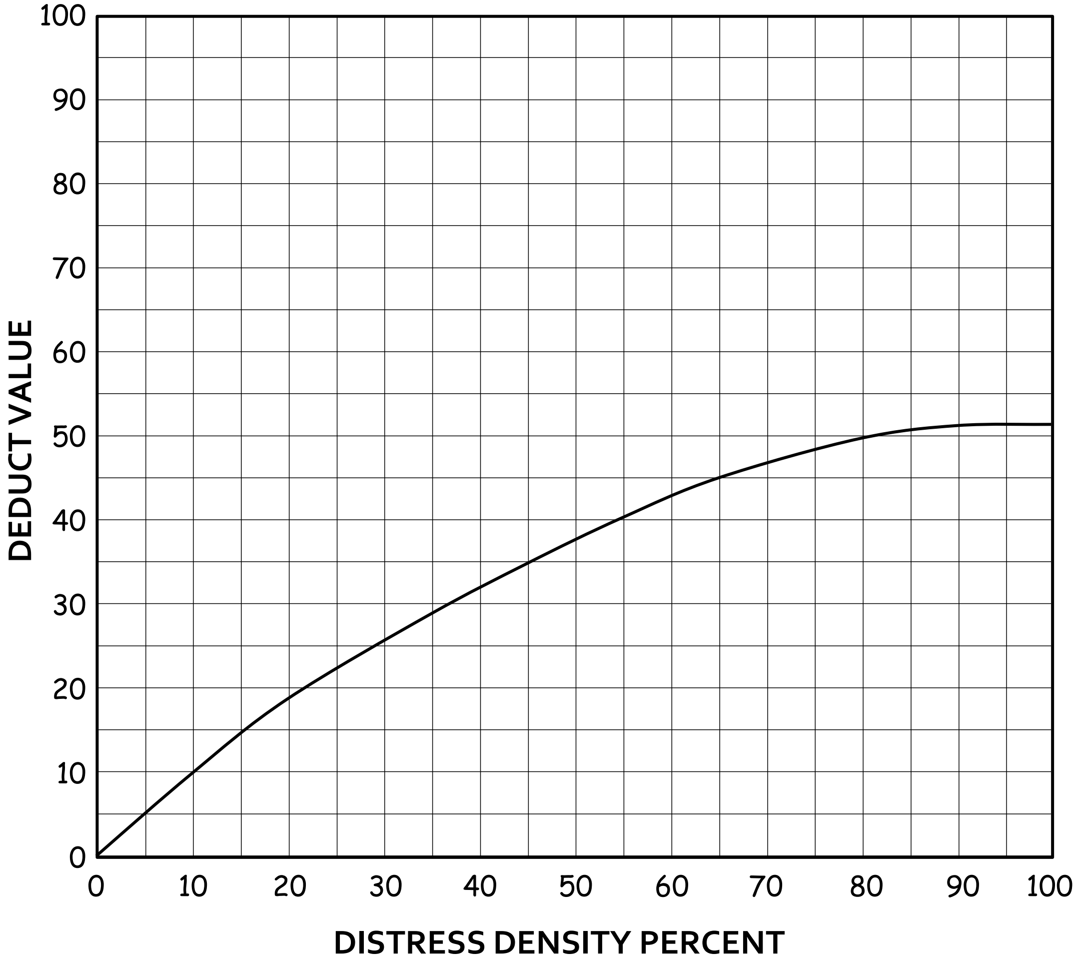


**Figure C-27 Deduct Values for Distress #70, Scaling, Map Cracking, Crazing**

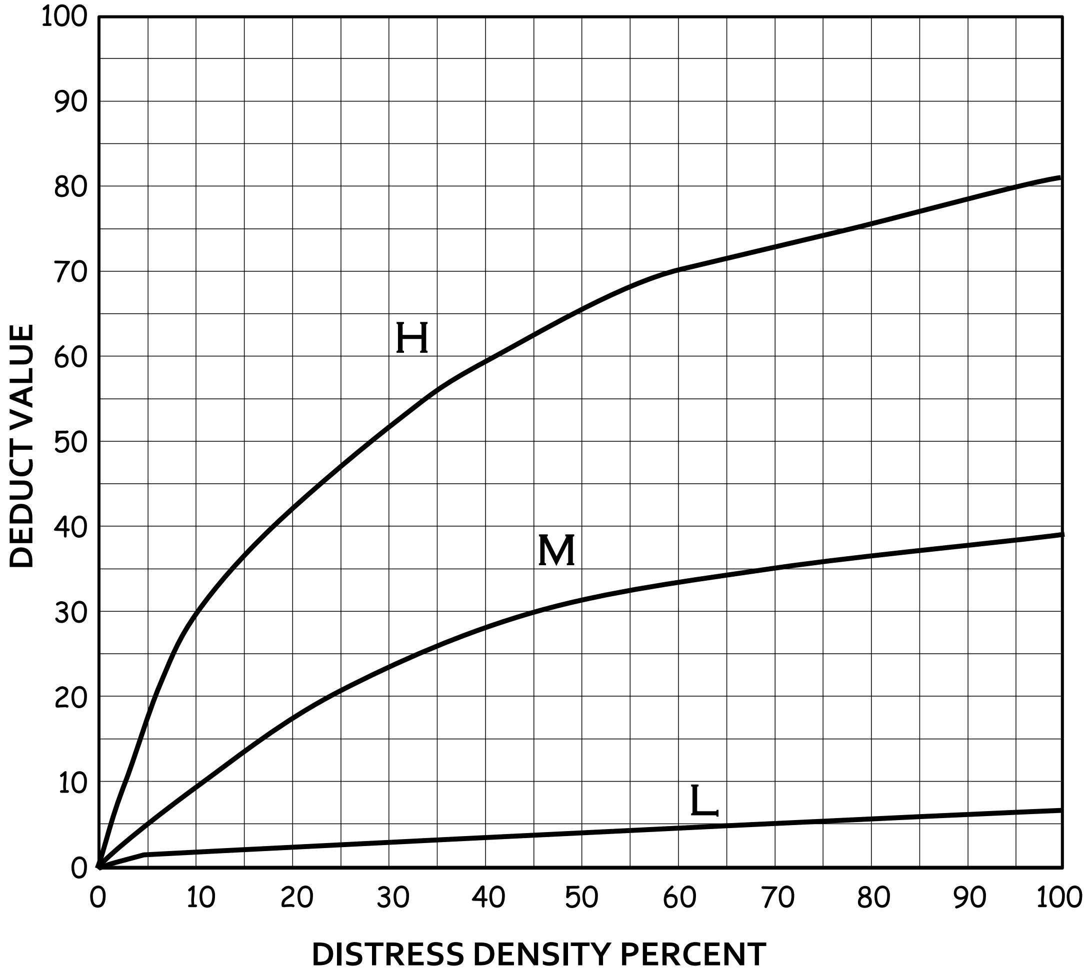


**Figure C-28 Deduct Values for Distress #71, Settlement or Faulting**

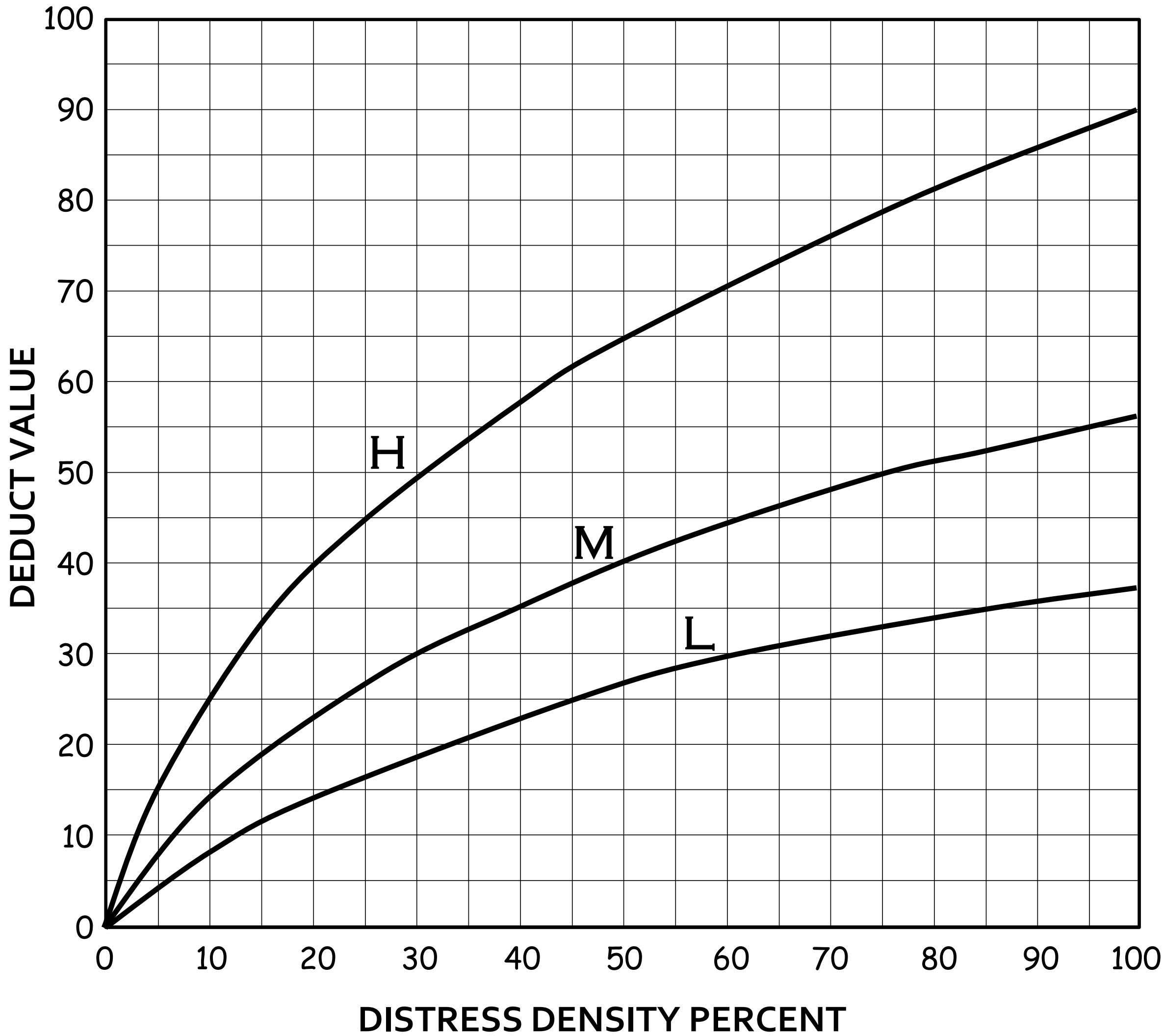


**Figure C-29 Deduct Values for Distress #72, Shattered Slab / Intersecting Cracks**

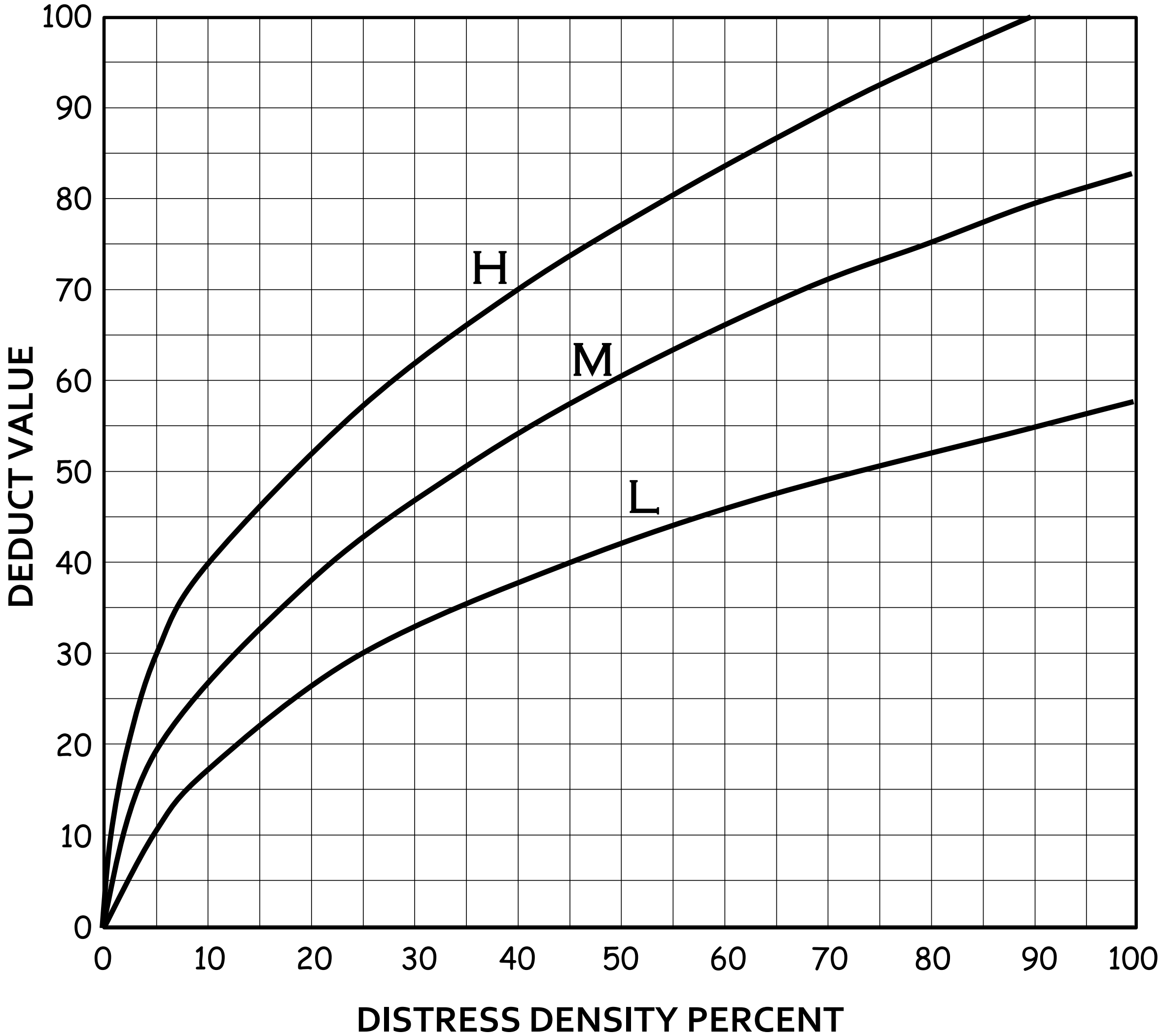


**Figure C-30 Deduct Values for Distress #73, Shrinkage Cracks**

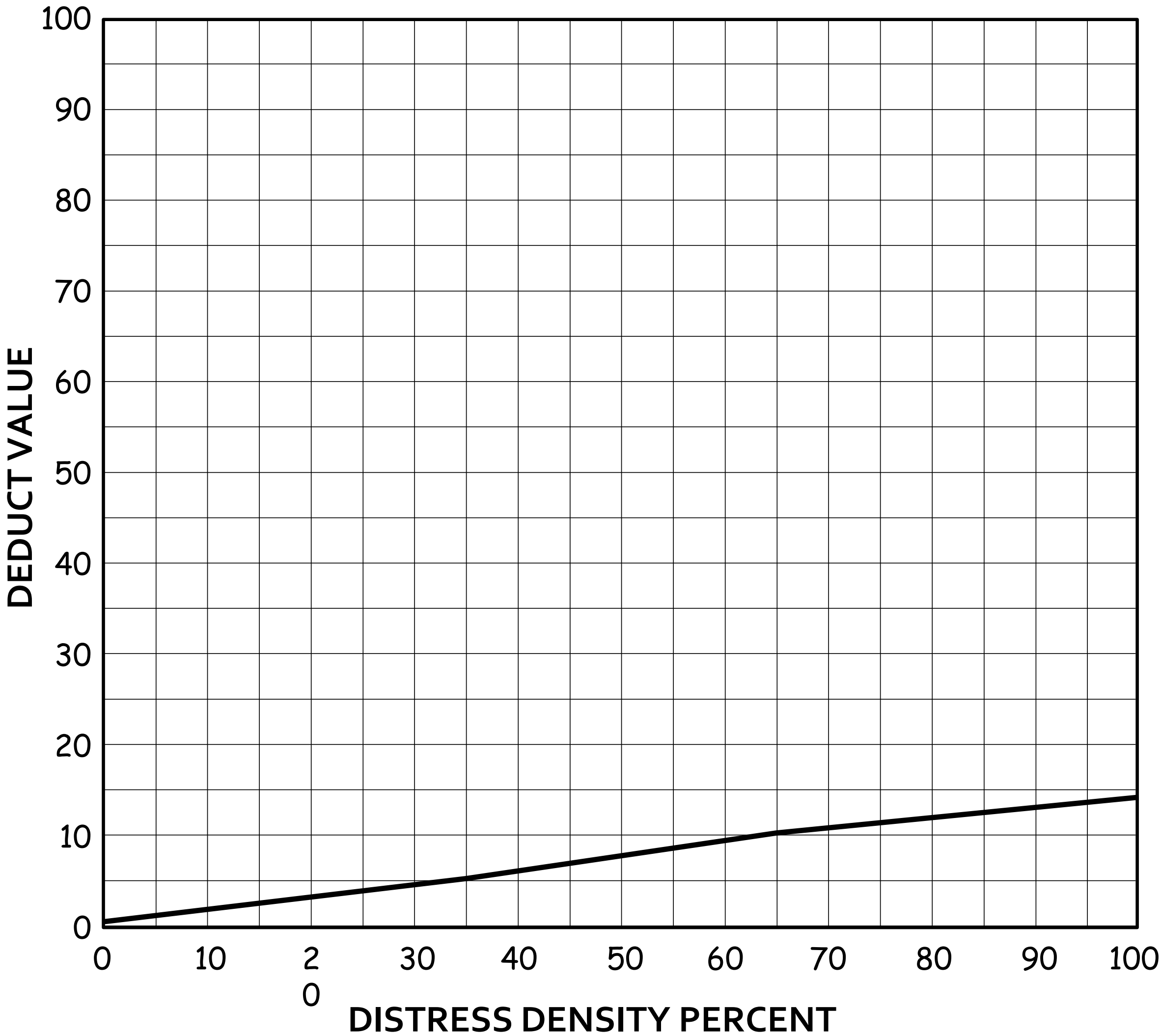


**Figure C-31 Deduct Values for Distress #74, Spalling (Joint)**

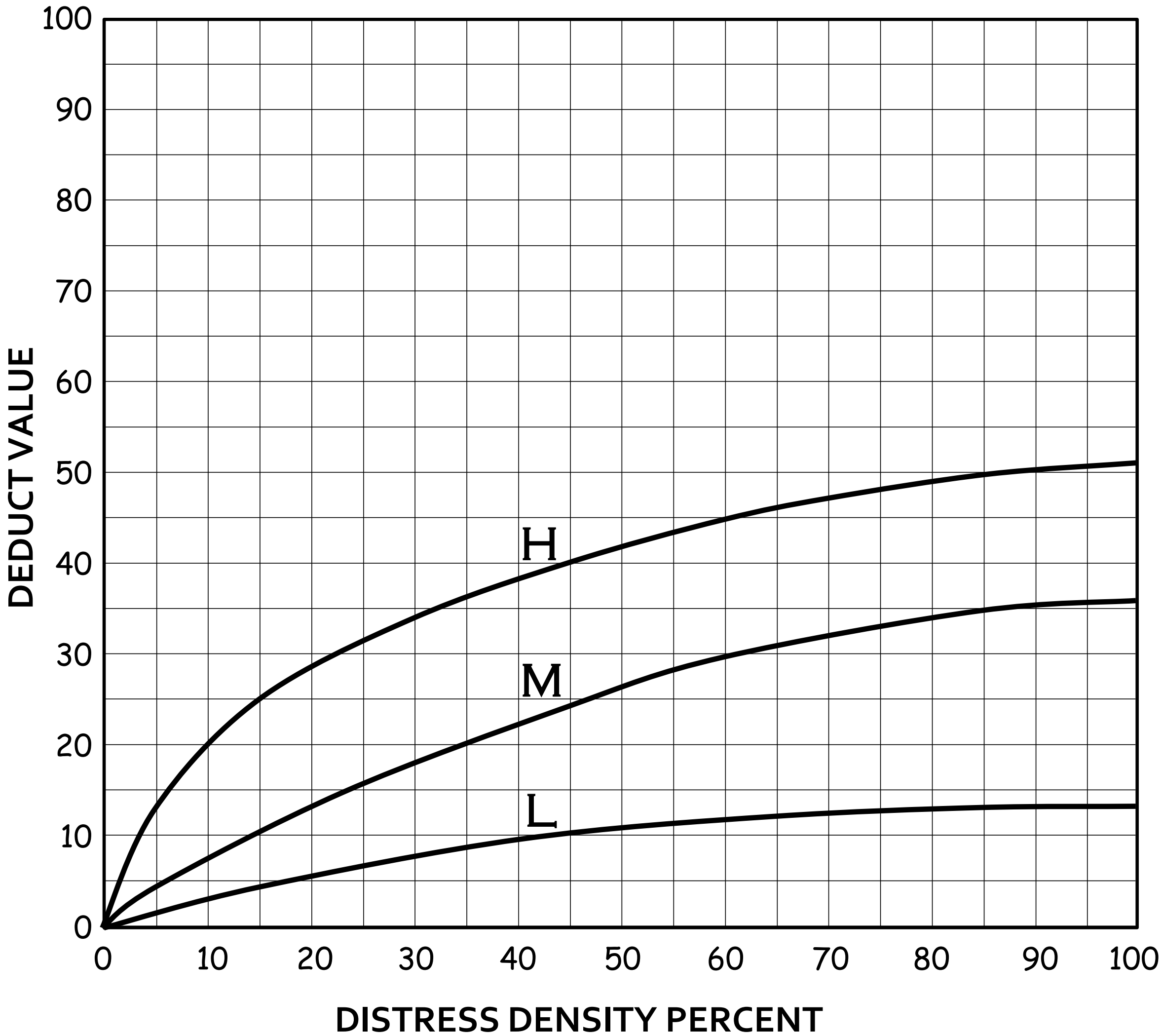


**Figure C-32 Deduct Values for Distress #75, Spalling (Corner)**

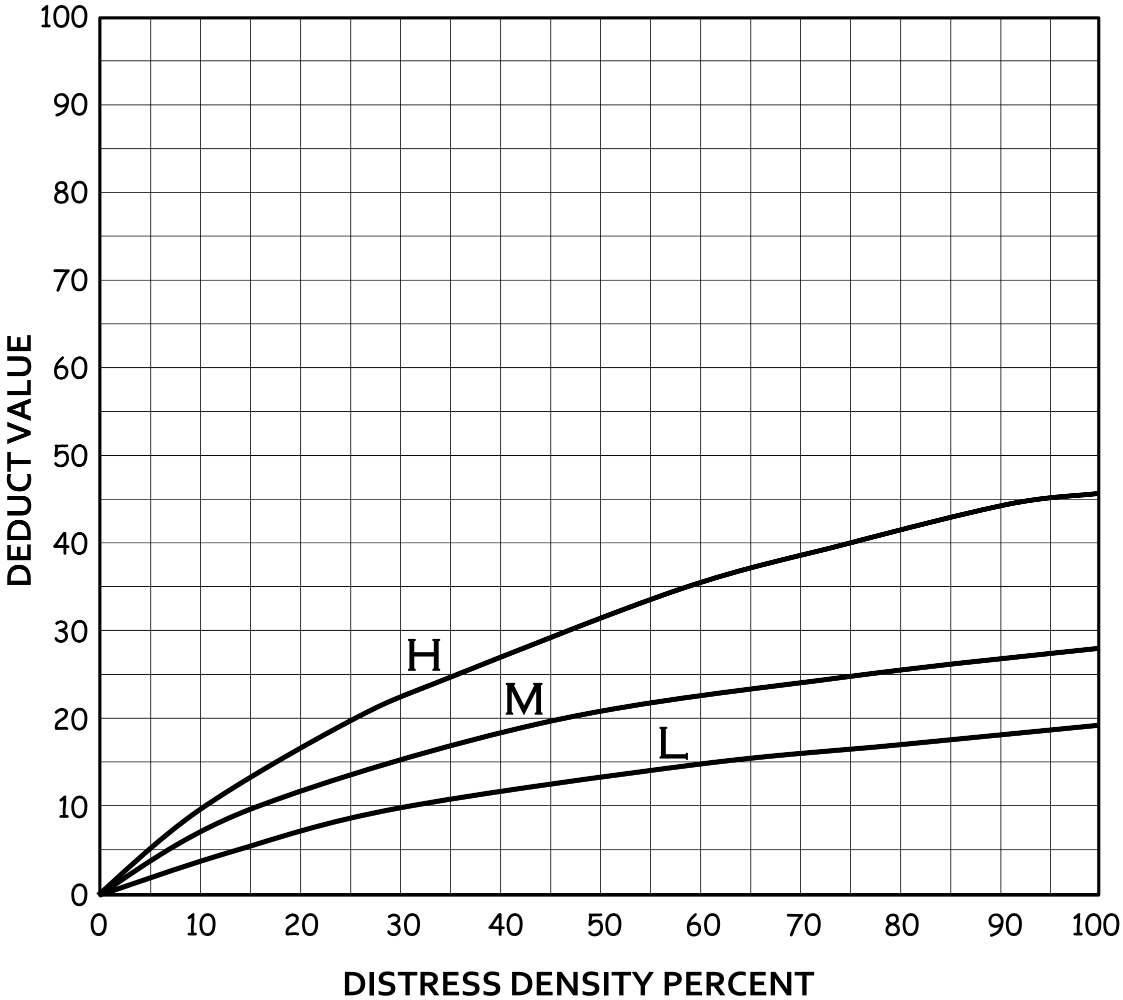
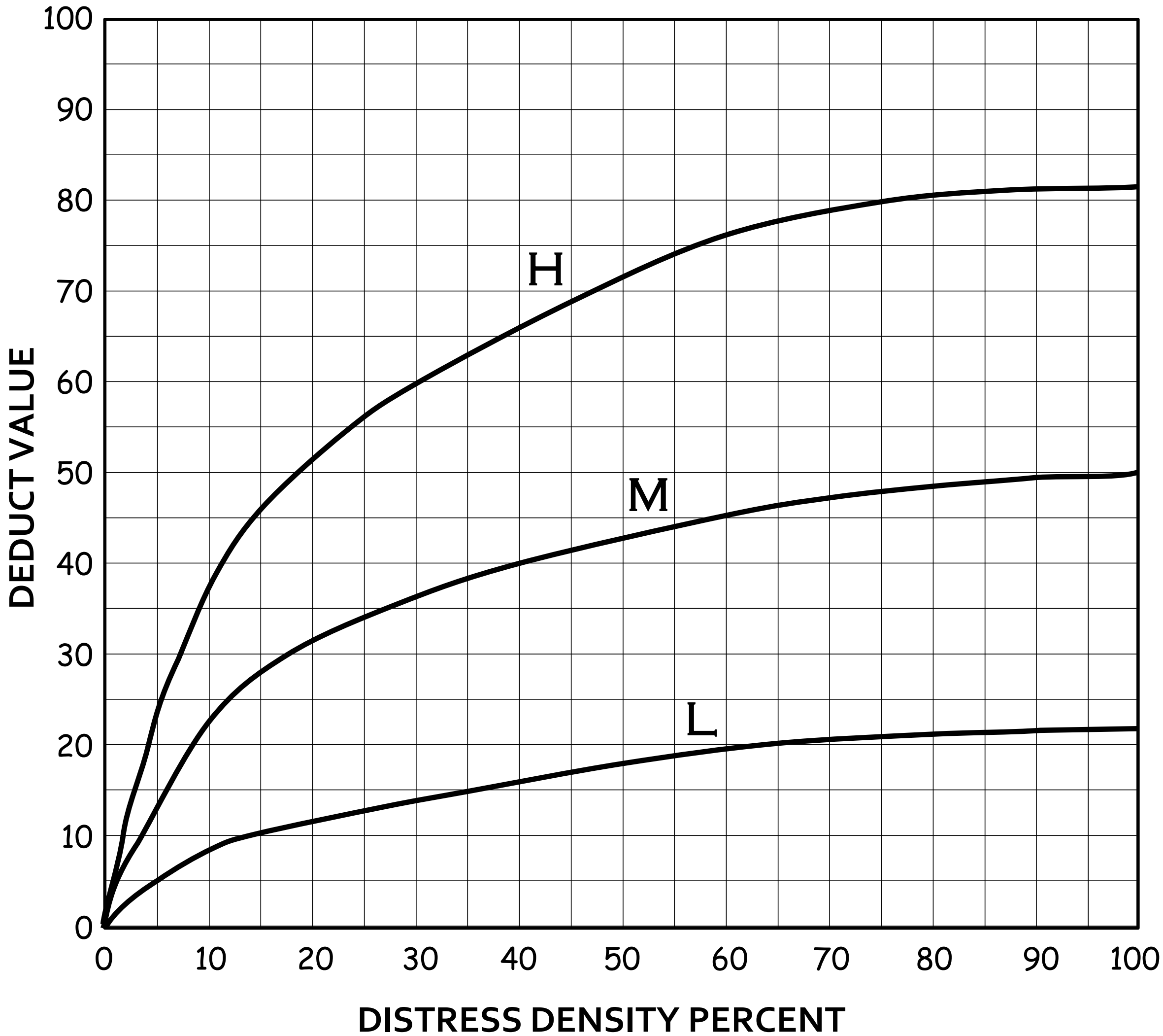
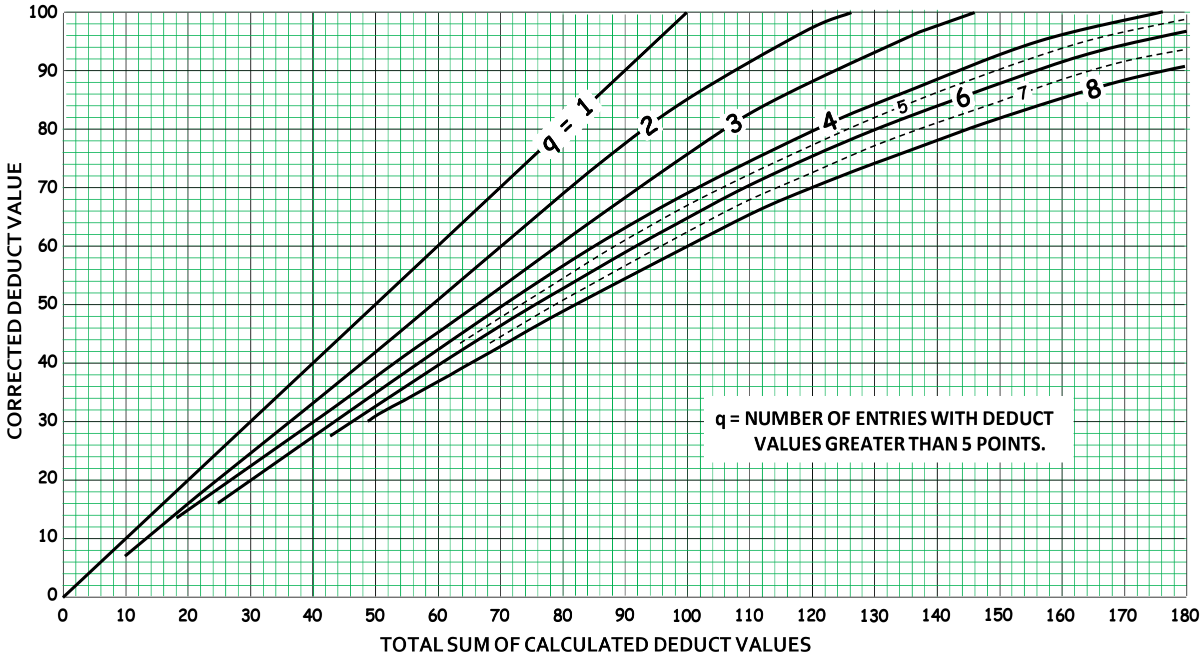


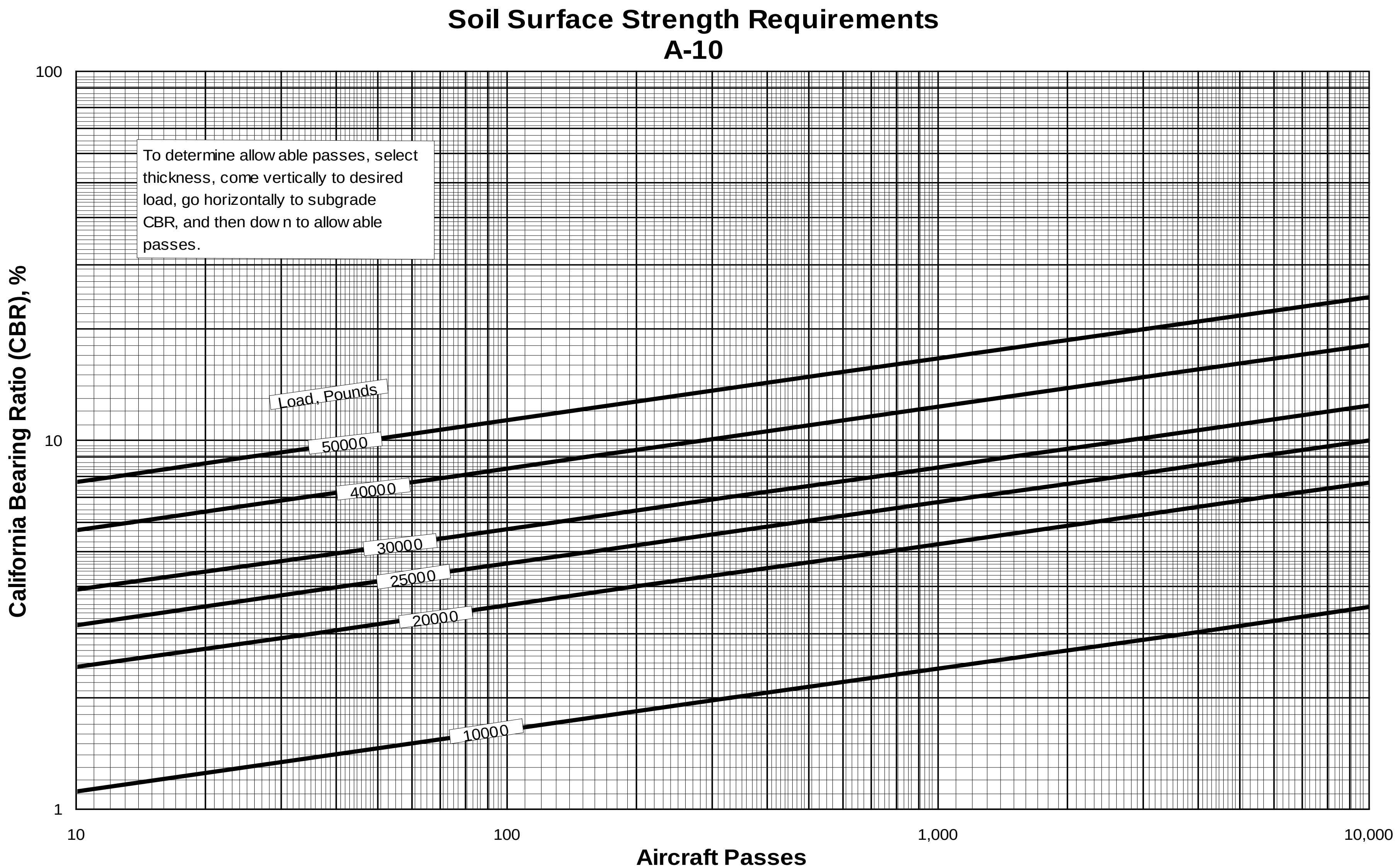
**Figure C-33 Deduct Values for Distress #76, Alkali-Silica Reaction (ASR)**



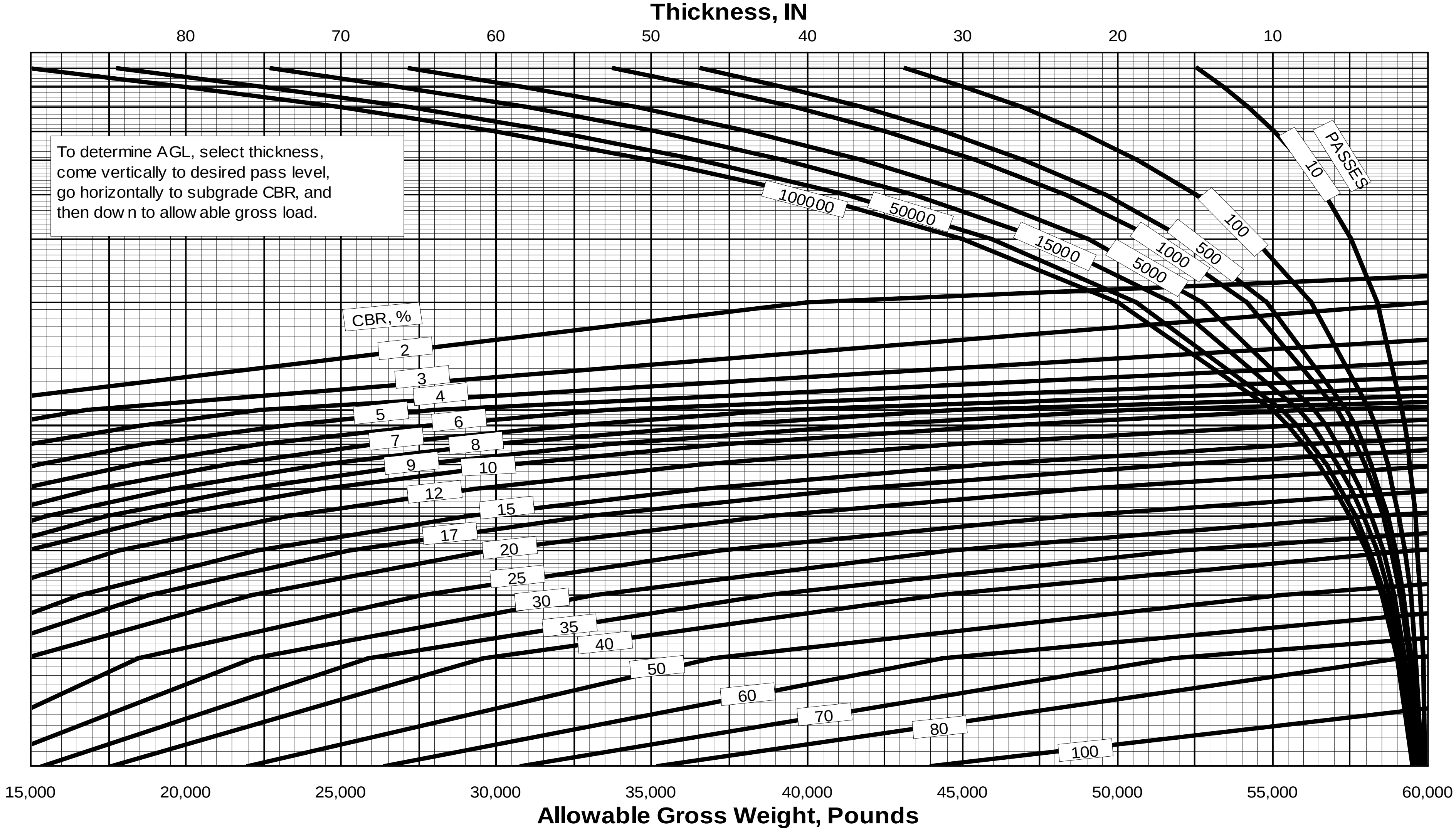
## Figure C-34 Corrected Deduct Values for Rigid (PCC) Pavements



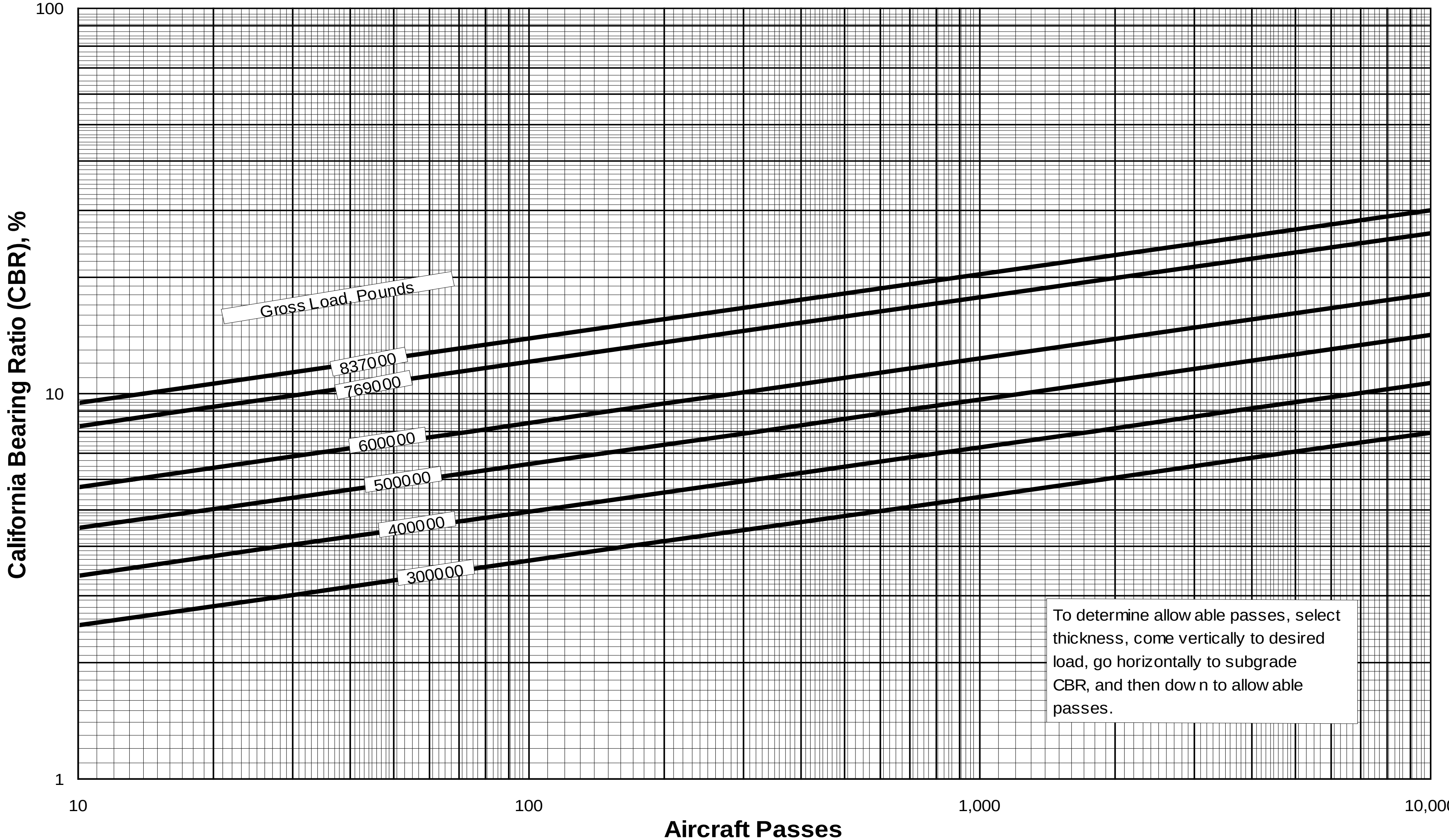
## APPENDIX D UNSURFACED/AGGREGATE SURFACED EVALUATION CURVES



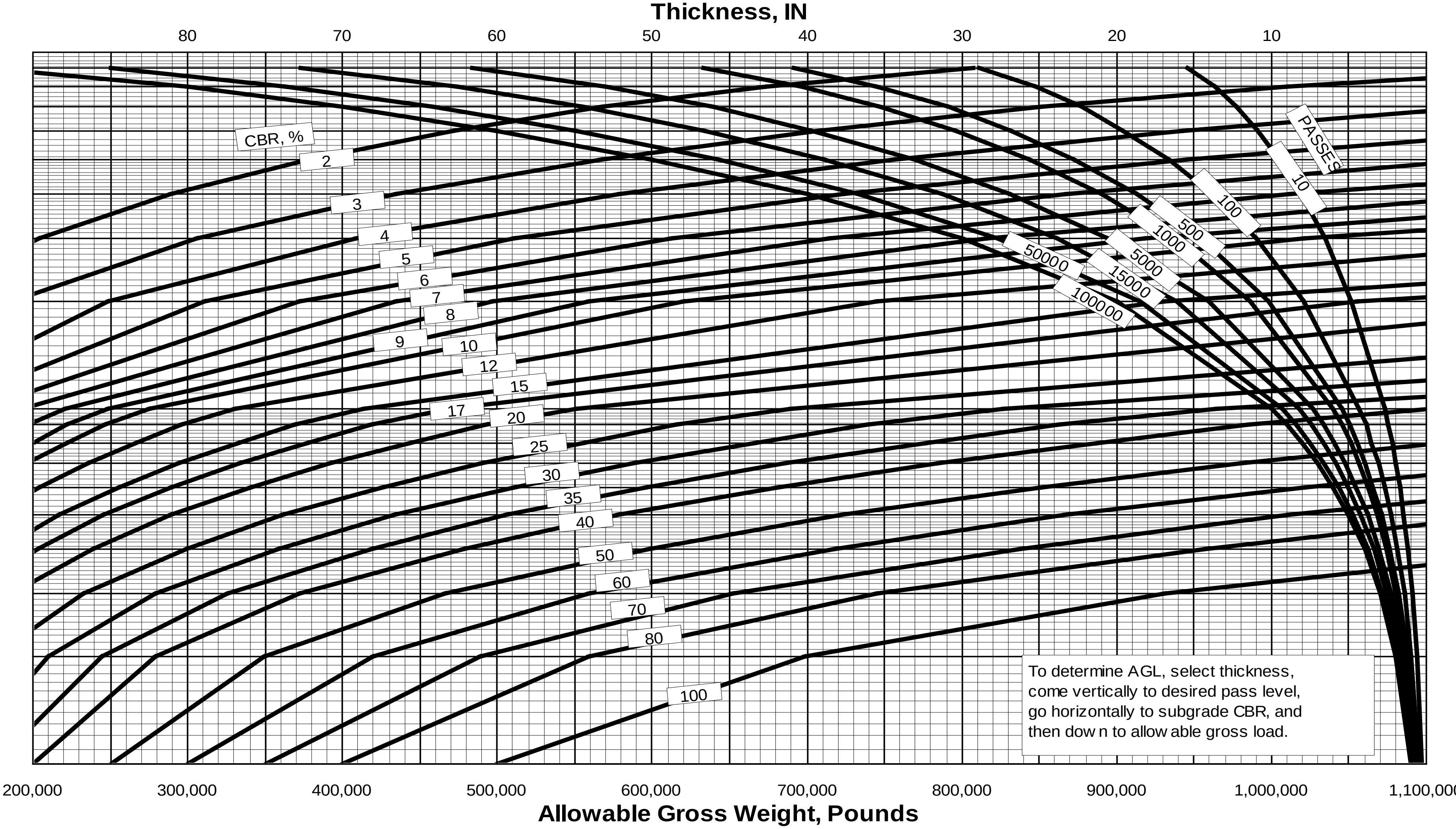
# Aggregate Surfaced Evaluation Allowable Load
## A-10

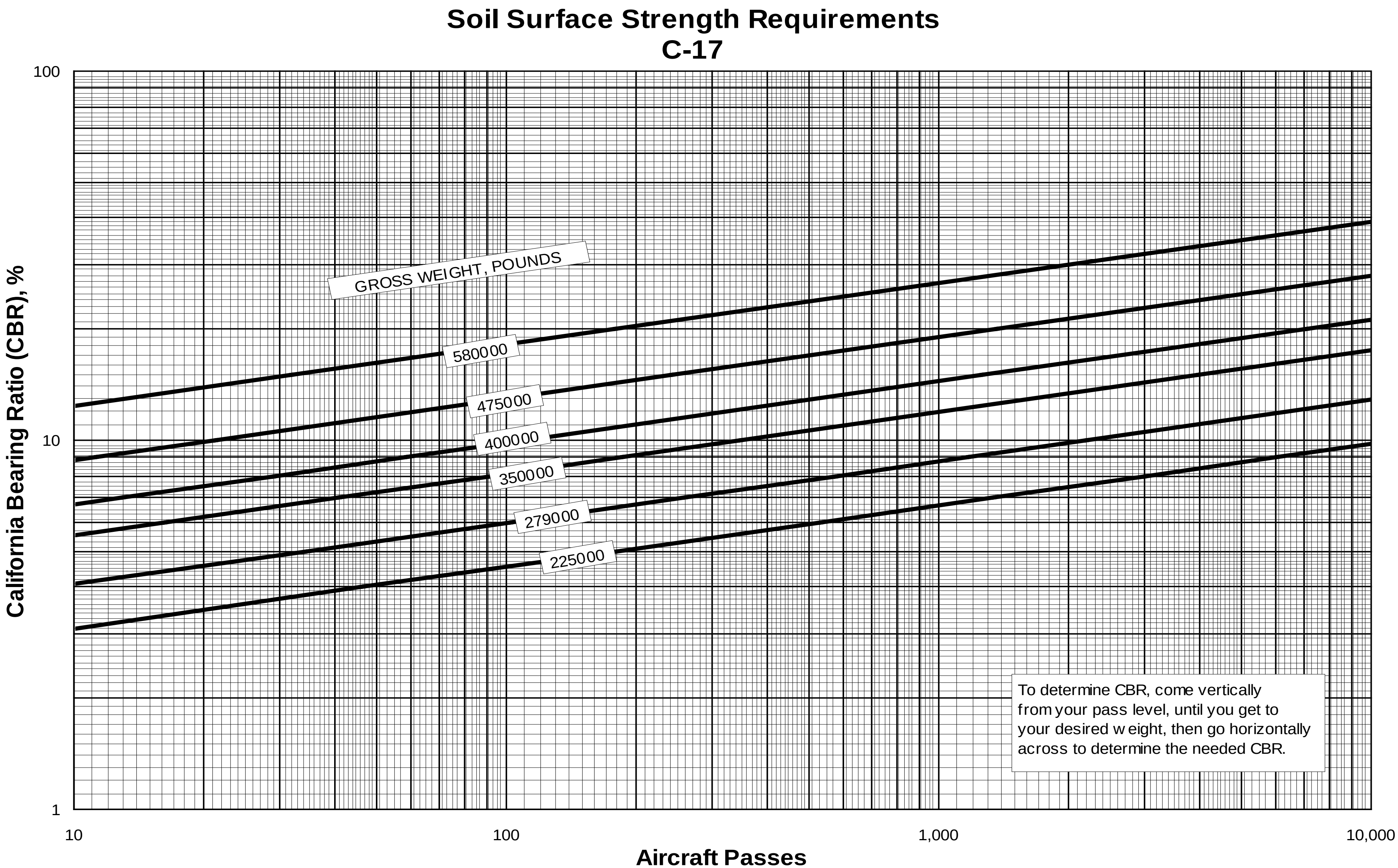


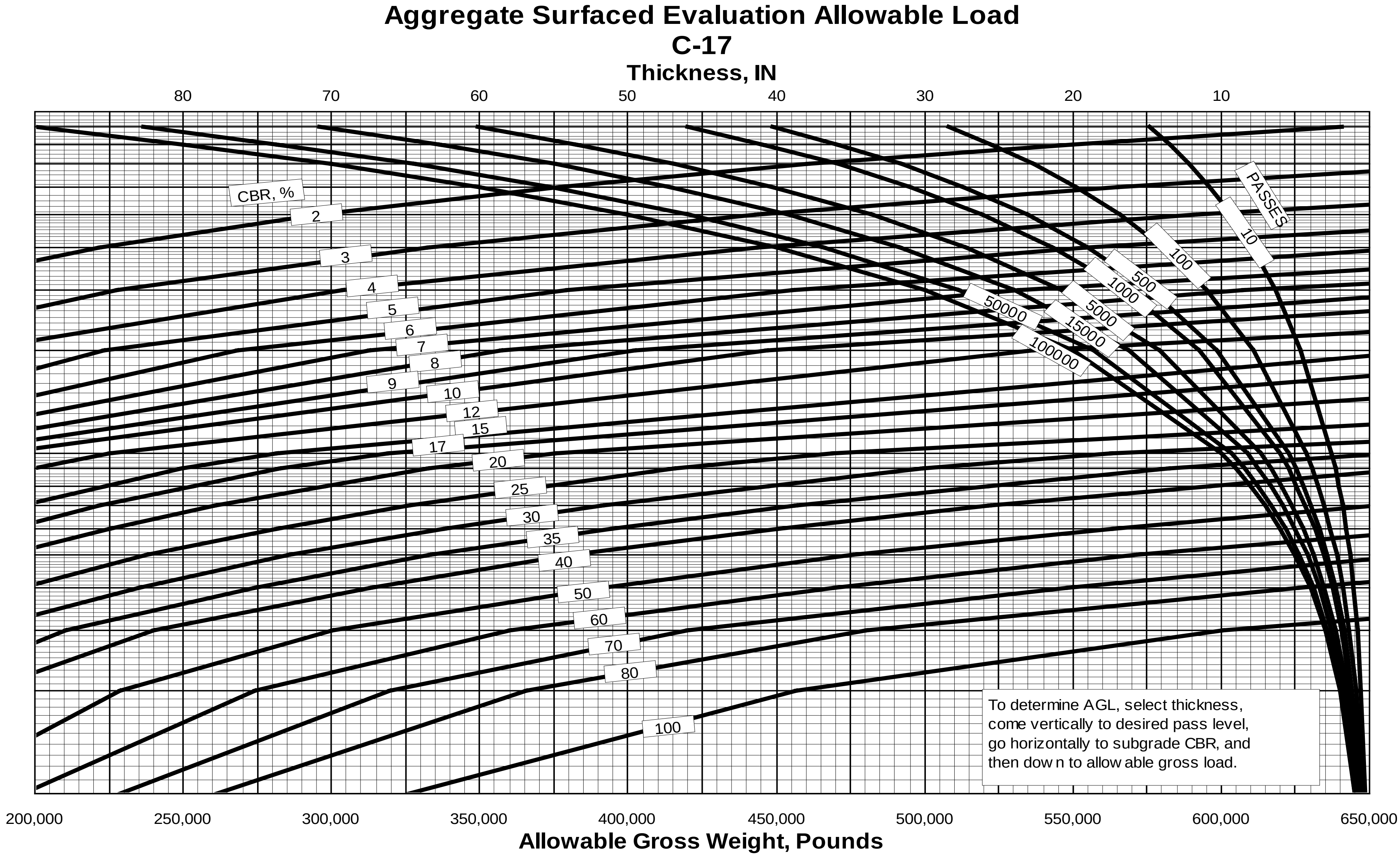
## Soil Surface Strength Requirements
## C-5A



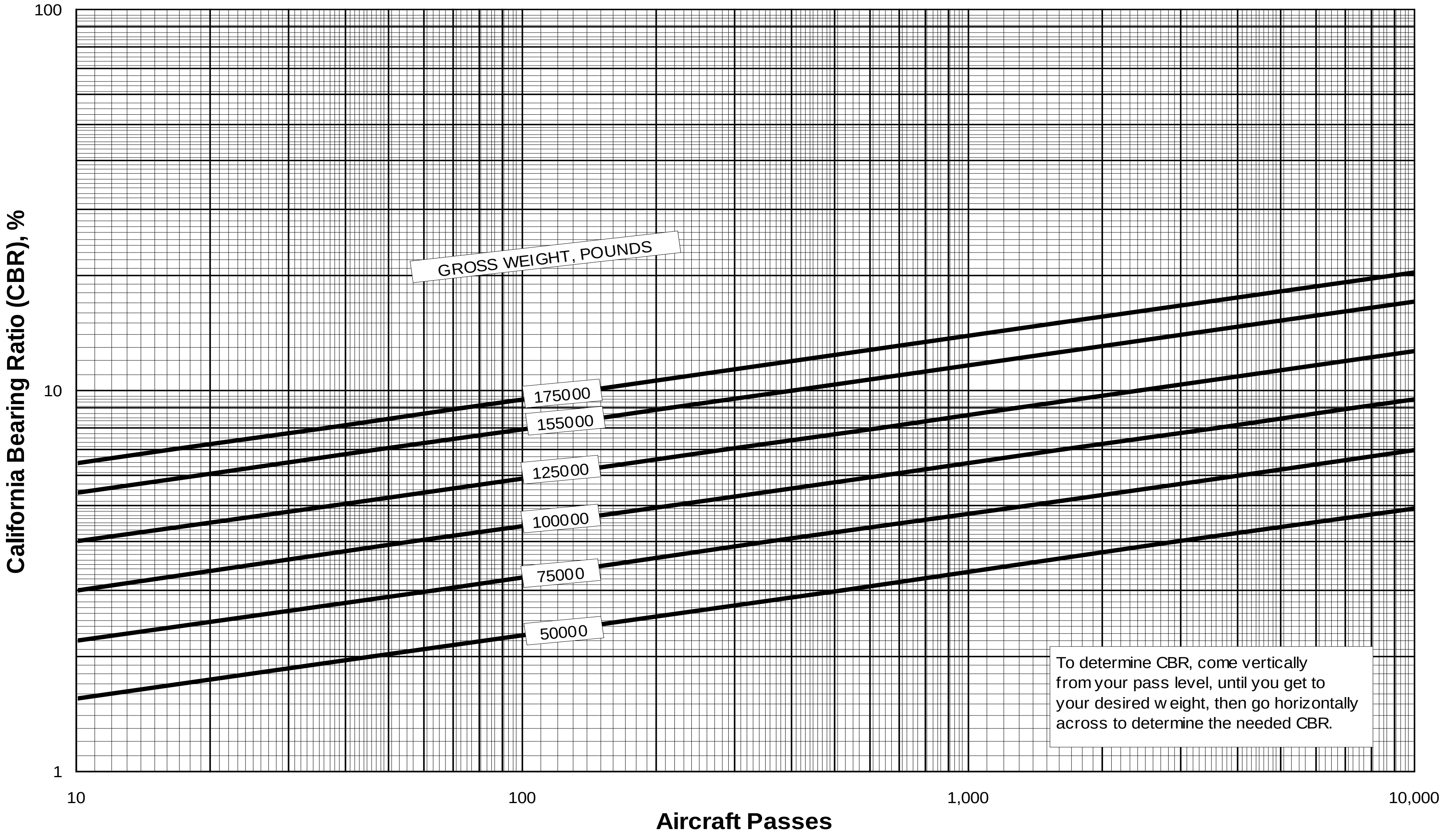
## Aggregate Surfaced Evaluation Allowable Load
## C-5A



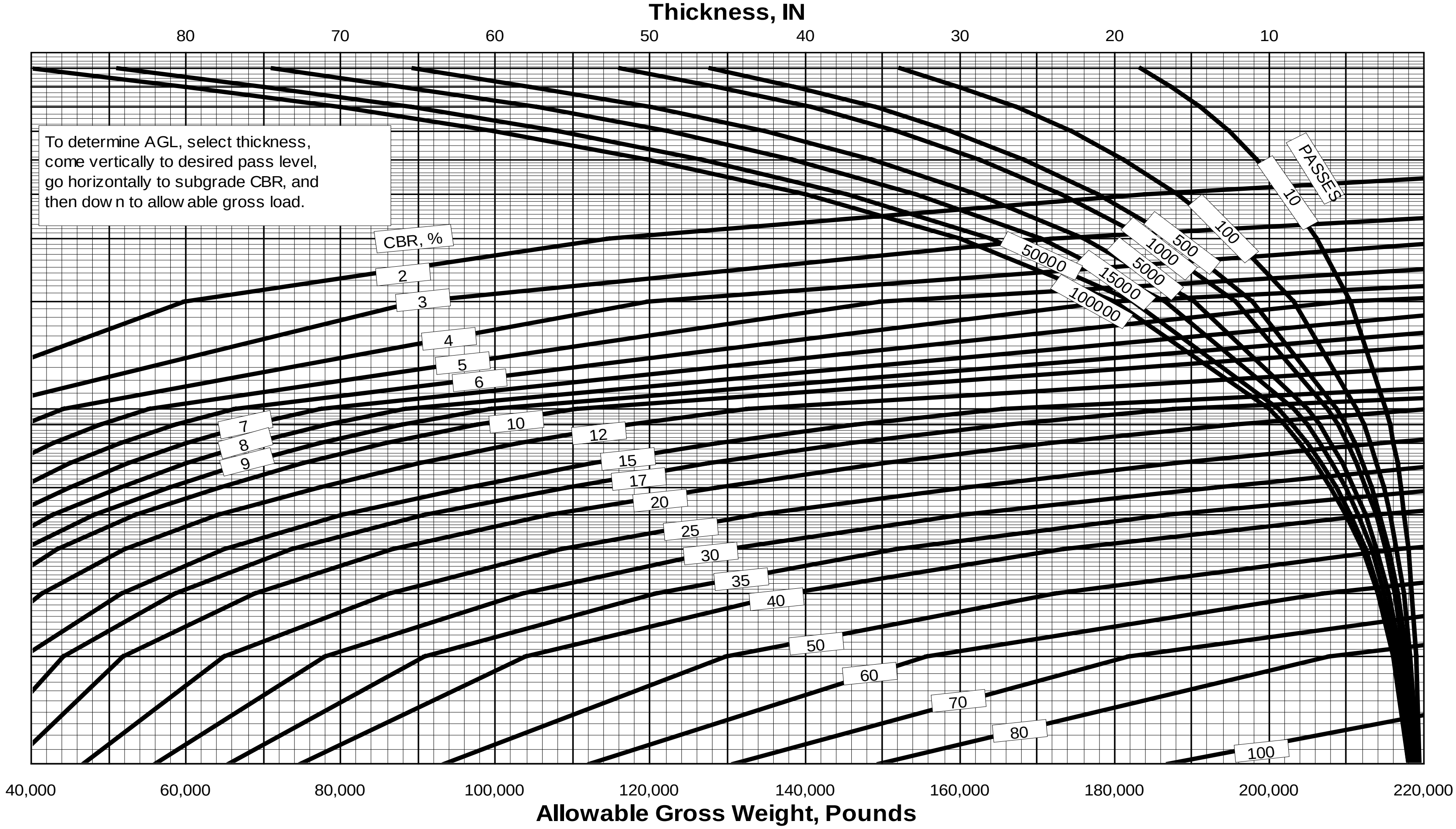

Soil Surface Strength Requirements
C-17
California Bearing Ratio (CBR), %
100
10
1
Aircraft Passes
10
100
1,000
10,000
GROSS WEIGHT, POUNDS
580000
475000
400000
350000
279000
225000
To determine CBR, come vertically from your pass level, until you get to your desired weight, then go horizontally across to determine the needed CBR.

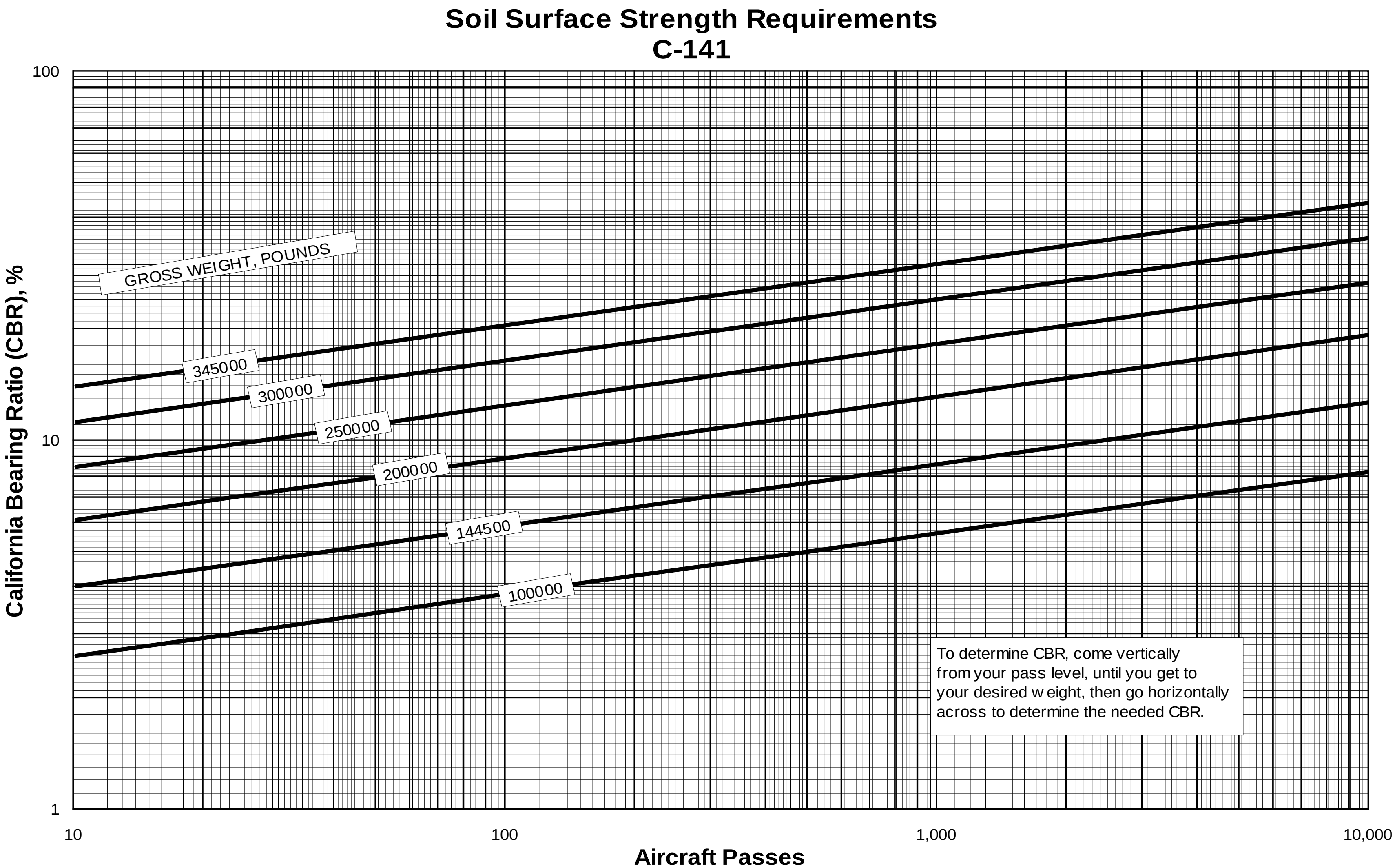

Aggregate Surfaced Evaluation Allowable Load
C-17
Thickness, IN
80
70
60
50
40
30
20
10
CBR, %
2
3
4
5
6
7
8
9
10
12
15
17
20
25
30
35
40
50
60
70
80
100
PASSES
10
100
500
1000
5000
15000
50000
100000
To determine AGL, select thickness, come vertically to desired pass level, go horizontally to subgrade CBR, and then down to allowable gross load.
200,000
250,000
300,000
350,000
400,000
450,000
500,000
550,000
600,000
650,000
Allowable Gross Weight, Pounds

## Soil Surface Strength Requirements
## C-130H

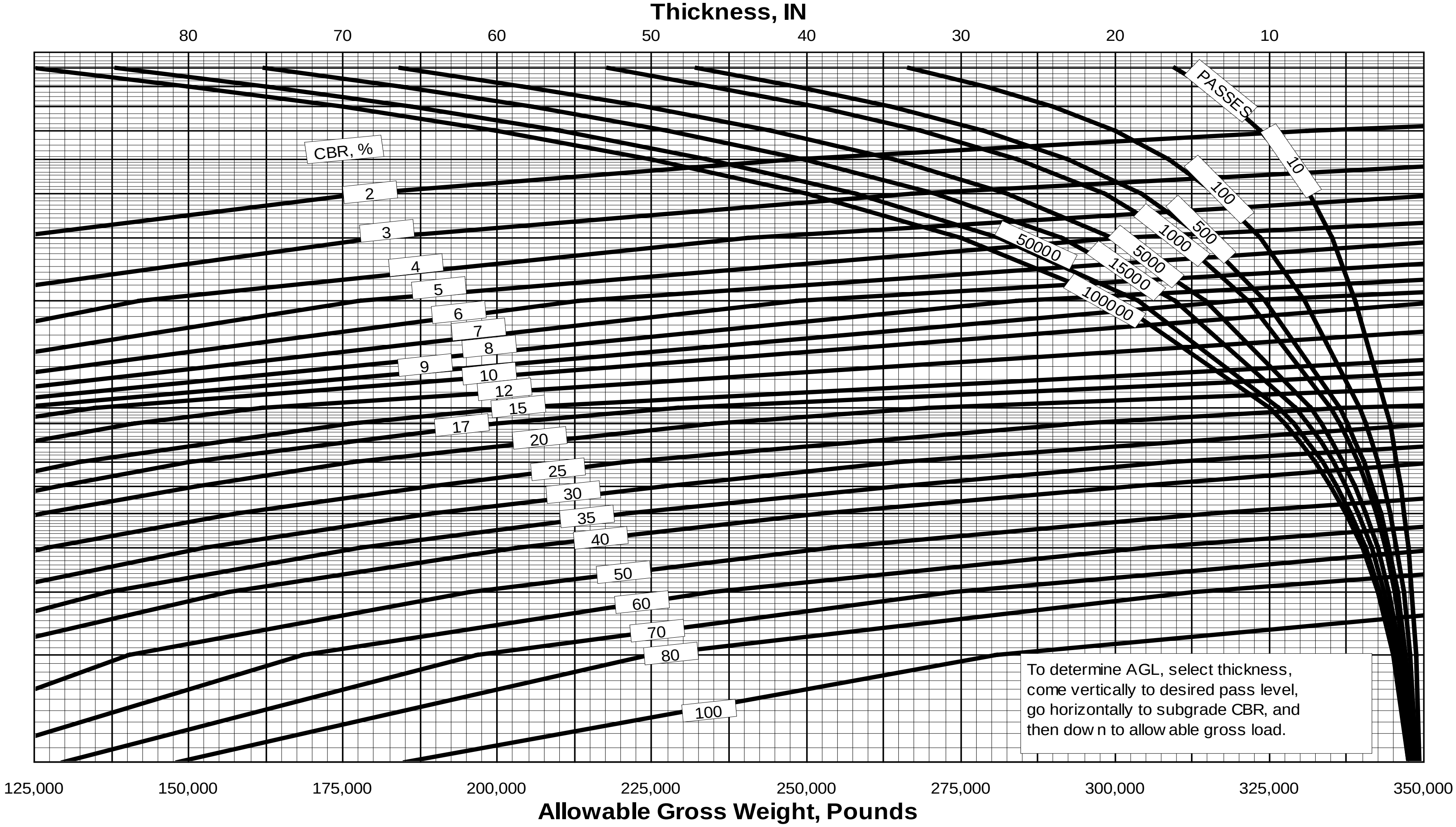


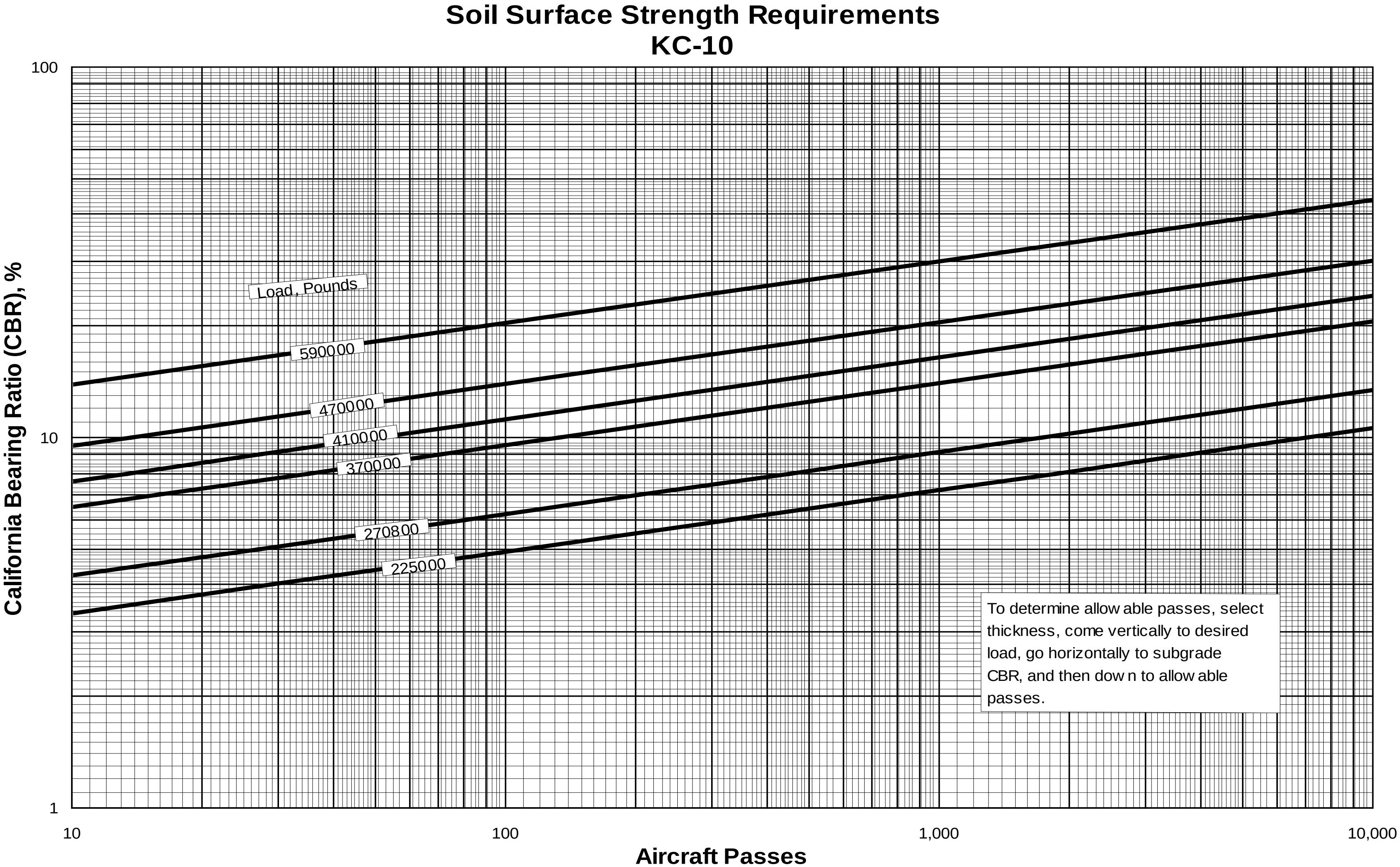
## Aggregate Surfaced Evaluation Allowable Load
## C-130H



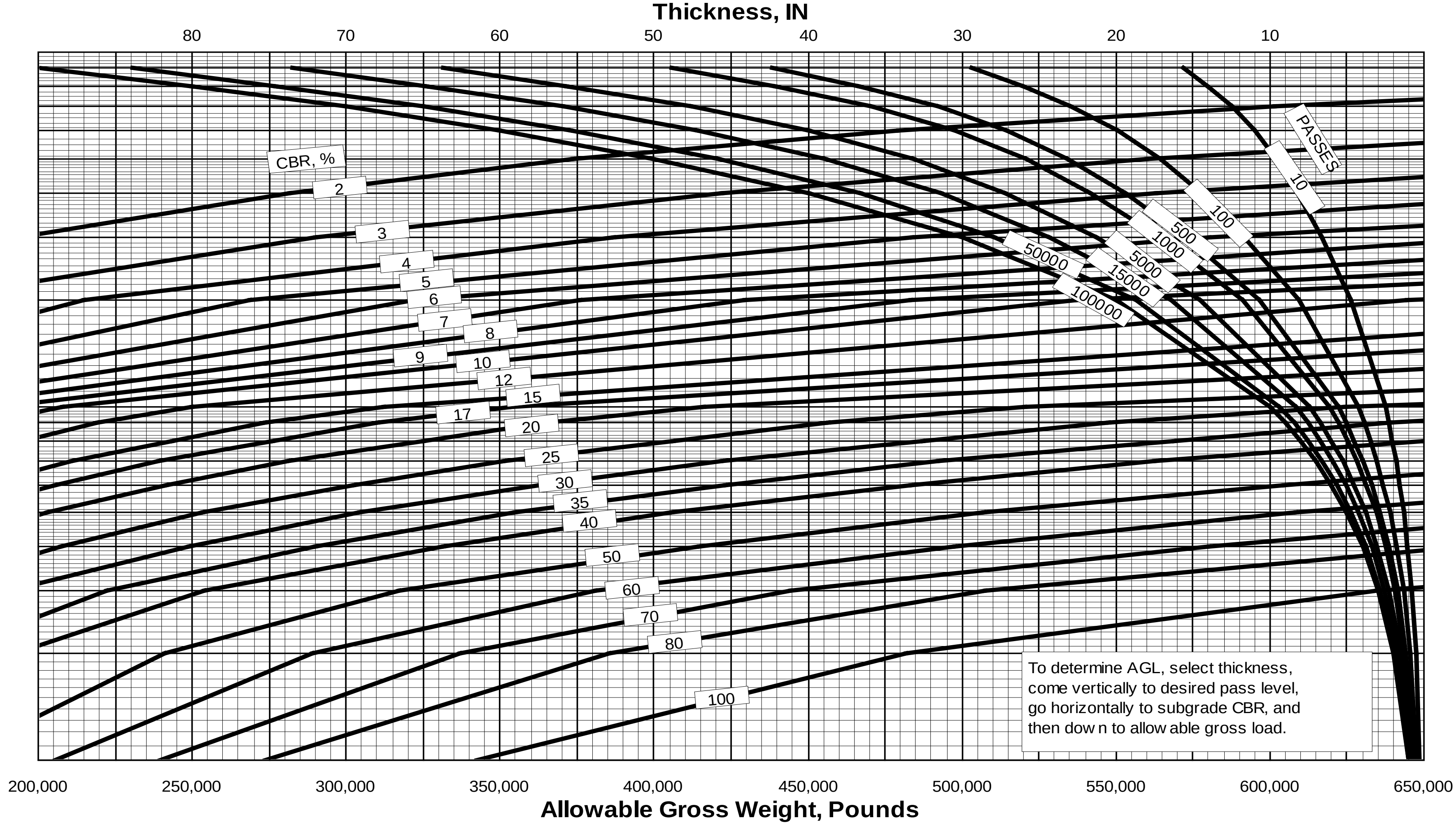

Soil Surface Strength Requirements
C-141
California Bearing Ratio (CBR), %
100
10
1
10
100
1,000
10,000
Aircraft Passes
GROSS WEIGHT, POUNDS
345000
300000
250000
200000
144500
100000
To determine CBR, come vertically from your pass level, until you get to your desired weight, then go horizontally across to determine the needed CBR.

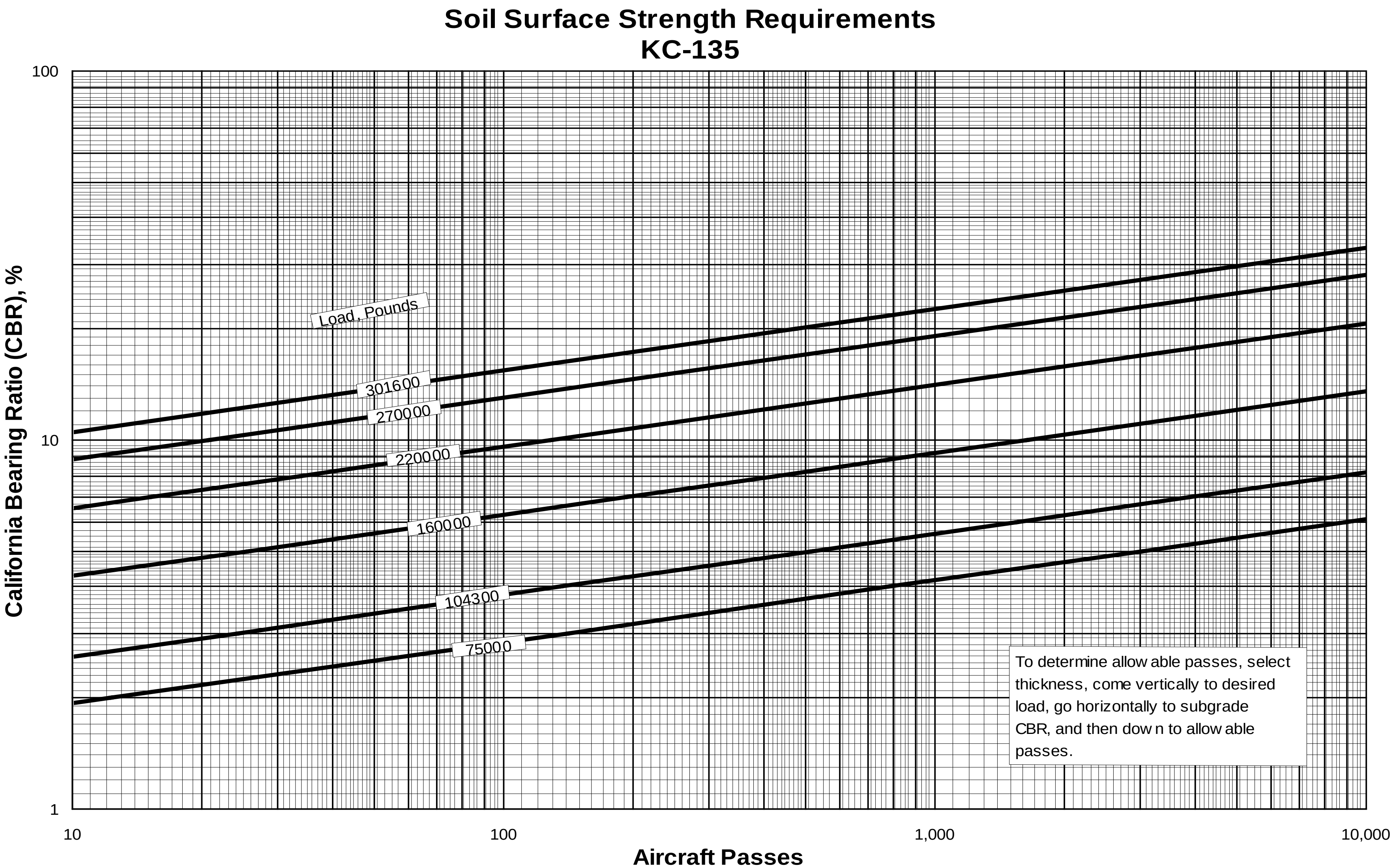
## Aggregate Surfaced Evaluation Allowable Load
## C-141



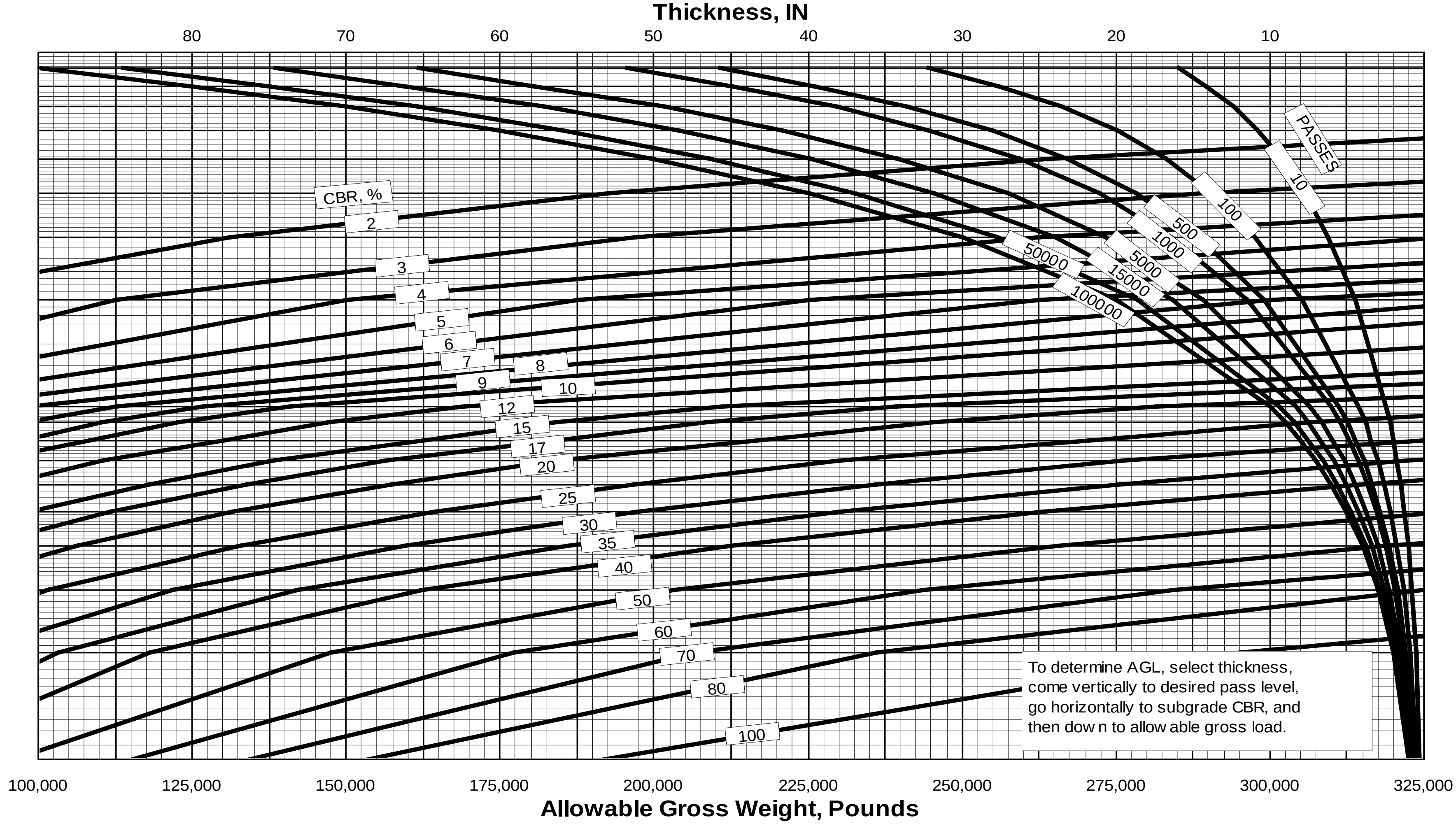

Soil Surface Strength Requirements
KC-10
California Bearing Ratio (CBR), %
100
10
1
Load, Pounds
590000
470000
410000
370000
270800
225000
To determine allowable passes, select thickness, come vertically to desired load, go horizontally to subgrade CBR, and then down to allowable passes.
10
100
1,000
10,000
Aircraft Passes

## Aggregate Surfaced Evaluation Allowable Load
## KC-10



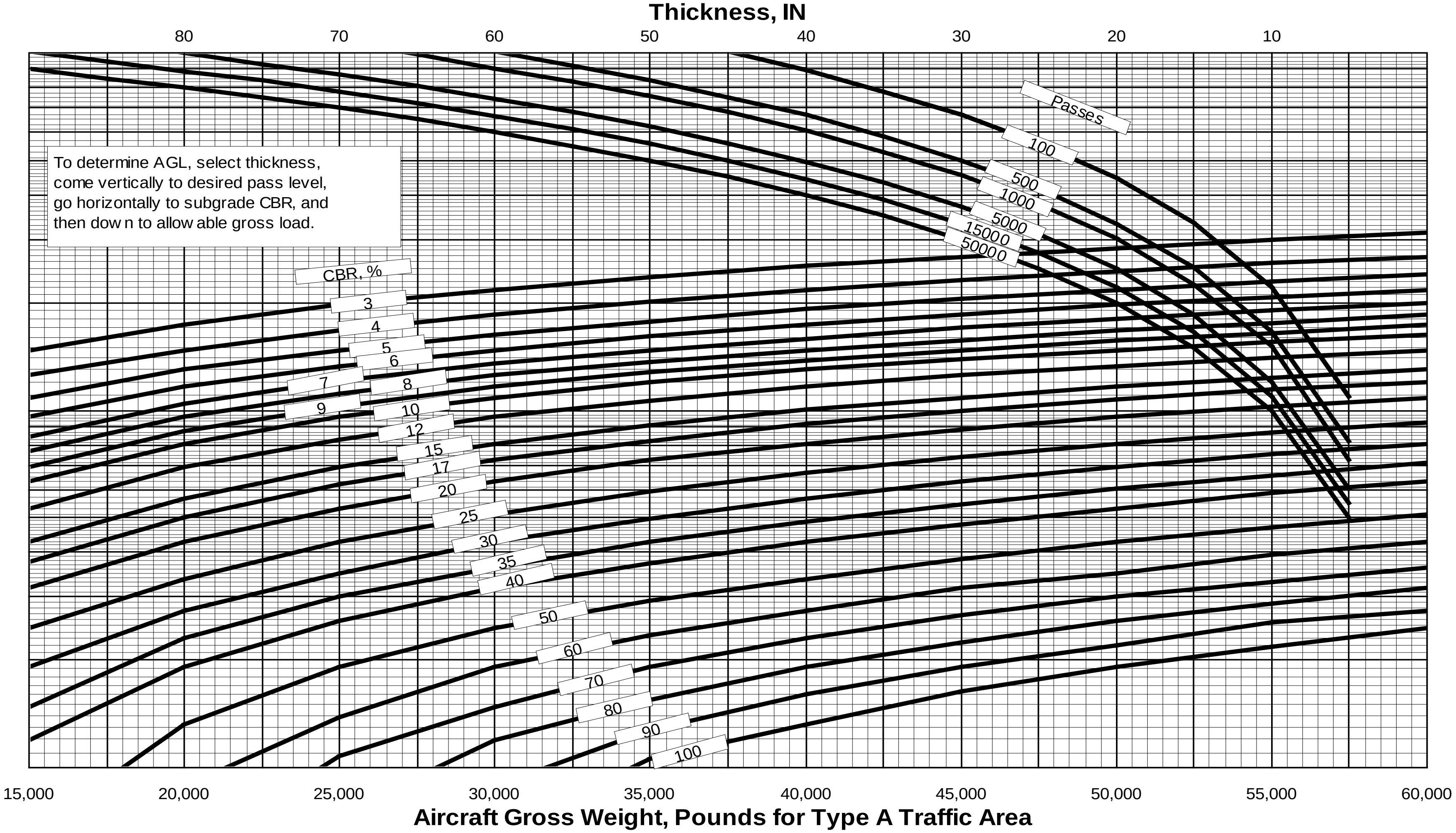

Soil Surface Strength Requirements
KC-135
California Bearing Ratio (CBR), %
Aircraft Passes
100
10
1
10
100
1,000
10,000
Load, Pounds
301600
270000
220000
160000
104300
75000
To determine allow able passes, select thickness, come vertically to desired load, go horizontally to subgrade CBR, and then dow n to allow able passes.

## Aggregate Surfaced Evaluation Allowable Load
## KC-135

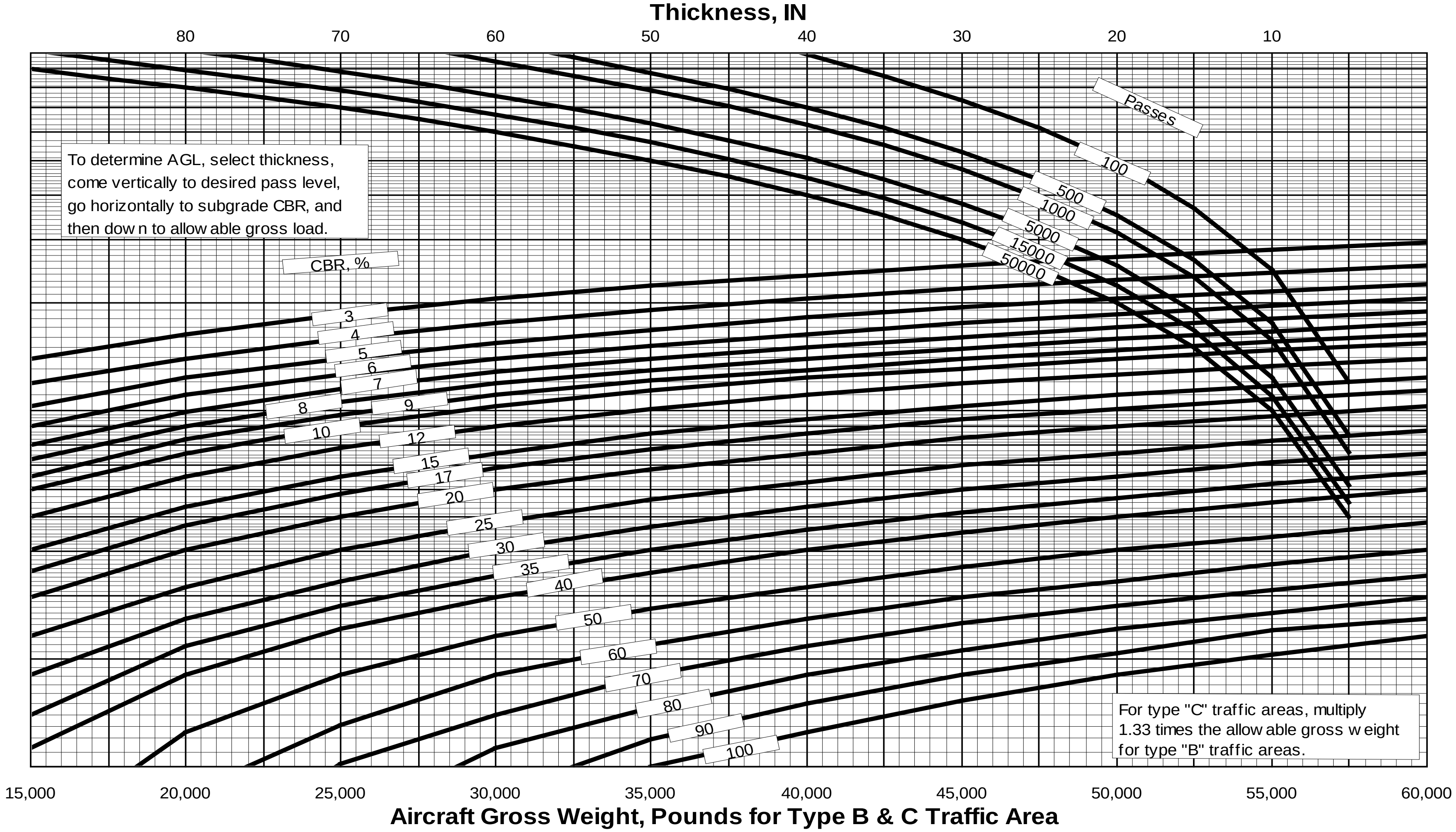


# APPENDIX E FLEXIBLE PAVEMENT EVALUATION CURVES

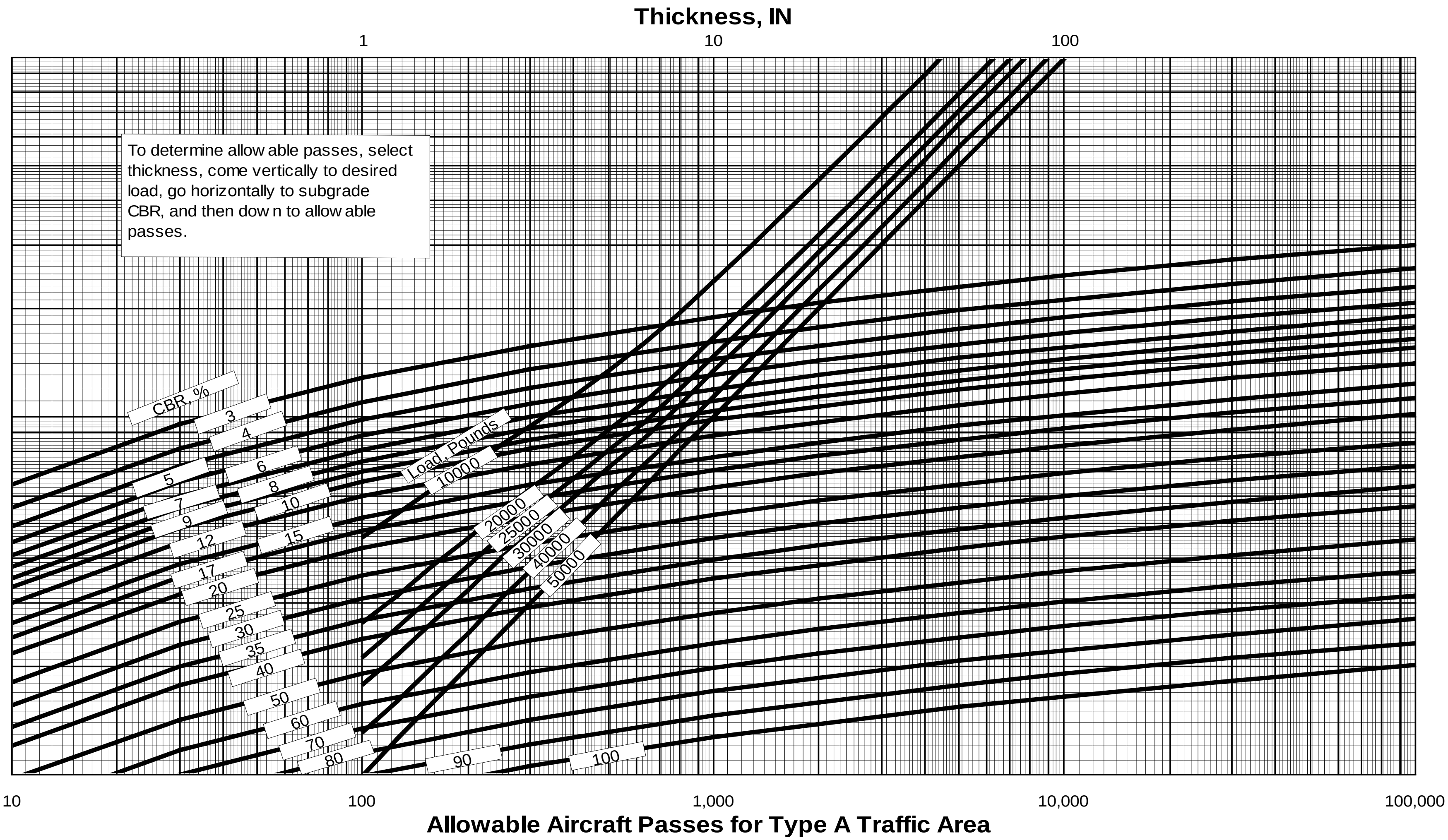
## Flexible Pavement Evaluation Allowable Gross Load - A Traffic Area
## A-10



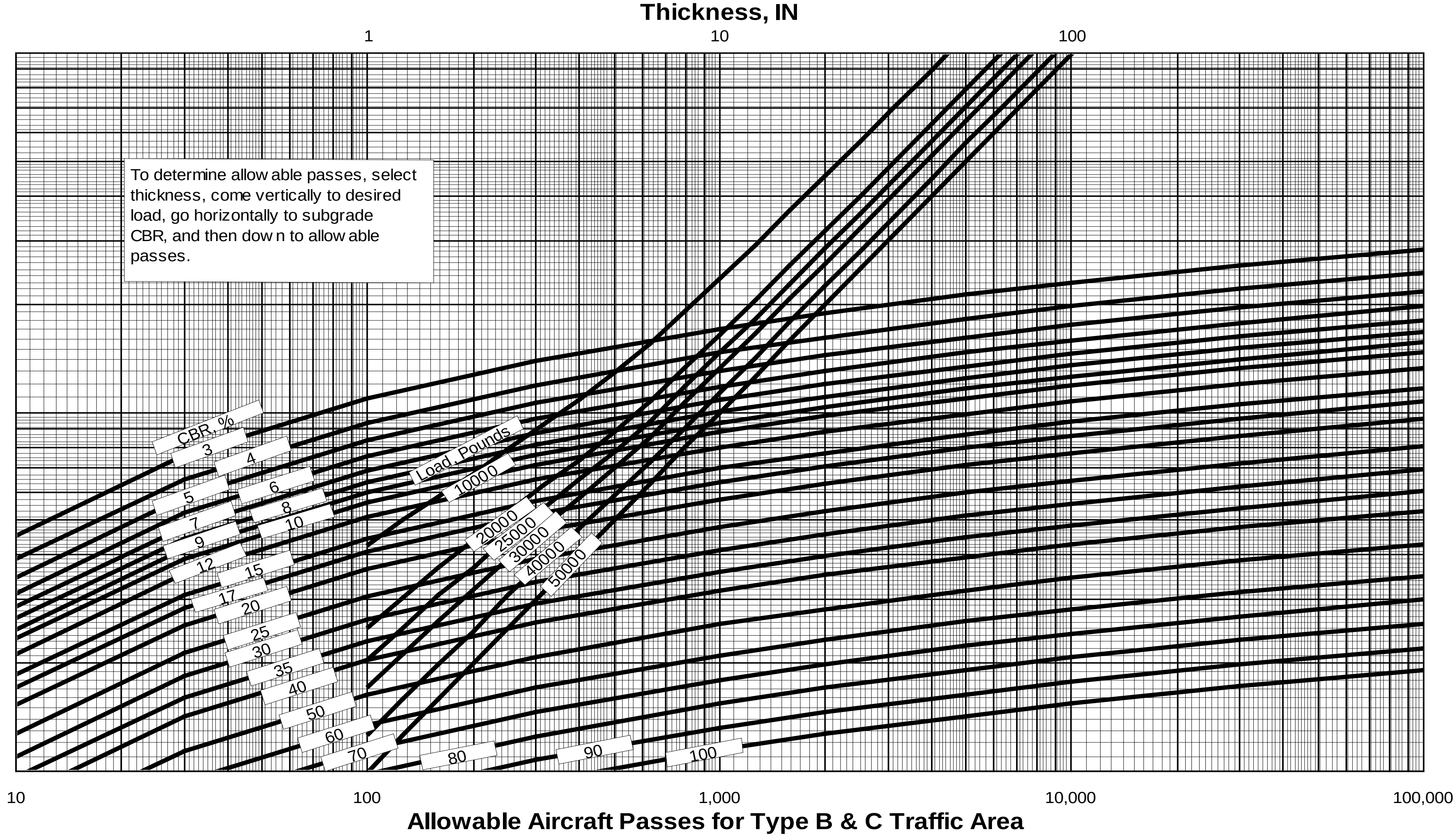
## Flexible Pavement Evaluation Allowable Gross Load - B & C Traffic Area
## A-10

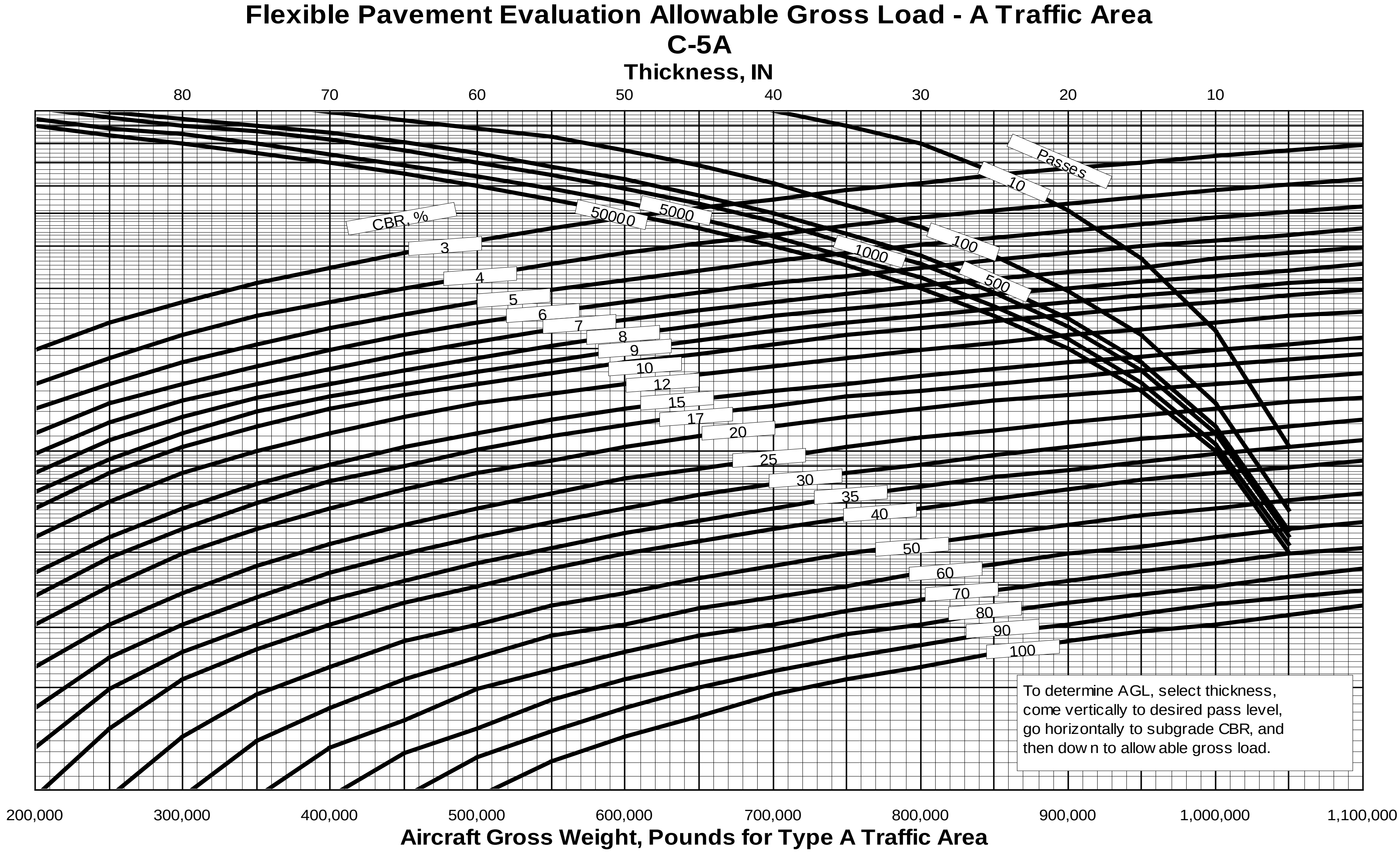


## Flexible Pavement Evaluation Allowable Passes - A Traffic Area
## A-10

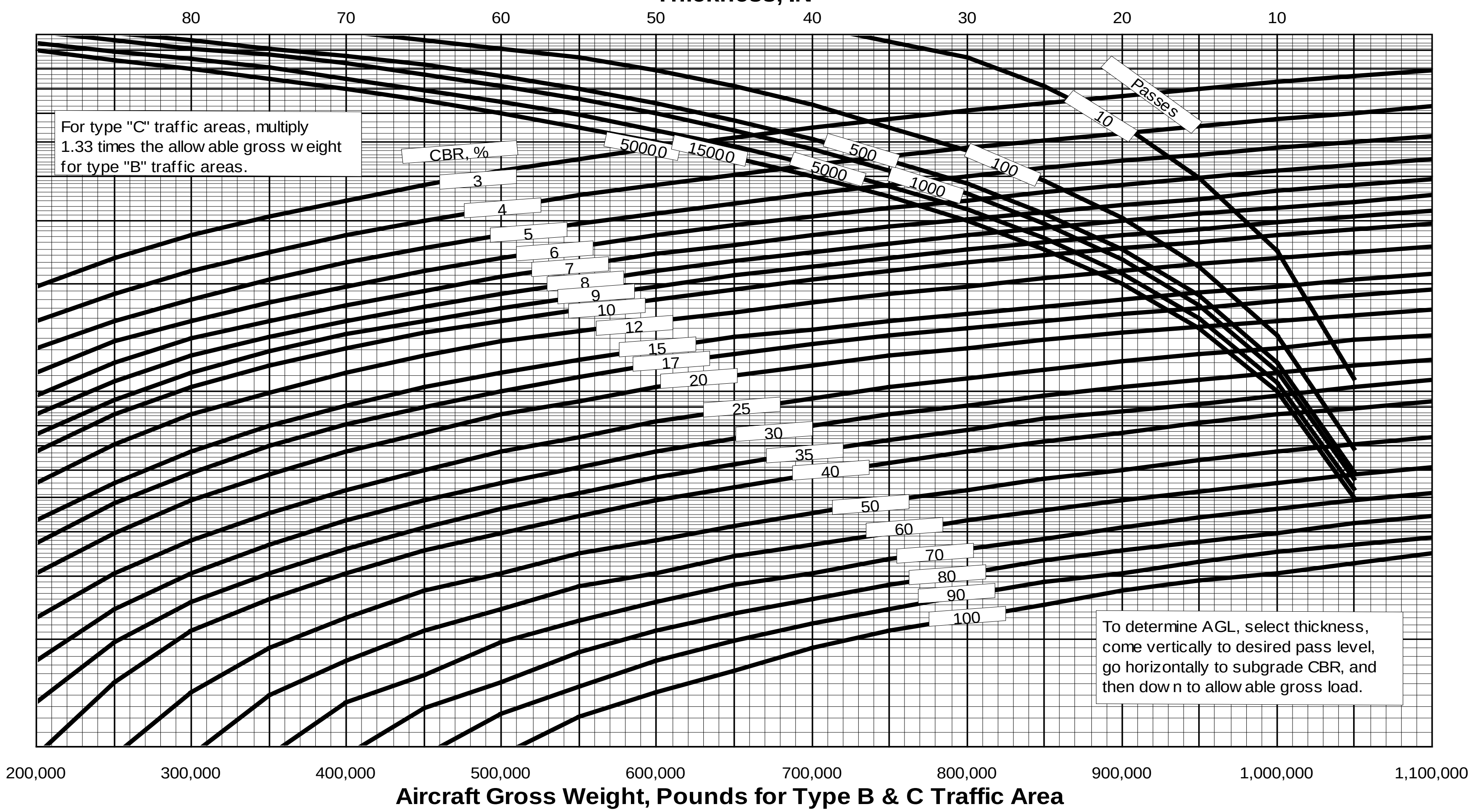


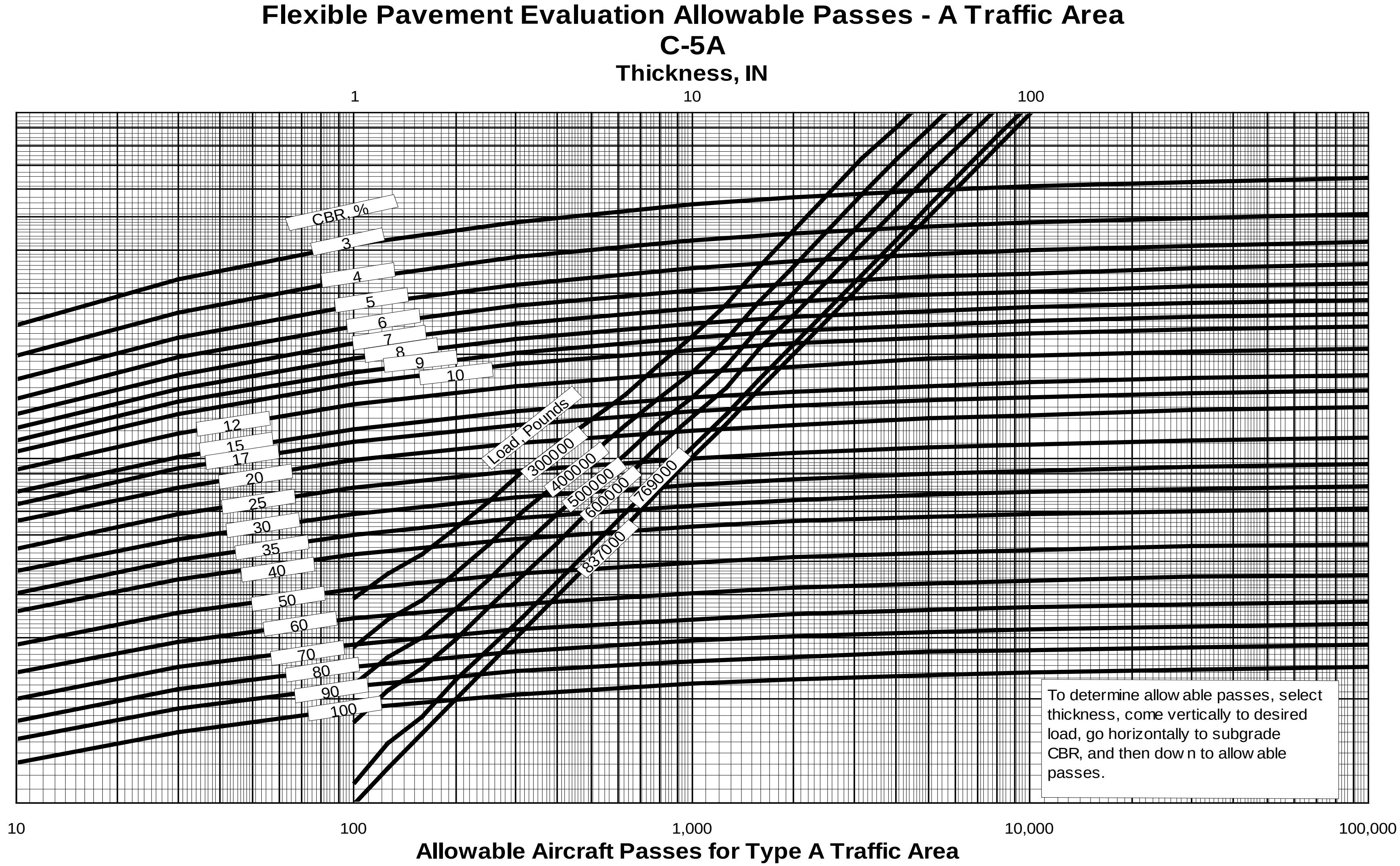
## Flexible Pavement Evaluation Allowable Passes - B & C Traffic Area
## A-10




Flexible Pavement Evaluation Allowable Gross Load - A Traffic Area
C-5A
Thickness, IN
80
70
60
50
40
30
20
10
Passes
10
100
500
1000
5000
50000
CBR, %
3
4
5
6
7
8
9
10
12
15
17
20
25
30
35
40
50
60
70
80
90
100
To determine AGL, select thickness, come vertically to desired pass level, go horizontally to subgrade CBR, and then dow n to allow able gross load.
200,000
300,000
400,000
500,000
600,000
700,000
800,000
900,000
1,000,000
1,100,000
Aircraft Gross Weight, Pounds for Type A Traffic Area

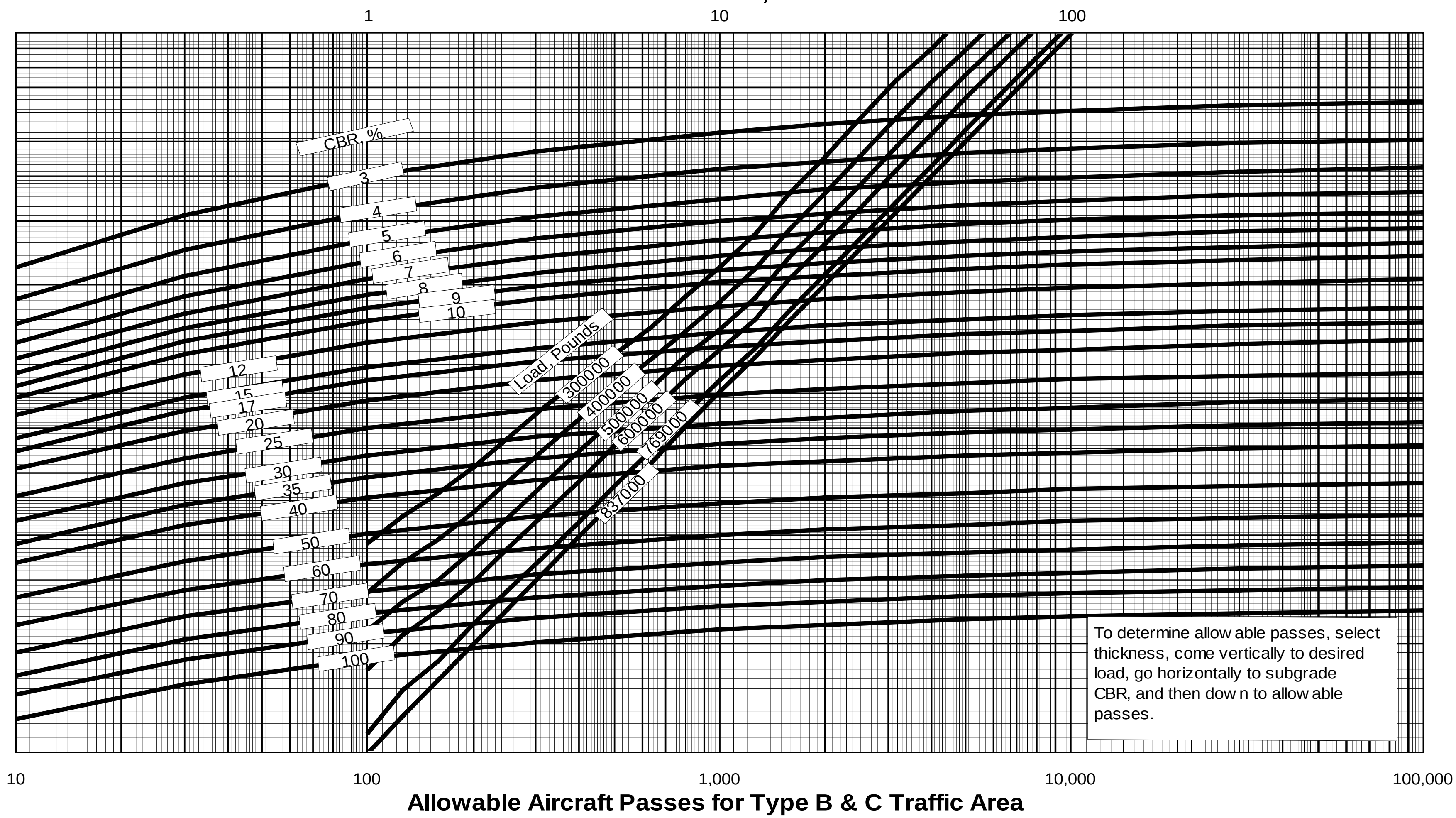
## Flexible Pavement Evaluation Allowable Gross Load - B & C Traffic Area
## C-5A



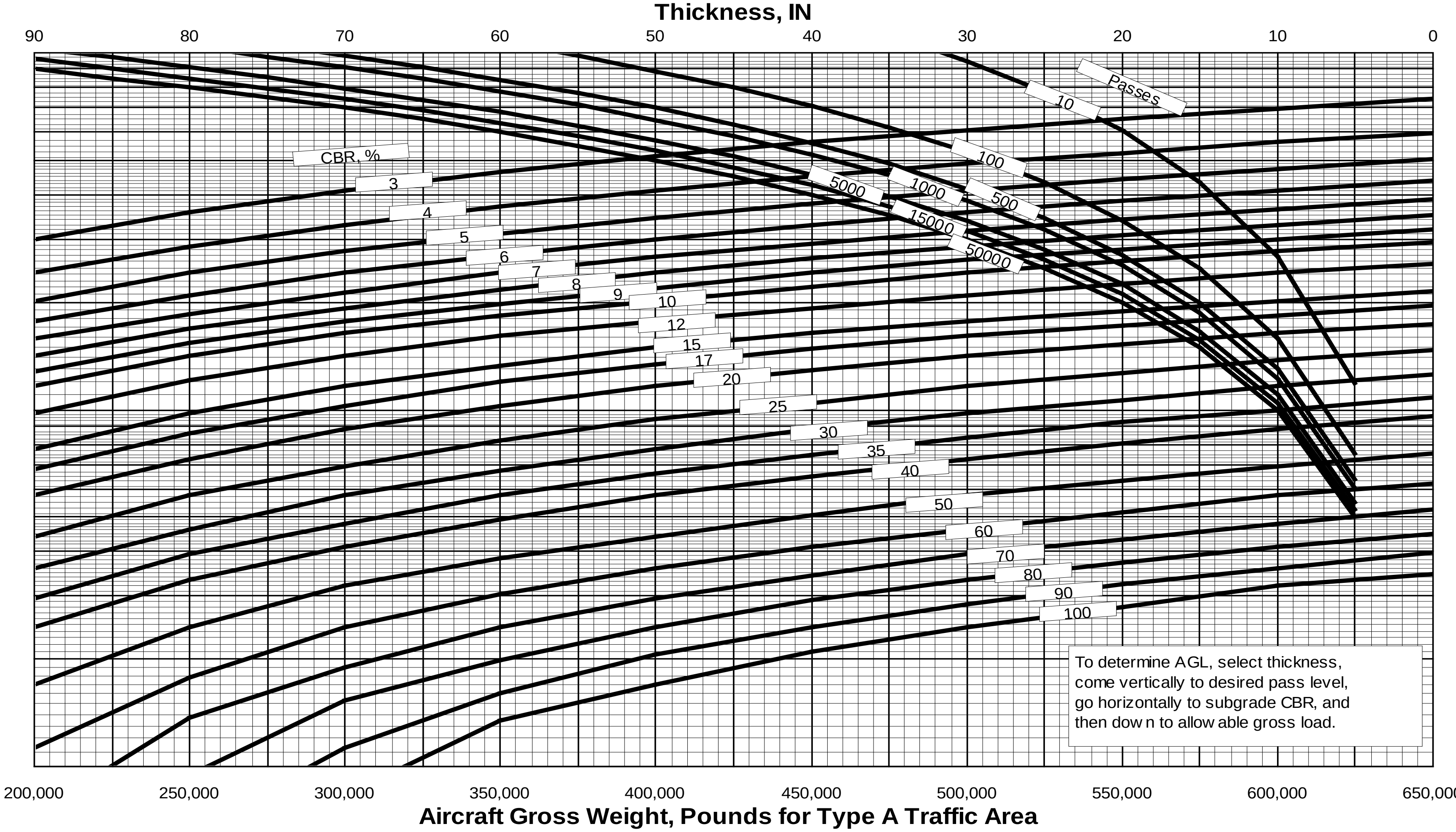

Flexible Pavement Evaluation Allowable Passes - A Traffic Area
C-5A
Thickness, IN
1
10
100
CBR, %
3
4
5
6
7
8
9
10
12
15
17
20
25
30
35
40
50
60
70
80
90
100
Load, Pounds
300000
400000
500000
600000
769000
837000
To determine allow able passes, select thickness, come vertically to desired load, go horizontally to subgrade CBR, and then dow n to allow able passes.
10
100
1,000
10,000
100,000
Allowable Aircraft Passes for Type A Traffic Area

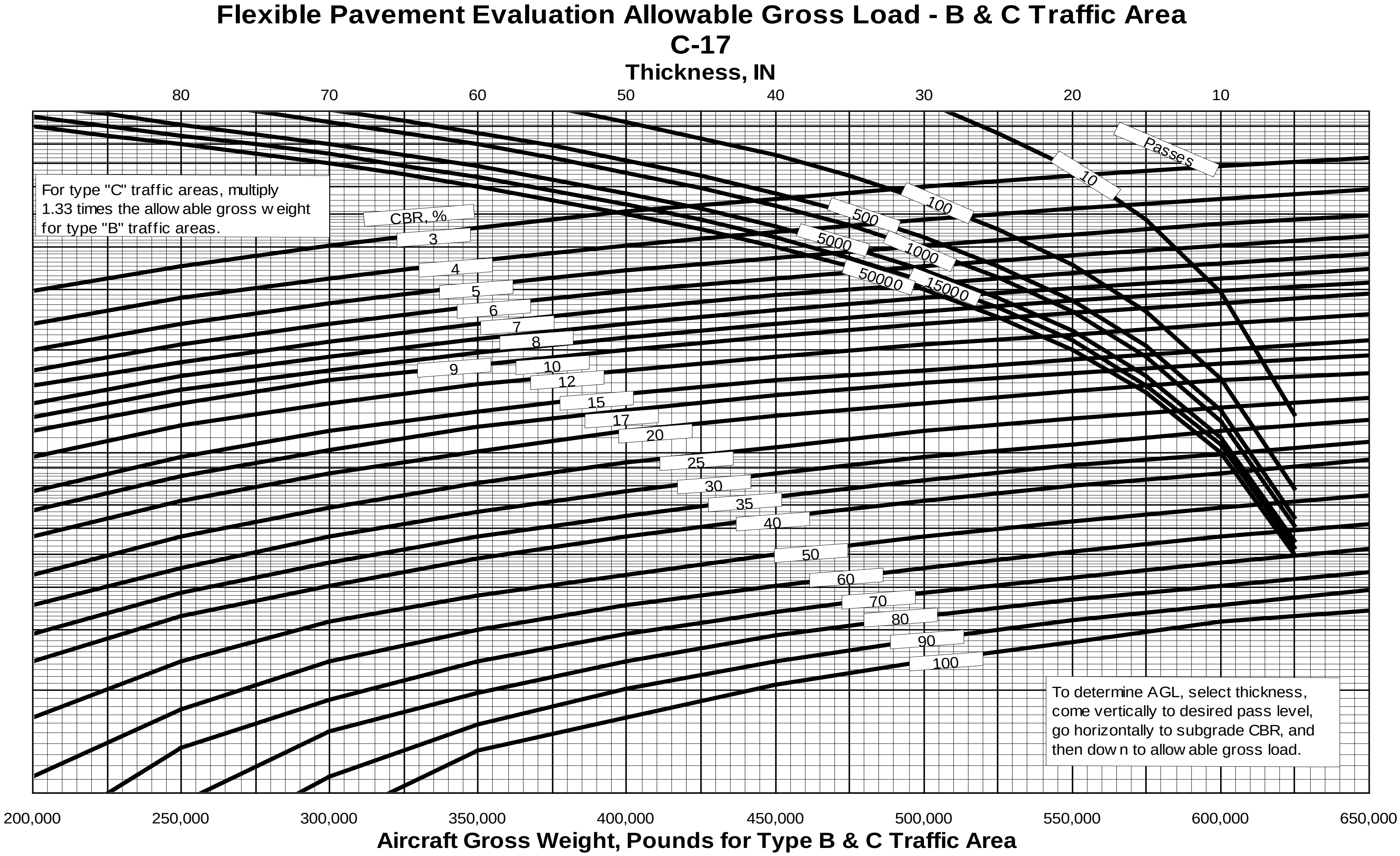
## Flexible Pavement Evaluation Allowable Passes - B & C Traffic Area

### C-5A

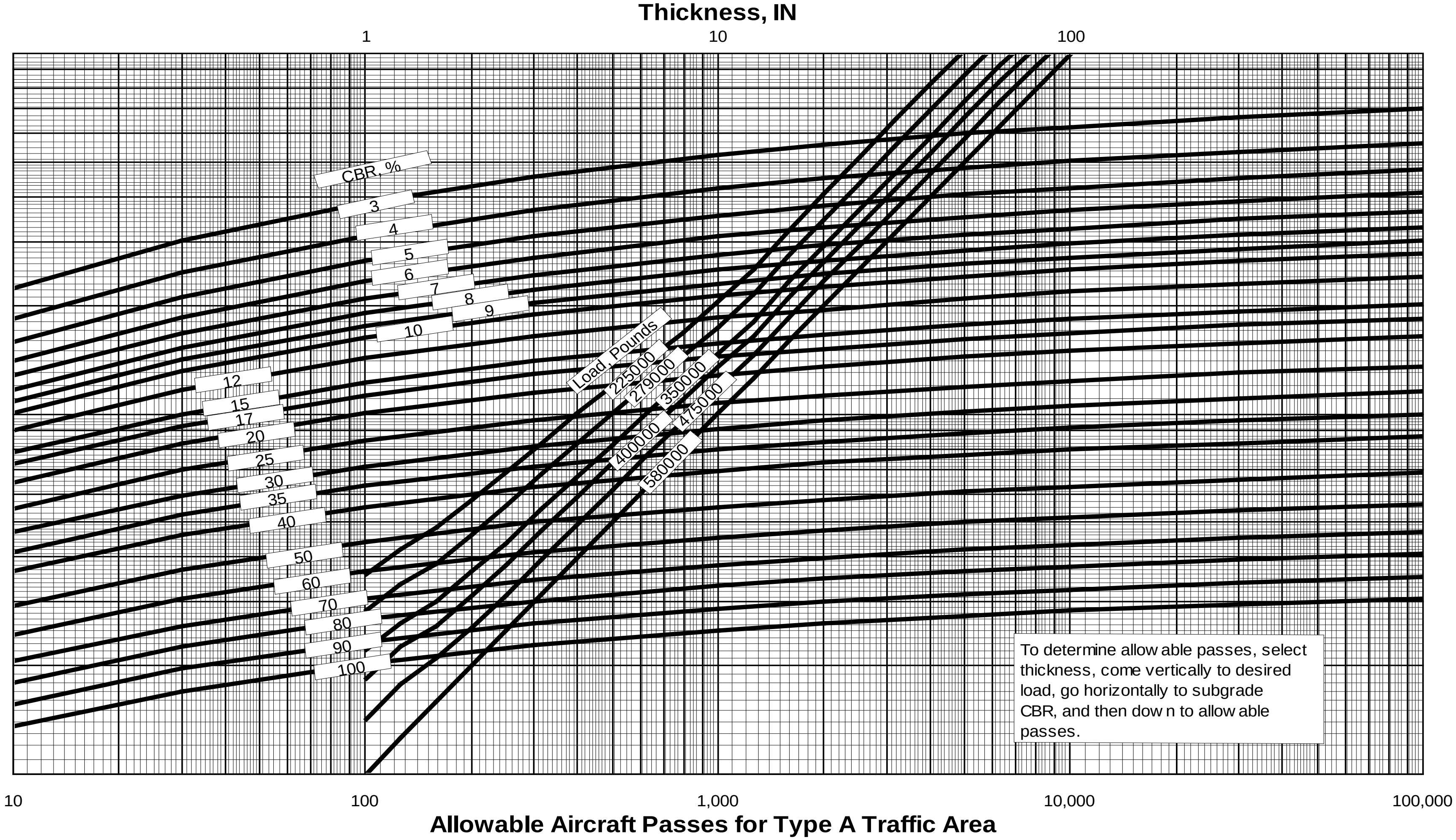


## Flexible Pavement Evaluation Allowable Gross Load - A Traffic Area
## C-17

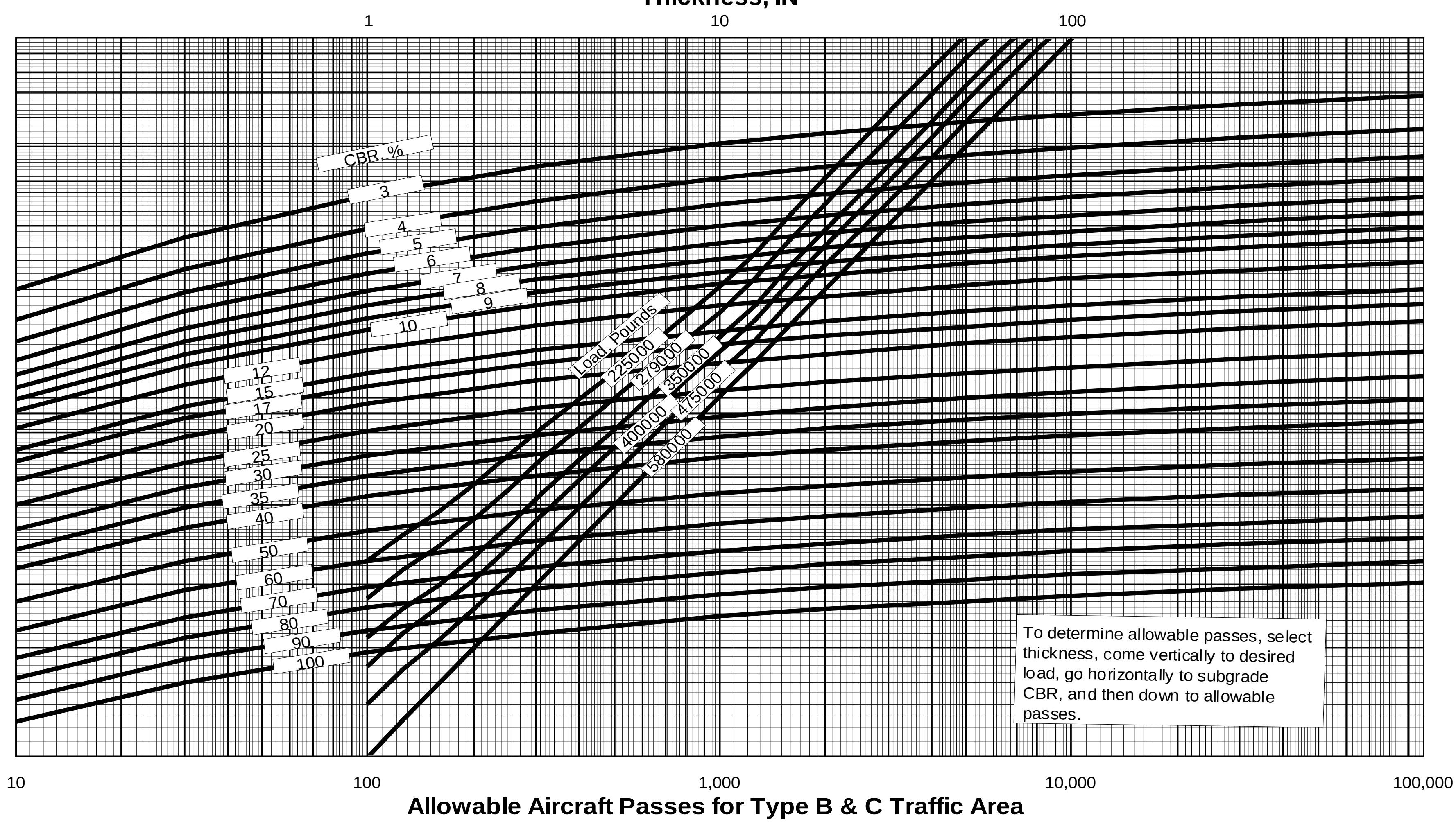



Flexible Pavement Evaluation Allowable Gross Load - B & C Traffic Area
C-17
Thickness, IN
80
70
60
50
40
30
20
10
Passes
10
100
500
1000
5000
15000
50000
CBR, %
3
4
5
6
7
8
9
10
12
15
17
20
25
30
35
40
50
60
70
80
90
100
For type "C" traffic areas, multiply 1.33 times the allowable gross weight for type "B" traffic areas.
To determine AGL, select thickness, come vertically to desired pass level, go horizontally to subgrade CBR, and then down to allowable gross load.
200,000
250,000
300,000
350,000
400,000
450,000
500,000
550,000
600,000
650,000
Aircraft Gross Weight, Pounds for Type B & C Traffic Area

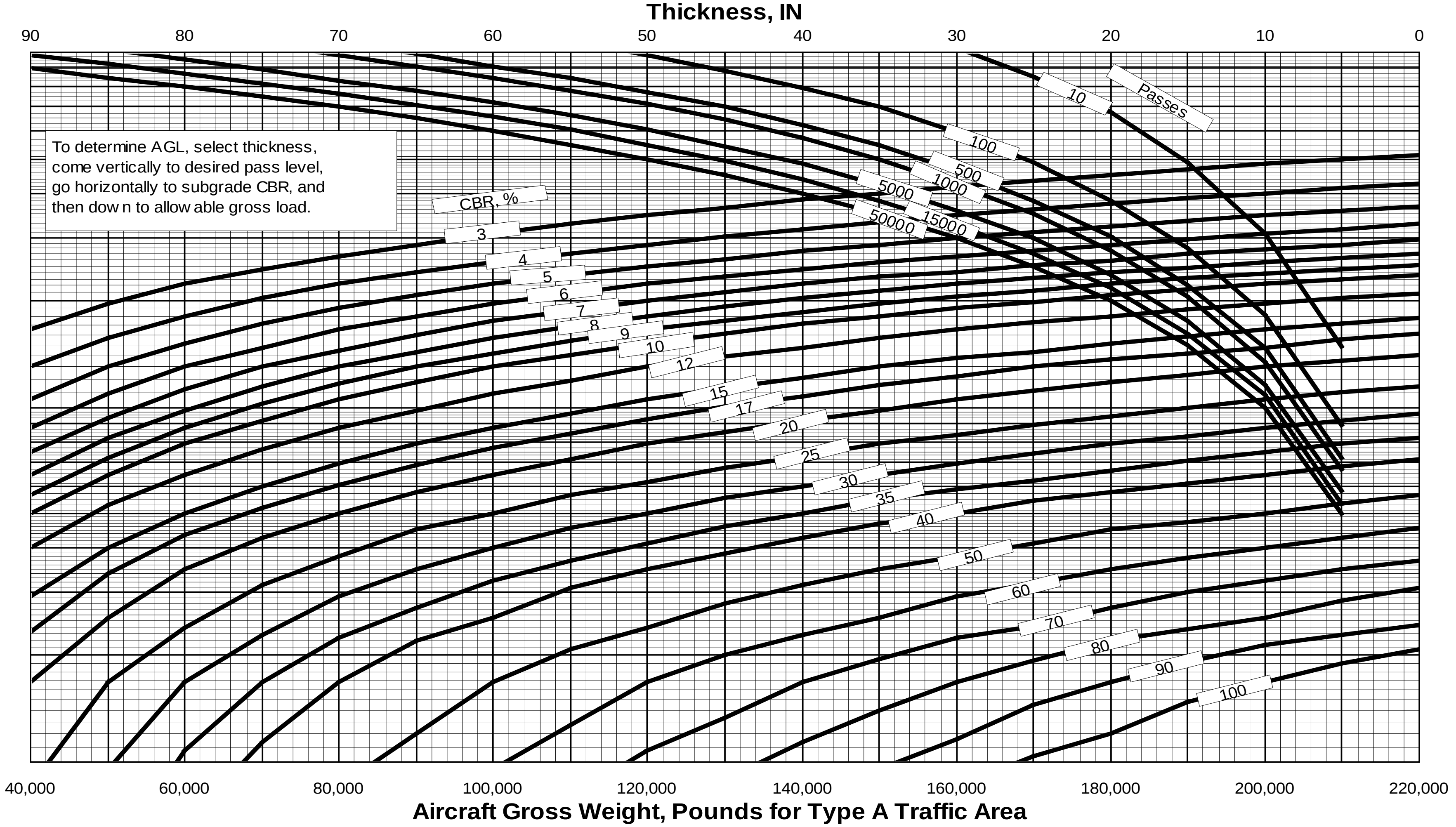
## Flexible Pavement Evaluation Allowable Passes - A Traffic Area
## C-17

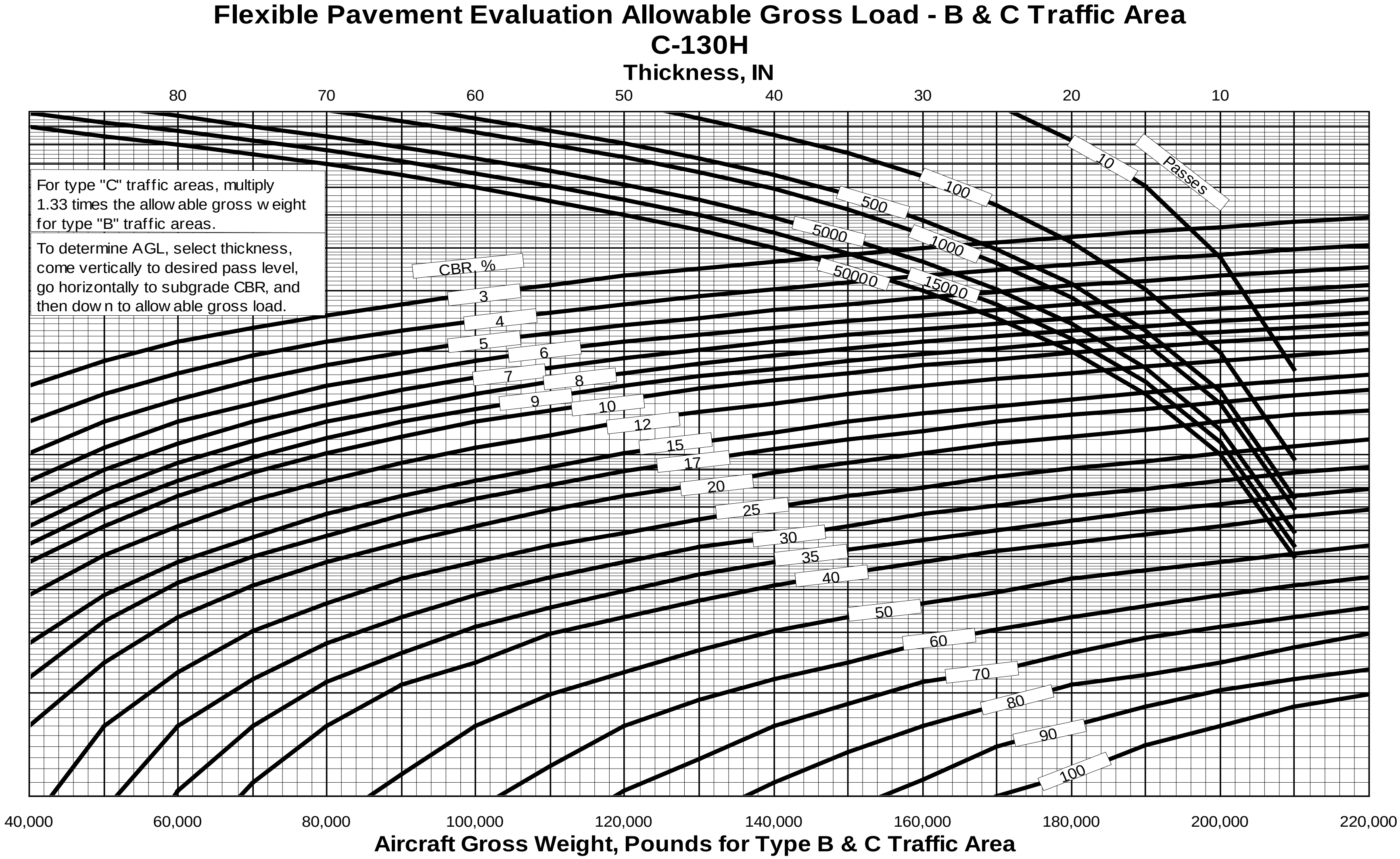


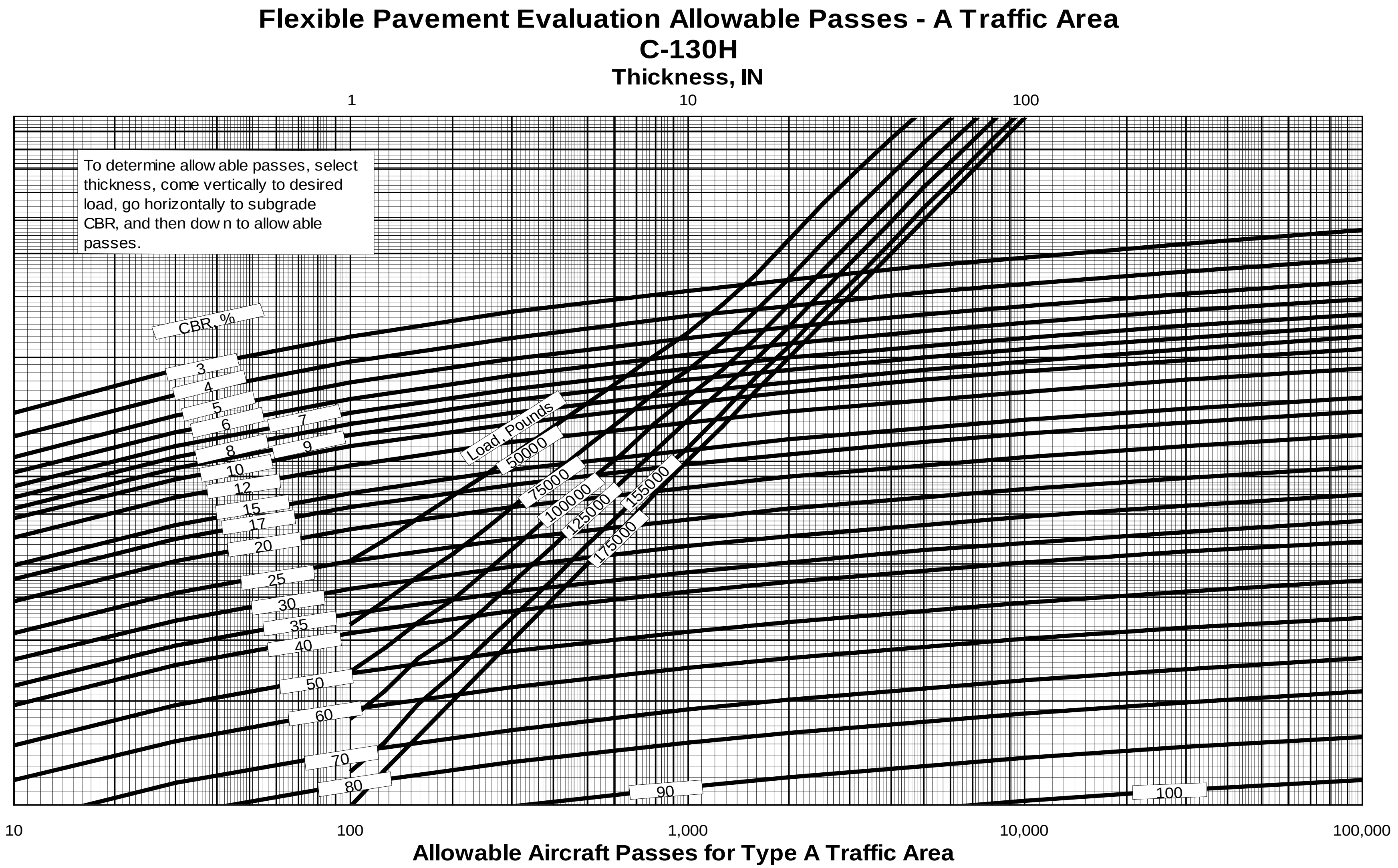
## Flexible Pavement Evaluation Allowable Passes - B & C Traffic Area
## C-17

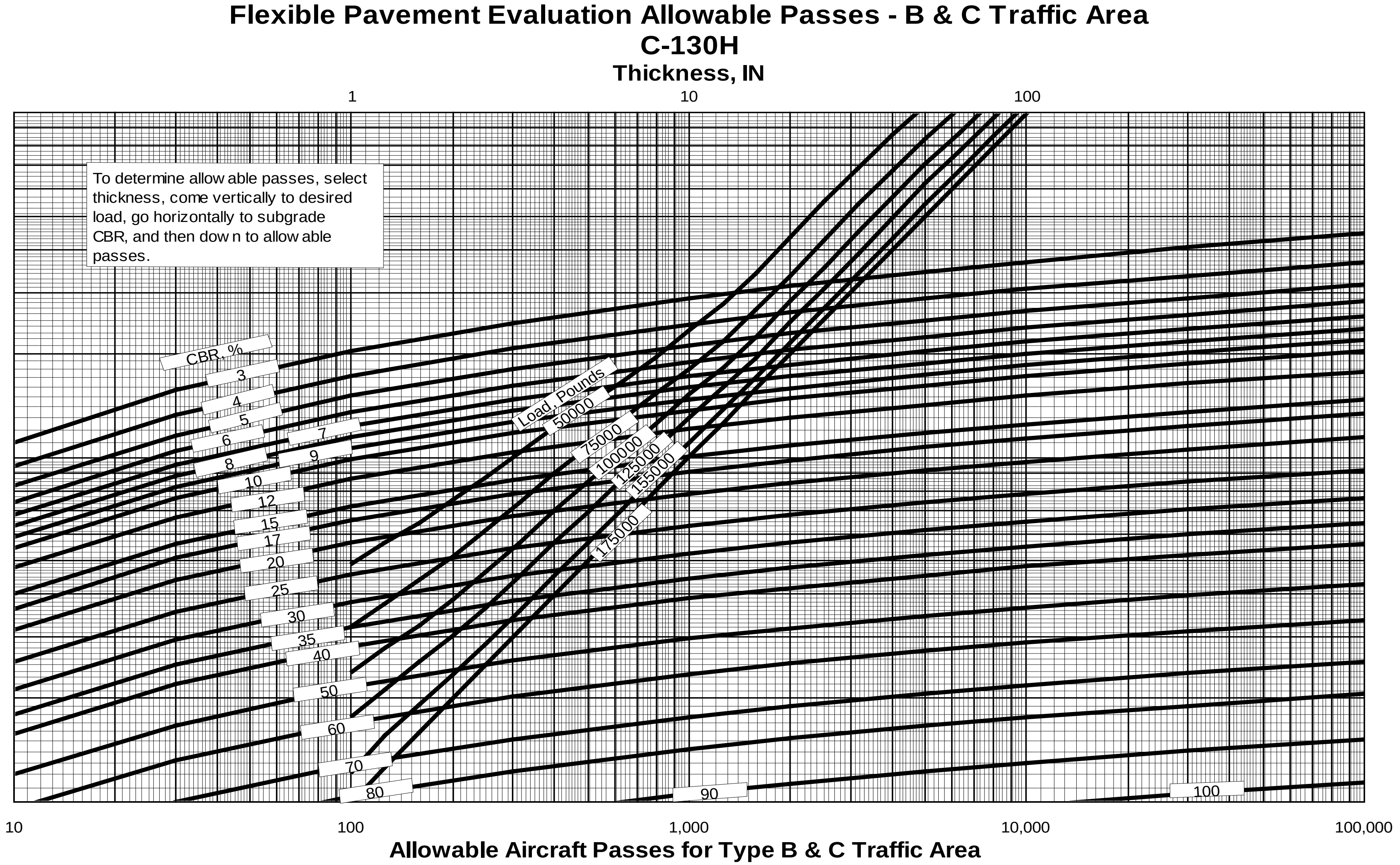


## Flexible Pavement Evaluation Allowable Gross Load - A Traffic Area
## C-130H

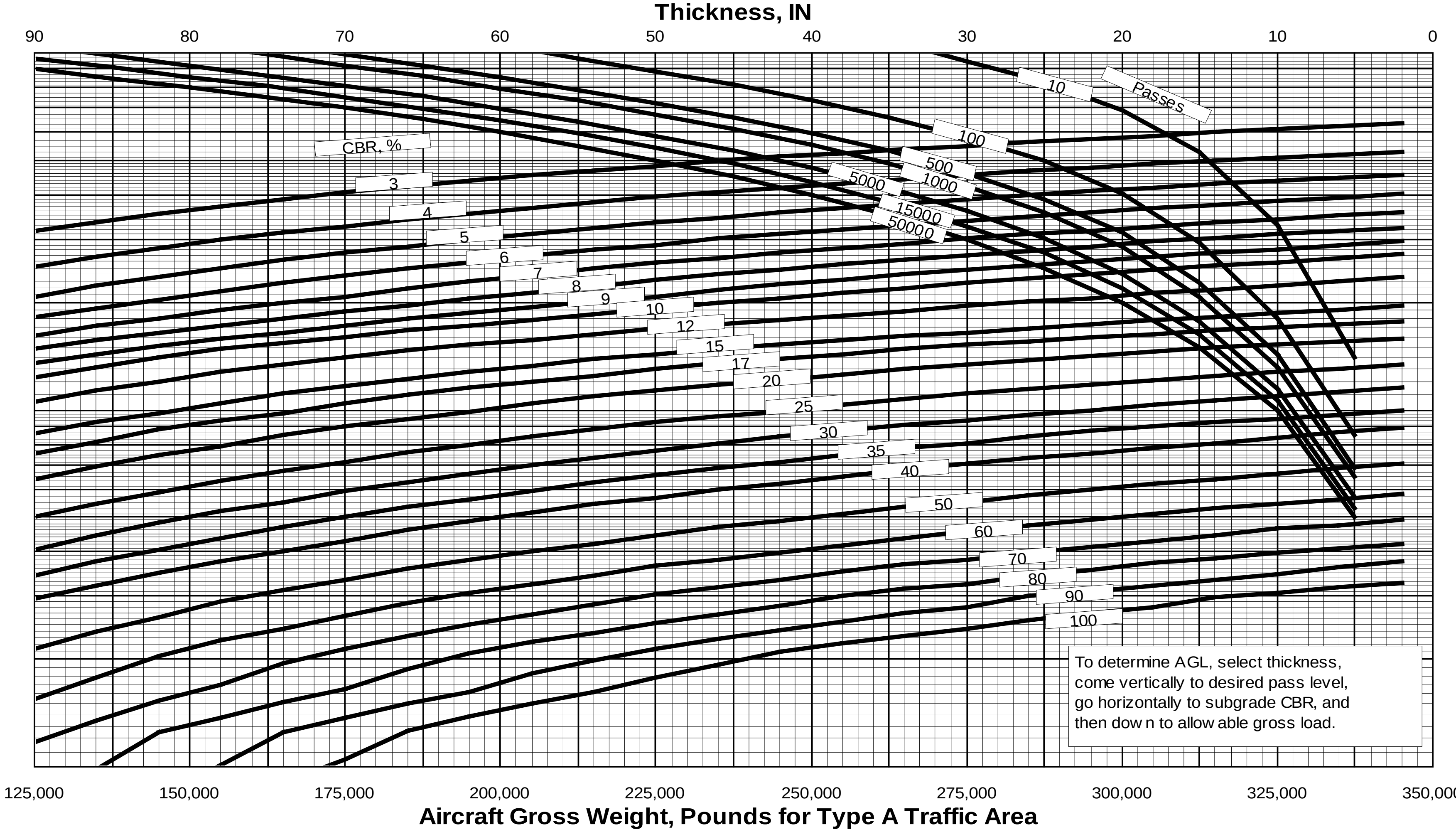



Flexible Pavement Evaluation Allowable Gross Load - B & C Traffic Area
C-130H
Thickness, IN
80
70
60
50
40
30
20
10
For type "C" traffic areas, multiply 1.33 times the allowable gross weight for type "B" traffic areas.
To determine AGL, select thickness, come vertically to desired pass level, go horizontally to subgrade CBR, and then down to allowable gross load.
Passes
10
100
500
1000
5000
15000
50000
CBR, %
3
4
5
6
7
8
9
10
12
15
17
20
25
30
35
40
50
60
70
80
90
100
40,000
60,000
80,000
100,000
120,000
140,000
160,000
180,000
200,000
220,000
Aircraft Gross Weight, Pounds for Type B & C Traffic Area

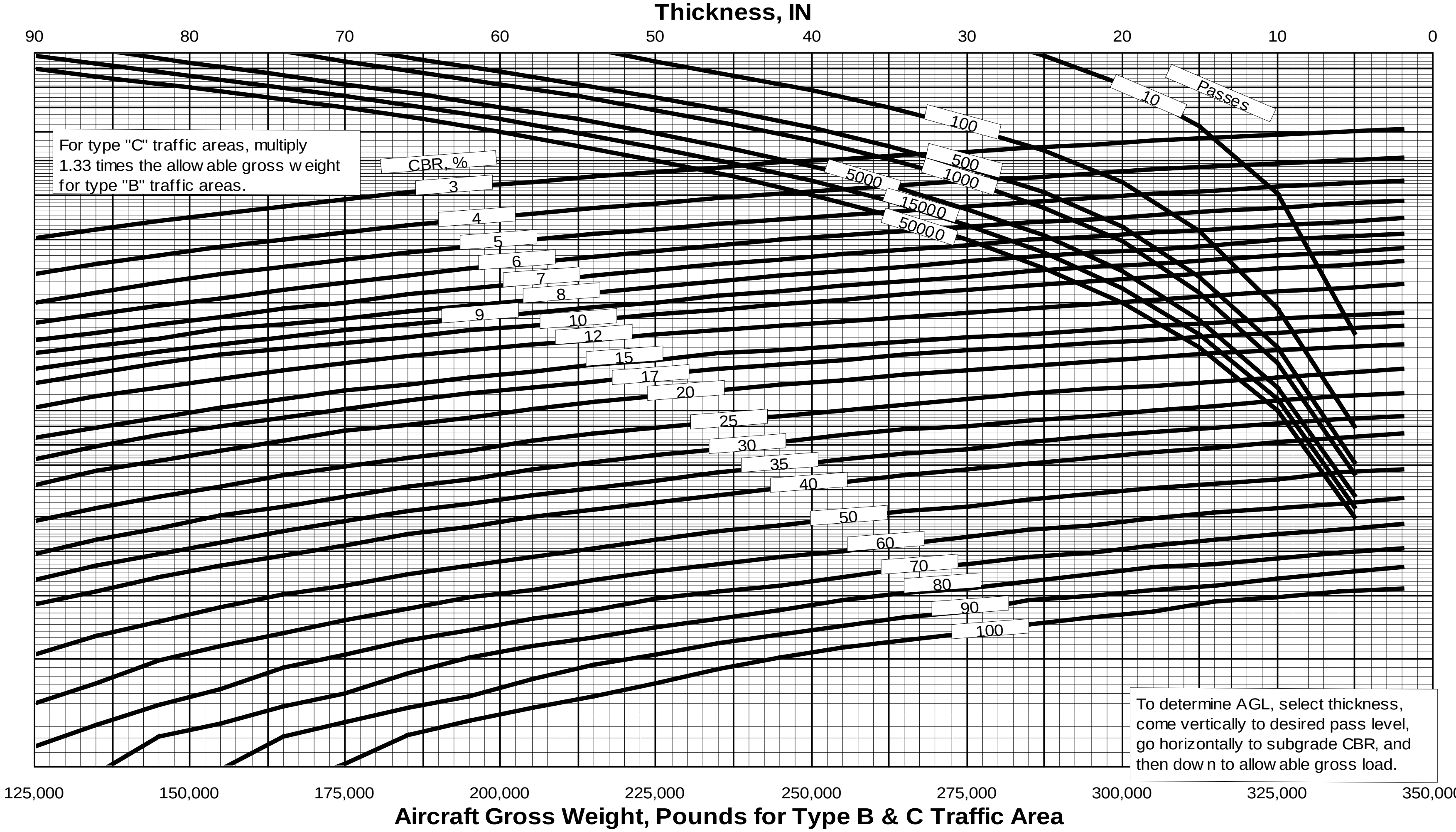

Flexible Pavement Evaluation Allowable Passes - A Traffic Area
C-130H
Thickness, IN
1
10
100
To determine allowable passes, select thickness, come vertically to desired load, go horizontally to subgrade CBR, and then down to allowable passes.
CBR, %
3
4
5
6
7
8
9
10
12
15
17
20
25
30
35
40
50
60
70
80
90
100
Load, Pounds
50000
75000
100000
125000
155000
175000
10
100
1,000
10,000
100,000
Allowable Aircraft Passes for Type A Traffic Area


Flexible Pavement Evaluation Allowable Passes - B & C Traffic Area
C-130H
Thickness, IN
1
10
100
To determine allowable passes, select thickness, come vertically to desired load, go horizontally to subgrade CBR, and then down to allowable passes.
CBR, %
3
4
5
6
7
8
9
10
12
15
17
20
25
30
35
40
50
60
70
80
90
100
Load, Pounds
50000
75000
100000
125000
155000
175000
10
100
1,000
10,000
100,000
Allowable Aircraft Passes for Type B & C Traffic Area

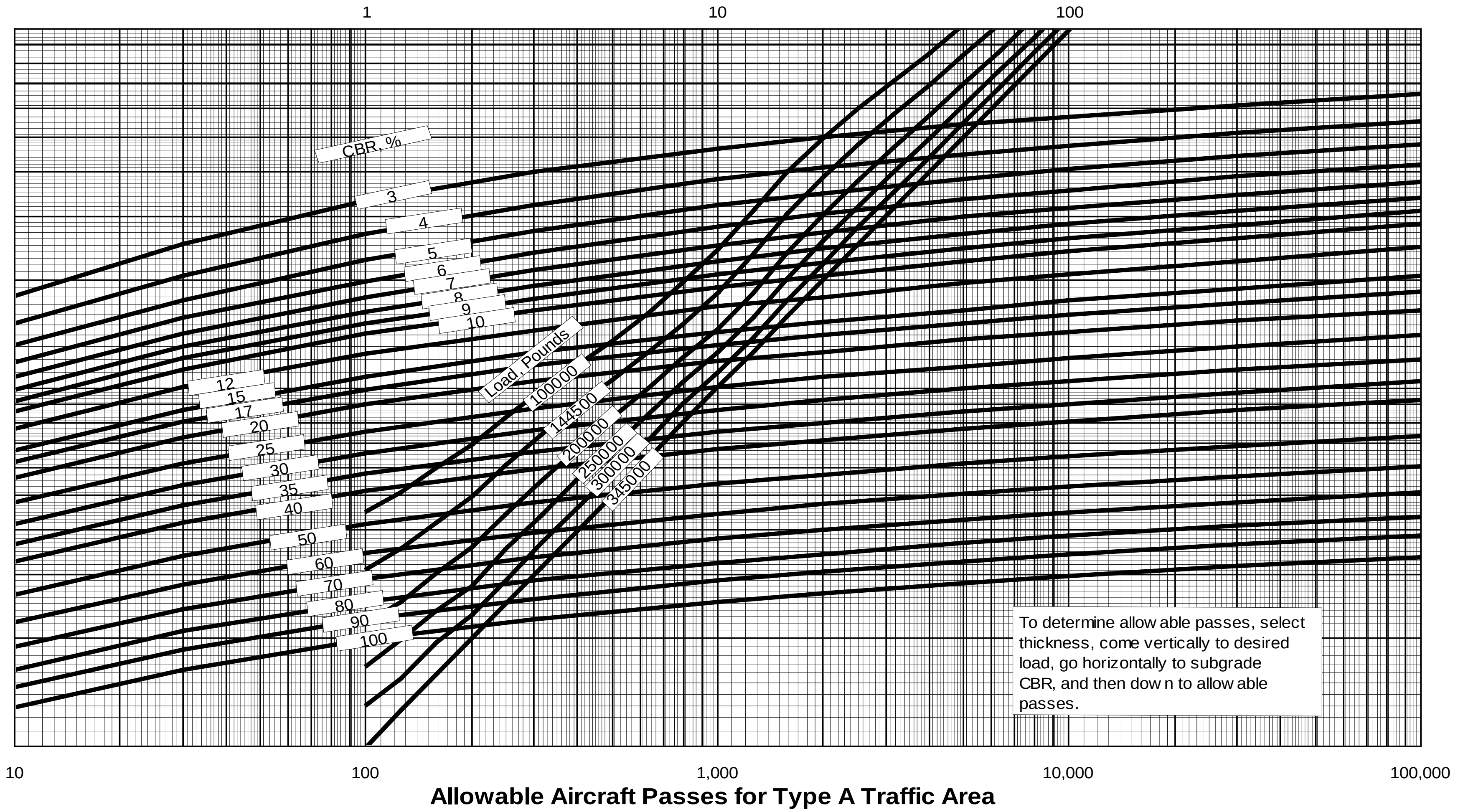
## Flexible Pavement Evaluation Allowable Gross Load - A Traffic Area
## C-141

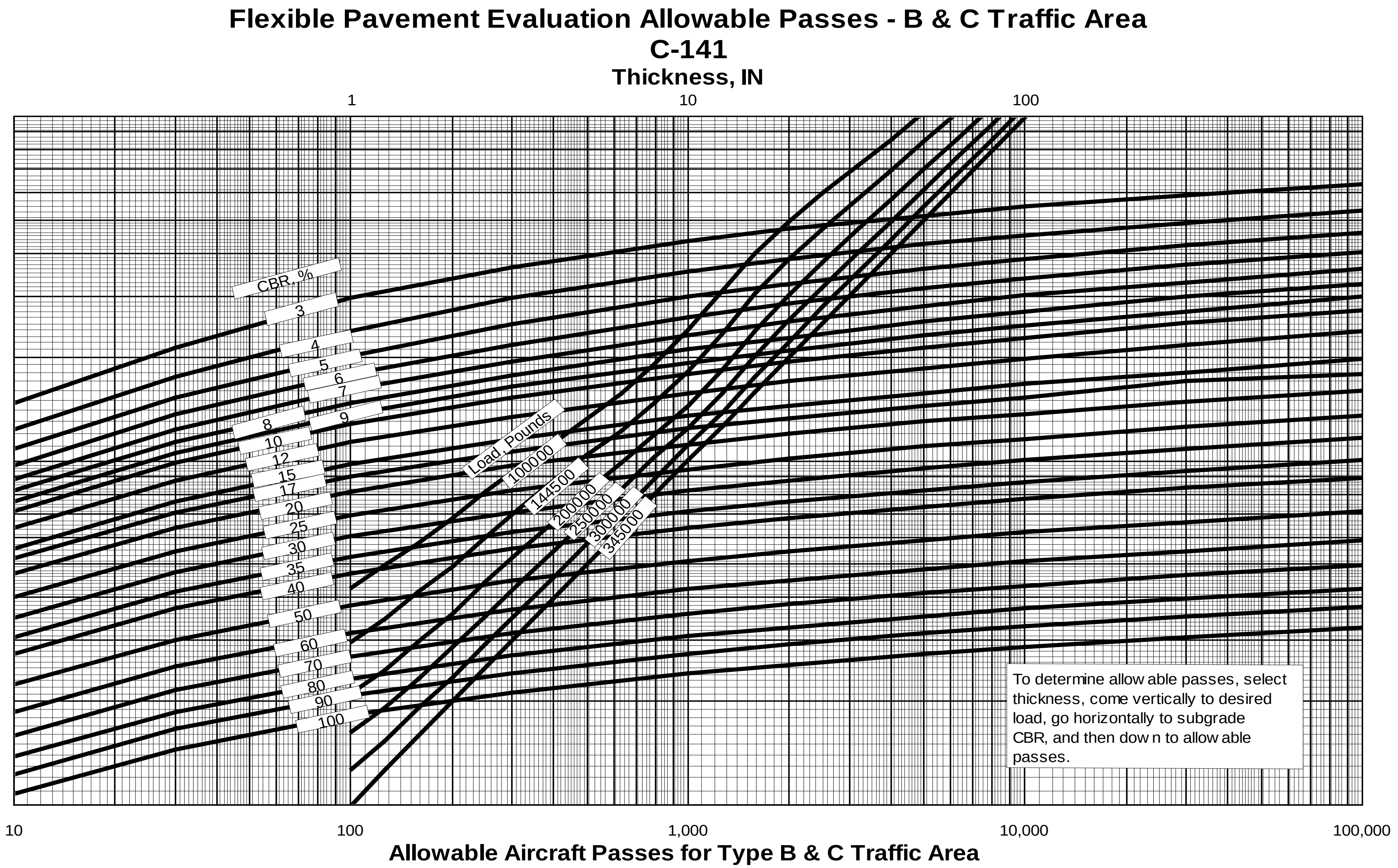


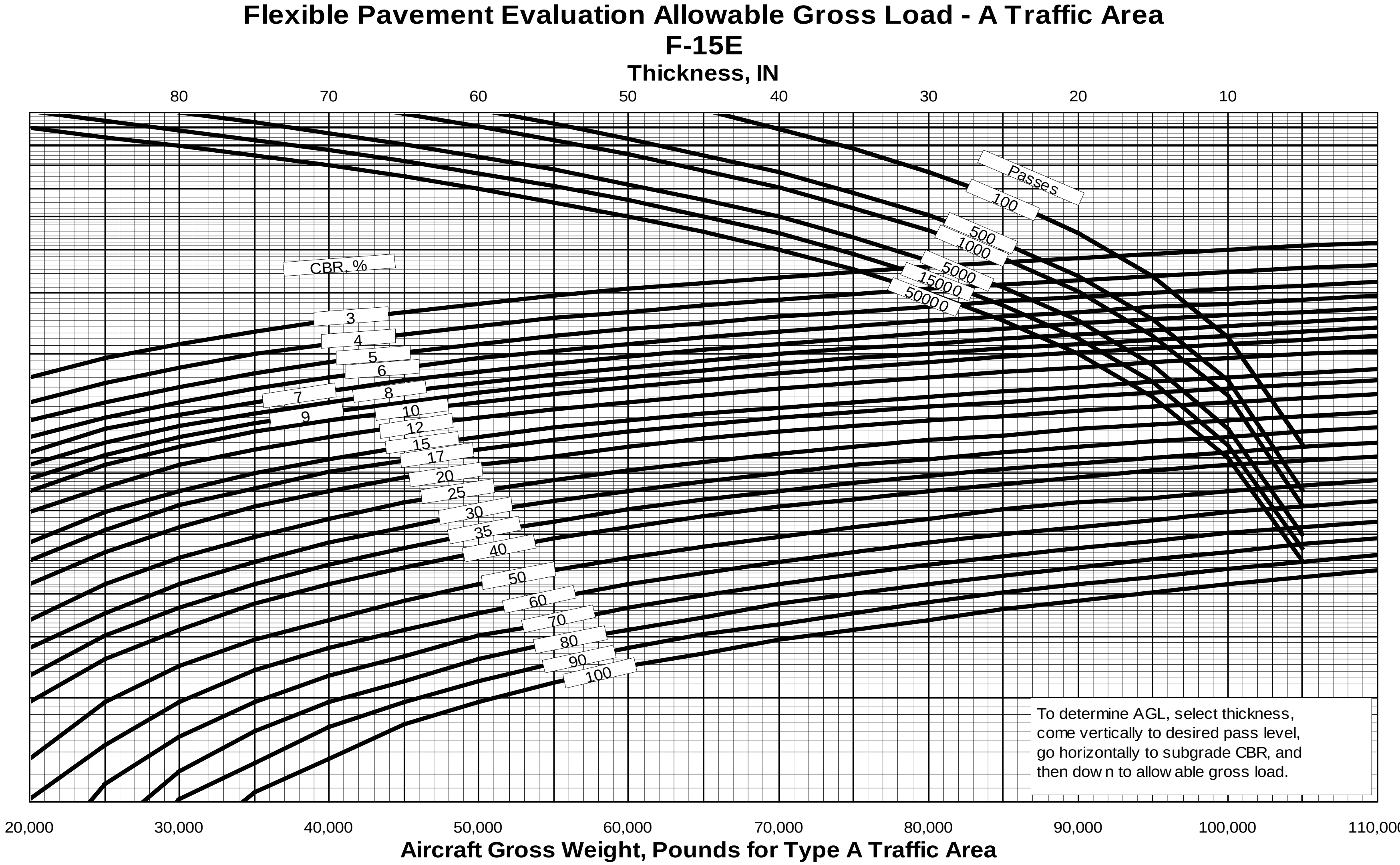
**Flexible Pavement Evaluation Allowable Gross Load - B & C Traffic Area**
**C-141**

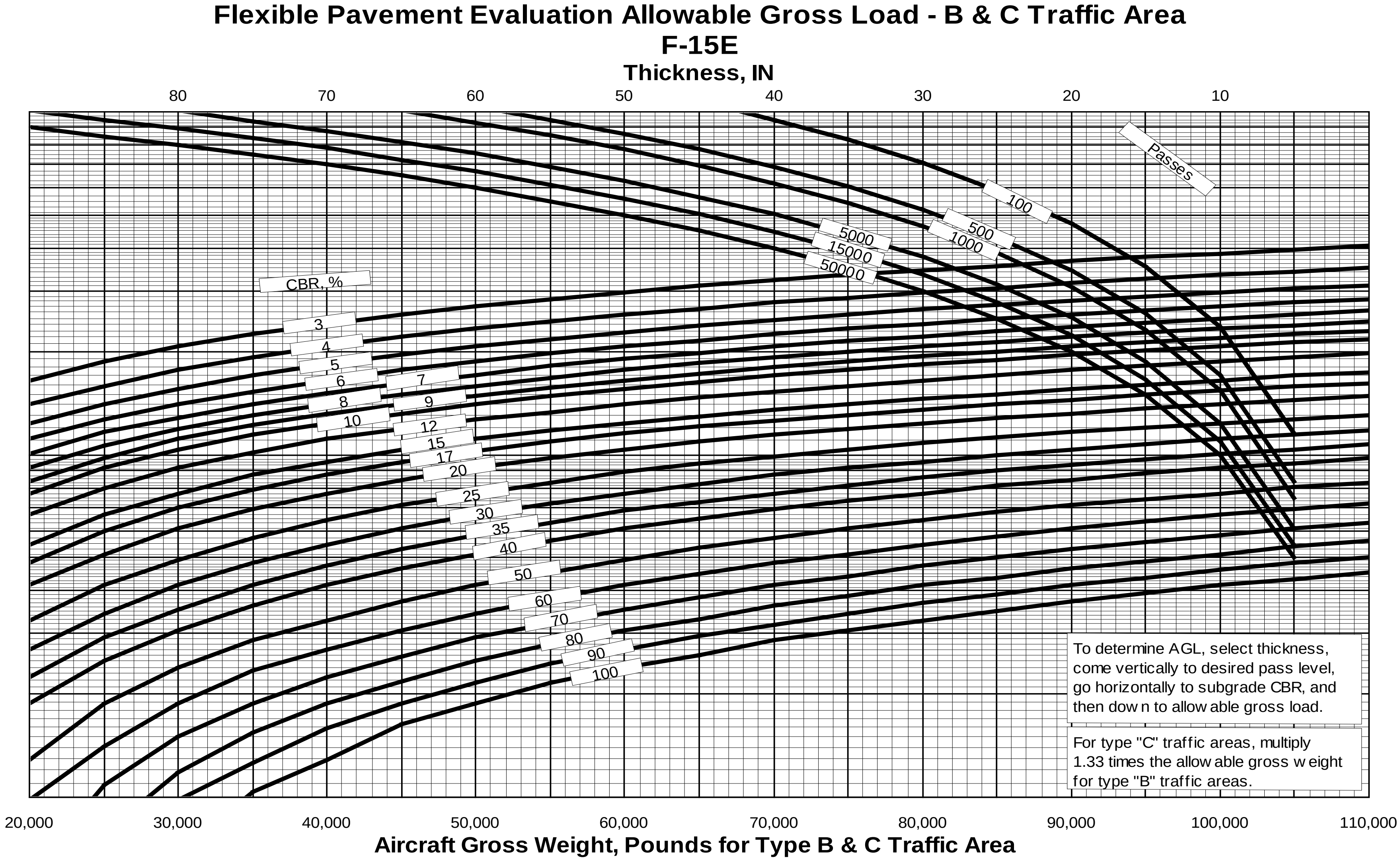


## Flexible Pavement Evaluation Allowable Passes - A Traffic Area
## C-141

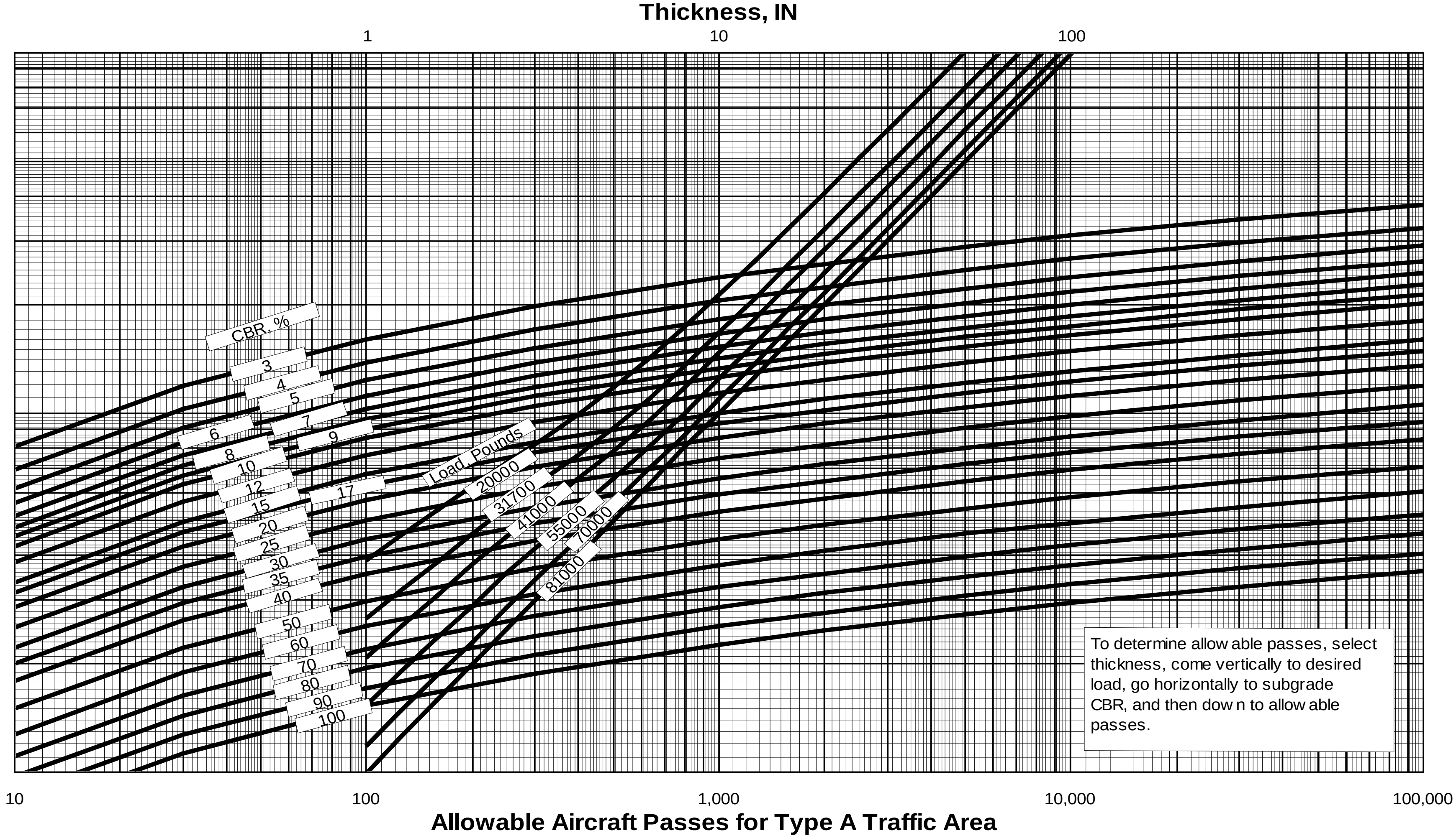



Flexible Pavement Evaluation Allowable Passes - B & C Traffic Area
C-141
Thickness, IN
1
10
100
CBR, %
3
4
5
6
7
8
9
10
12
15
17
20
25
30
35
40
50
60
70
80
90
100
Load, Pounds
100000
144500
200000
250000
300000
345000
To determine allowable passes, select thickness, come vertically to desired load, go horizontally to subgrade CBR, and then down to allowable passes.
10
100
1,000
10,000
100,000
Allowable Aircraft Passes for Type B & C Traffic Area

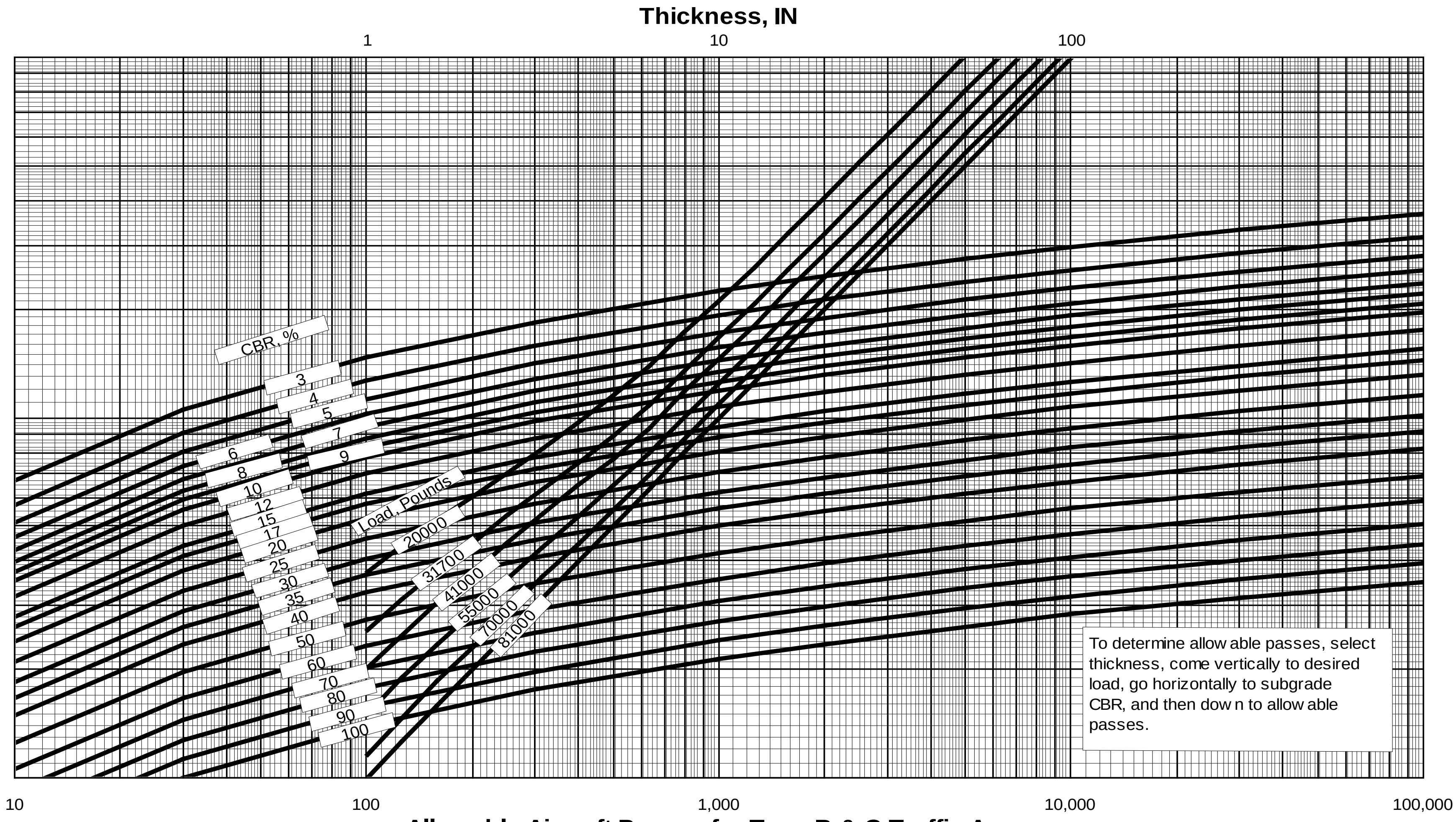

Flexible Pavement Evaluation Allowable Gross Load - A Traffic Area
F-15E
Thickness, IN
80
70
60
50
40
30
20
10
Passes
100
500
1000
5000
15000
50000
CBR, %
3
4
5
6
7
8
9
10
12
15
17
20
25
30
35
40
50
60
70
80
90
100
To determine AGL, select thickness, come vertically to desired pass level, go horizontally to subgrade CBR, and then dow n to allow able gross load.
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
110,000
Aircraft Gross Weight, Pounds for Type A Traffic Area


Flexible Pavement Evaluation Allowable Gross Load - B & C Traffic Area
F-15E
Thickness, IN
80
70
60
50
40
30
20
10
Passes
100
500
1000
5000
15000
50000
CBR, %
3
4
5
6
7
8
9
10
12
15
17
20
25
30
35
40
50
60
70
80
90
100
To determine AGL, select thickness, come vertically to desired pass level, go horizontally to subgrade CBR, and then down to allowable gross load.
For type "C" traffic areas, multiply 1.33 times the allowable gross weight for type "B" traffic areas.
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
110,000
Aircraft Gross Weight, Pounds for Type B & C Traffic Area

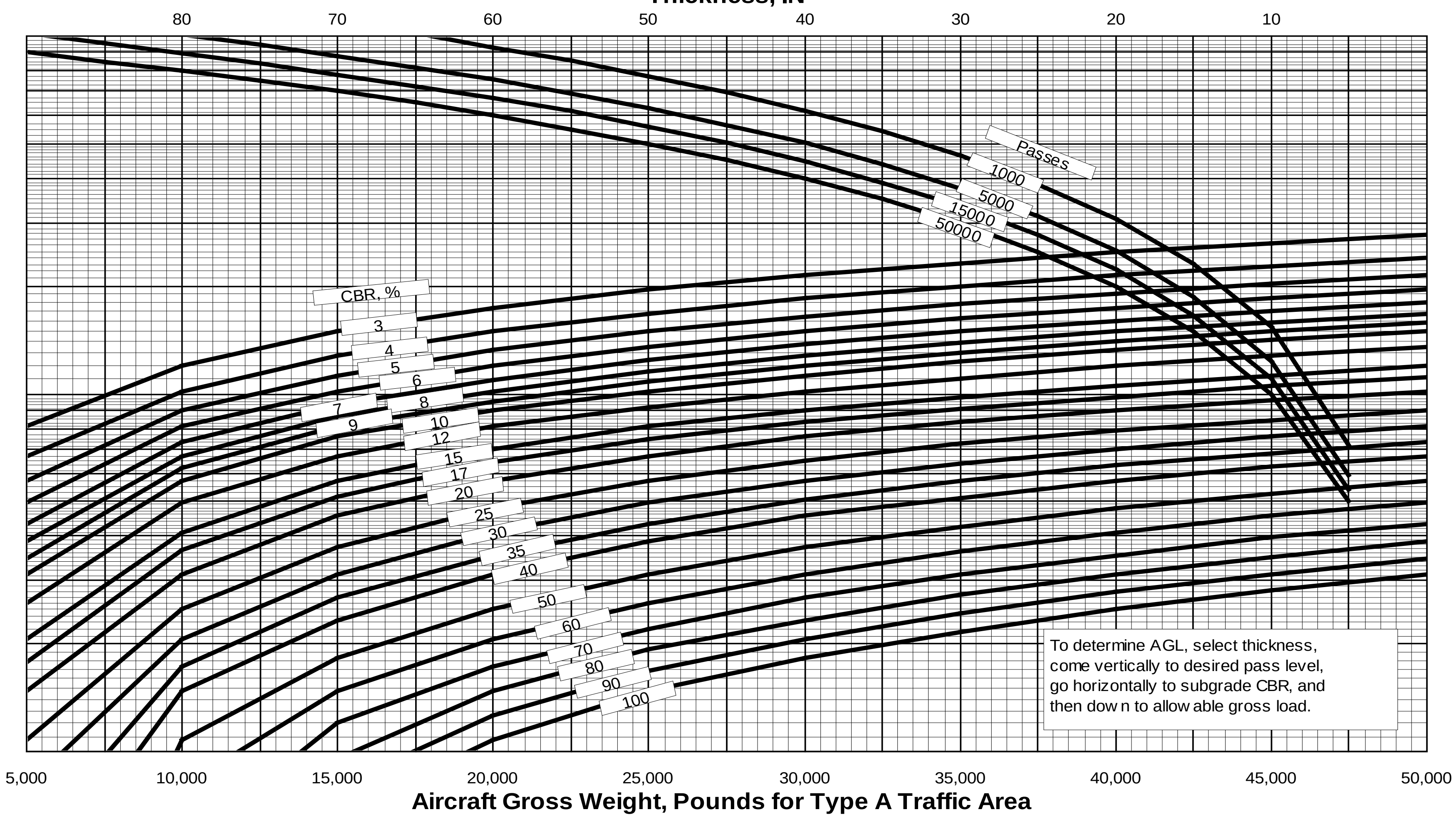
## Flexible Pavement Evaluation Allowable Passes - A Traffic Area
## F-15E



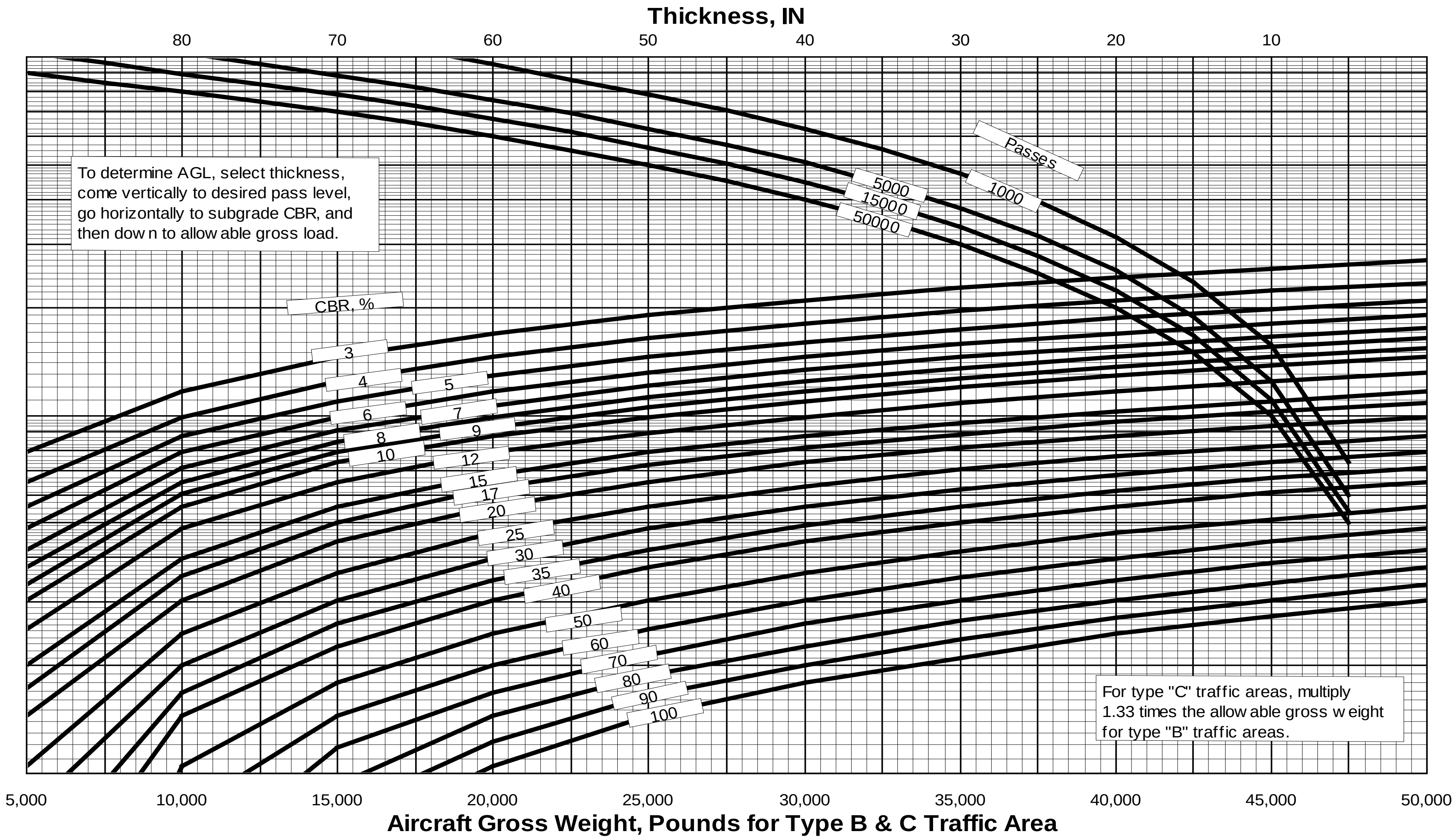
## Flexible Pavement Evaluation Allowable Passes - B & C Traffic Area
## F-15E



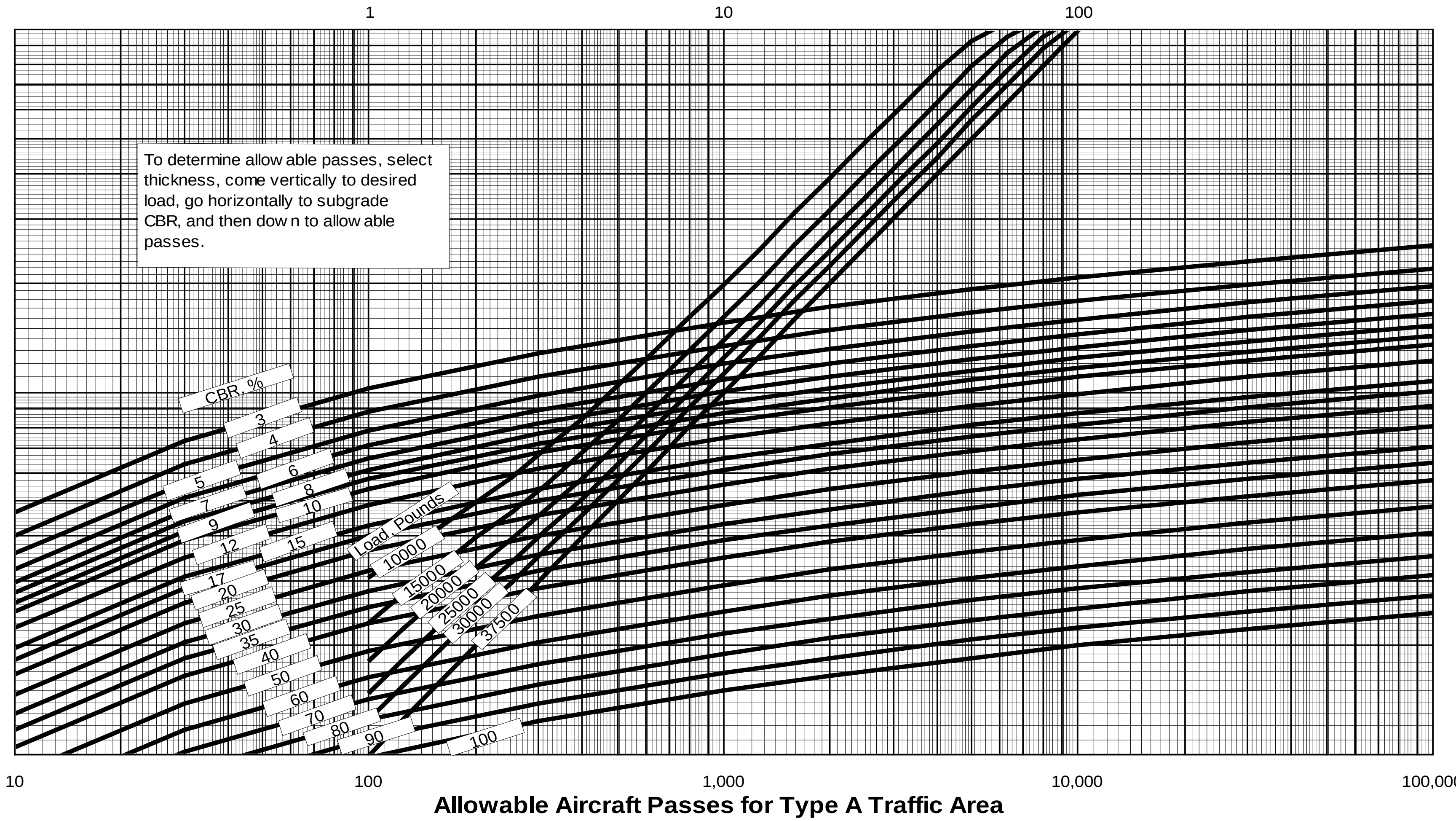
## Flexible Pavement Evaluation Allowable Gross Load - A Traffic Area
## F-16C/D



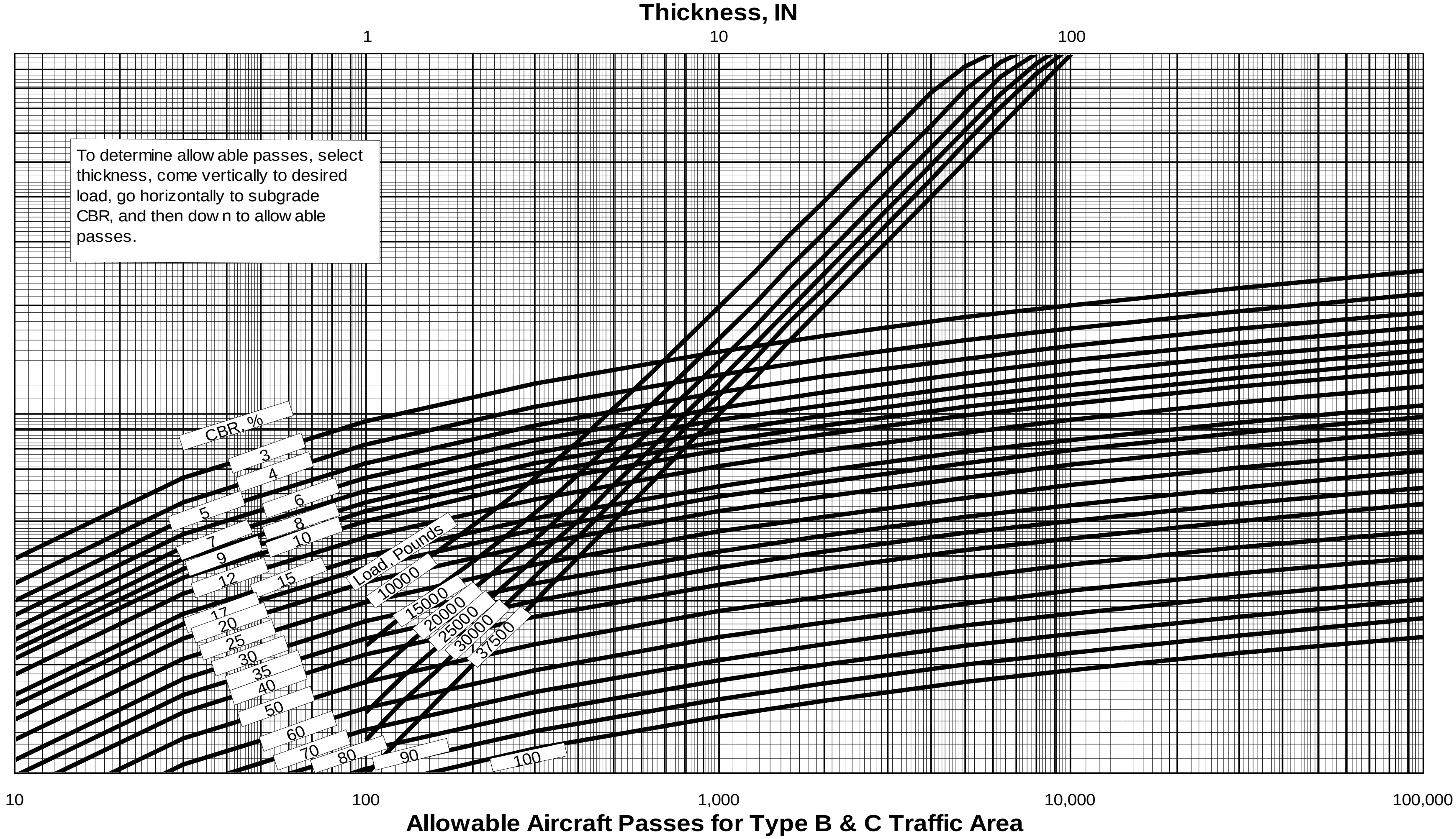
## Flexible Pavement Evaluation Allowable Gross Load - B & C Traffic Area
## F-16C/D



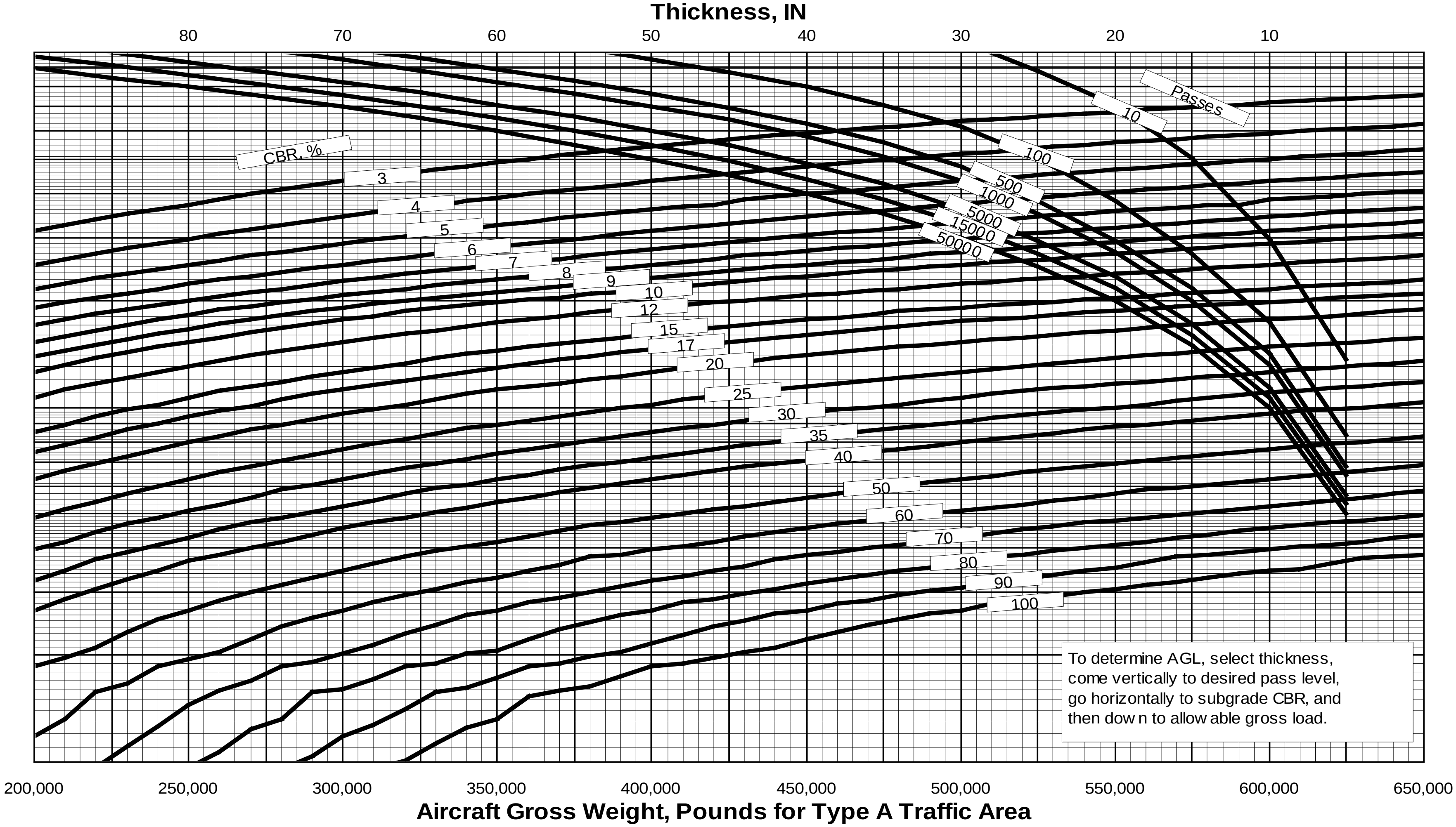
## Flexible Pavement Evaluation Allowable Passes - A Traffic Area
## F-16C/D

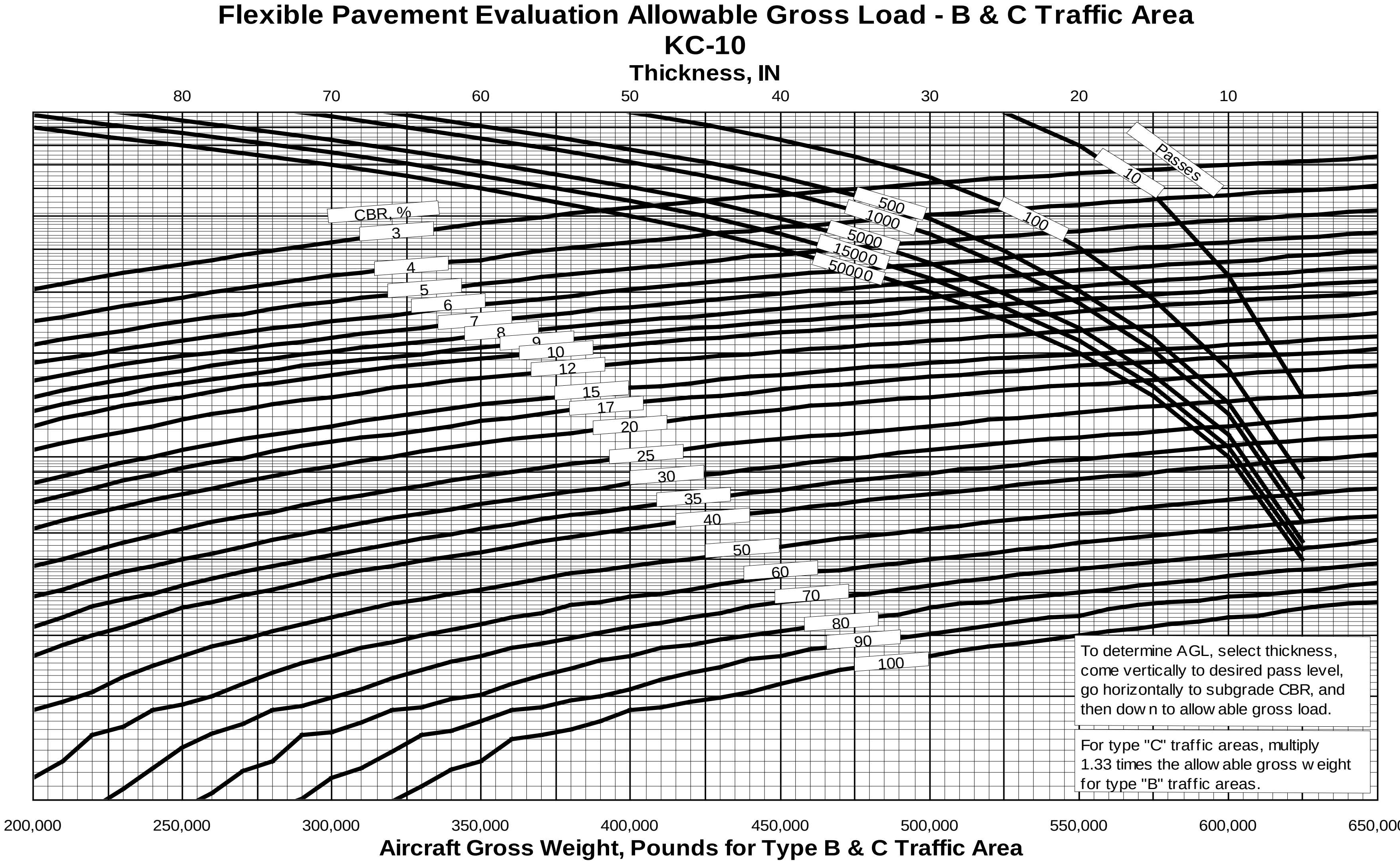


## Flexible Pavement Evaluation Allowable Passes - B & C Traffic Area
## F-16C/D

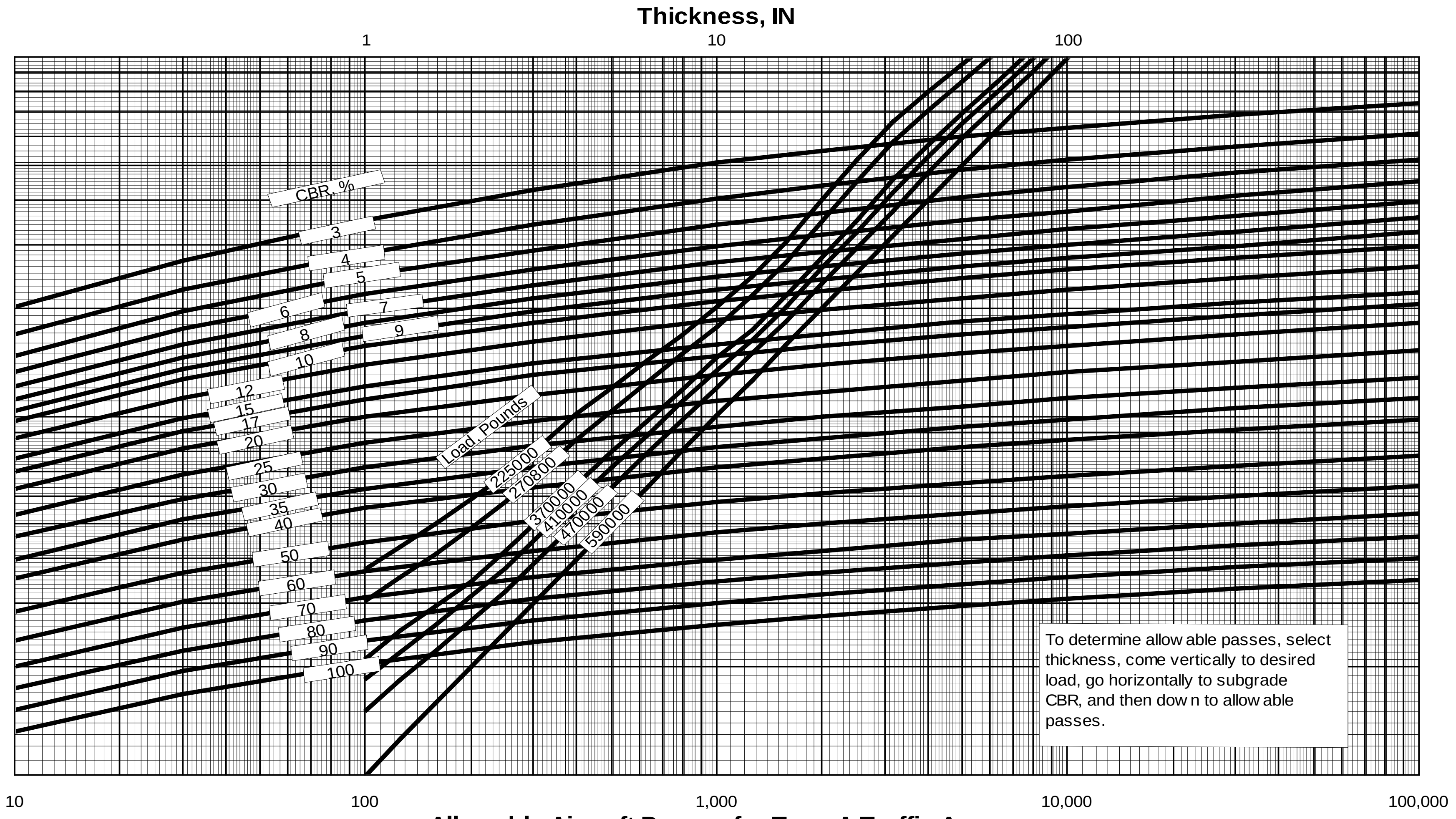


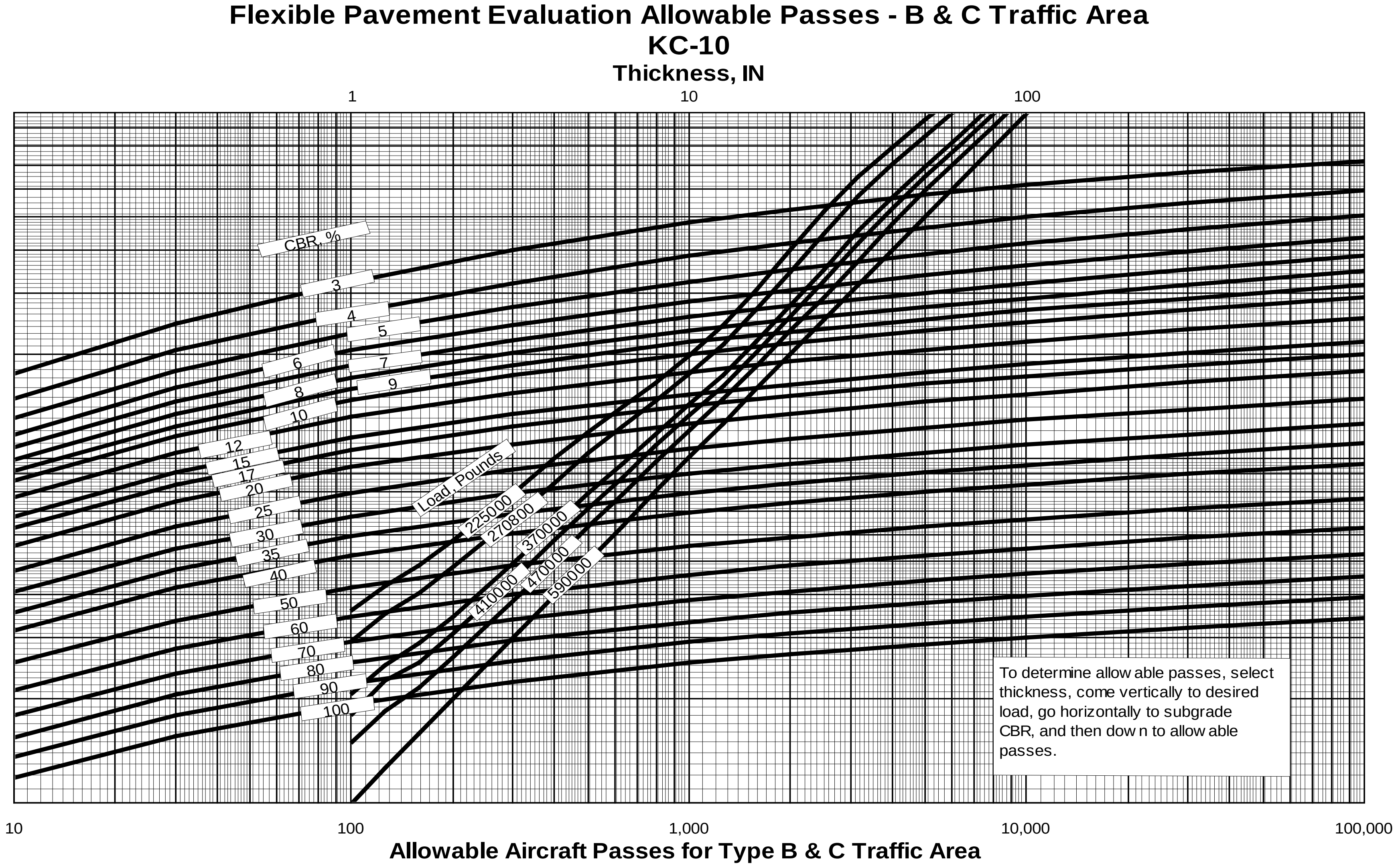
## Flexible Pavement Evaluation Allowable Gross Load - A Traffic Area
## KC-10

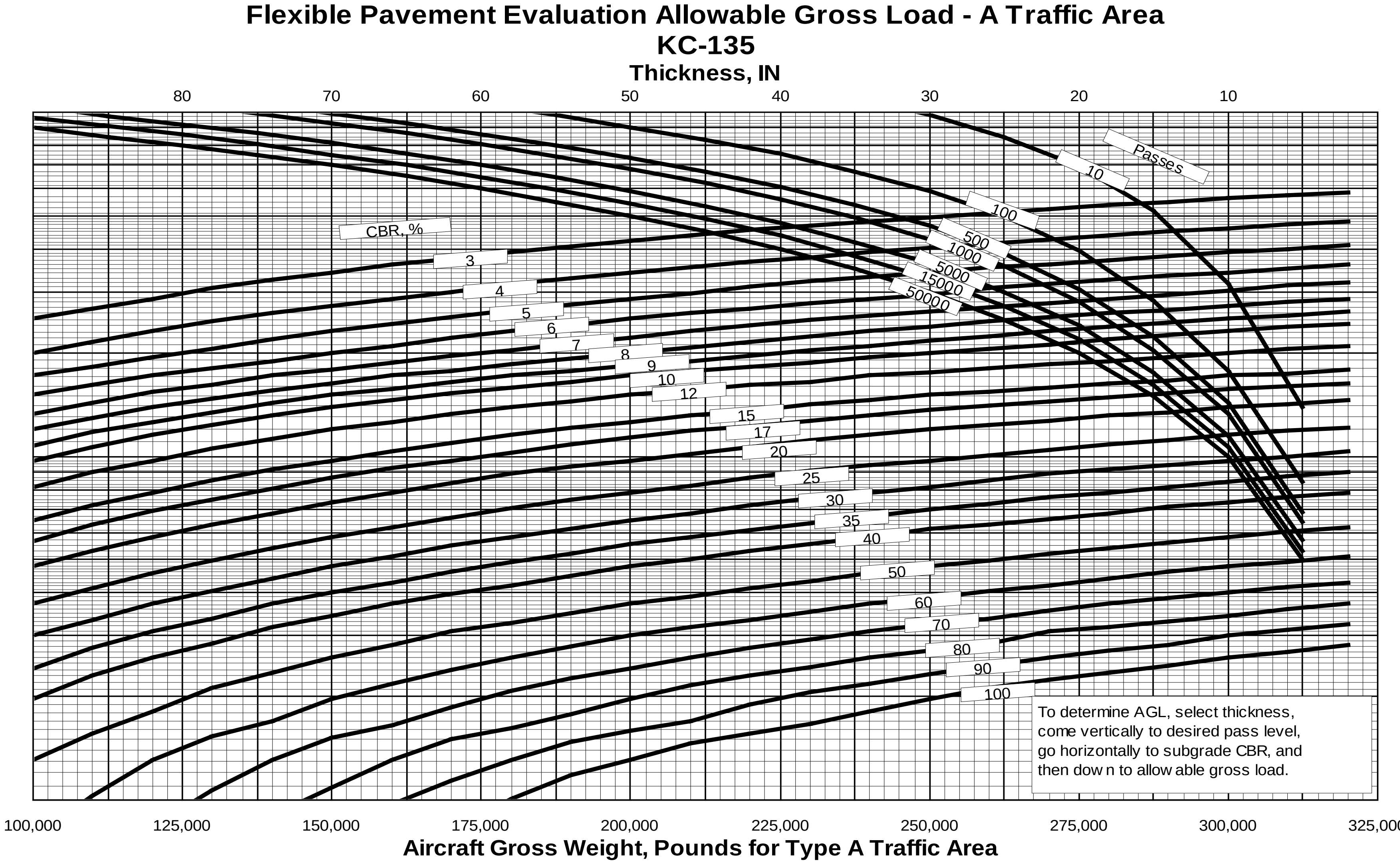



Flexible Pavement Evaluation Allowable Gross Load - B & C Traffic Area
KC-10
Thickness, IN
80
70
60
50
40
30
20
10
Passes
10
100
500
1000
5000
15000
50000
CBR, %
3
4
5
6
7
8
9
10
12
15
17
20
25
30
35
40
50
60
70
80
90
100
To determine AGL, select thickness, come vertically to desired pass level, go horizontally to subgrade CBR, and then down to allowable gross load.
For type "C" traffic areas, multiply 1.33 times the allowable gross weight for type "B" traffic areas.
200,000
250,000
300,000
350,000
400,000
450,000
500,000
550,000
600,000
650,000
Aircraft Gross Weight, Pounds for Type B & C Traffic Area

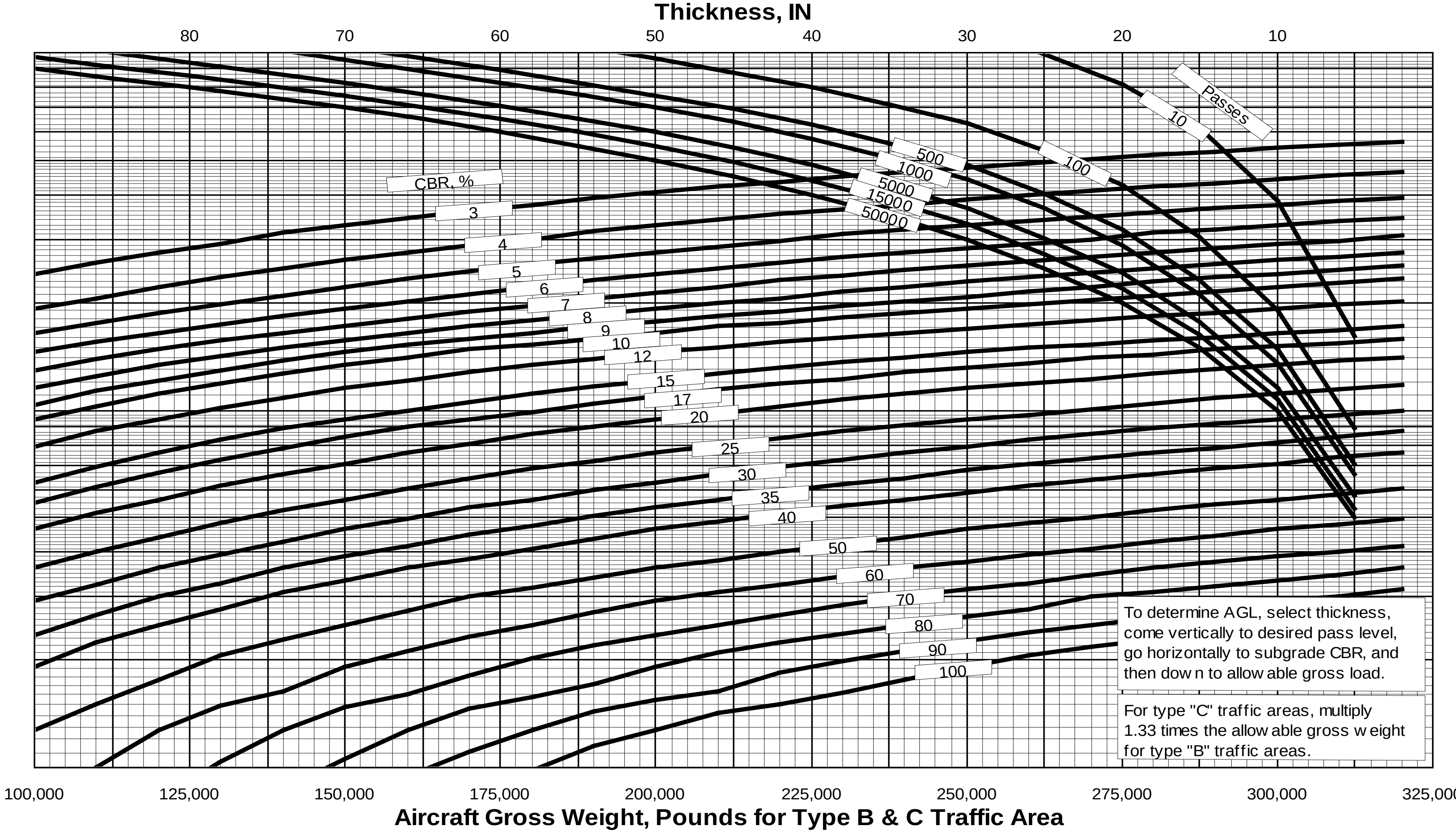
## Flexible Pavement Evaluation Allowable Passes - A Traffic Area
## KC-10

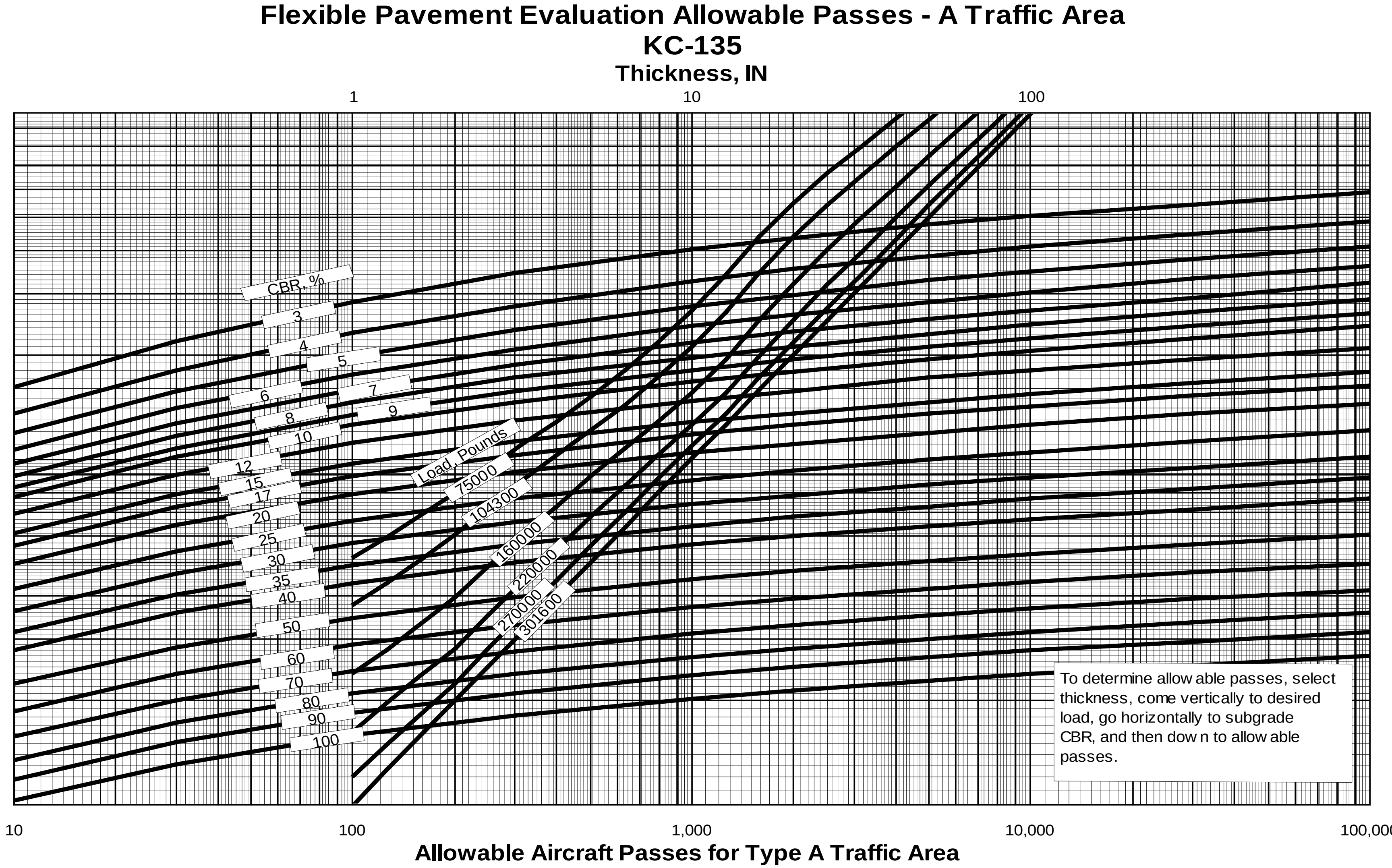



Flexible Pavement Evaluation Allowable Passes - B & C Traffic Area
KC-10
Thickness, IN
1
10
100
CBR, %
3
4
5
6
7
8
9
10
12
15
17
20
25
30
35
40
50
60
70
80
90
100
Load, Pounds
225000
270800
370000
410000
470000
590000
To determine allowable passes, select thickness, come vertically to desired load, go horizontally to subgrade CBR, and then down to allowable passes.
10
100
1,000
10,000
100,000
Allowable Aircraft Passes for Type B & C Traffic Area

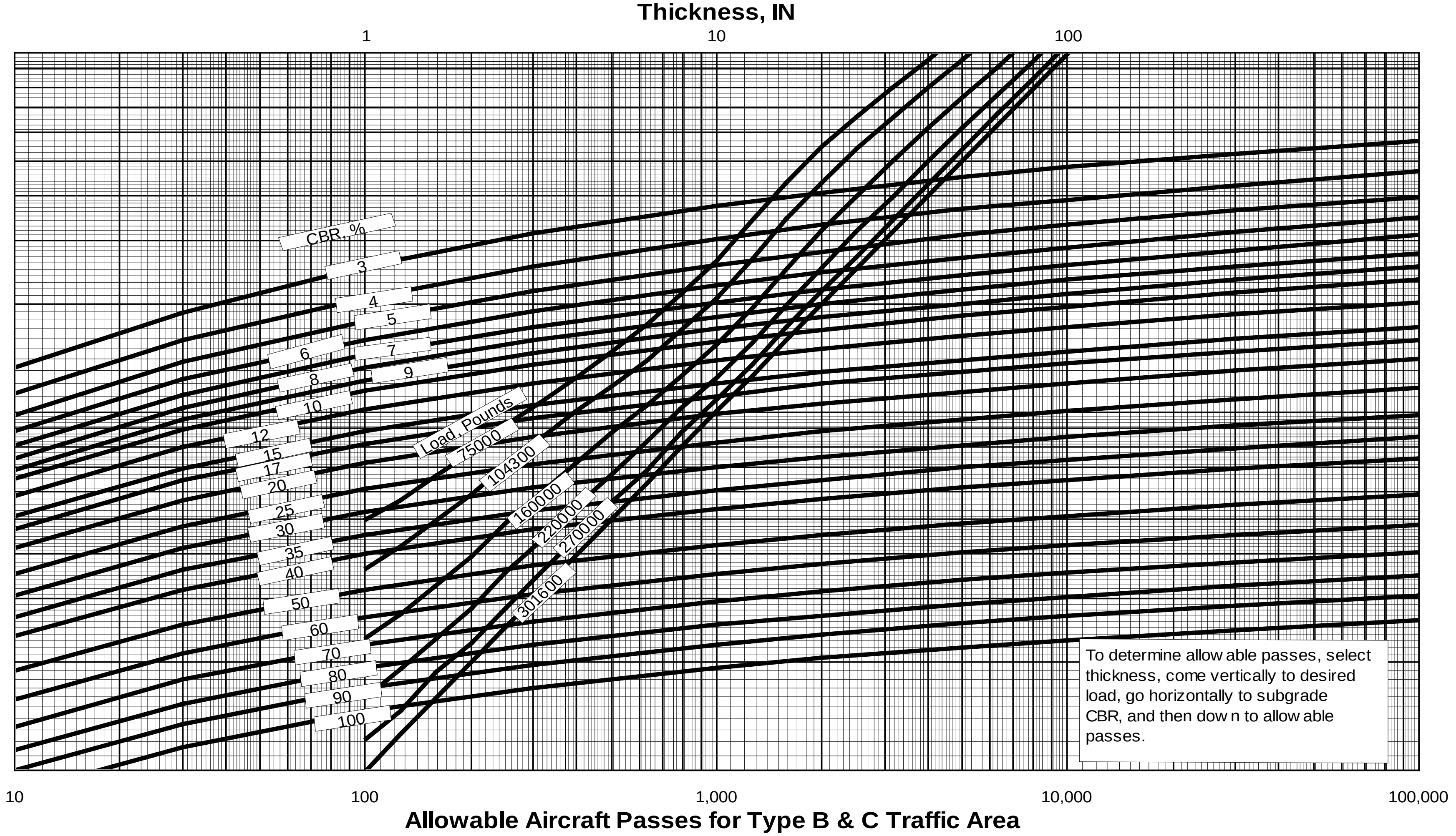

Flexible Pavement Evaluation Allowable Gross Load - A Traffic Area
KC-135
Thickness, IN
80
70
60
50
40
30
20
10
Passes
10
100
500
1000
5000
15000
50000
CBR, %
3
4
5
6
7
8
9
10
12
15
17
20
25
30
35
40
50
60
70
80
90
100
To determine AGL, select thickness, come vertically to desired pass level, go horizontally to subgrade CBR, and then down to allowable gross load.
100,000
125,000
150,000
175,000
200,000
225,000
250,000
275,000
300,000
325,000
Aircraft Gross Weight, Pounds for Type A Traffic Area

## Flexible Pavement Evaluation Allowable Gross Load - B & C Traffic Area
## KC-135



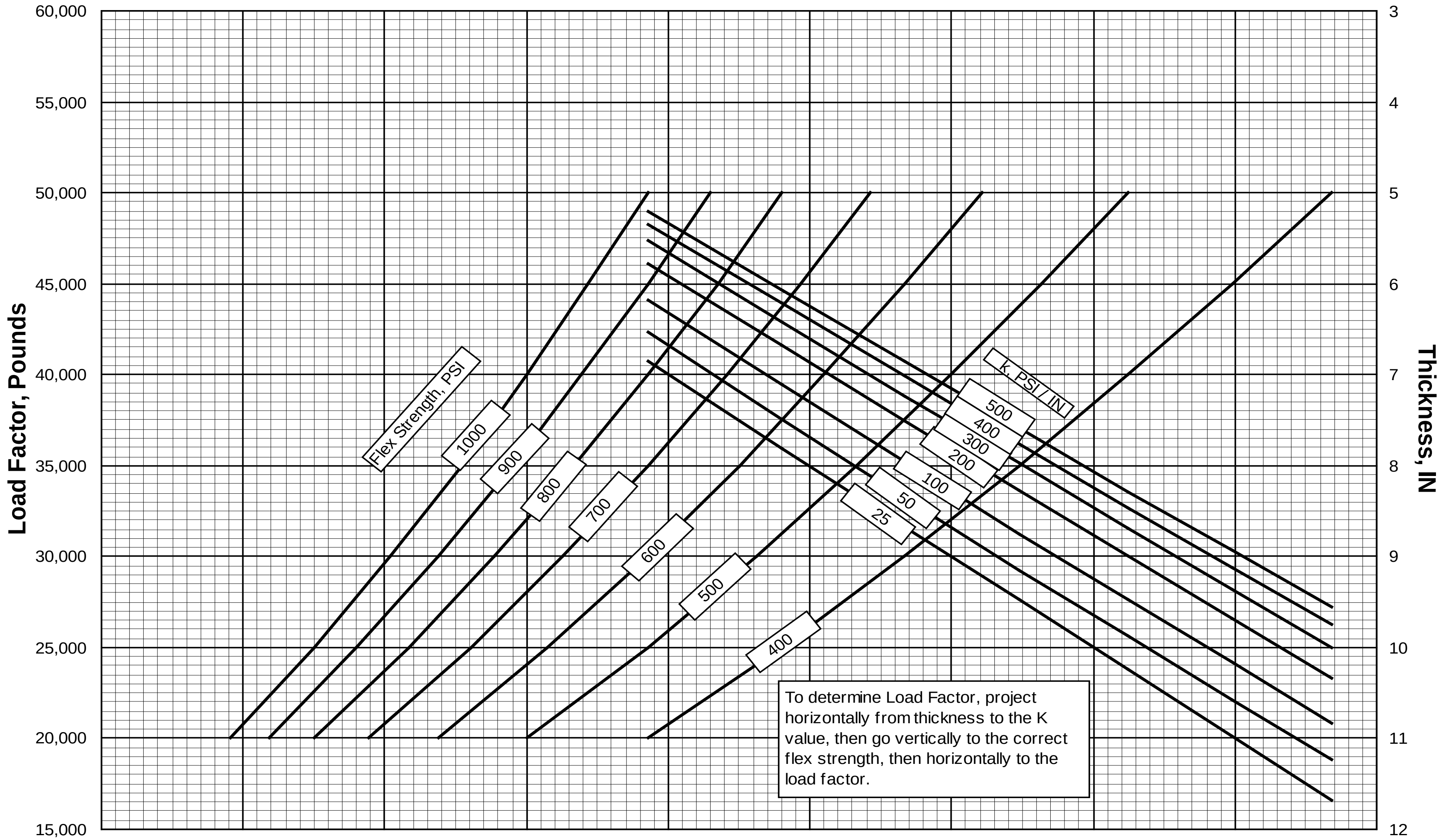

Flexible Pavement Evaluation Allowable Passes - A Traffic Area
KC-135
Thickness, IN
1
10
100
CBR, %
3
4
5
6
7
8
9
10
12
15
17
20
25
30
35
40
50
60
70
80
90
100
Load, Pounds
75000
104300
160000
220000
270000
301600
To determine allowable passes, select thickness, come vertically to desired load, go horizontally to subgrade CBR, and then down to allowable passes.
10
100
1,000
10,000
100,000
Allowable Aircraft Passes for Type A Traffic Area

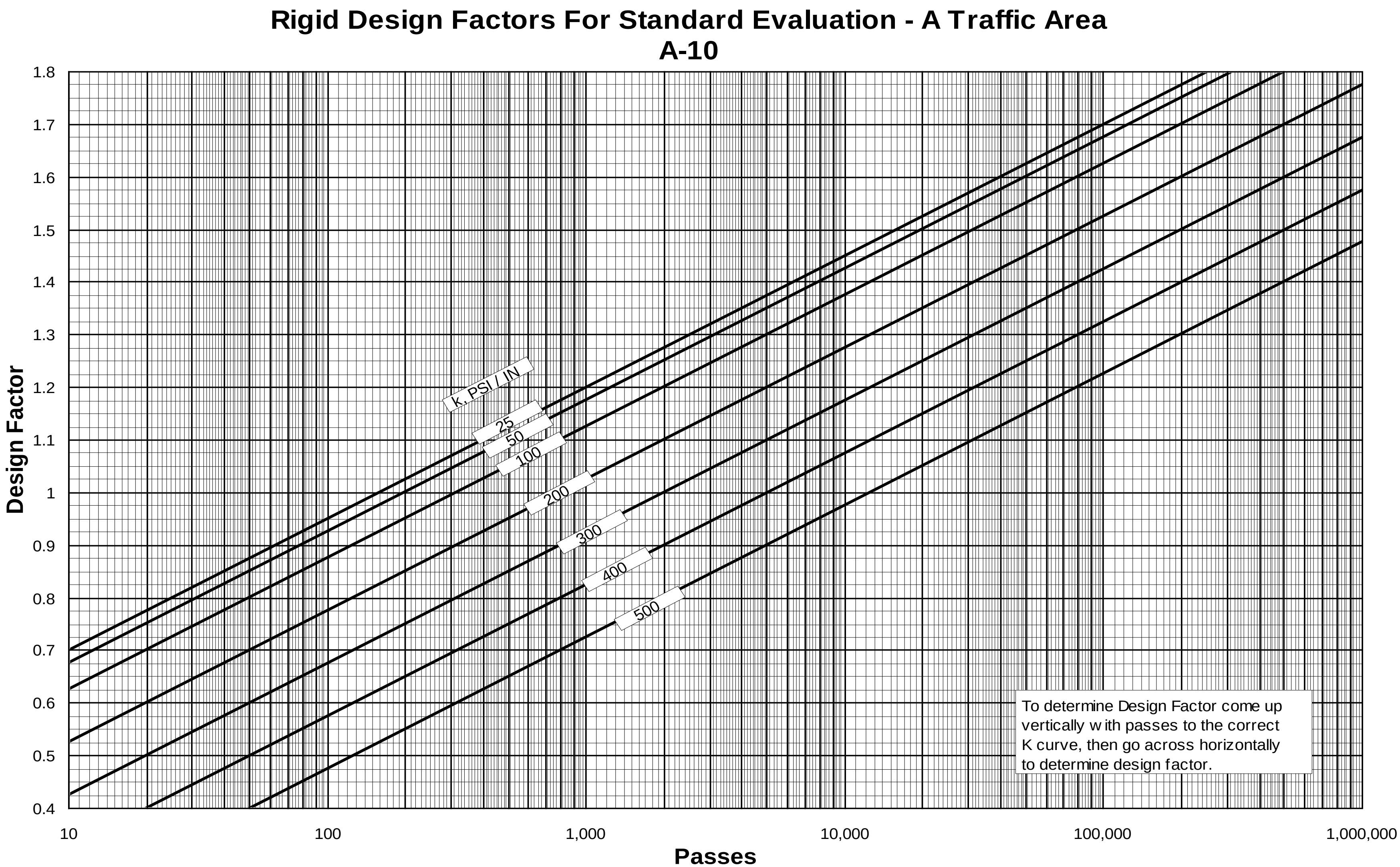
## Flexible Pavement Evaluation Allowable Passes - B & C Traffic Area
## KC-135

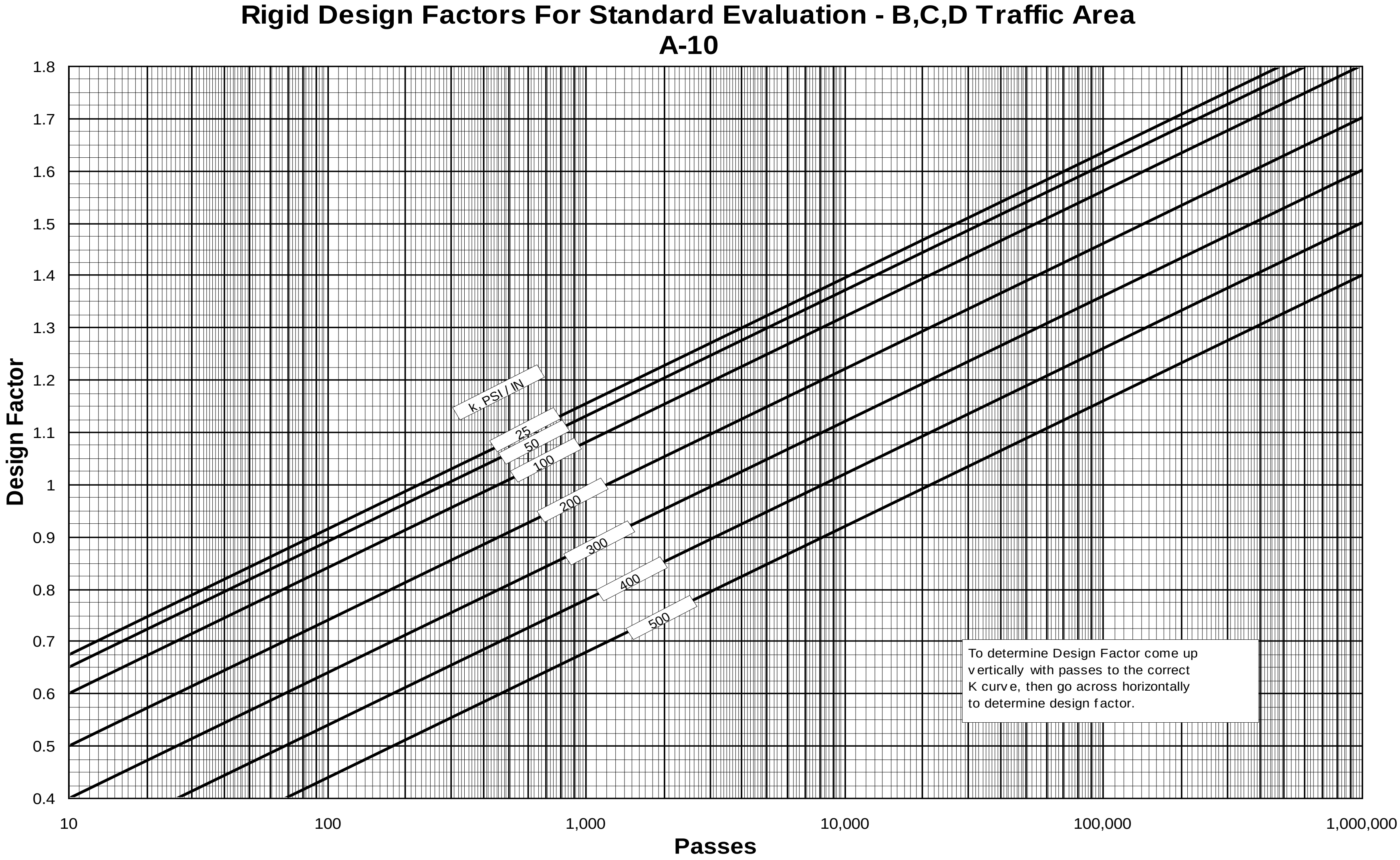


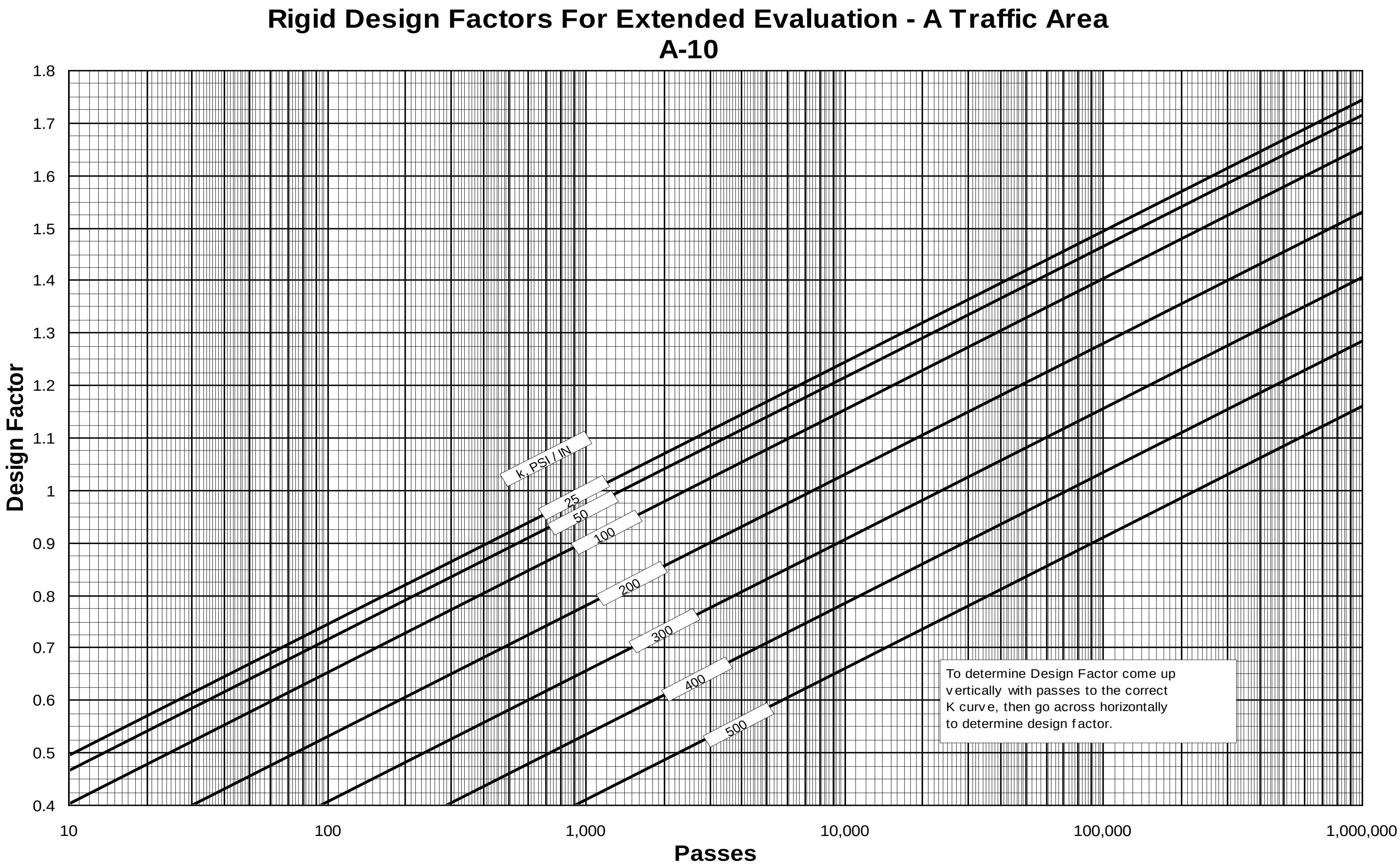
# APPENDIX F RIGID PAVEMENT EVALUATION CURVES

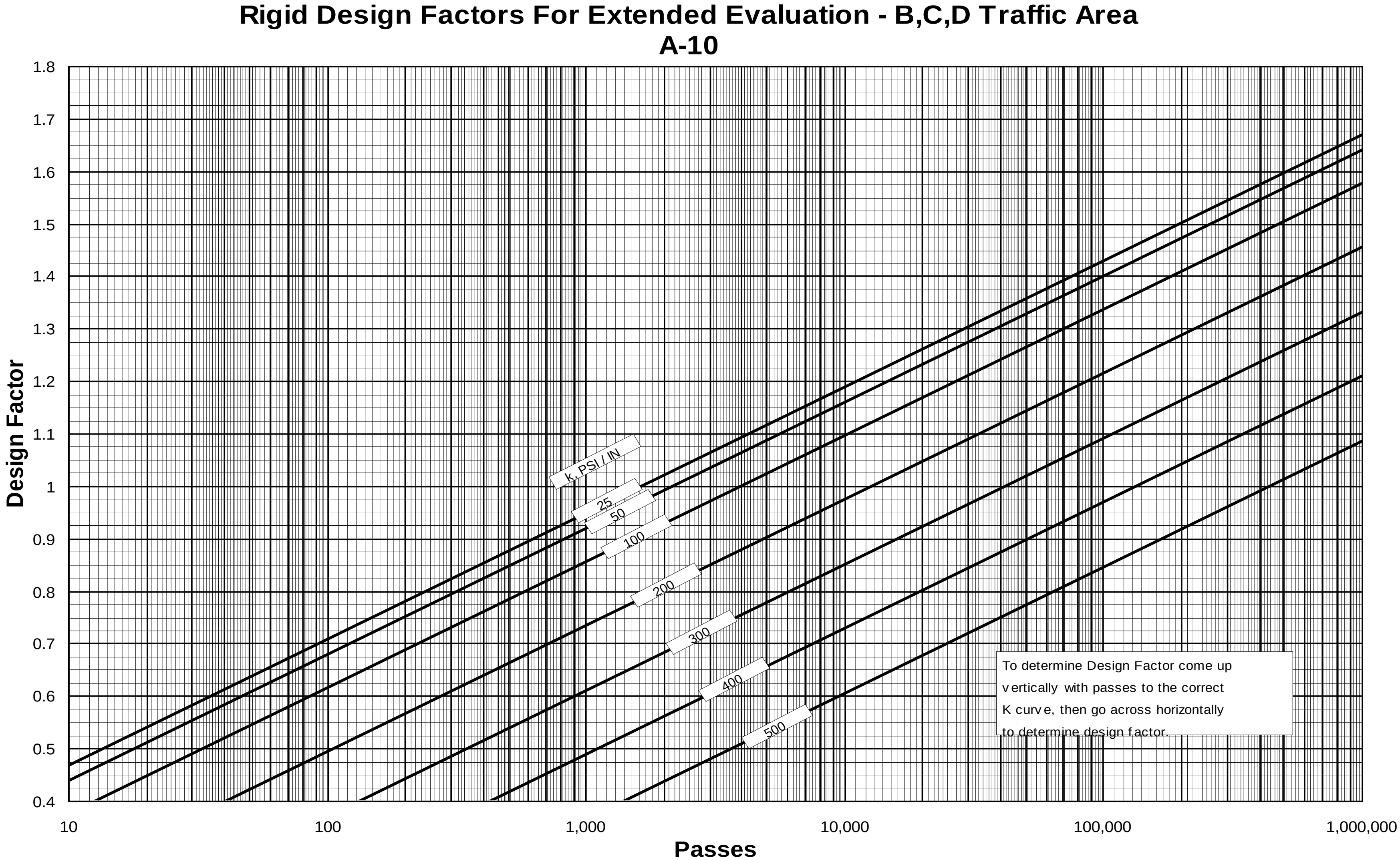
## Rigid Pavement Evaluation Load Factor
## A-10

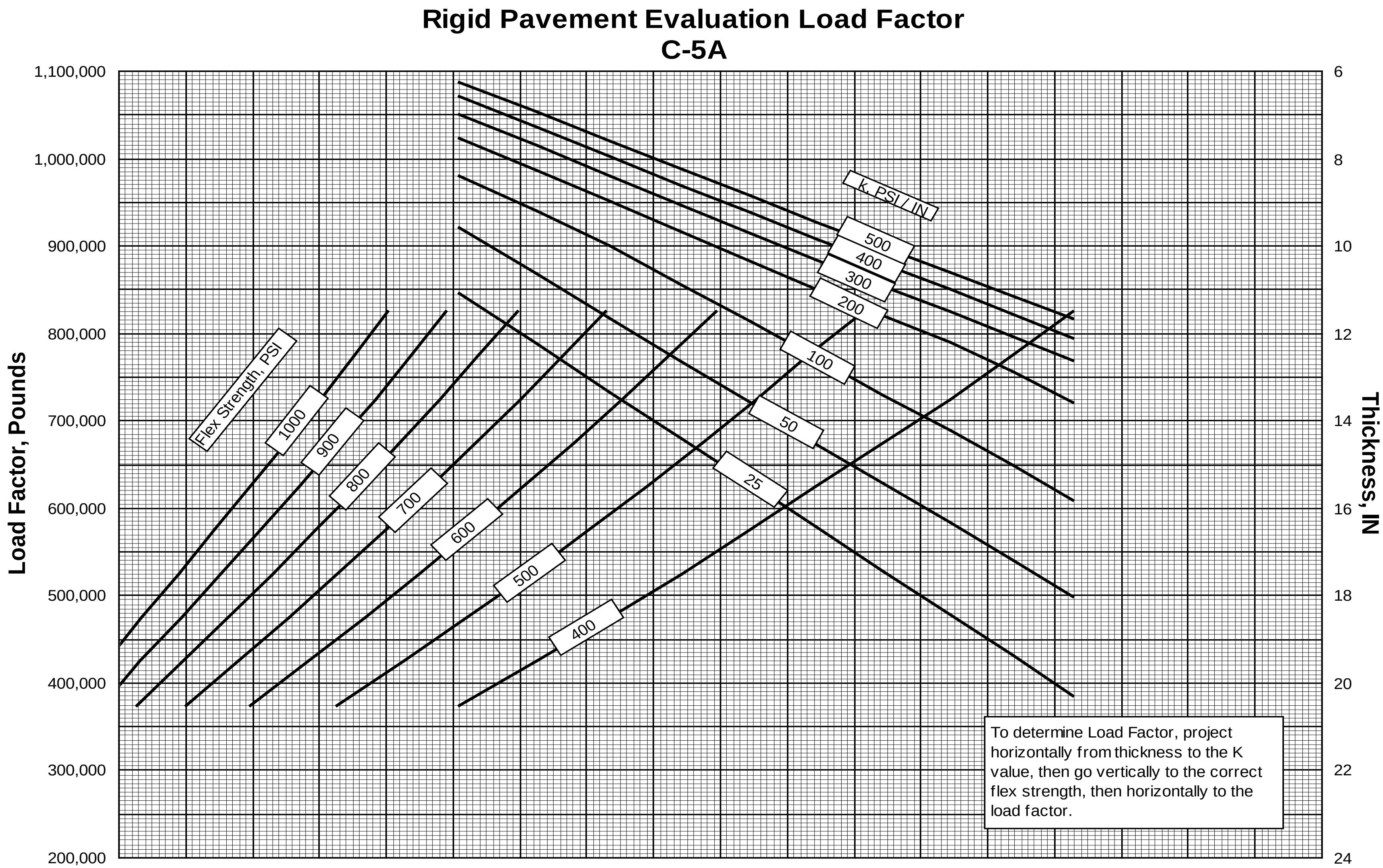


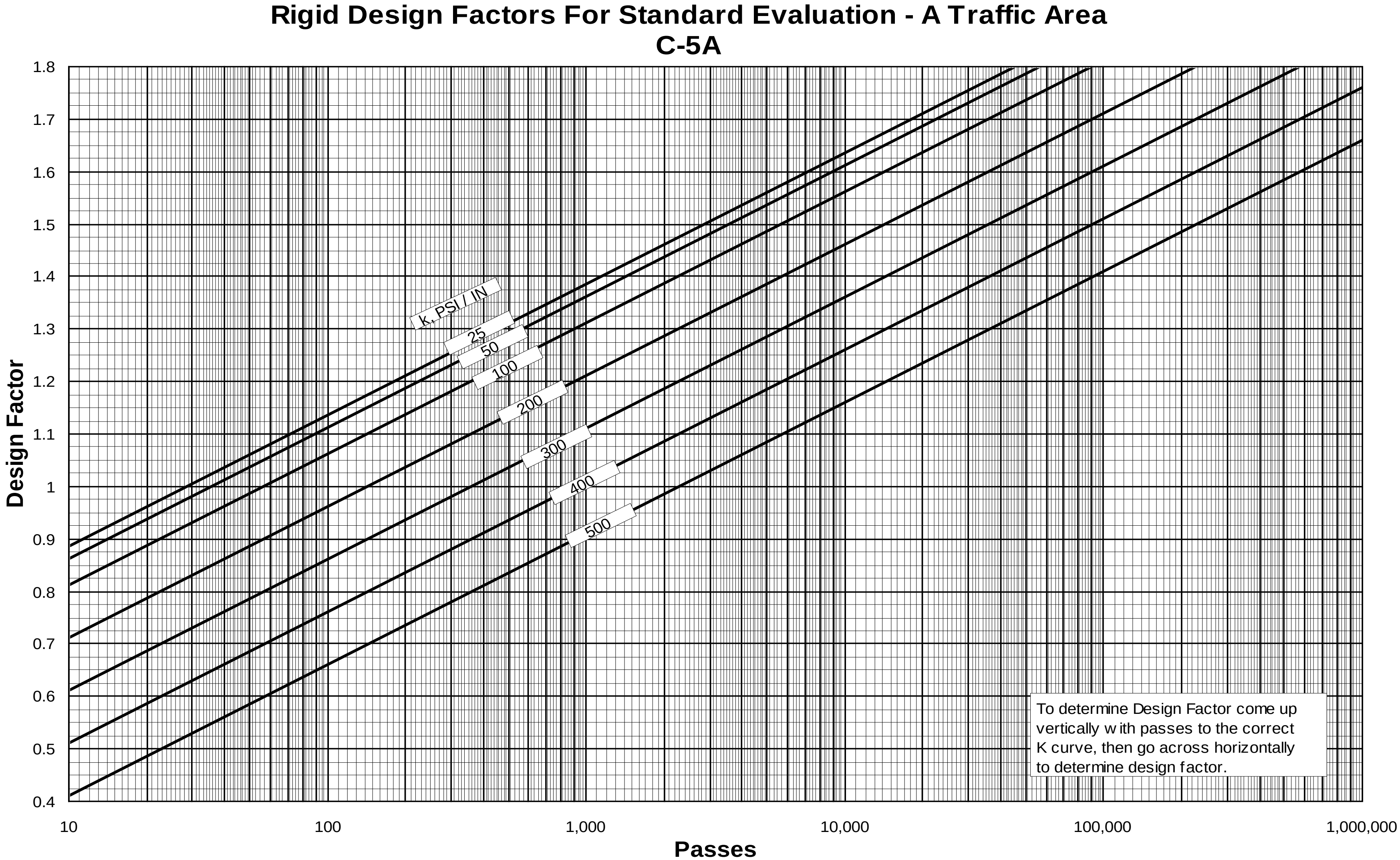

Rigid Design Factors For Standard Evaluation - A Traffic Area
A-10
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically w ith passes to the correct K curve, then go across horizontally to determine design factor.
10
100
1,000
10,000
100,000
1,000,000
Passes

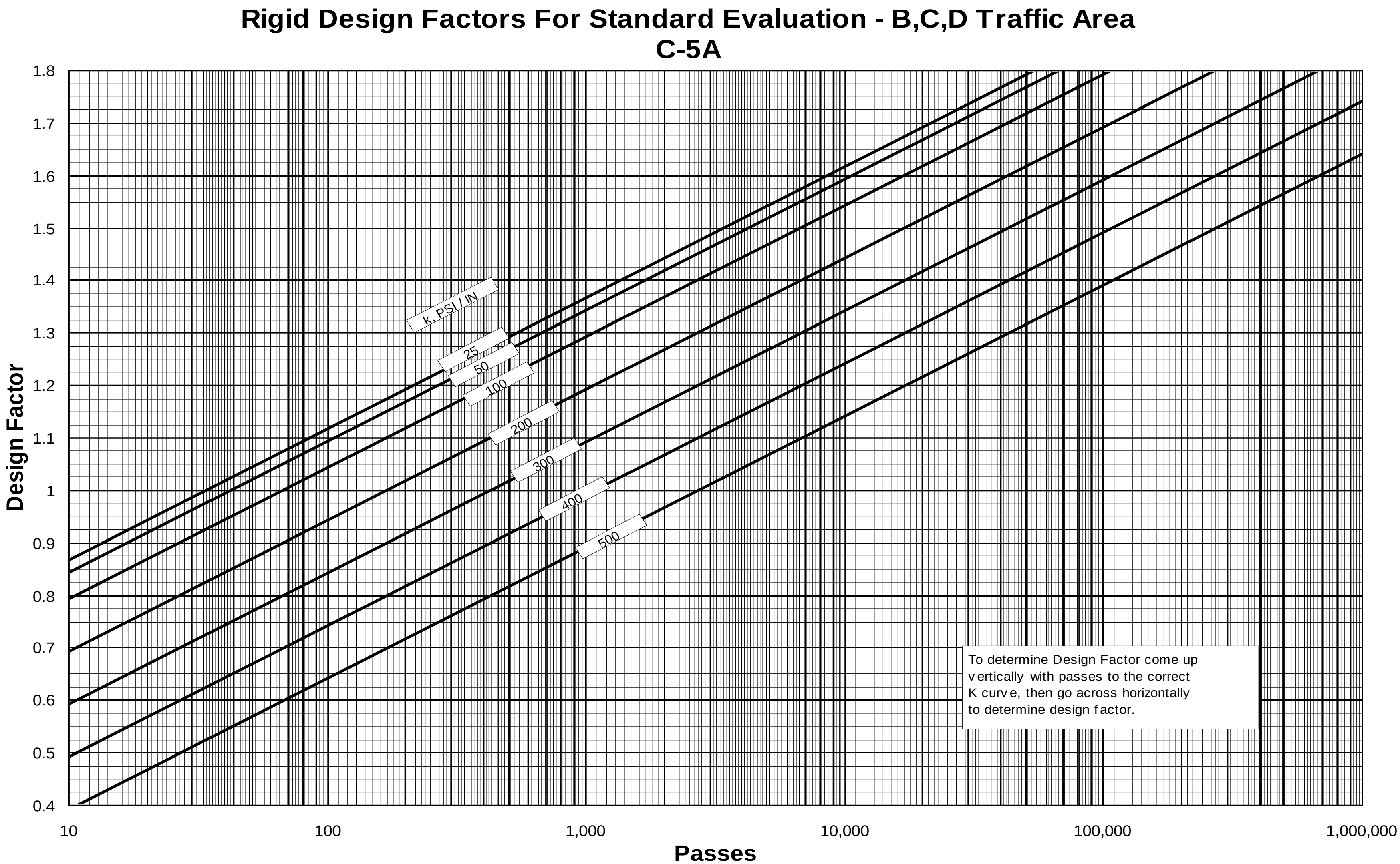

Rigid Design Factors For Standard Evaluation - B,C,D Traffic Area
A-10
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

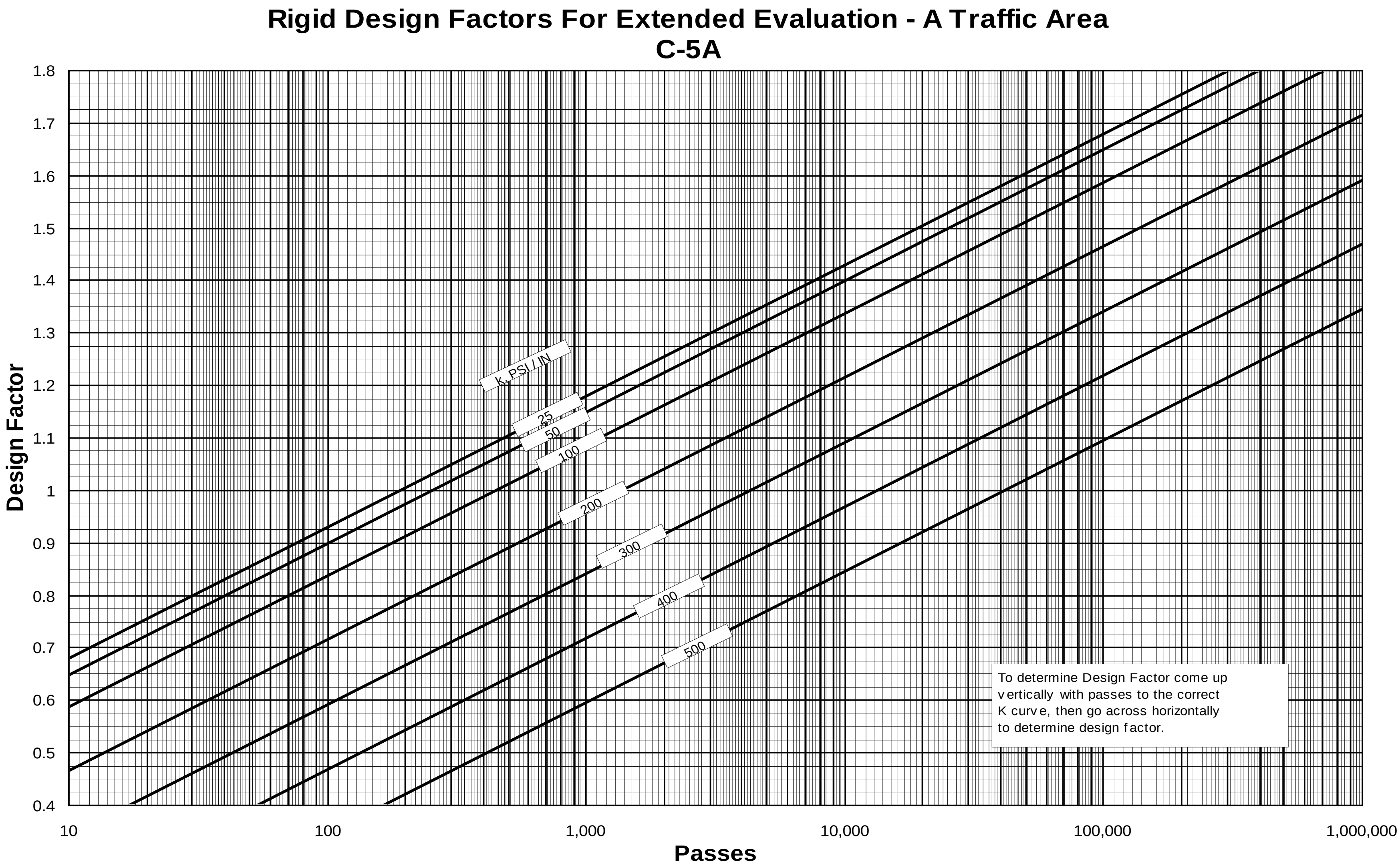

Rigid Design Factors For Extended Evaluation - A Traffic Area
A-10
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
K, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

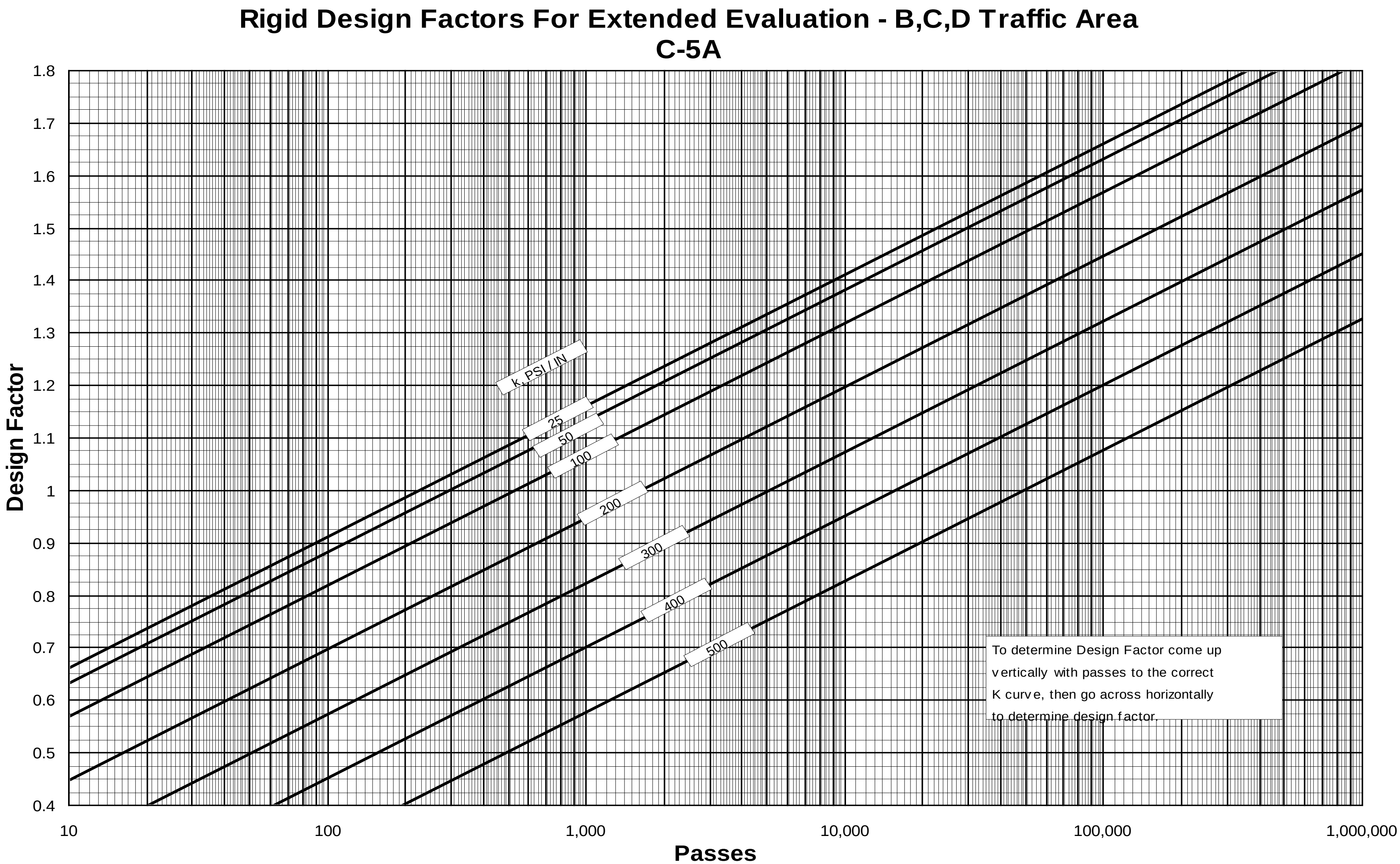

Rigid Design Factors For Extended Evaluation - B,C,D Traffic Area
A-10
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

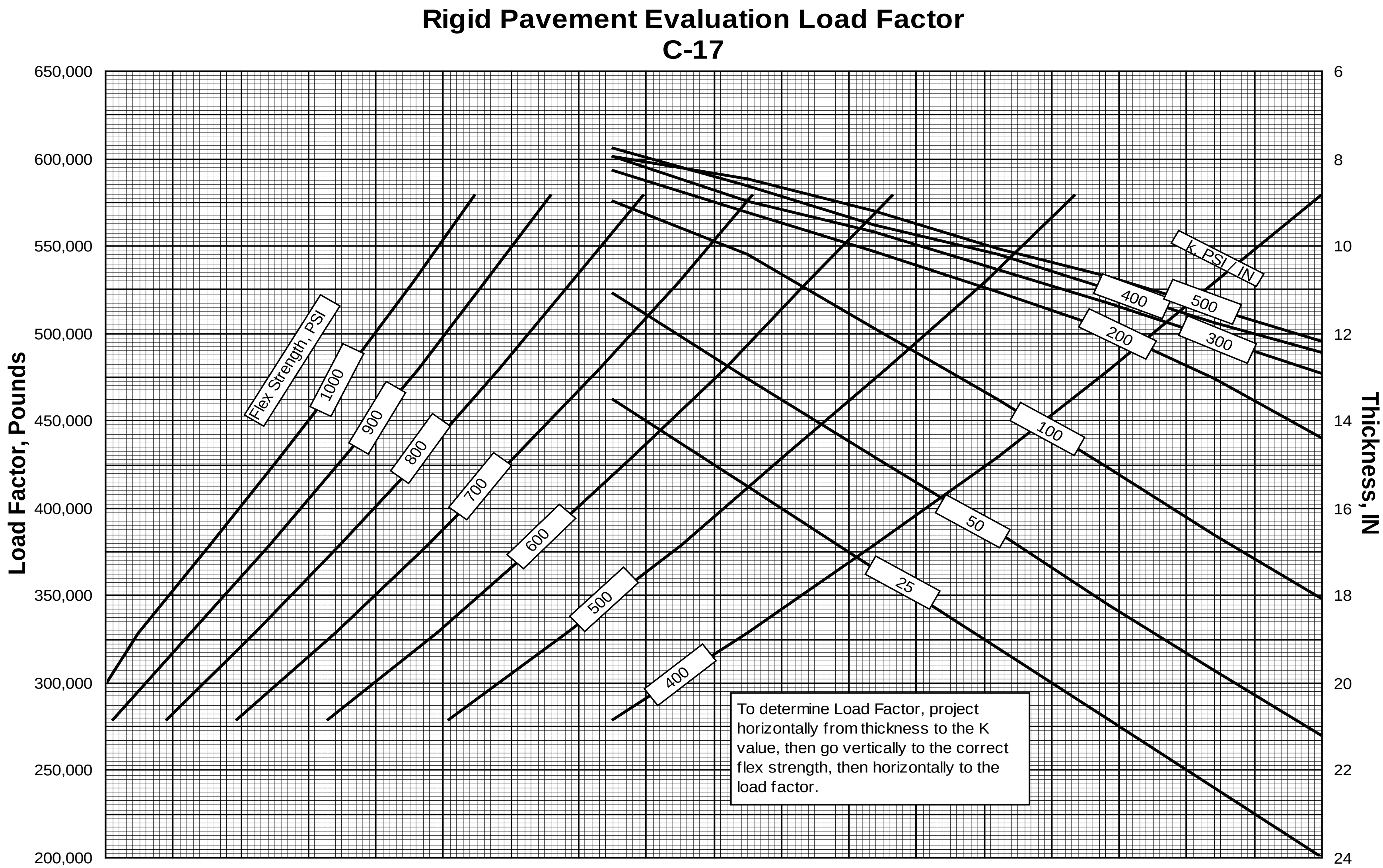

Rigid Pavement Evaluation Load Factor
C-5A
Load Factor, Pounds
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
Thickness, IN
6
8
10
12
14
16
18
20
22
24
k, PSI / IN
500
400
300
200
100
50
25
Flex Strength, PSI
1000
900
800
700
600
500
400
To determine Load Factor, project horizontally from thickness to the K value, then go vertically to the correct flex strength, then horizontally to the load factor.

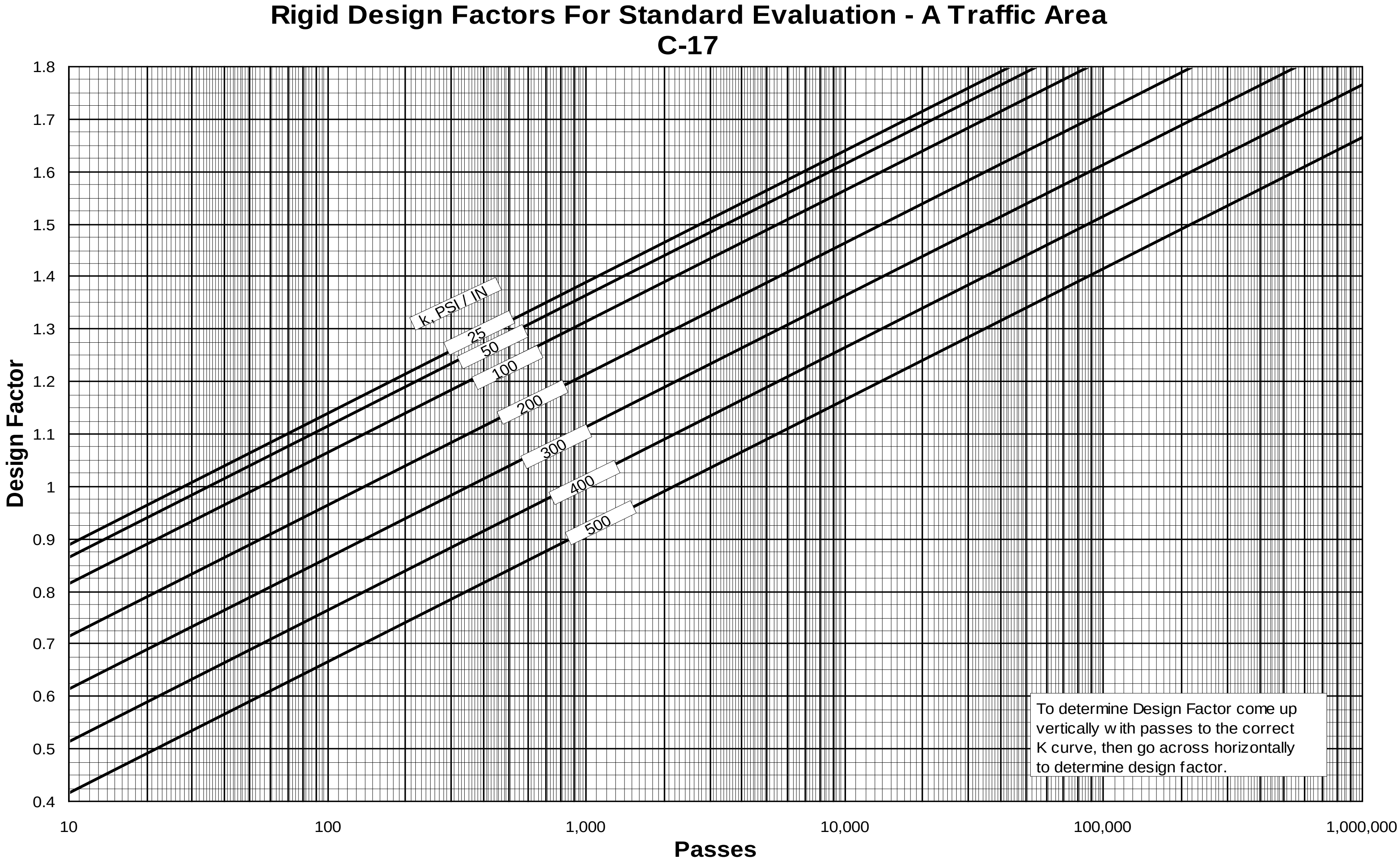

Rigid Design Factors For Standard Evaluation - A Traffic Area
C-5A
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically w ith passes to the correct K curve, then go across horizontally to determine design factor.

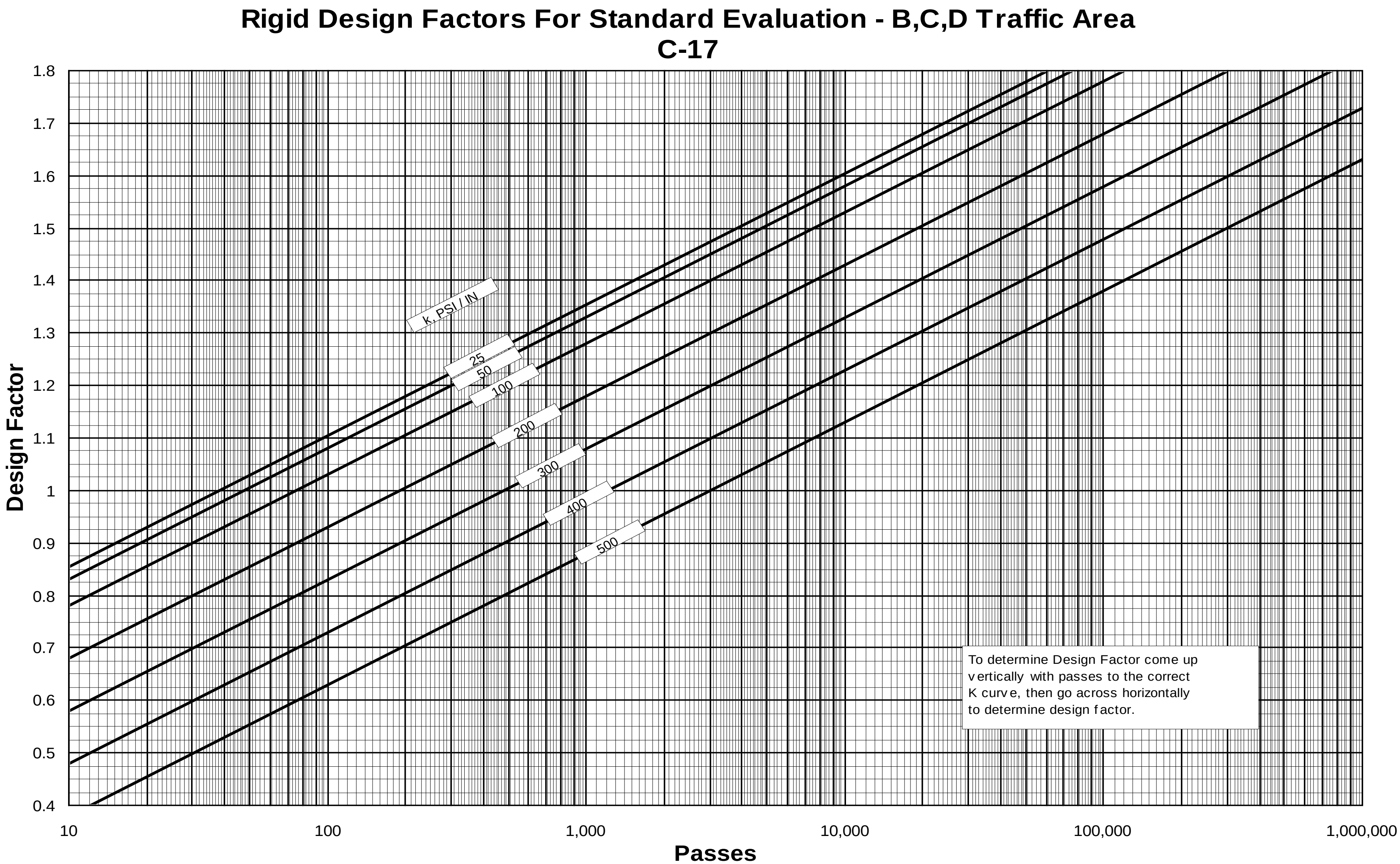

Rigid Design Factors For Standard Evaluation - B,C,D Traffic Area
C-5A
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
K, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

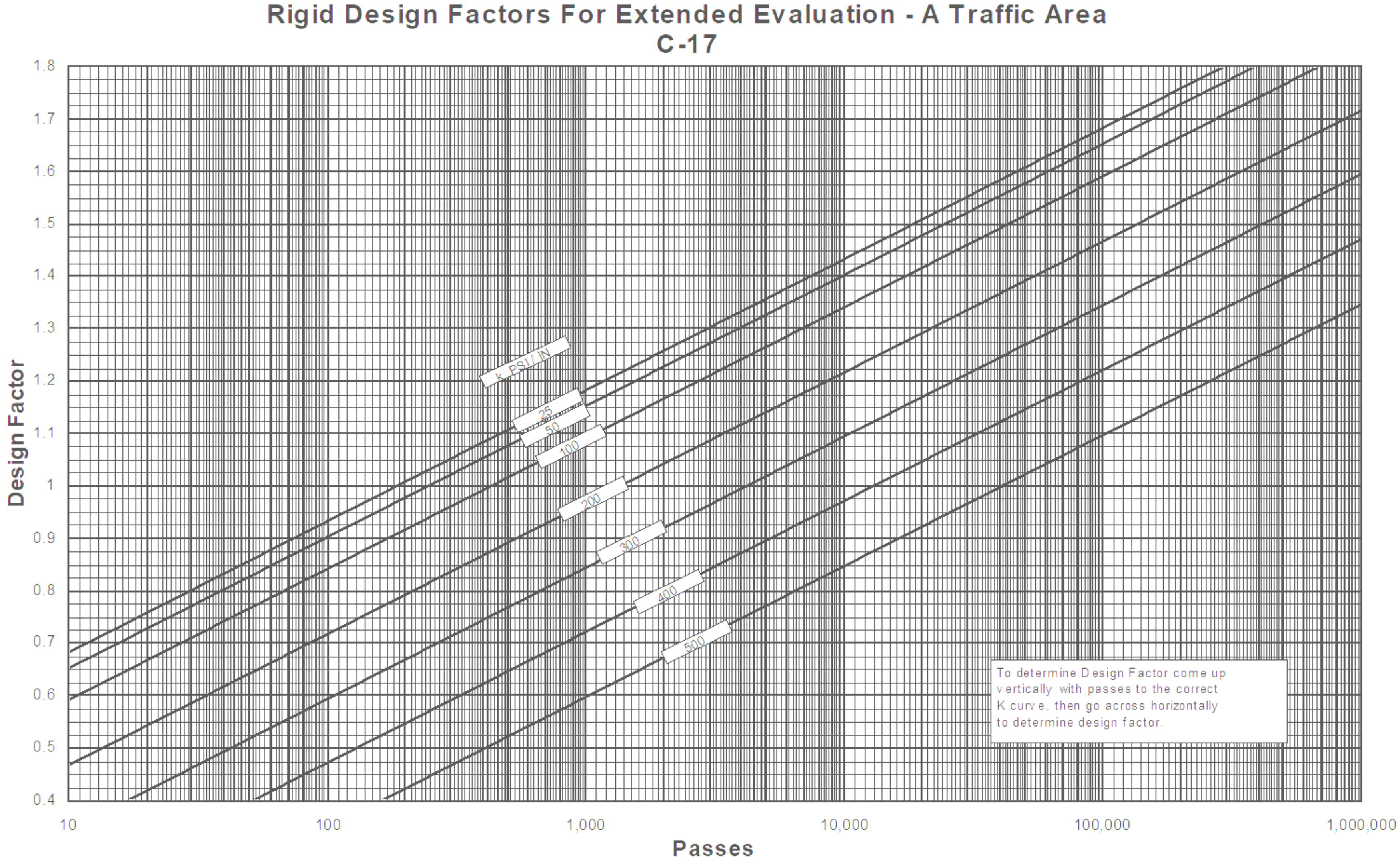

Rigid Design Factors For Extended Evaluation - A Traffic Area
C-5A
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

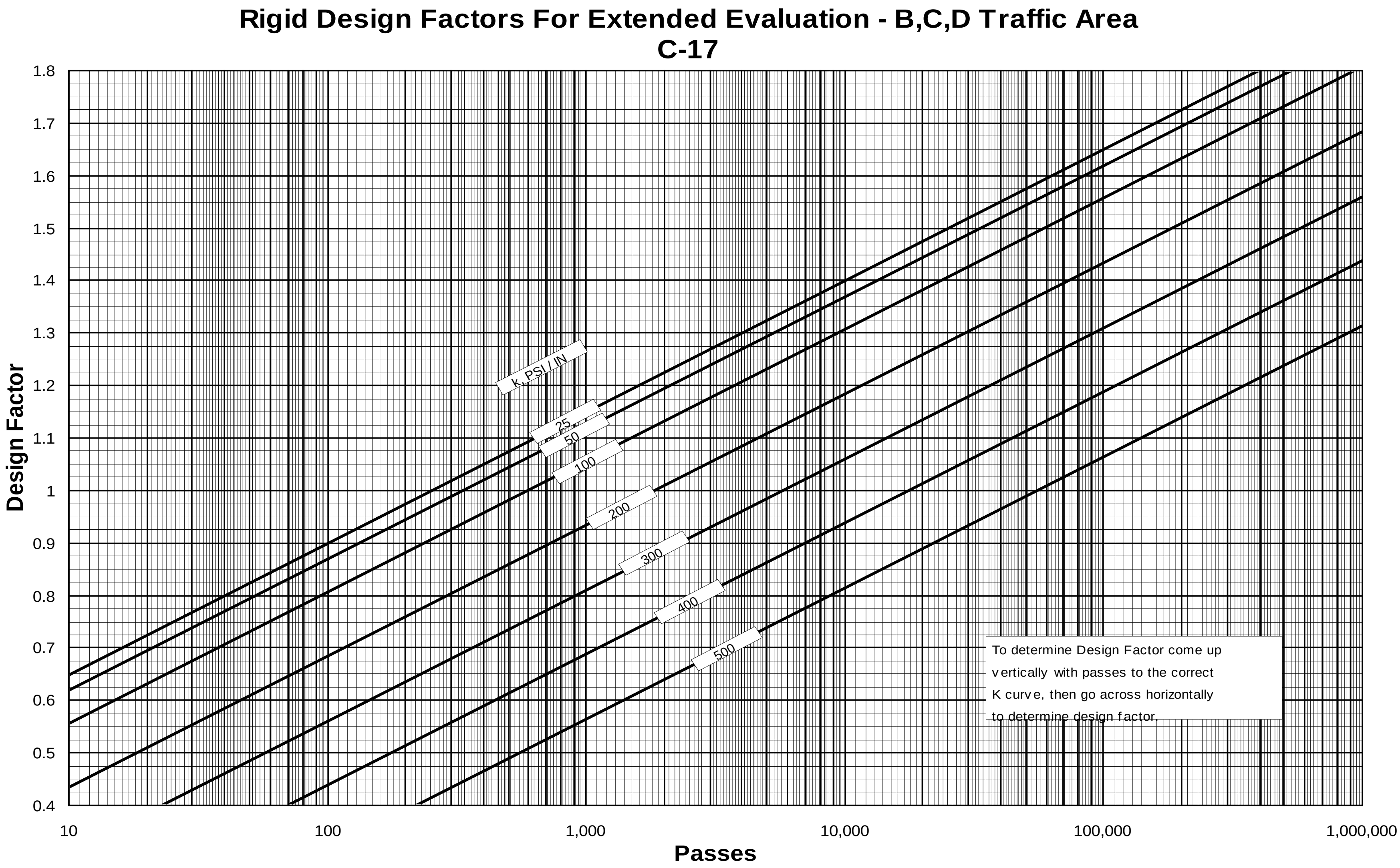

Rigid Design Factors For Extended Evaluation - B,C,D Traffic Area
C-5A
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
Design Factor
10
100
1,000
10,000
100,000
1,000,000
Passes
K, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.


Rigid Pavement Evaluation Load Factor
C-17
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
Load Factor, Pounds
6
8
10
12
14
16
18
20
22
24
Thickness, IN
Flex Strength, PSI
1000
900
800
700
600
500
400
K, PSI / IN
400
500
200
300
100
50
25
To determine Load Factor, project horizontally from thickness to the K value, then go vertically to the correct flex strength, then horizontally to the load factor.

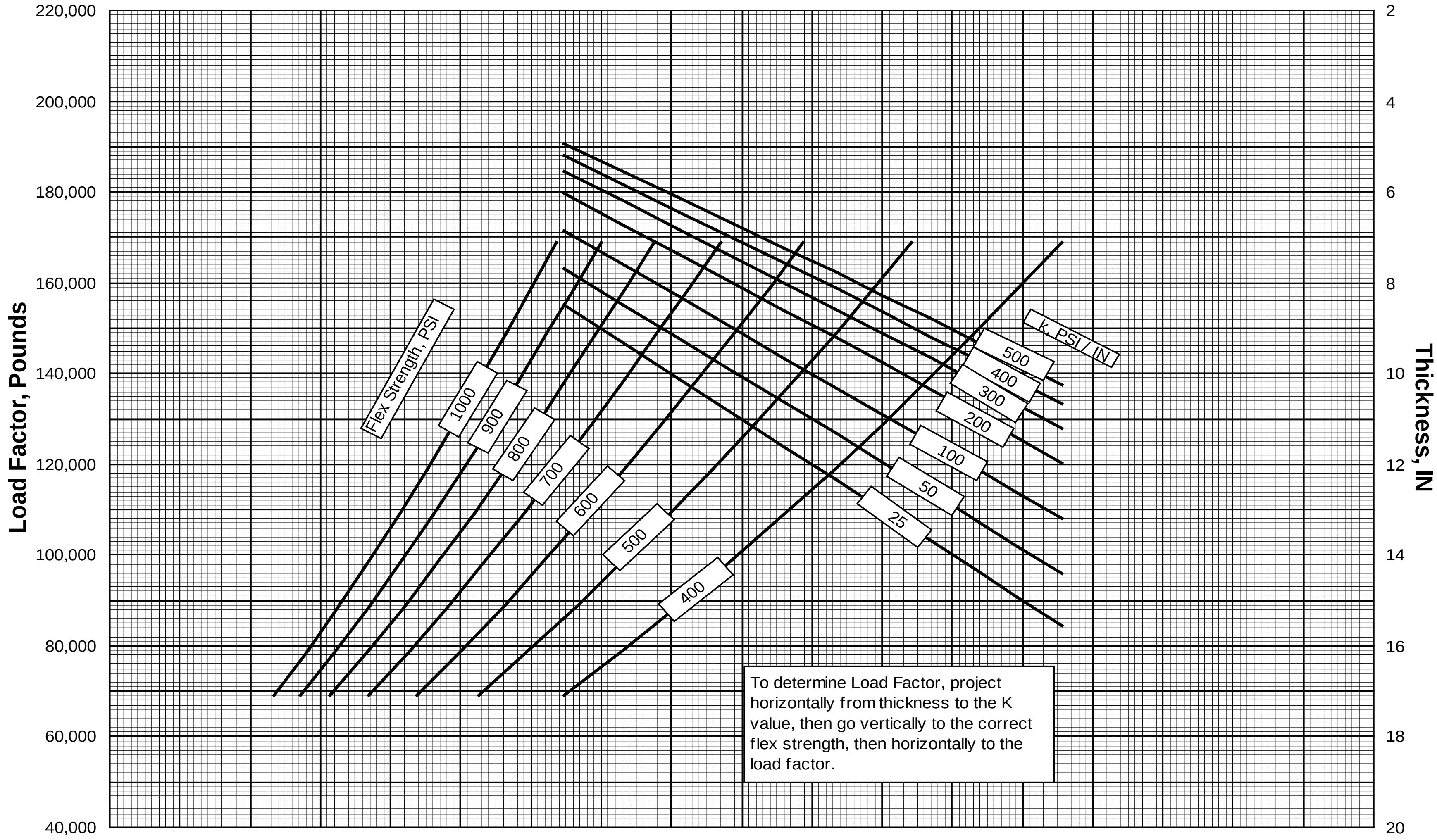

Rigid Design Factors For Standard Evaluation - A Traffic Area
C-17
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
k, PSI / IN
25
50
100
200
300
400
500
10
100
1,000
10,000
100,000
1,000,000
Passes
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

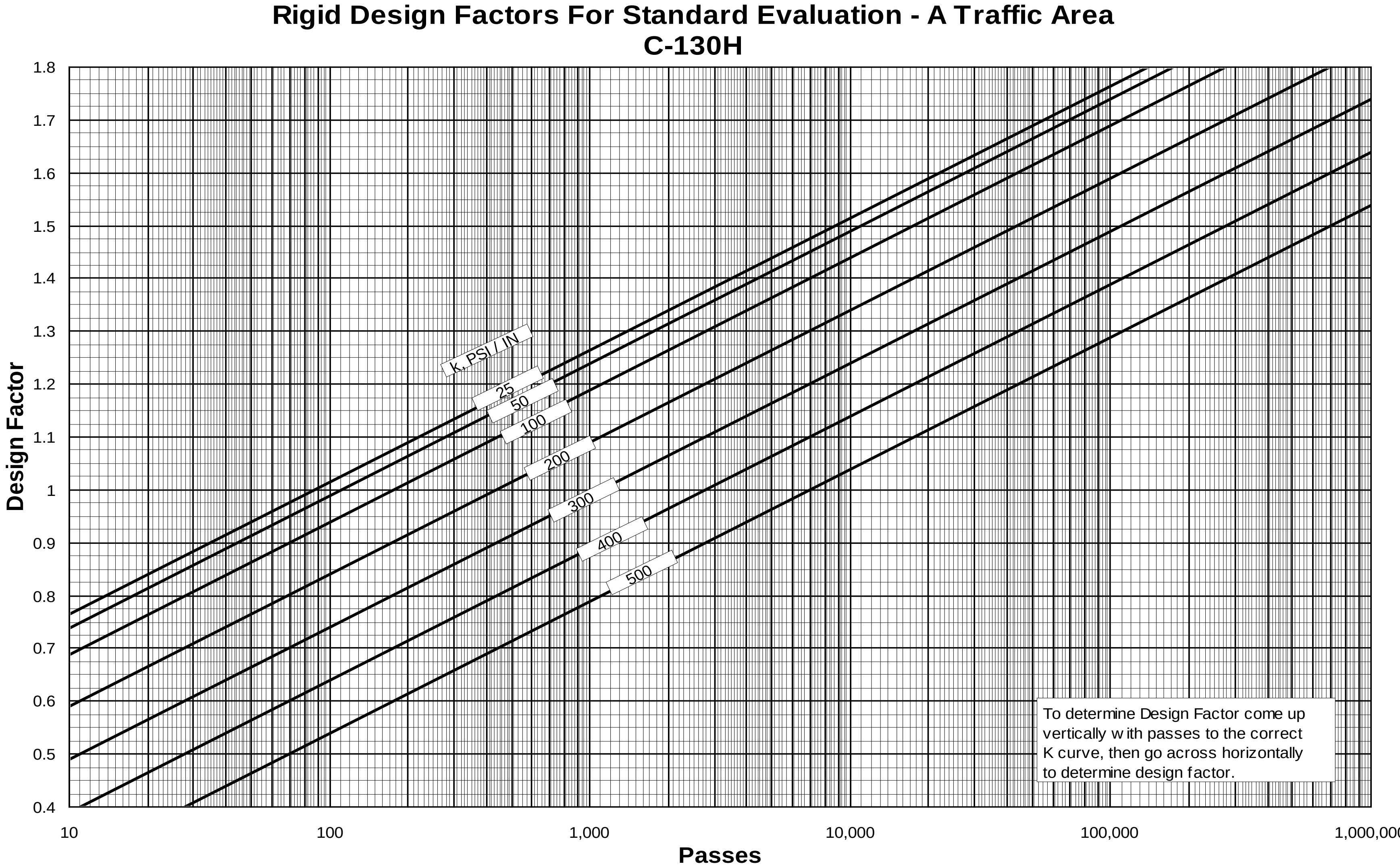

Rigid Design Factors For Standard Evaluation - B,C,D Traffic Area
C-17
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
K, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

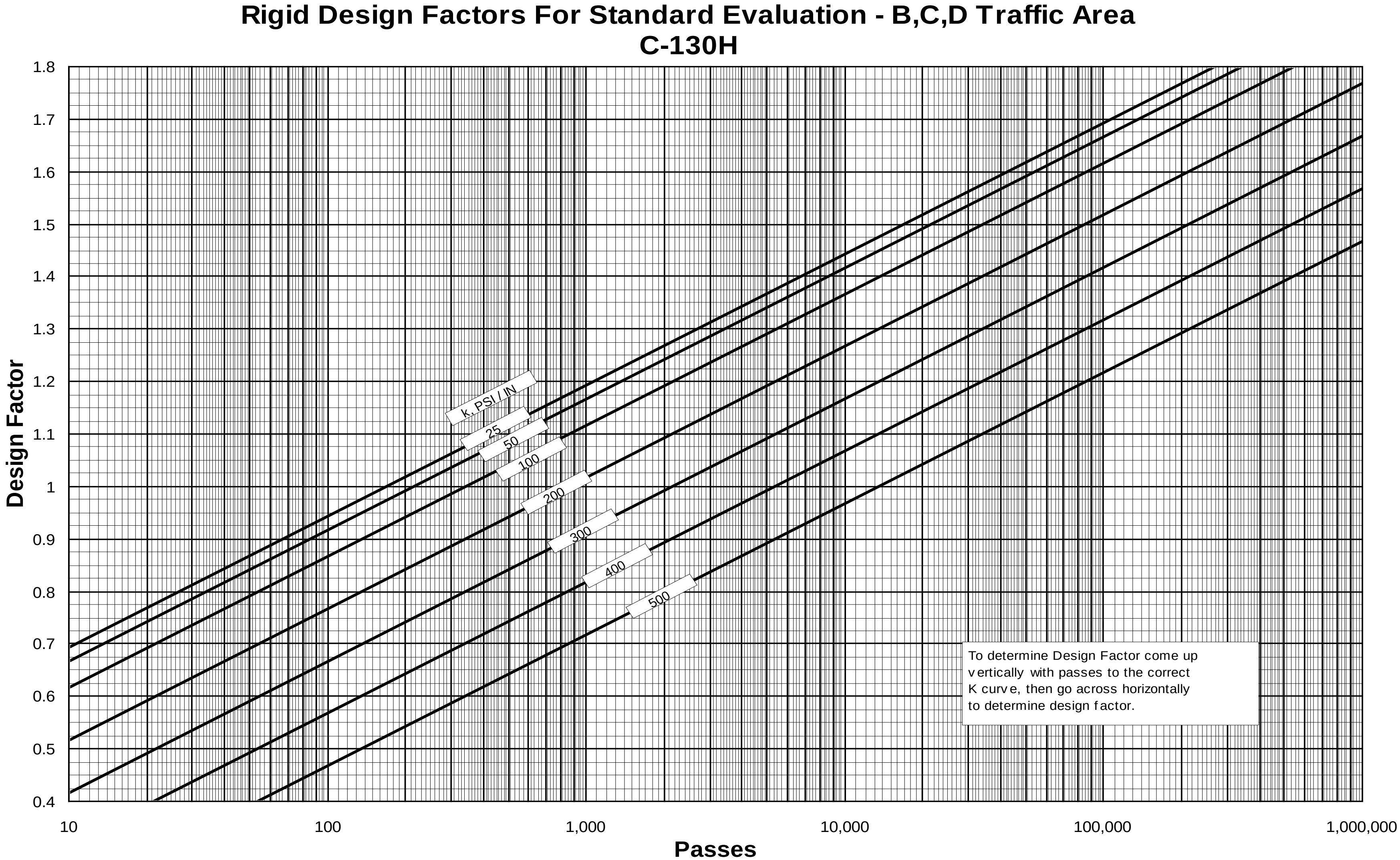

Rigid Design Factors For Extended Evaluation - A Traffic Area
C-17
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

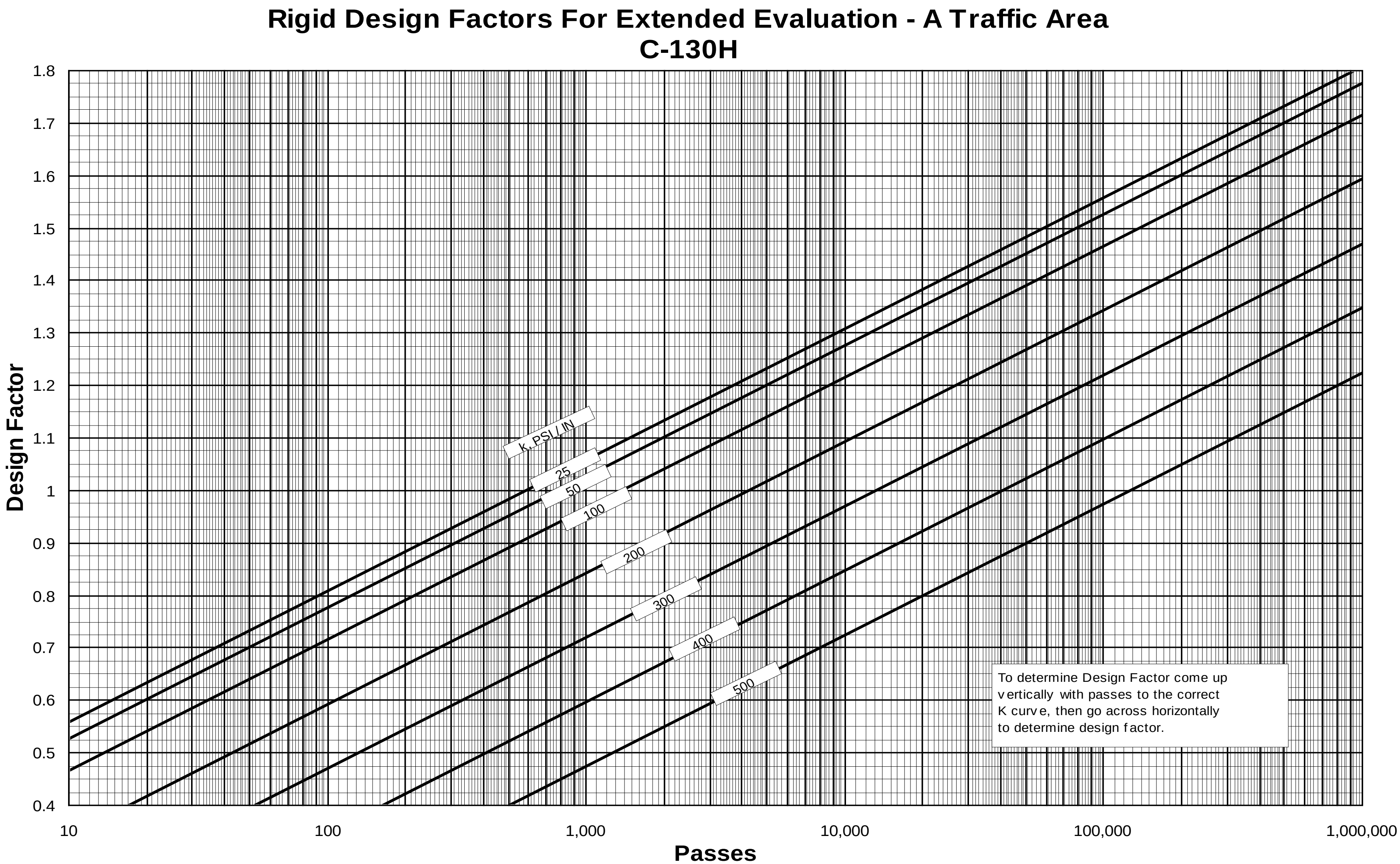

Rigid Design Factors For Extended Evaluation - B,C,D Traffic Area
C-17
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
K, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

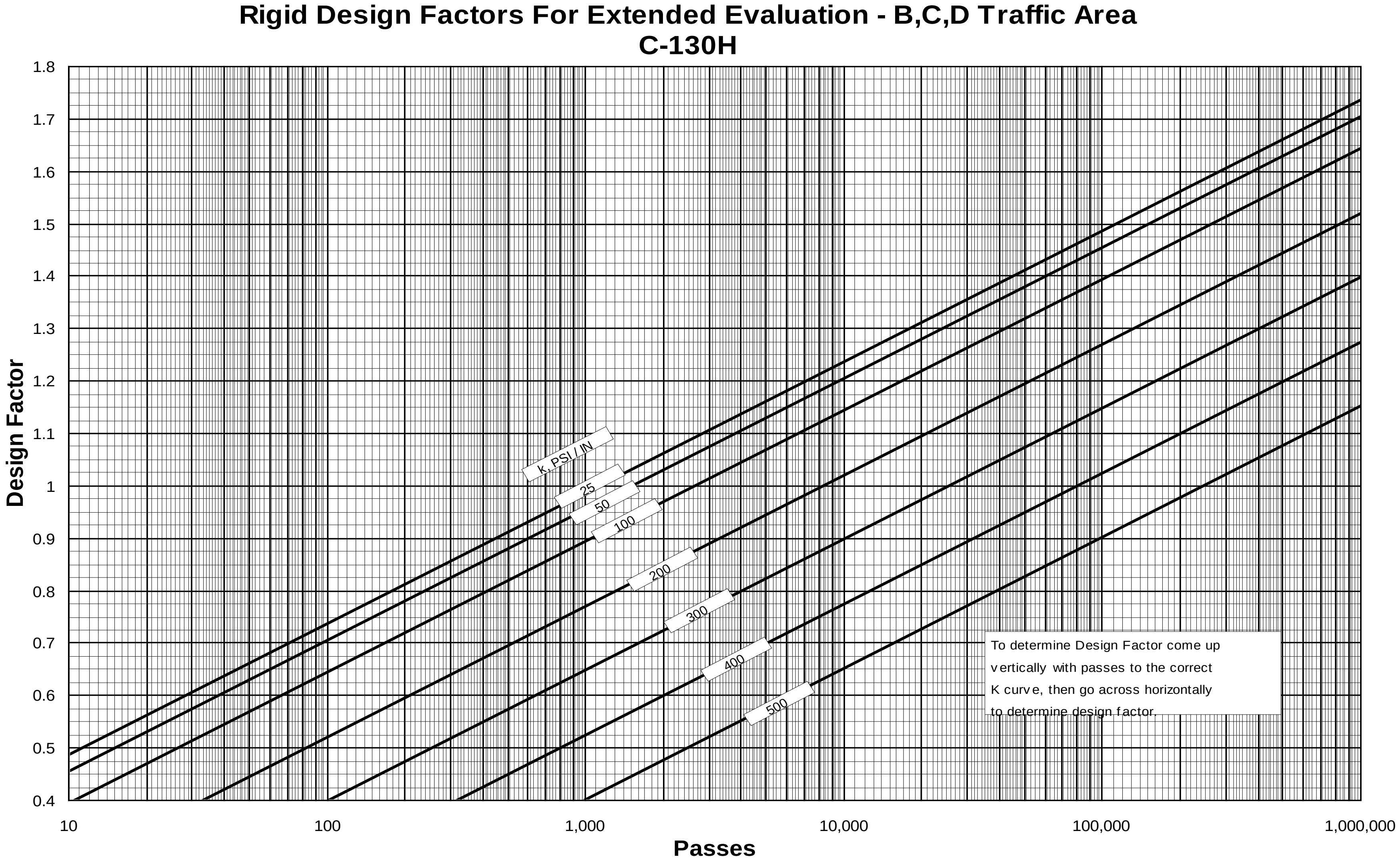
## Rigid Pavement Evaluation Load Factor
## C-130H



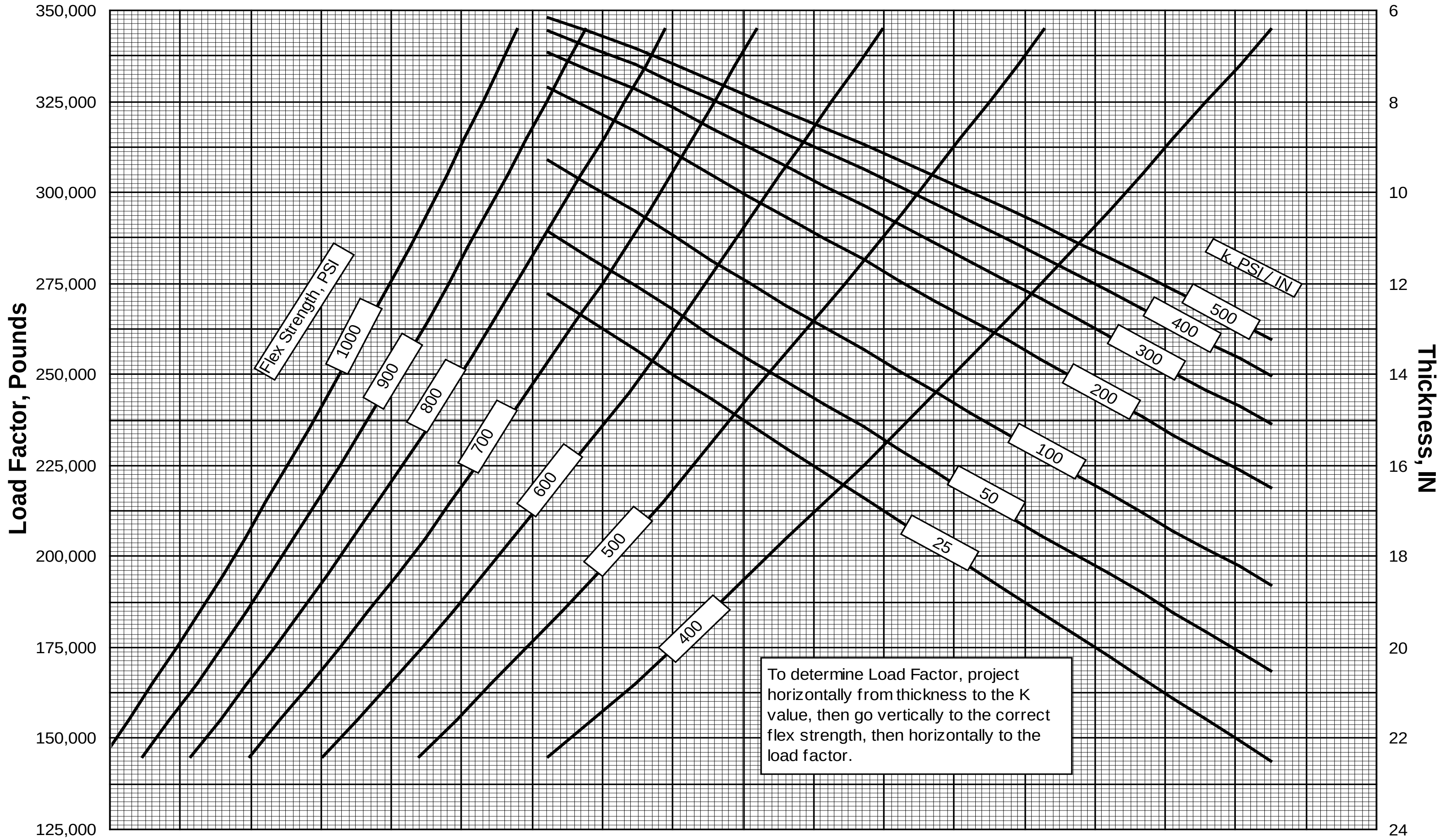

Rigid Design Factors For Standard Evaluation - A Traffic Area
C-130H
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
K, PSI / IN
25
50
100
200
300
400
500
10
100
1,000
10,000
100,000
1,000,000
Passes
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

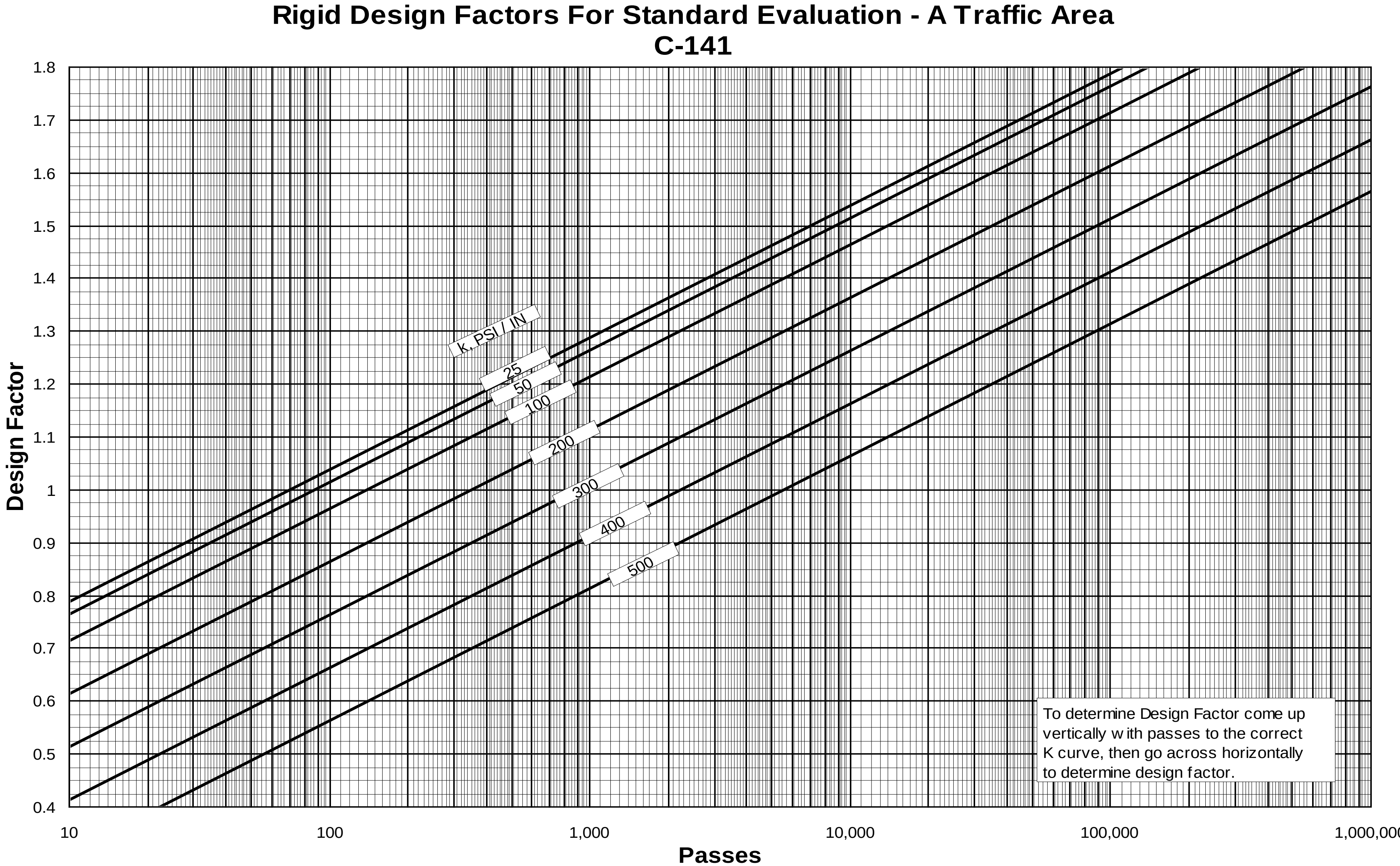

Rigid Design Factors For Standard Evaluation - B,C,D Traffic Area
C-130H
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

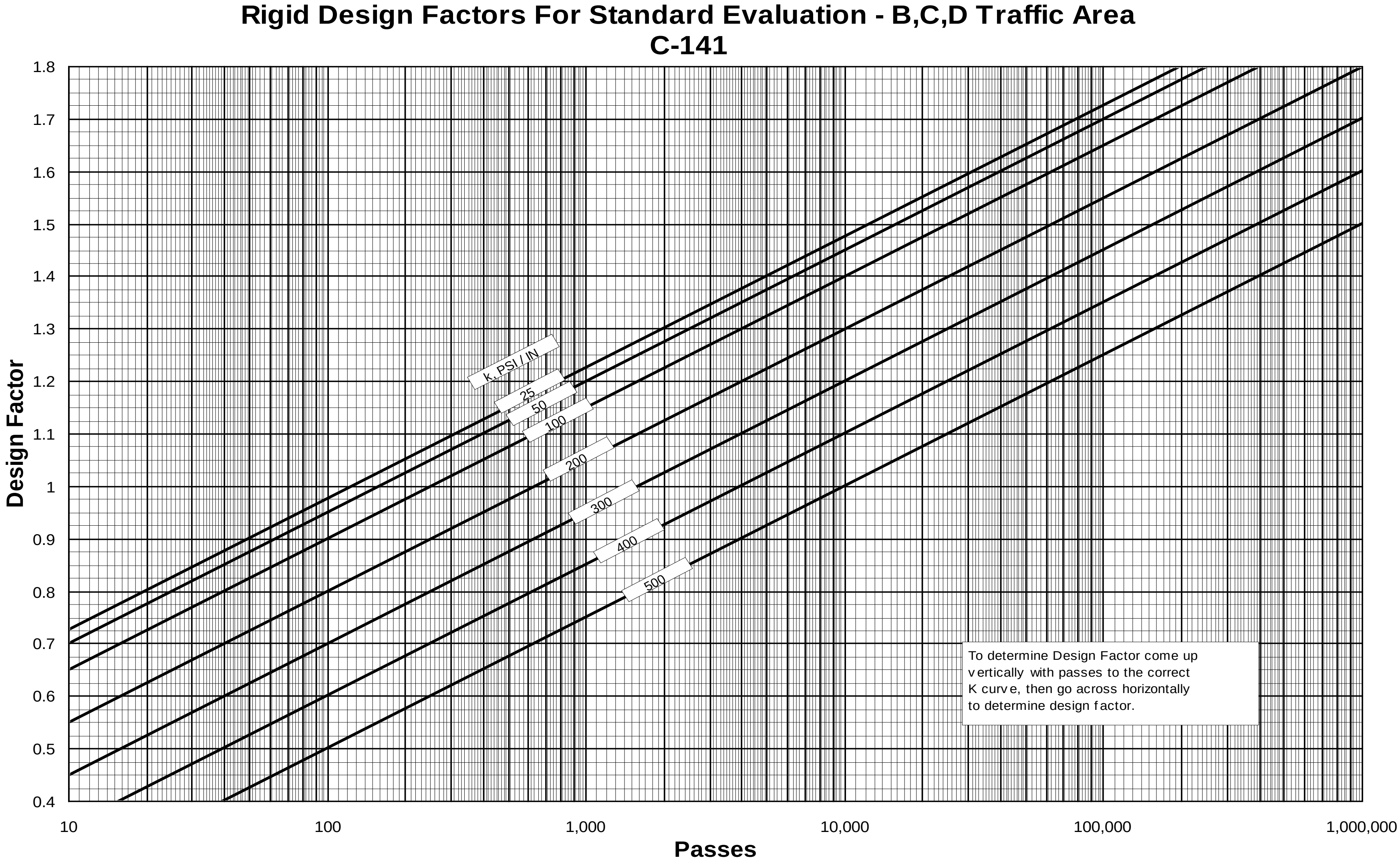

Rigid Design Factors For Extended Evaluation - A Traffic Area
C-130H
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

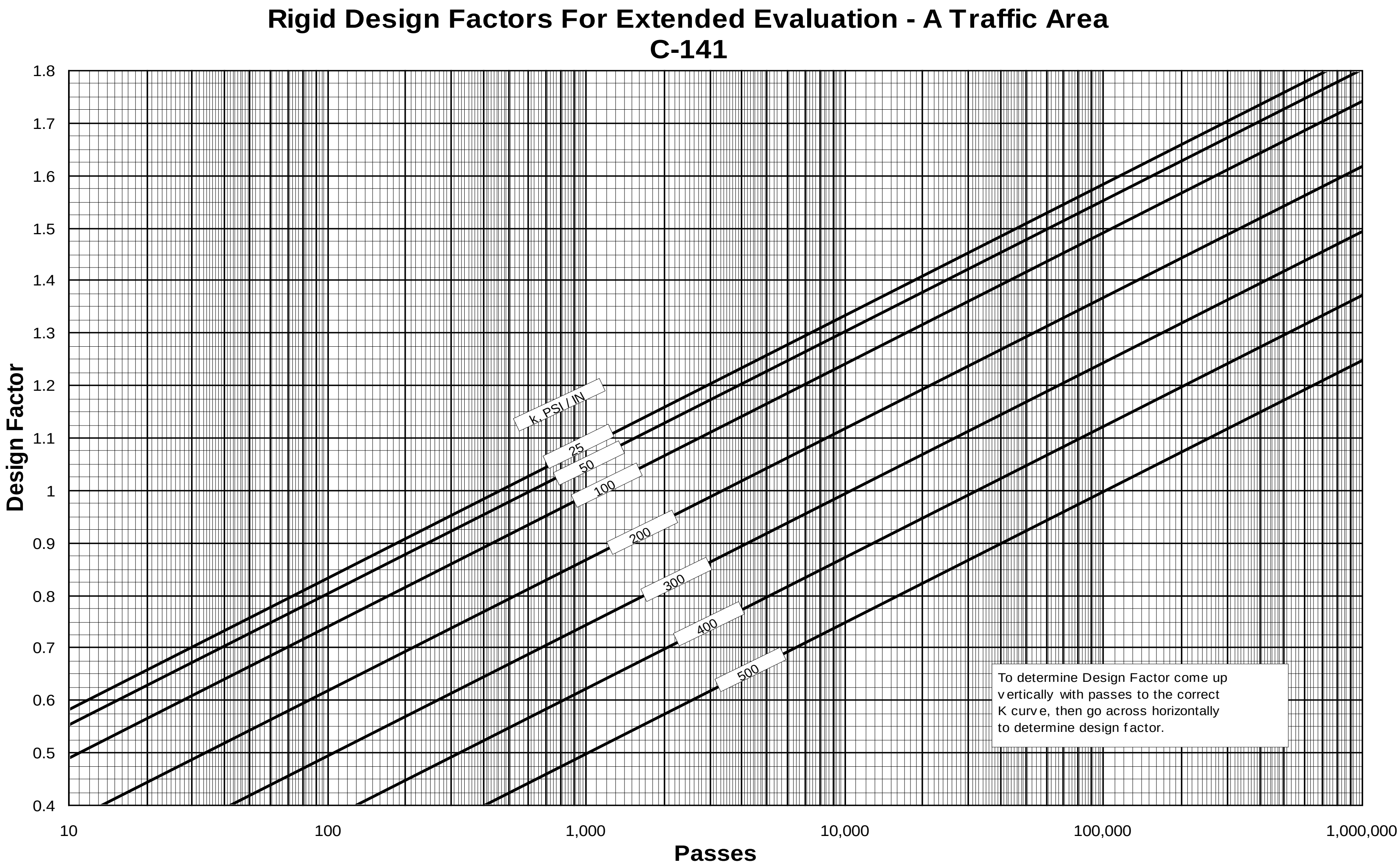

Rigid Design Factors For Extended Evaluation - B,C,D Traffic Area
C-130H
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

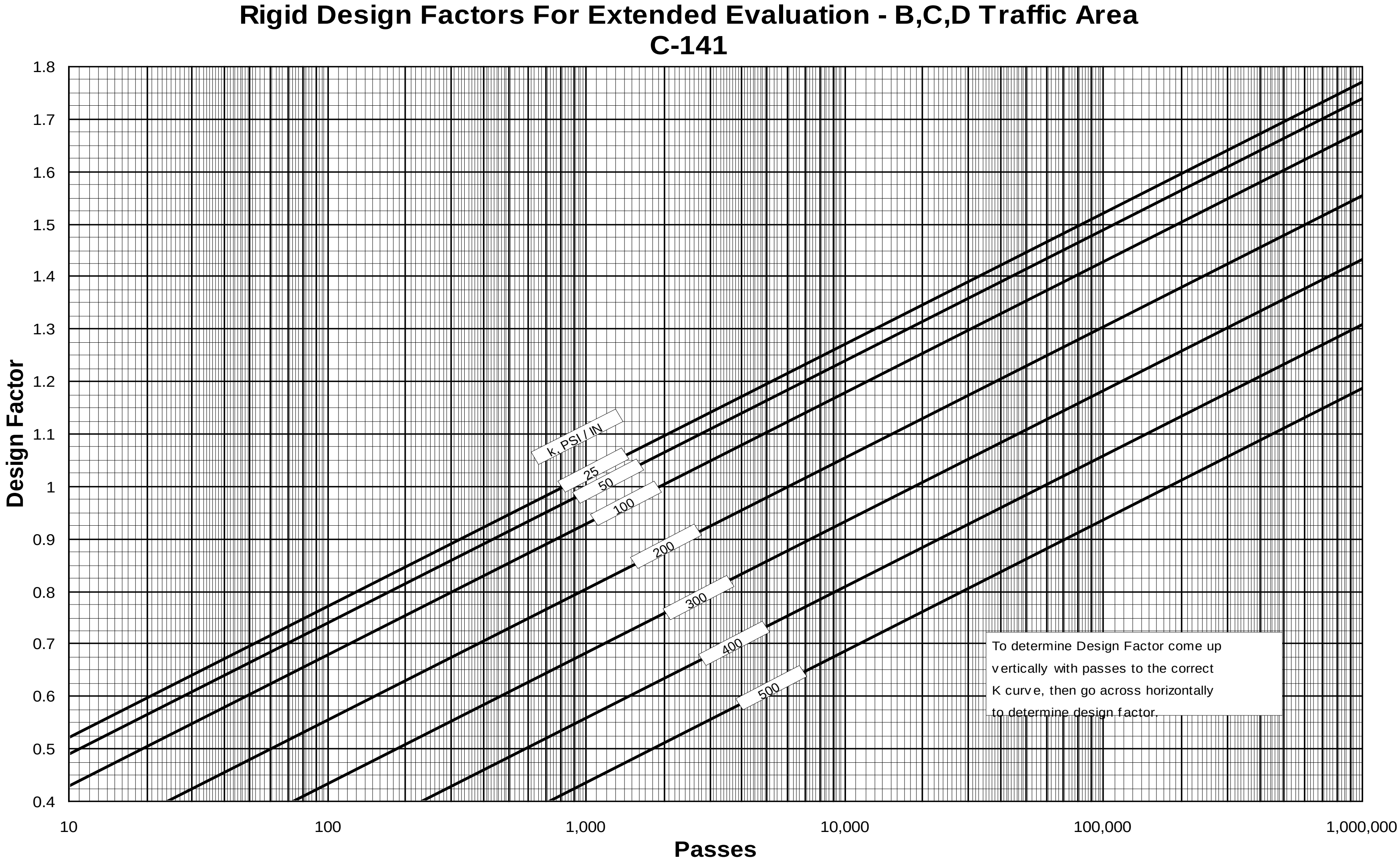
## Rigid Pavement Evaluation Load Factor
## C-141



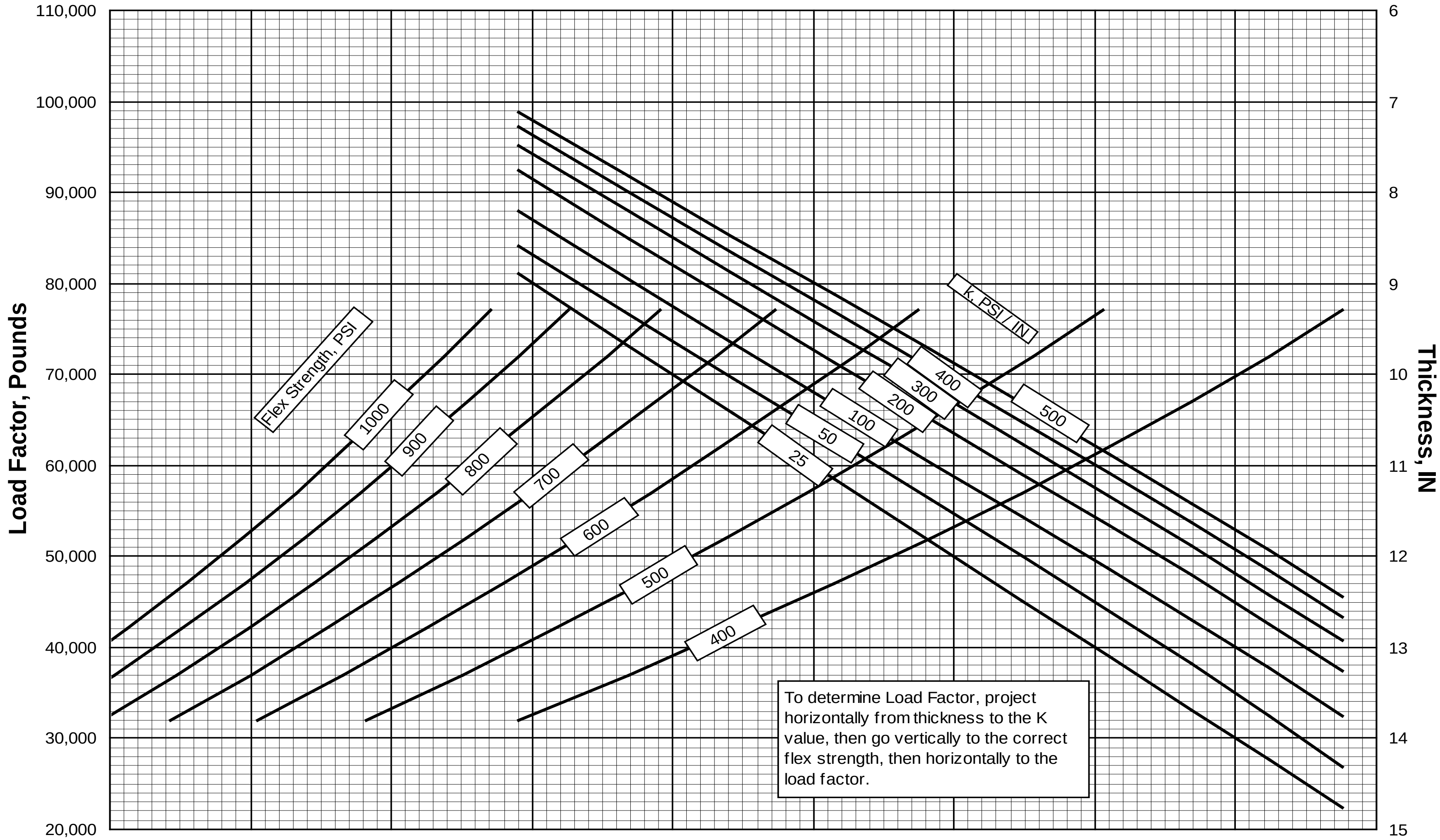

Rigid Design Factors For Standard Evaluation - A Traffic Area
C-141
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

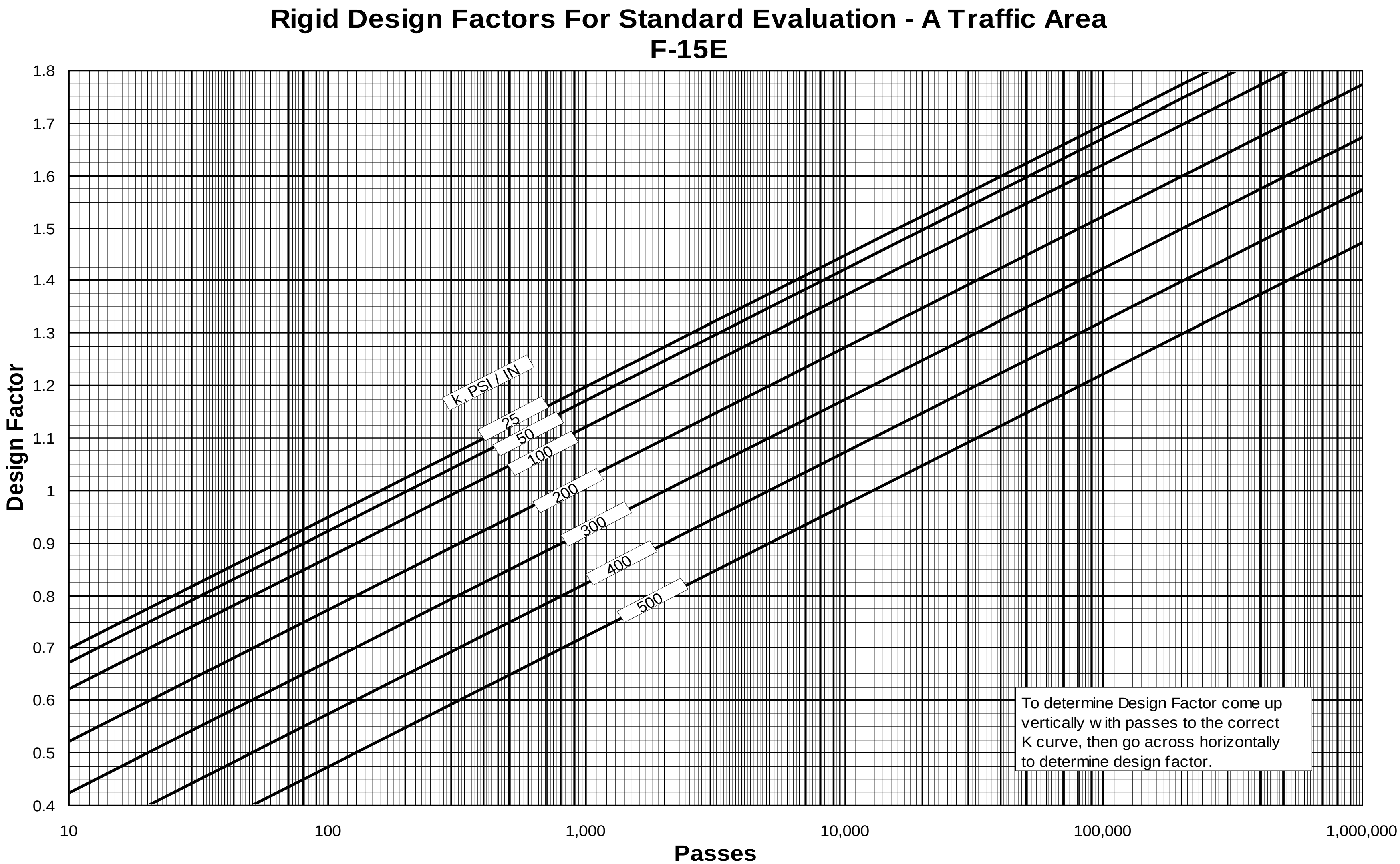

Rigid Design Factors For Standard Evaluation - B,C,D Traffic Area
C-141
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

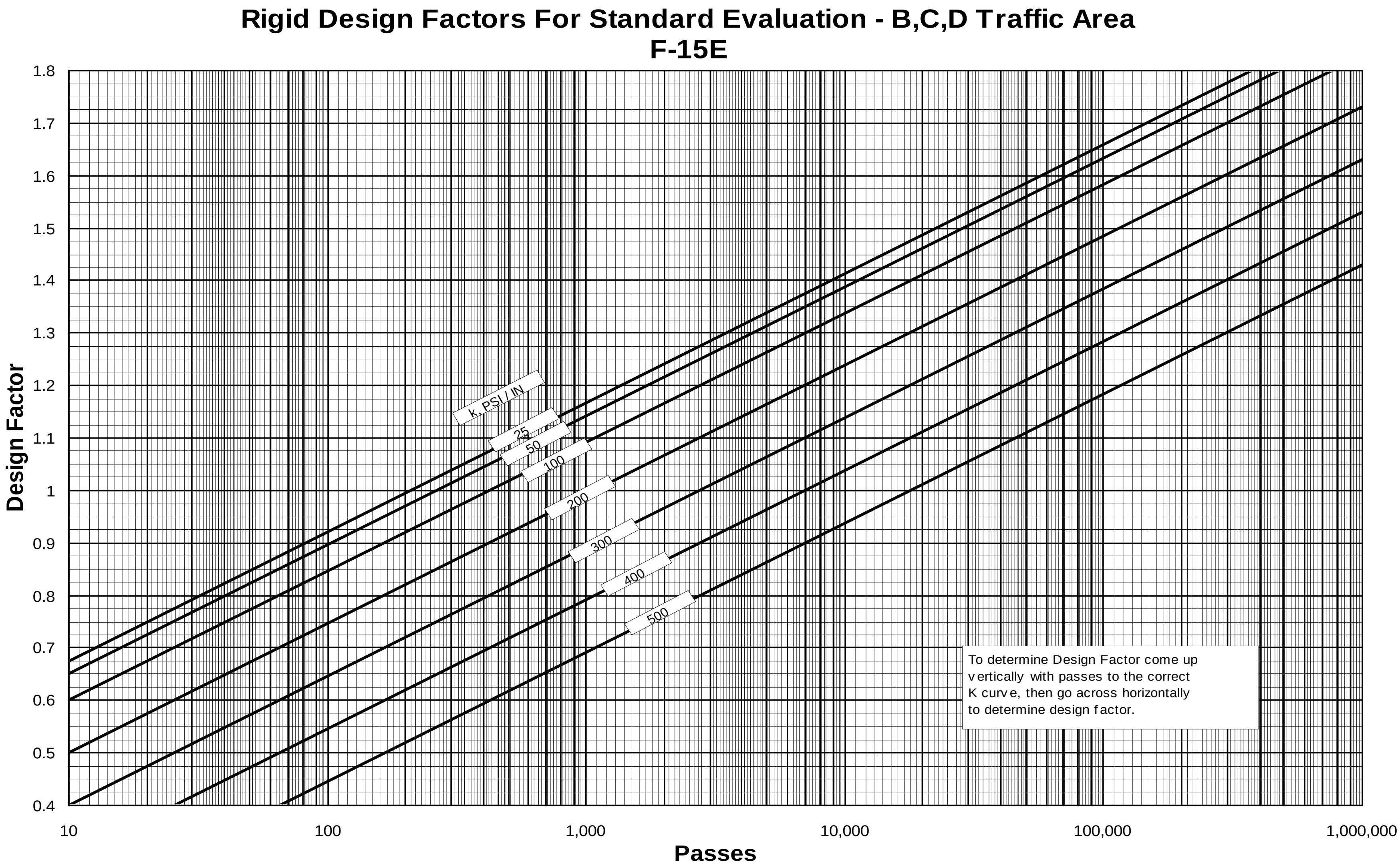

Rigid Design Factors For Extended Evaluation - A Traffic Area
C-141
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.


Rigid Design Factors For Extended Evaluation - B,C,D Traffic Area
C-141
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

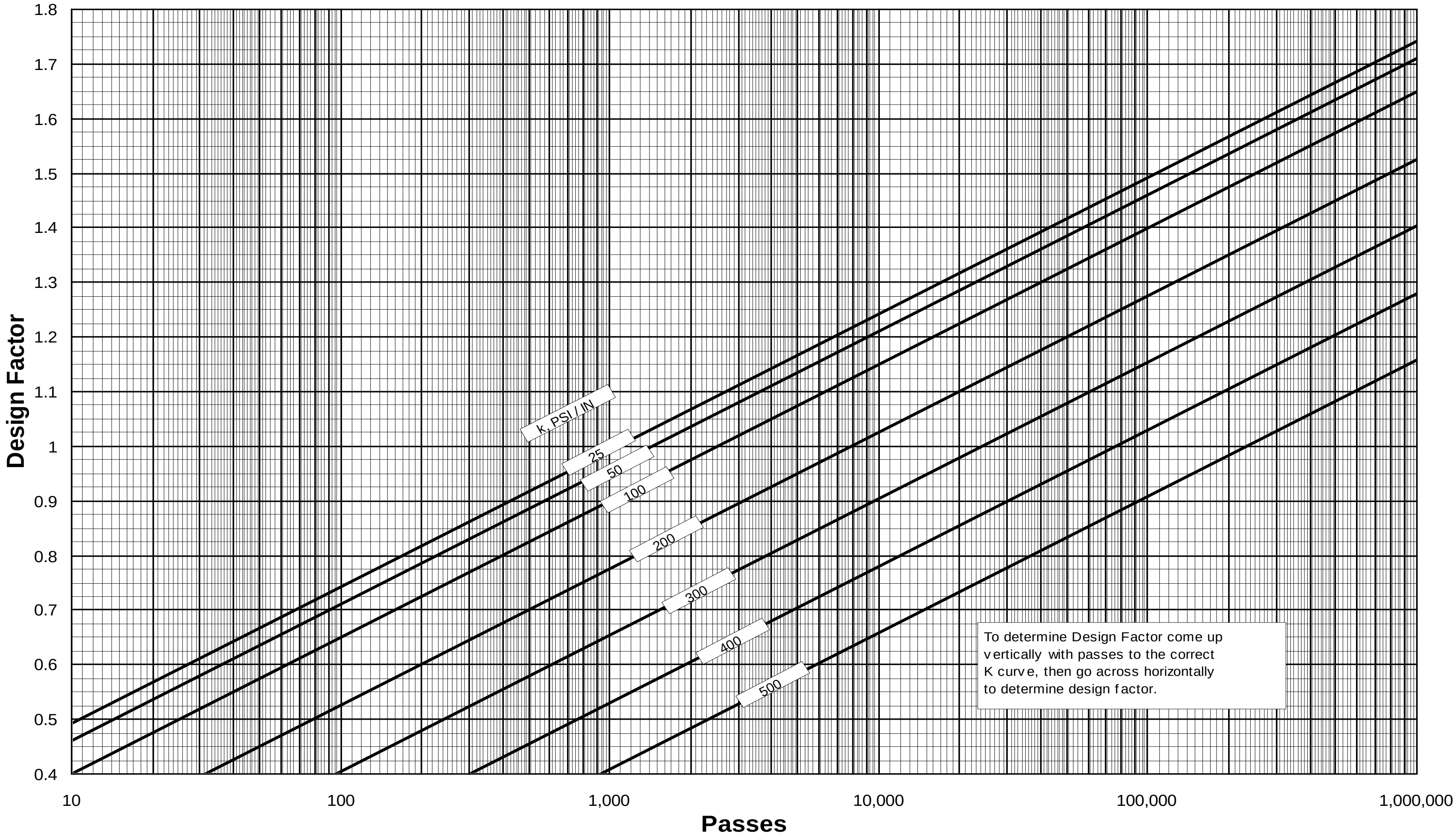
## Rigid Pavement Evaluation Load Factor
## F-15E

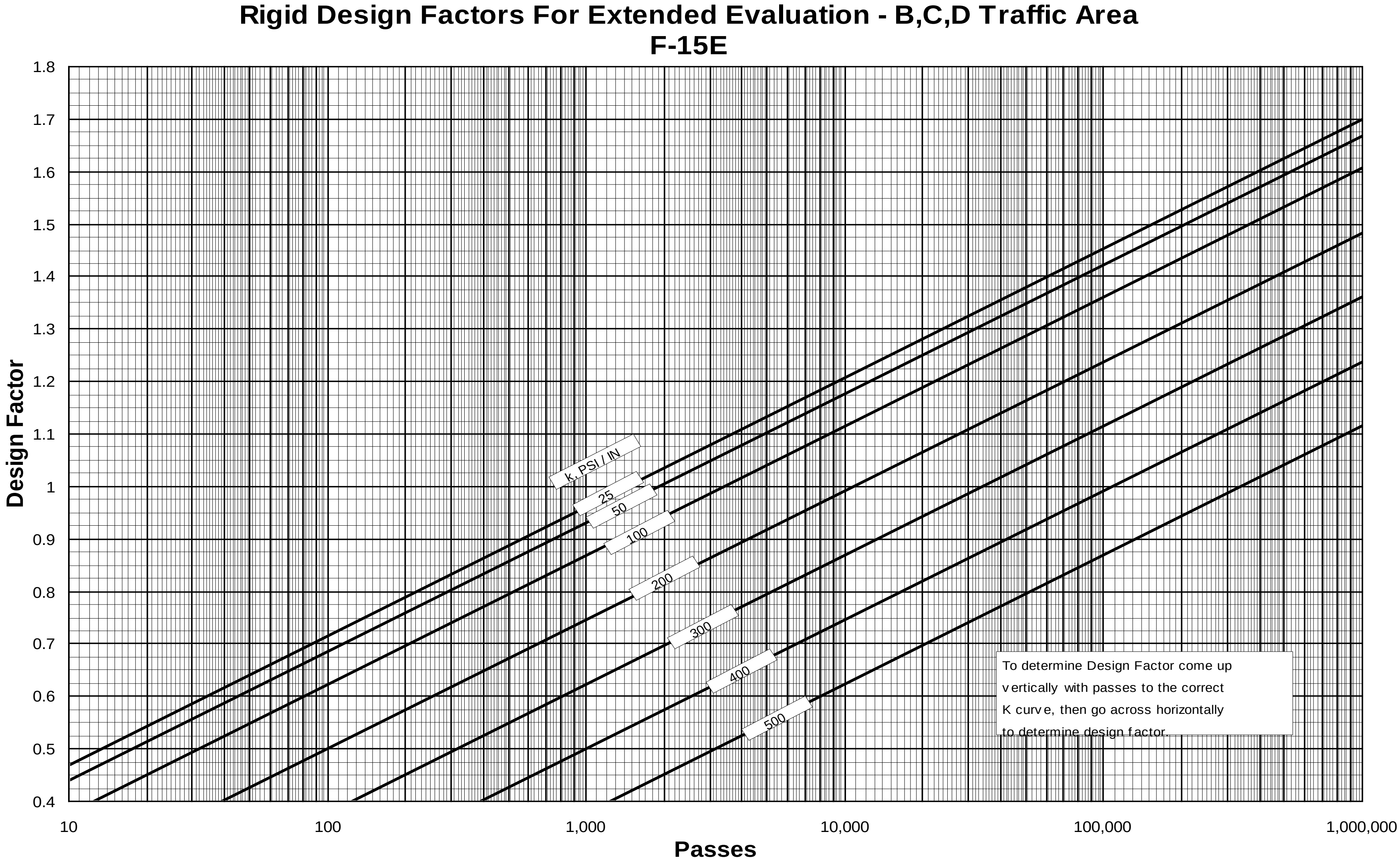


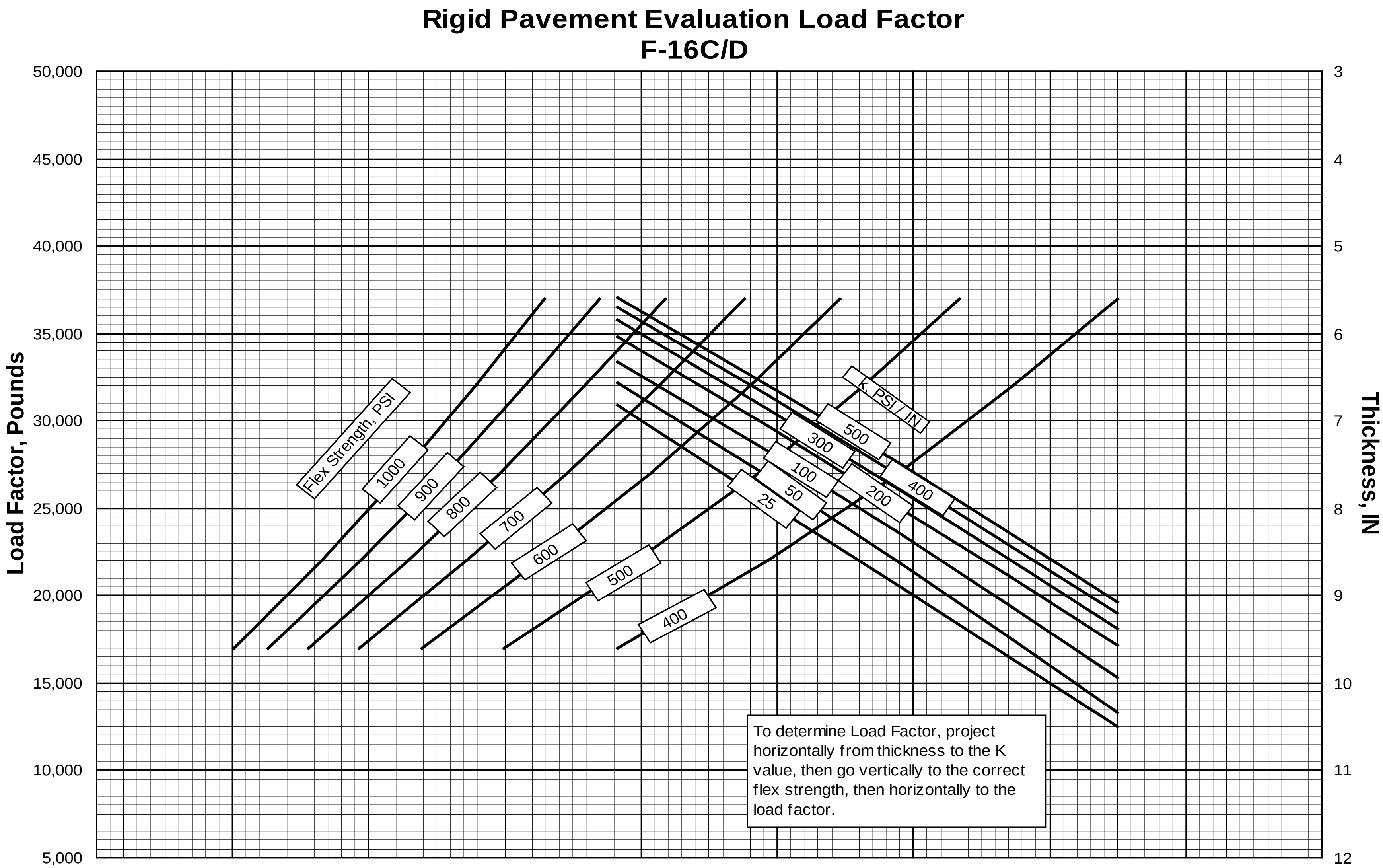

Rigid Design Factors For Standard Evaluation - A Traffic Area
F-15E
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

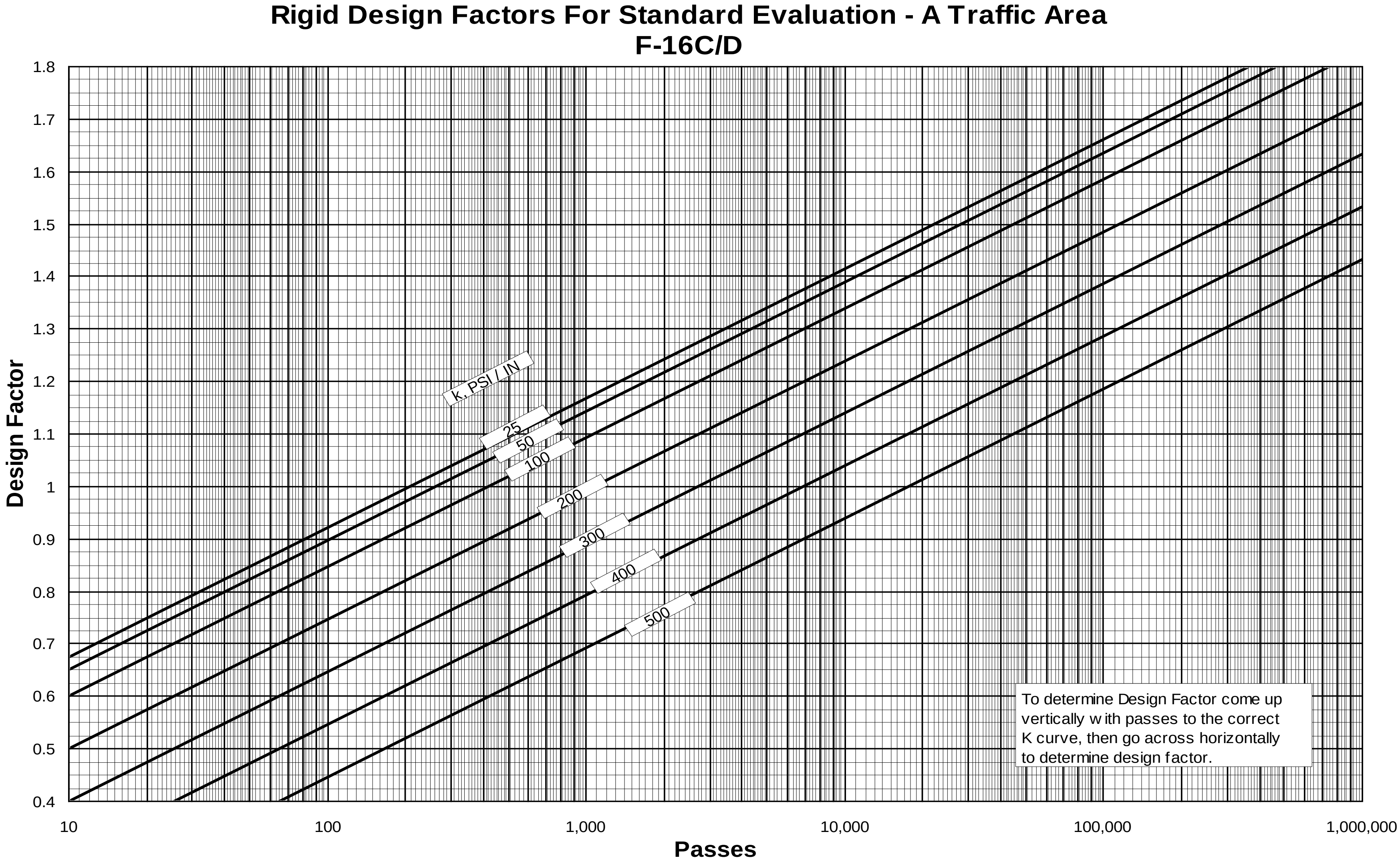

Rigid Design Factors For Standard Evaluation - B,C,D Traffic Area
F-15E
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

## Rigid Design Factors For Extended Evaluation - A Traffic Area
## F-15E

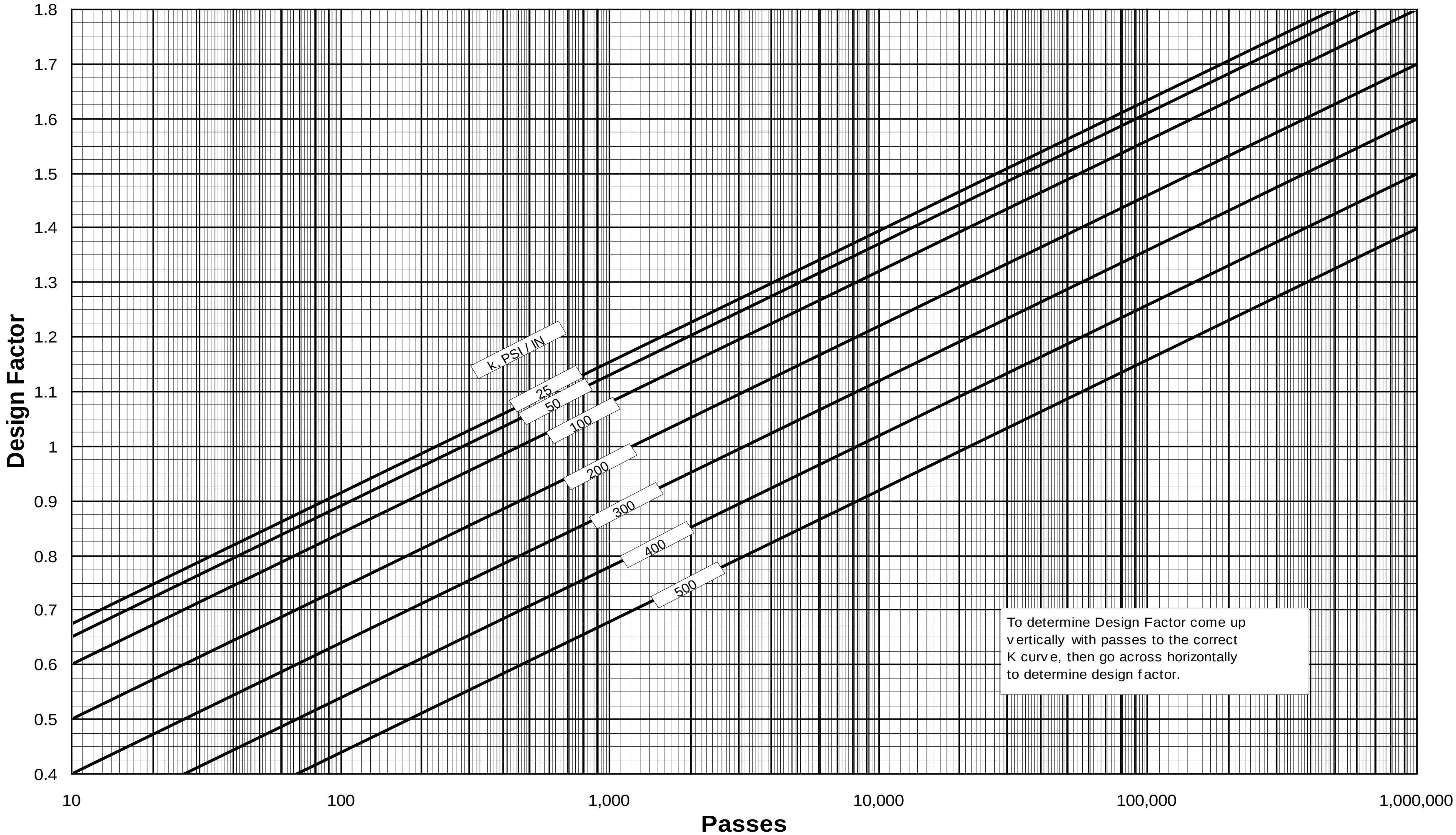


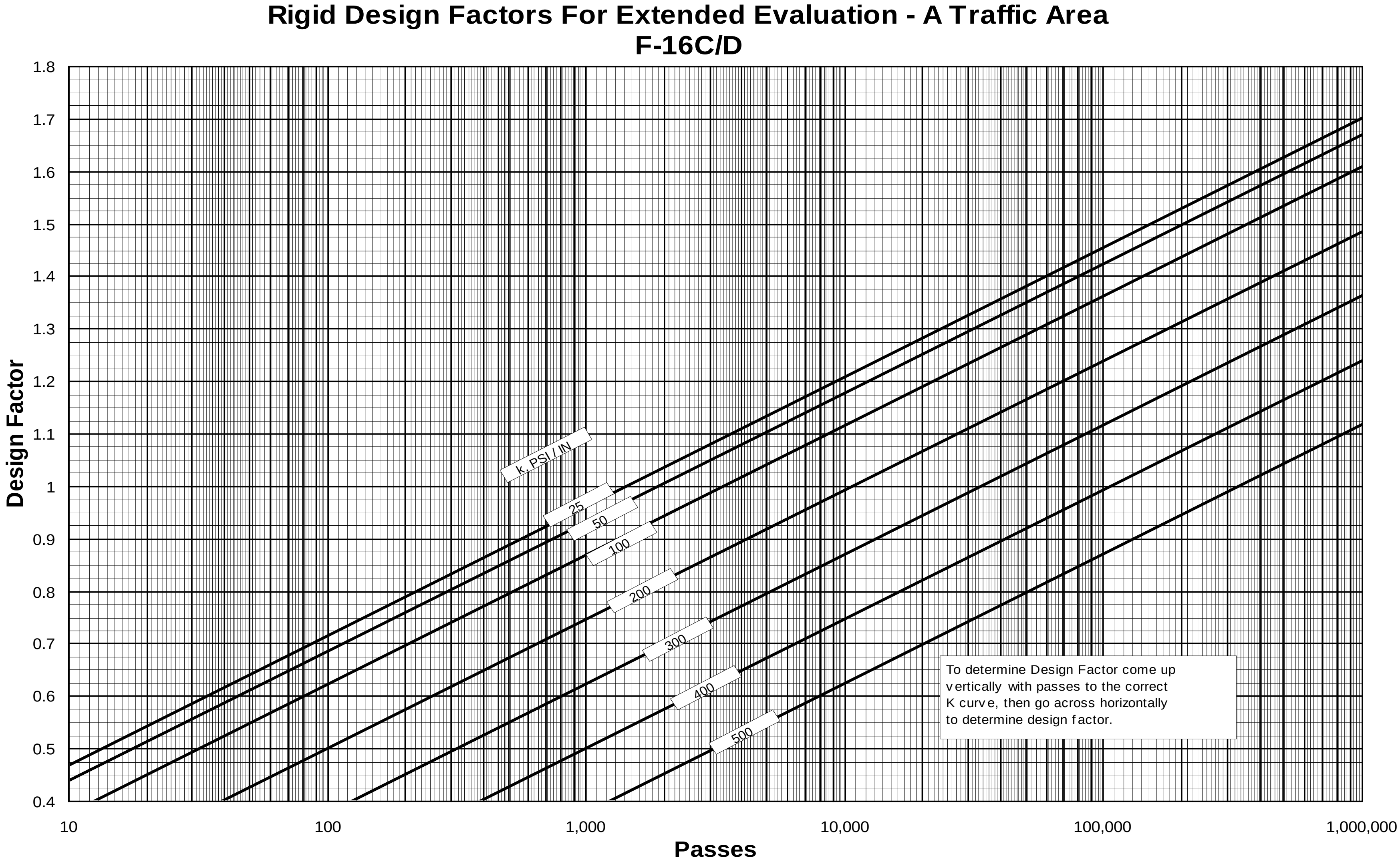

Rigid Design Factors For Extended Evaluation - B,C,D Traffic Area
F-15E
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

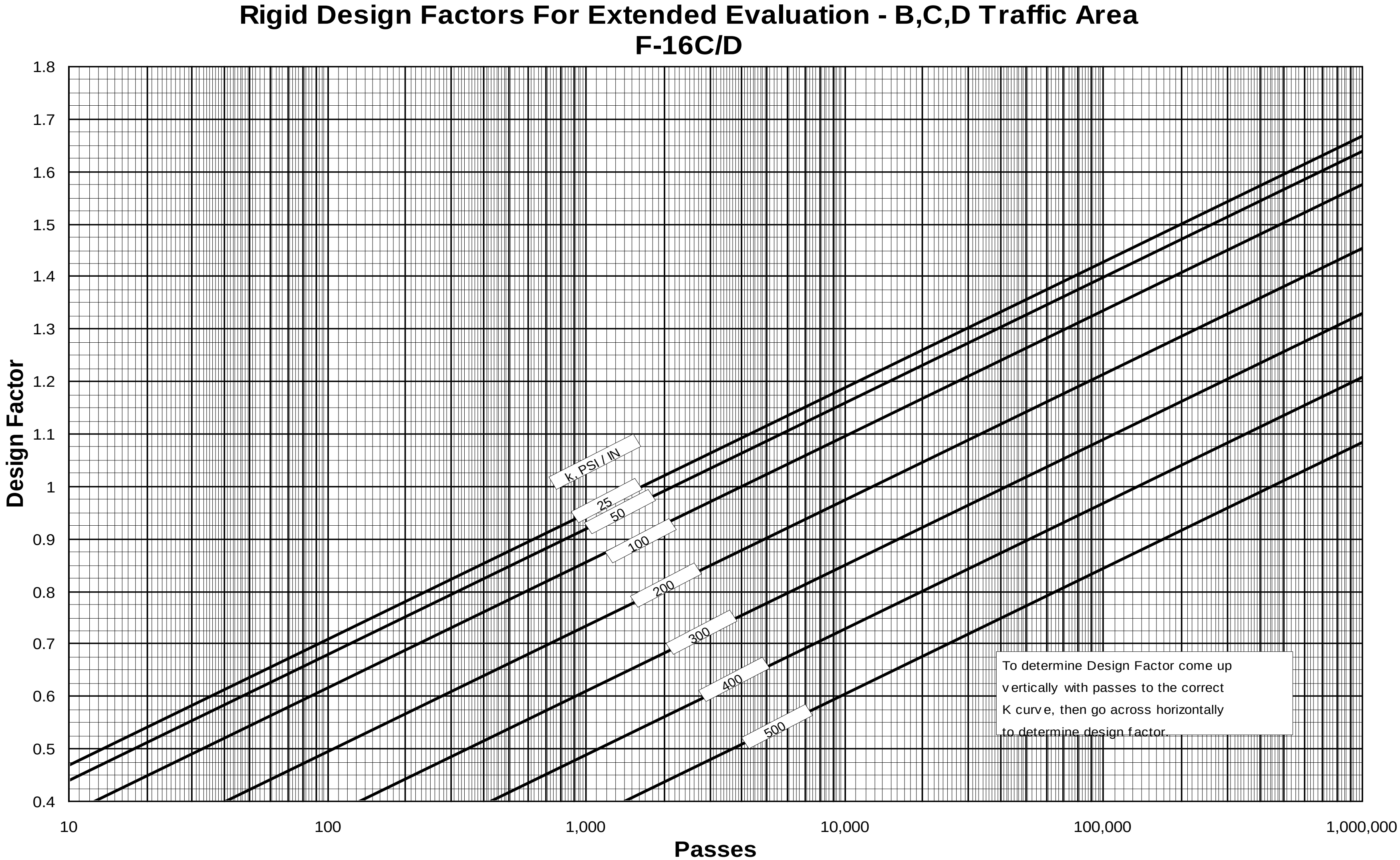

Rigid Pavement Evaluation Load Factor
F-16C/D
Load Factor, Pounds
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
Thickness, IN
3
4
5
6
7
8
9
10
11
12
Flex Strength, PSI
1000
900
800
700
600
500
400
K, PSI / IN
500
300
100
50
25
200
400
To determine Load Factor, project horizontally from thickness to the K value, then go vertically to the correct flex strength, then horizontally to the load factor.


Rigid Design Factors For Standard Evaluation - A Traffic Area
F-16C/D
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically w ith passes to the correct K curve, then go across horizontally to determine design factor.

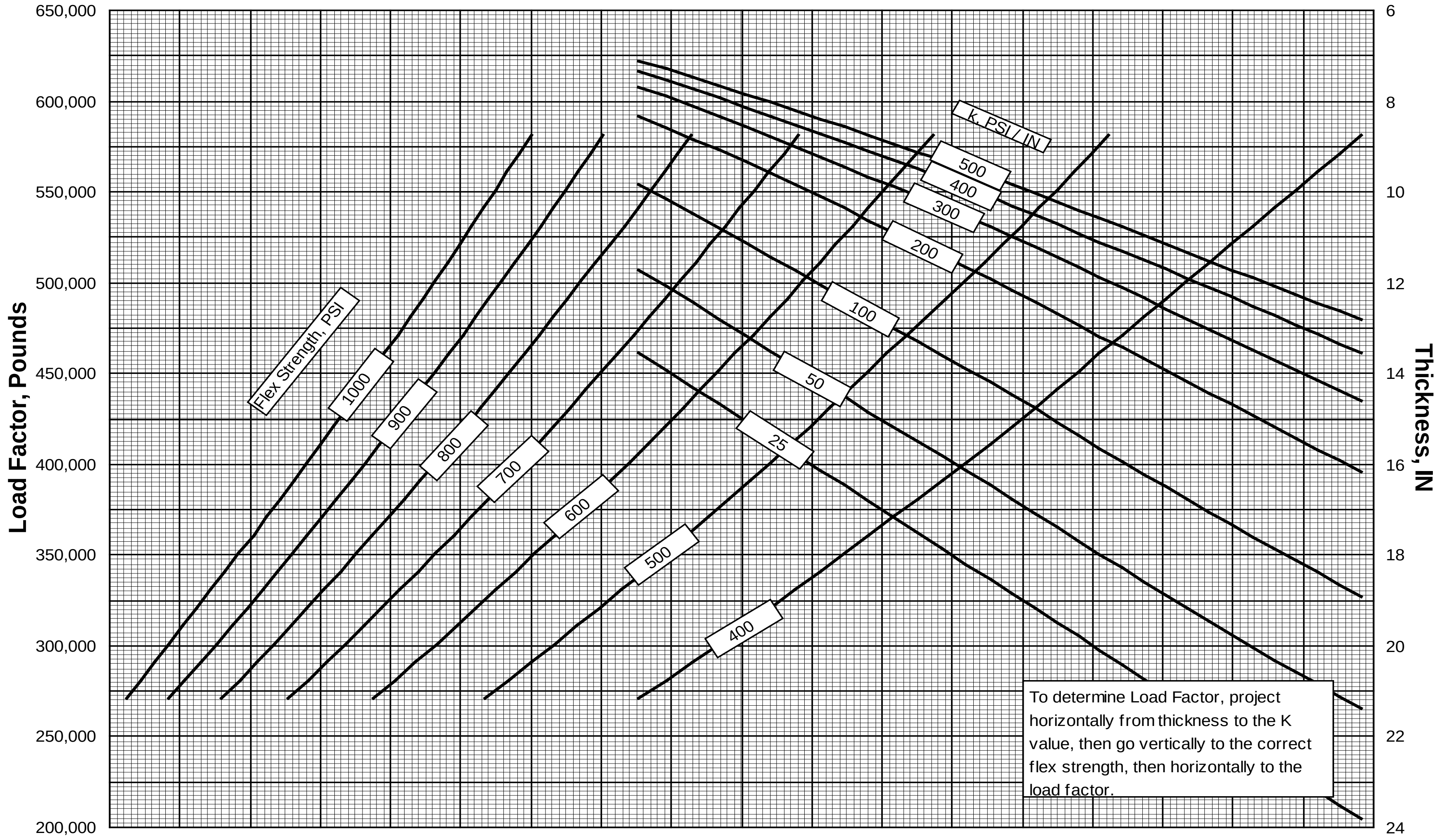
## Rigid Design Factors For Standard Evaluation - B,C,D Traffic Area
## F-16C/D

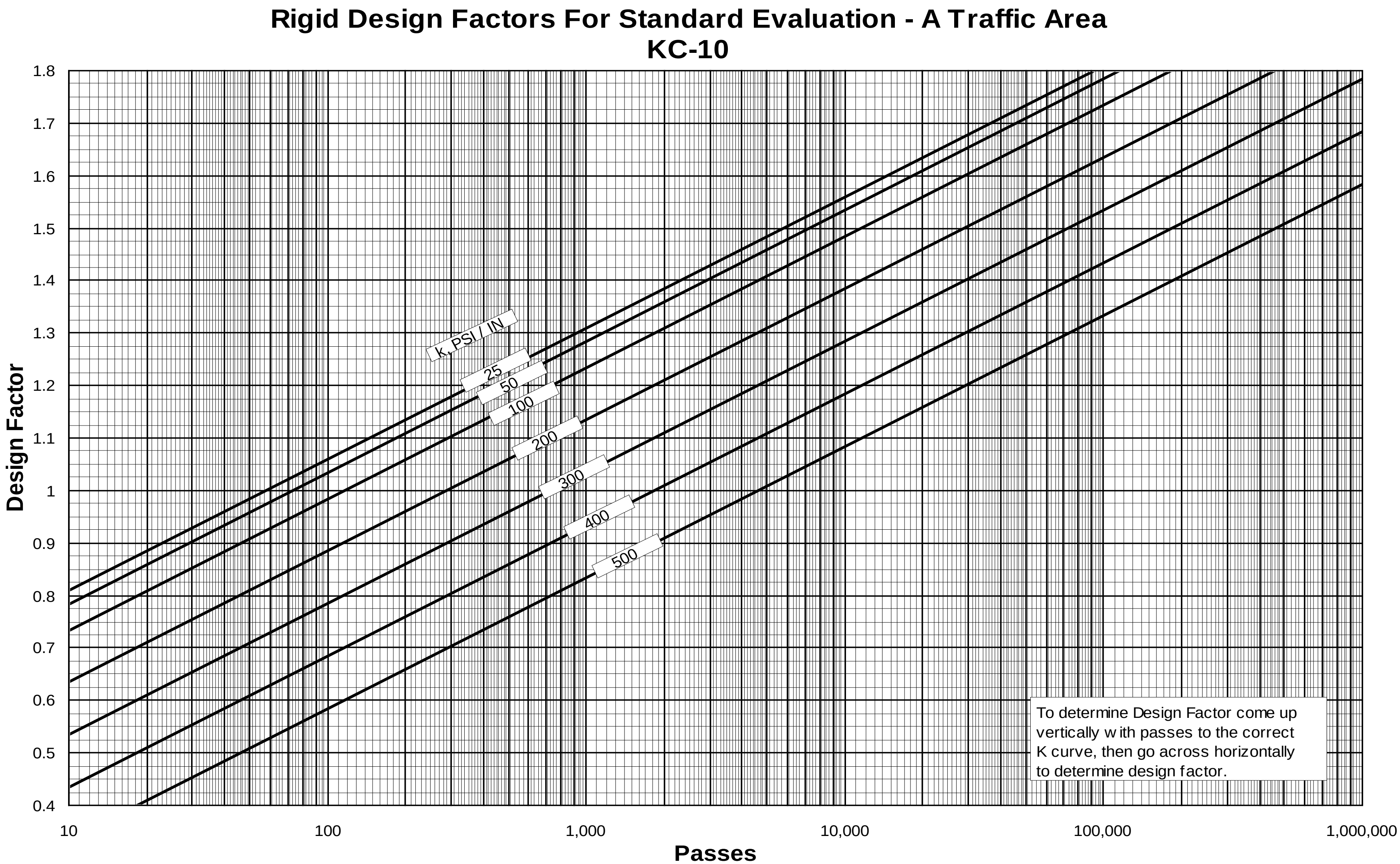


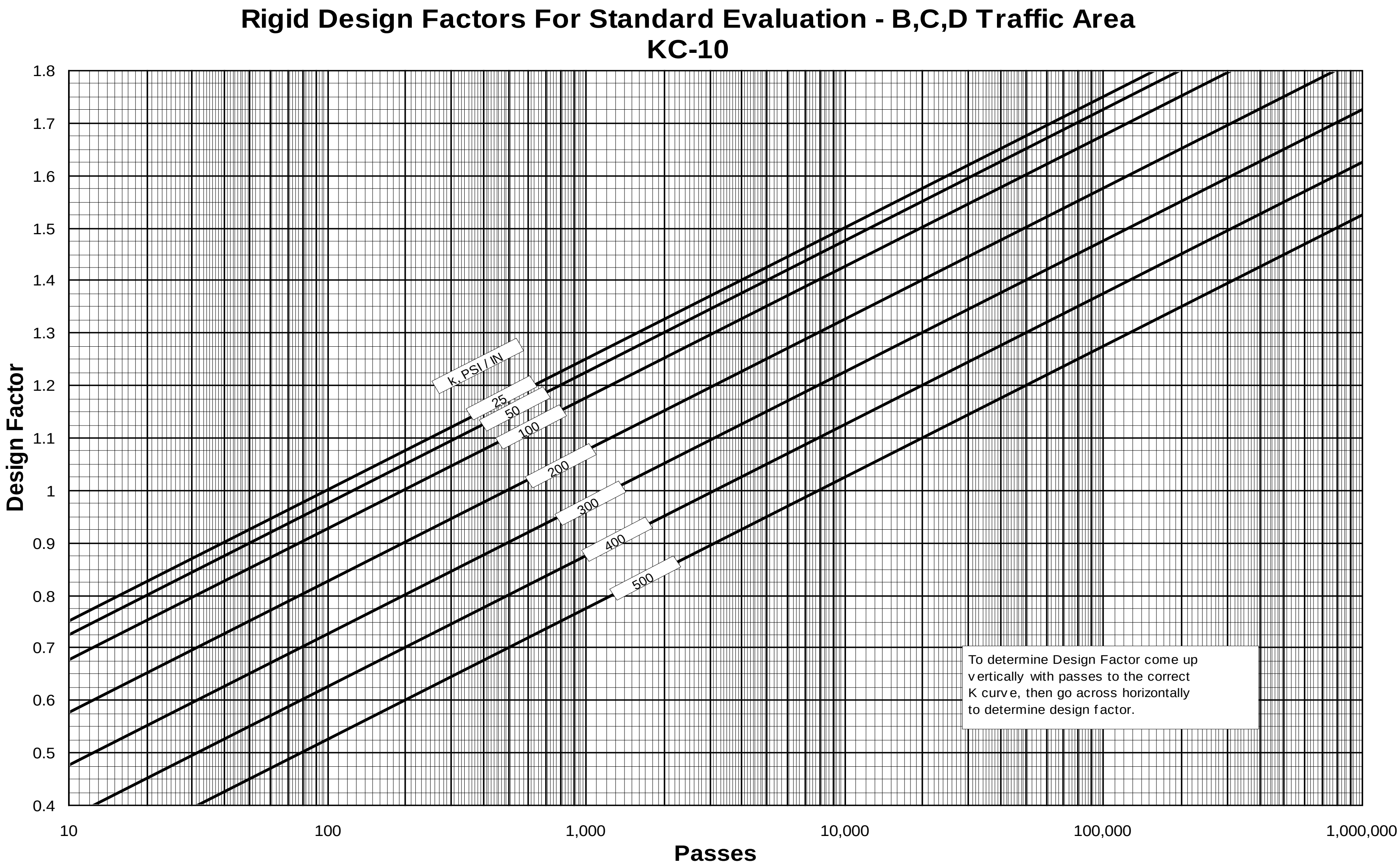

Rigid Design Factors For Extended Evaluation - A Traffic Area
F-16C/D
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
K, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

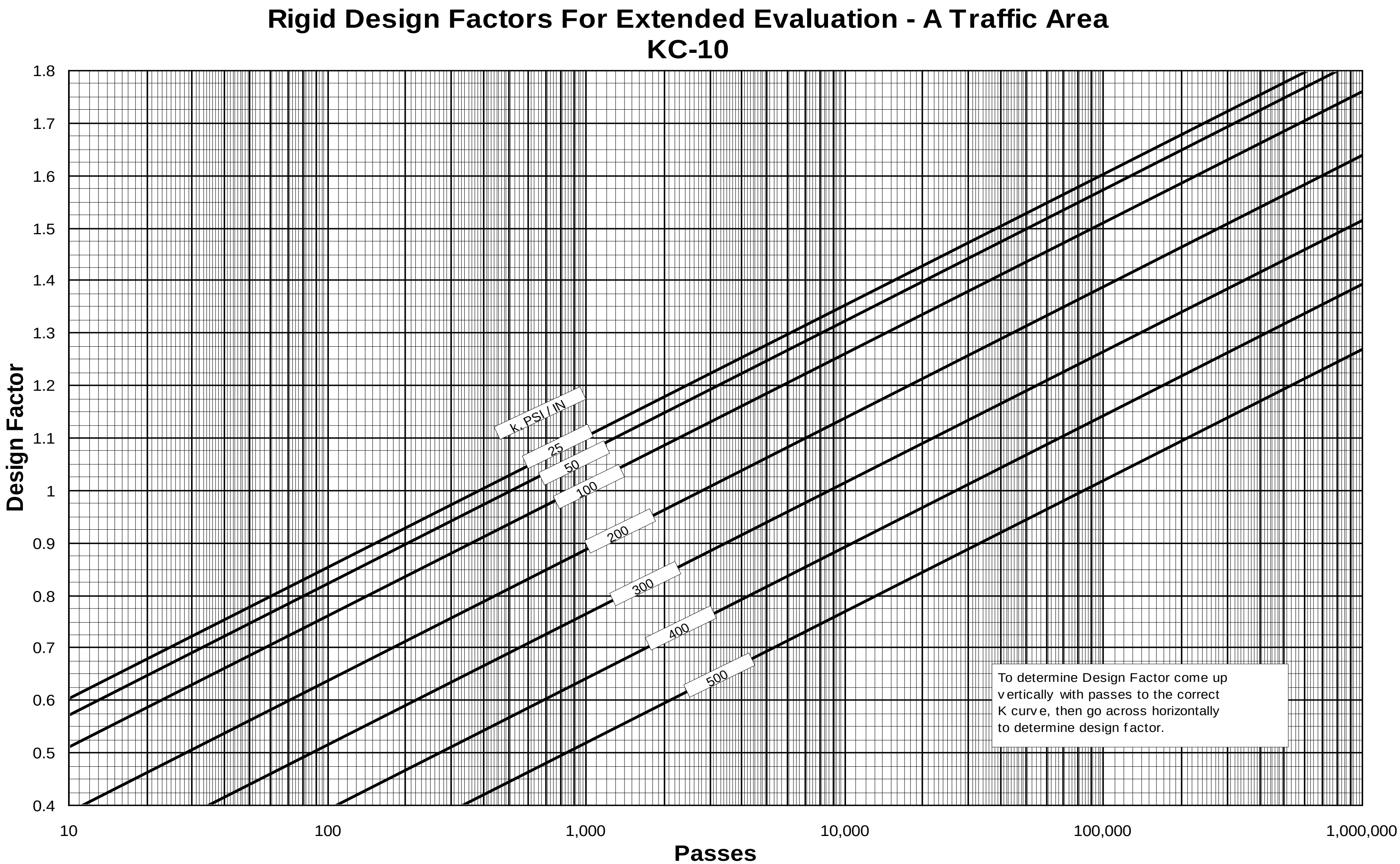

Rigid Design Factors For Extended Evaluation - B,C,D Traffic Area
F-16C/D
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

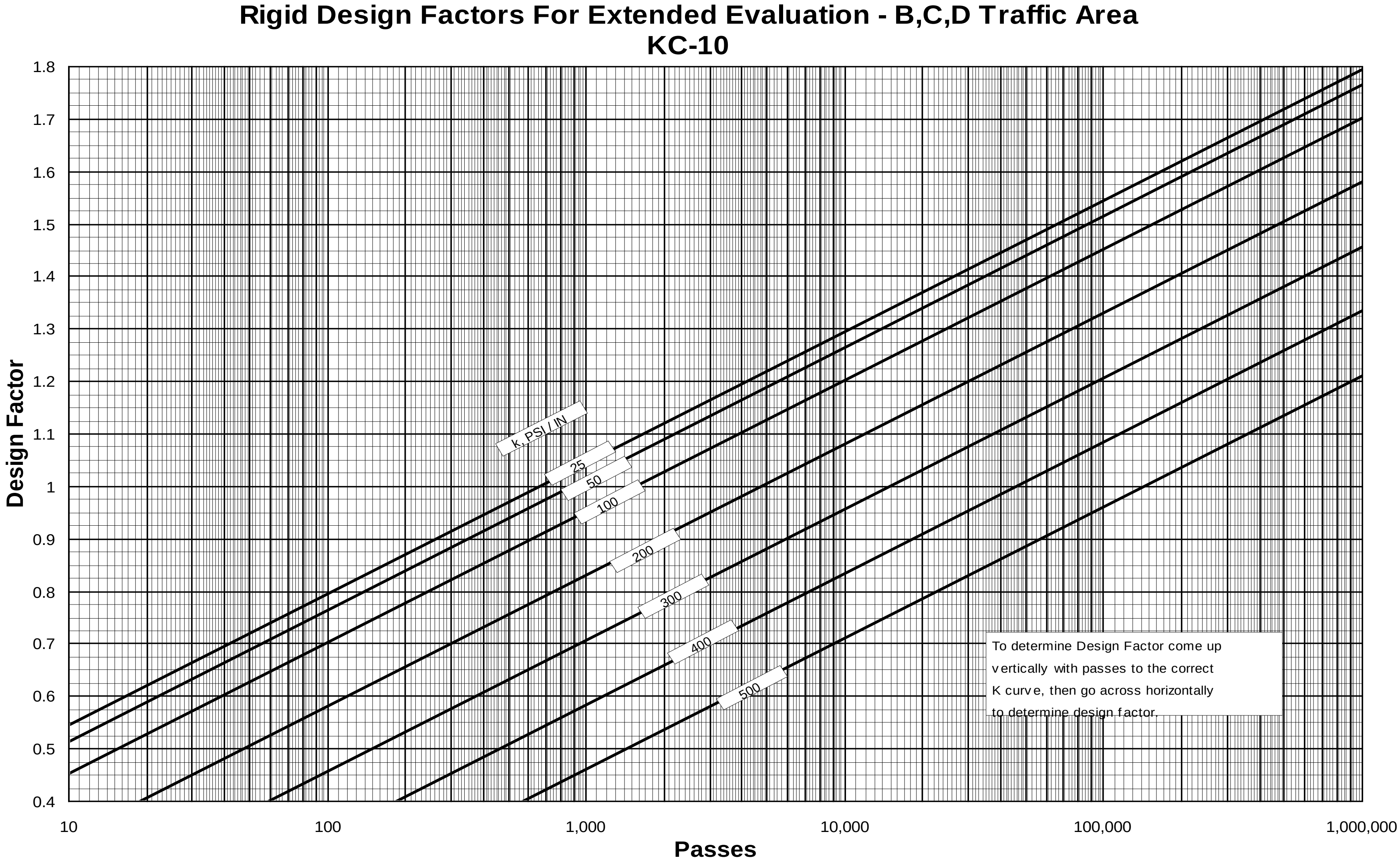
## Rigid Pavement Evaluation Load Factor
## KC-10

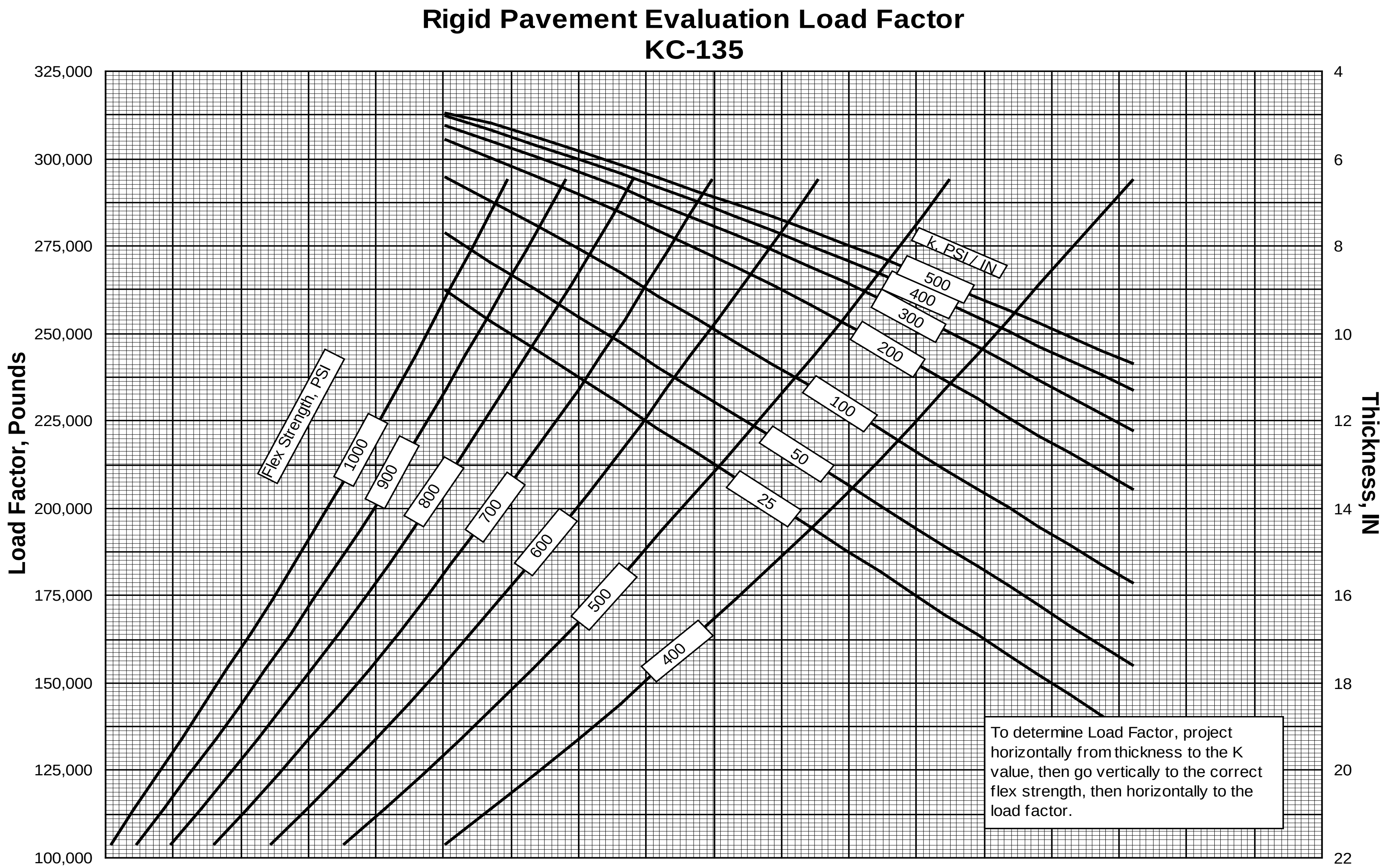


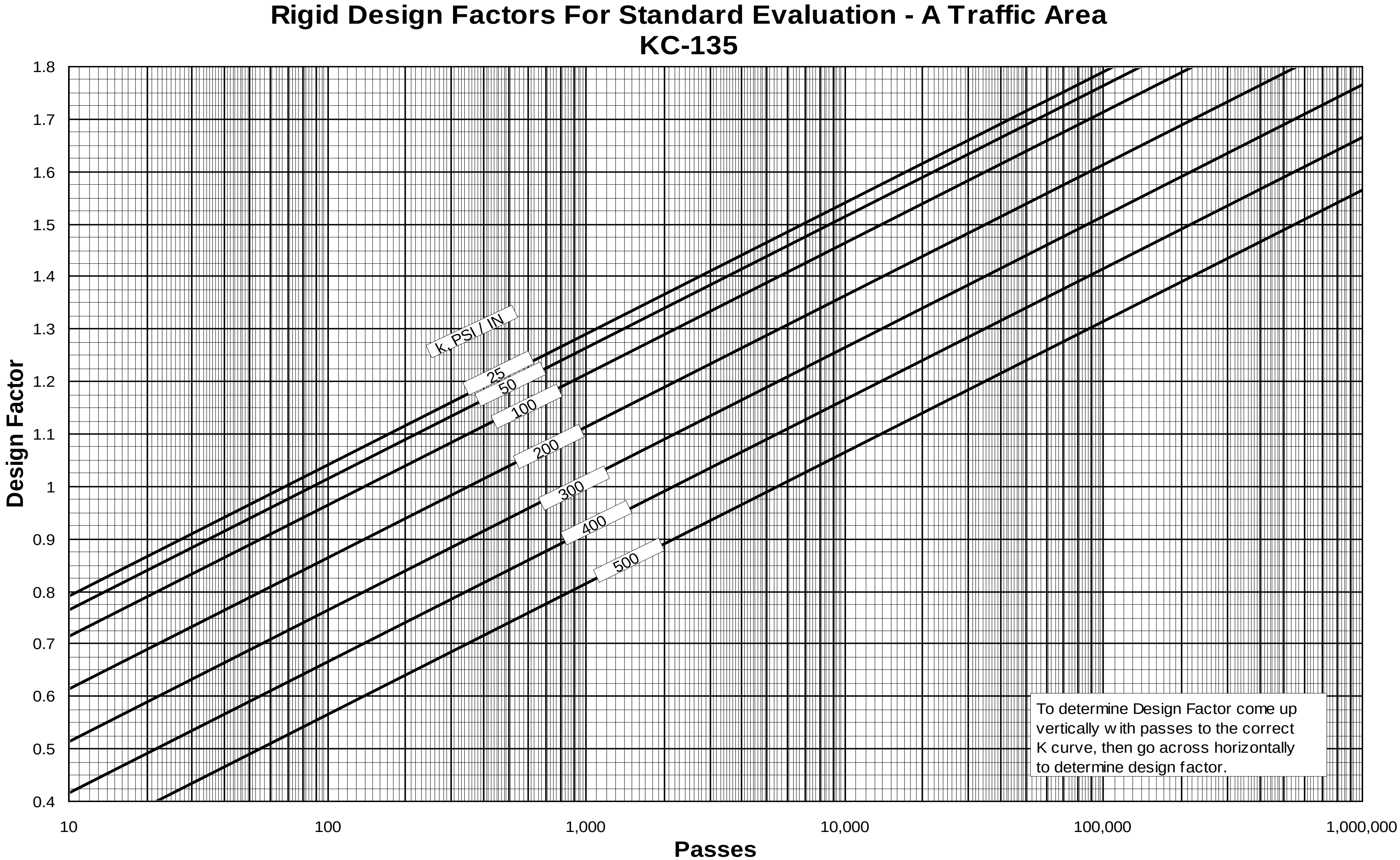

Rigid Design Factors For Standard Evaluation - A Traffic Area
KC-10
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

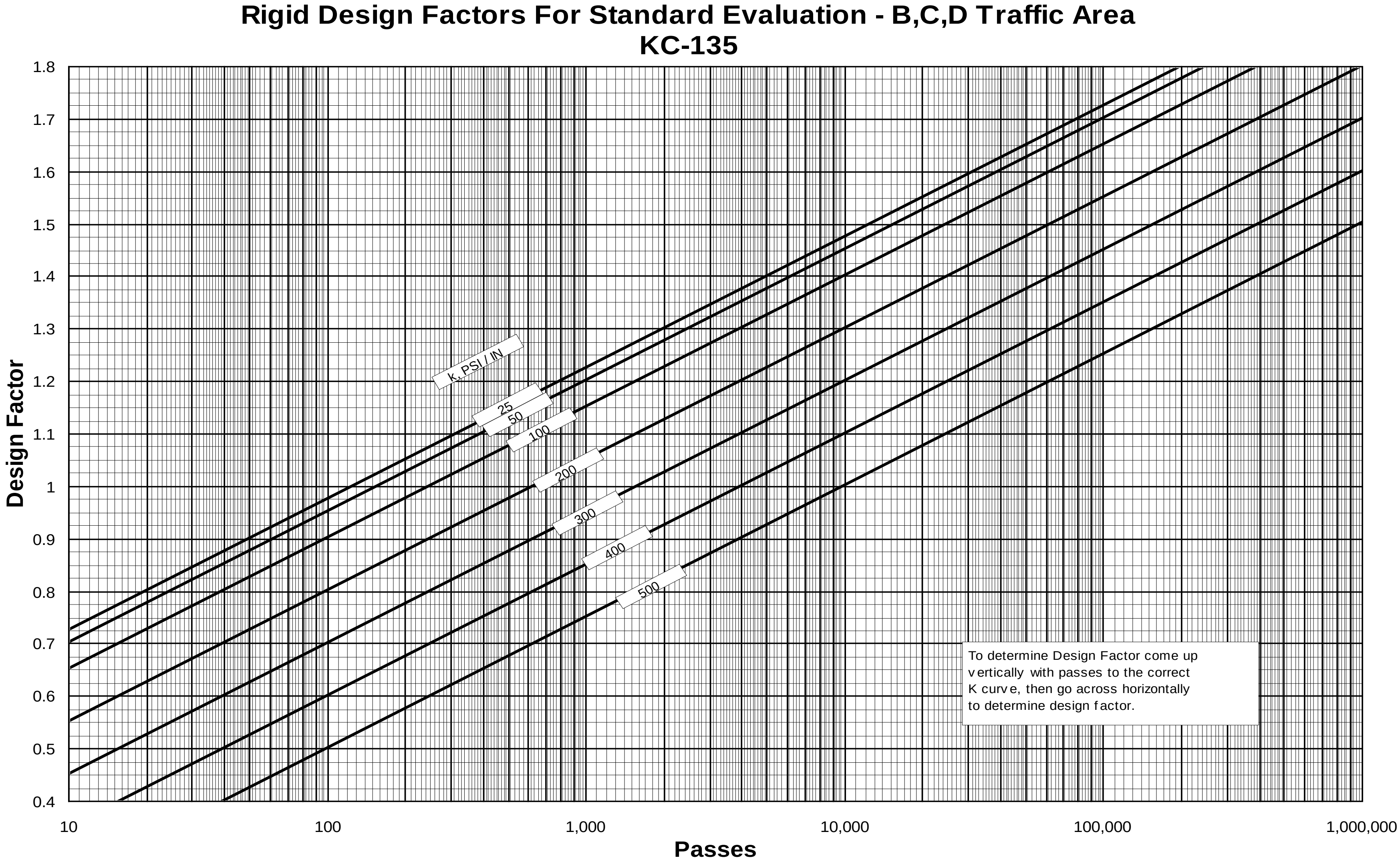

Rigid Design Factors For Standard Evaluation - B,C,D Traffic Area
KC-10
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
K, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

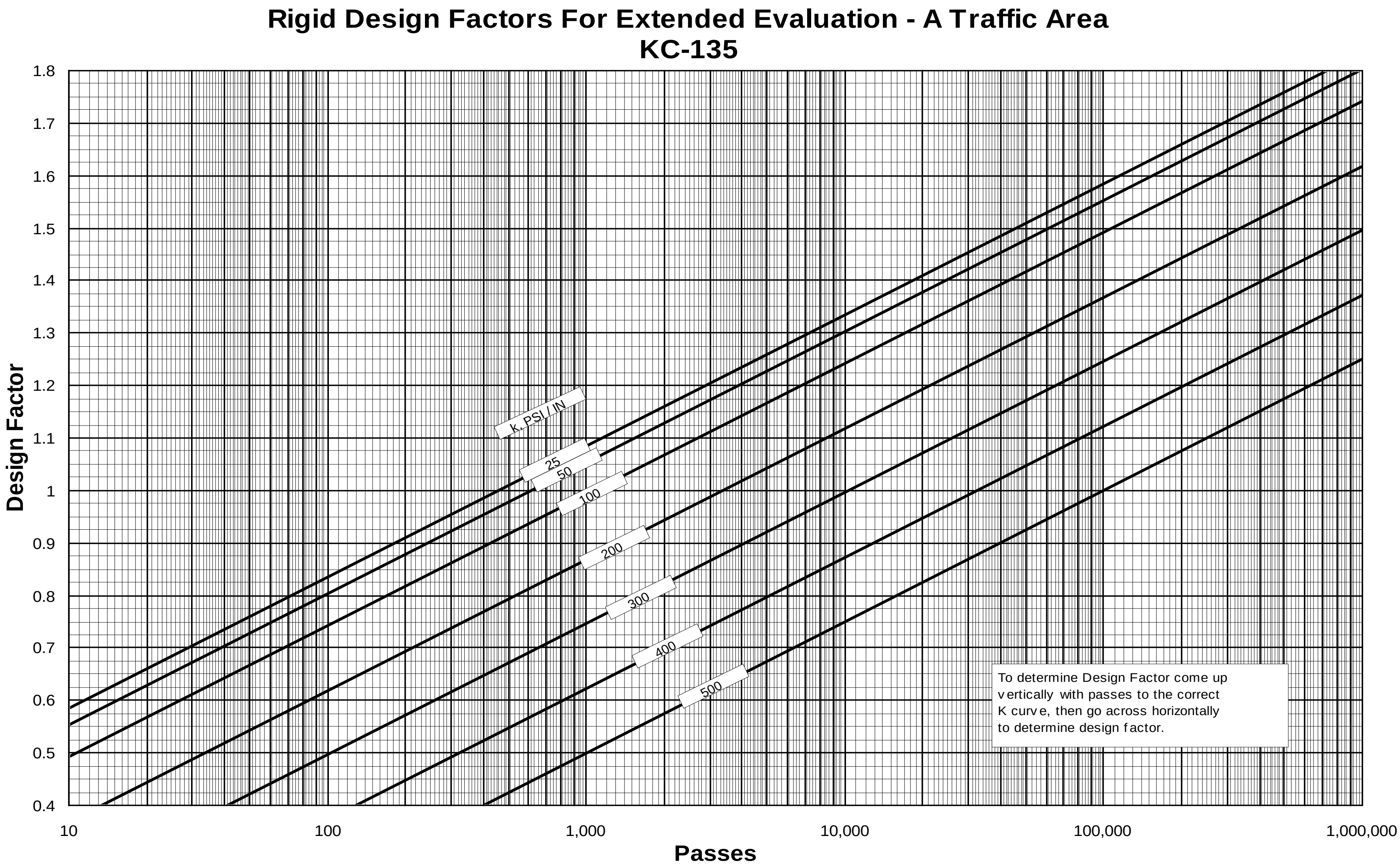

Rigid Design Factors For Extended Evaluation - A Traffic Area
KC-10
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

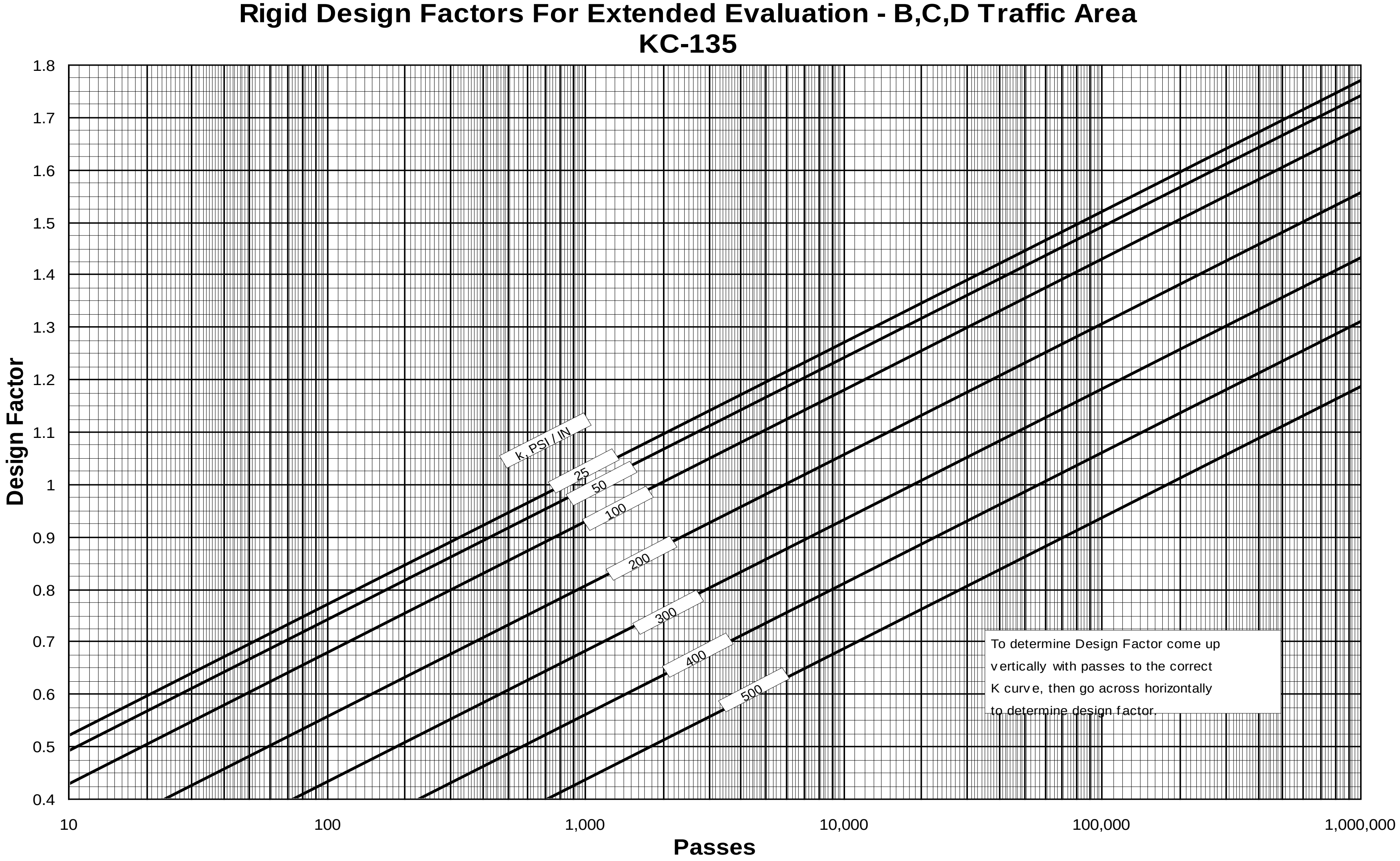

Rigid Design Factors For Extended Evaluation - B,C,D Traffic Area
KC-10
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
K PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.


Rigid Pavement Evaluation Load Factor
KC-135
Load Factor, Pounds
325,000
300,000
275,000
250,000
225,000
200,000
175,000
150,000
125,000
100,000
Thickness, IN
4
6
8
10
12
14
16
18
20
22
Flex Strength, PSI
1000
900
800
700
600
500
400
k, PSI / IN
500
400
300
200
100
50
25
To determine Load Factor, project horizontally from thickness to the K value, then go vertically to the correct flex strength, then horizontally to the load factor.


Rigid Design Factors For Standard Evaluation - A Traffic Area
KC-135
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically w ith passes to the correct K curve, then go across horizontally to determine design factor.


Rigid Design Factors For Standard Evaluation - B,C,D Traffic Area
KC-135
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
K, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.
10
100
1,000
10,000
100,000
1,000,000
Passes


Rigid Design Factors For Extended Evaluation - A Traffic Area
KC-135
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
k, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.


Rigid Design Factors For Extended Evaluation - B,C,D Traffic Area
KC-135
Design Factor
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes
K, PSI / IN
25
50
100
200
300
400
500
To determine Design Factor come up vertically with passes to the correct K curve, then go across horizontally to determine design factor.

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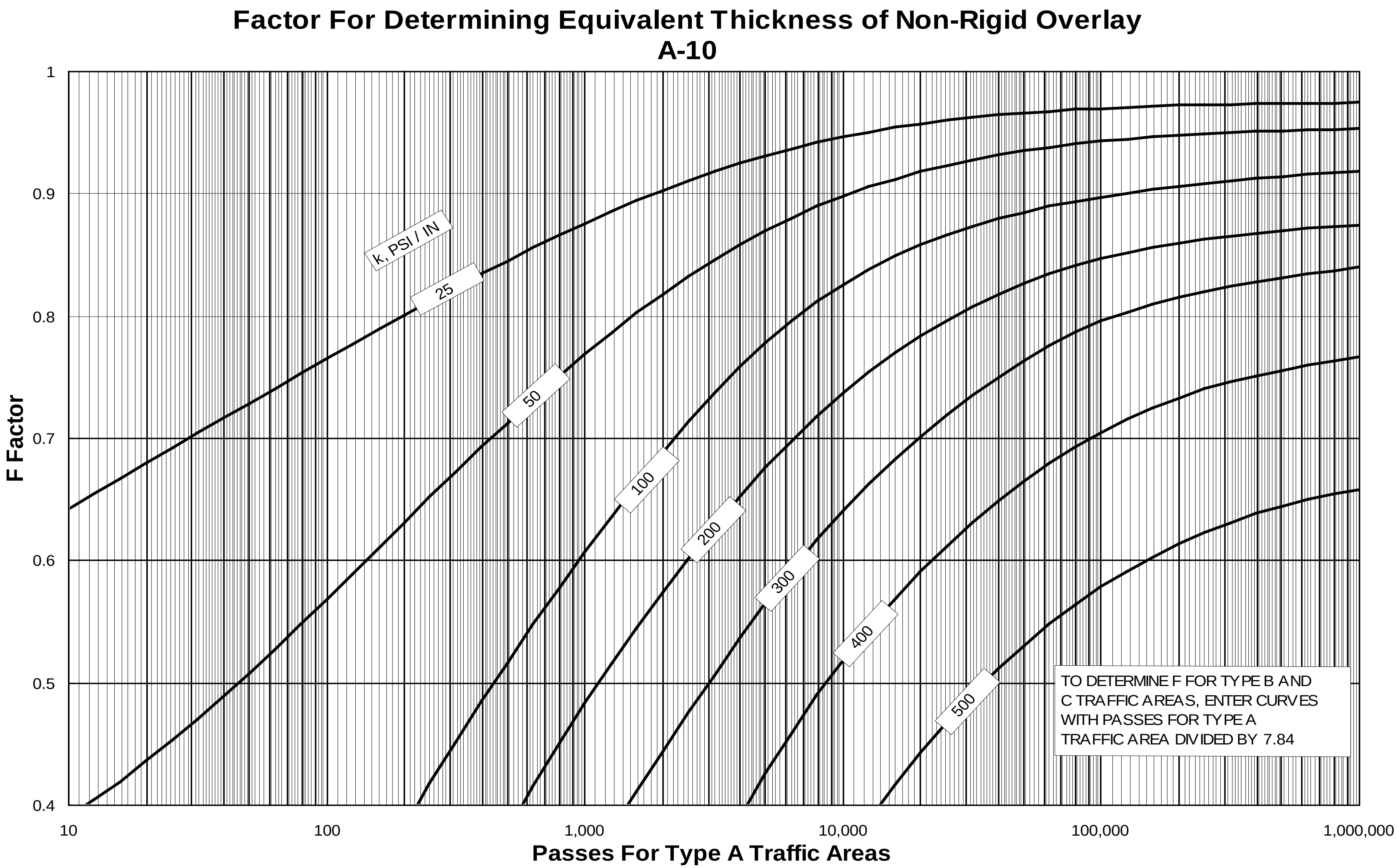
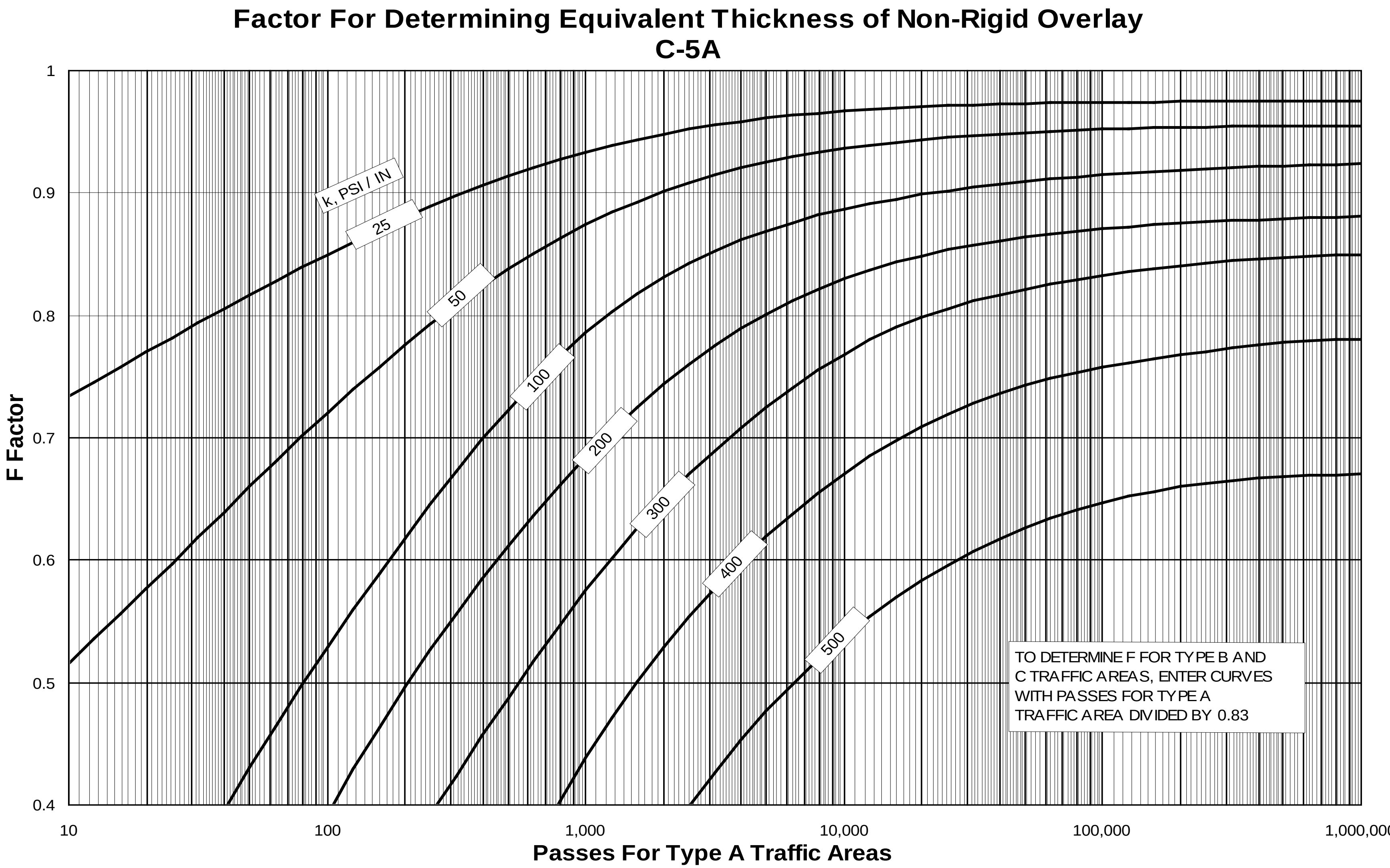
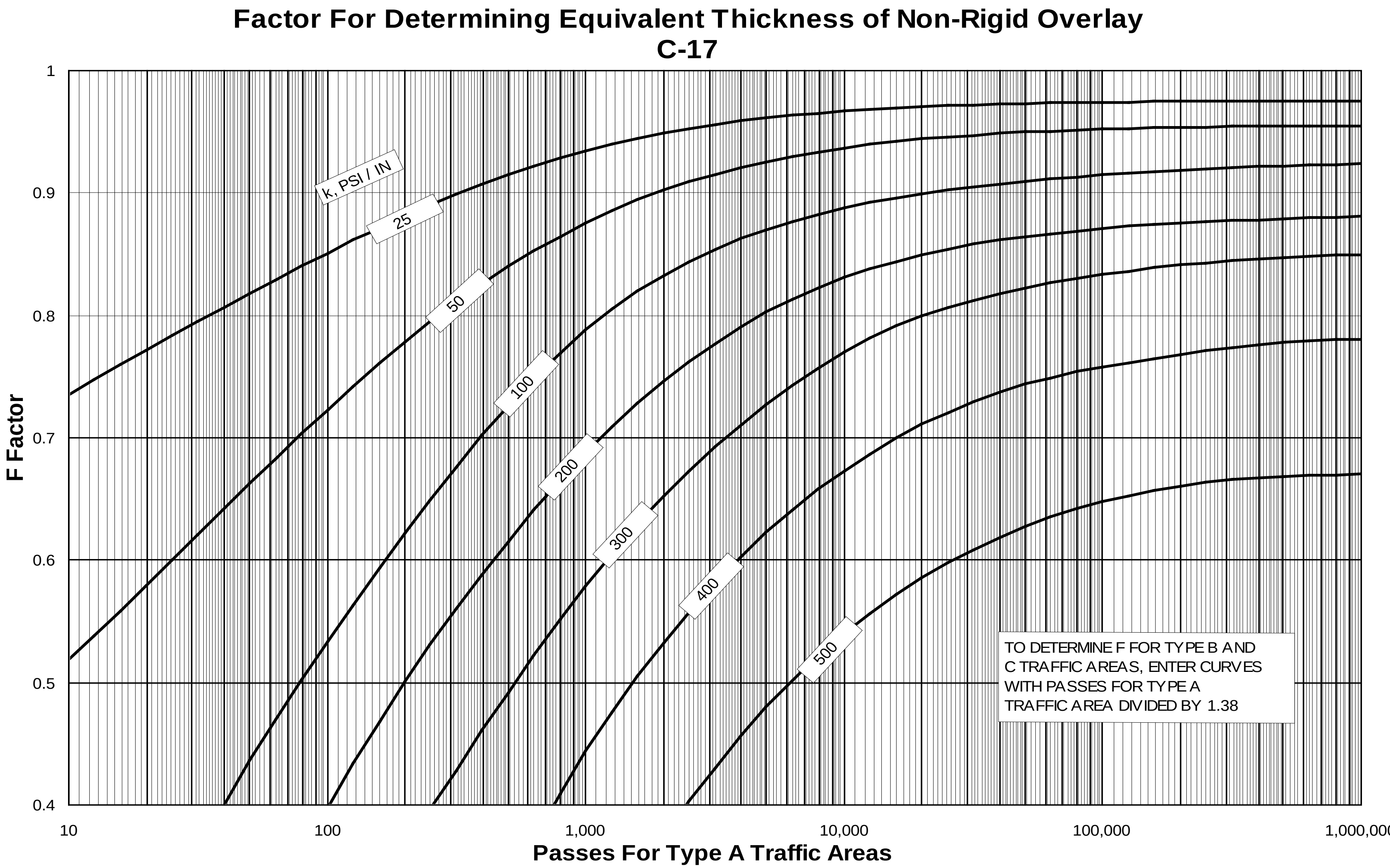
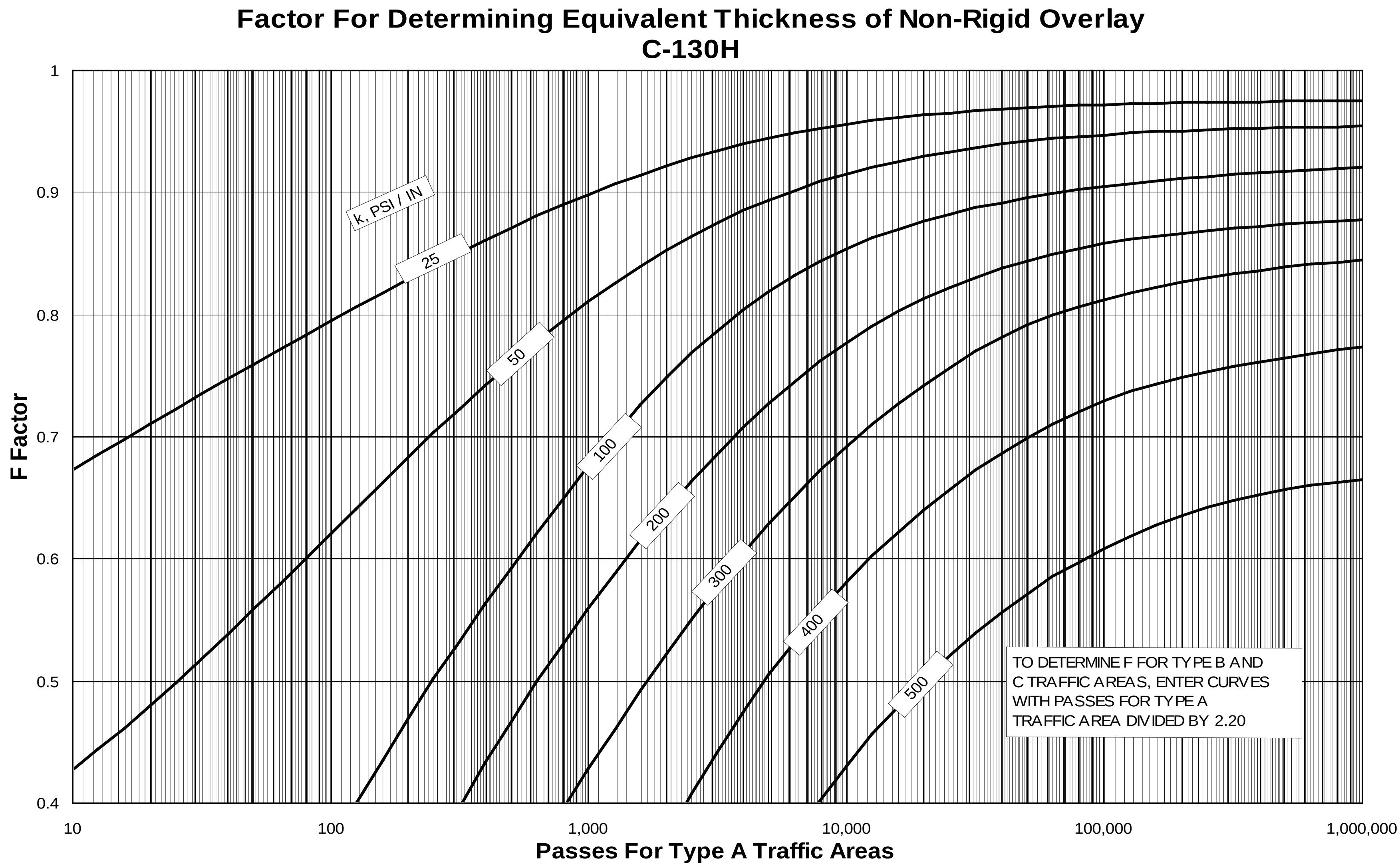
## APPENDIX G NONRIGID EQUIVALENT THICKNESS CURVES

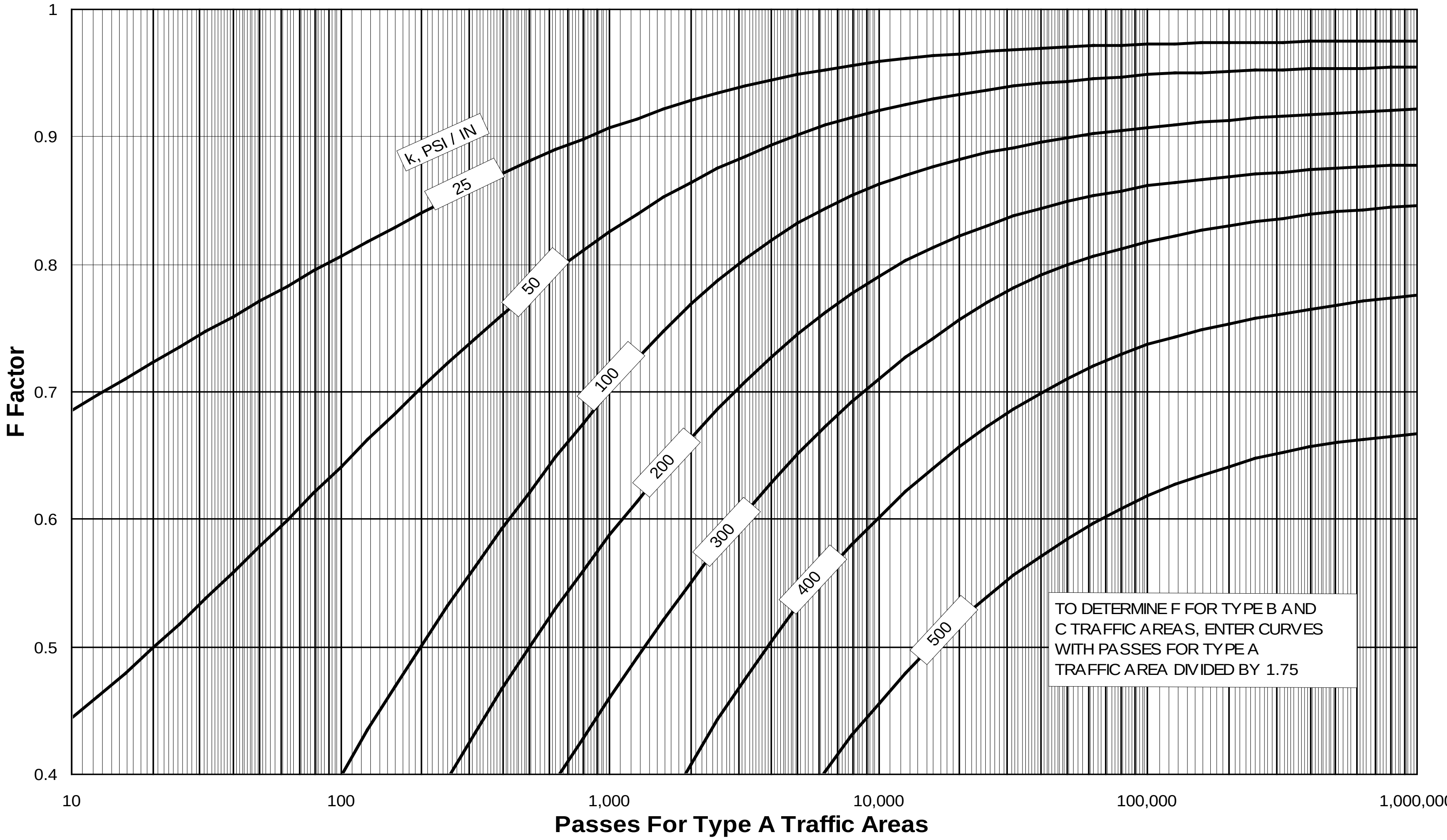


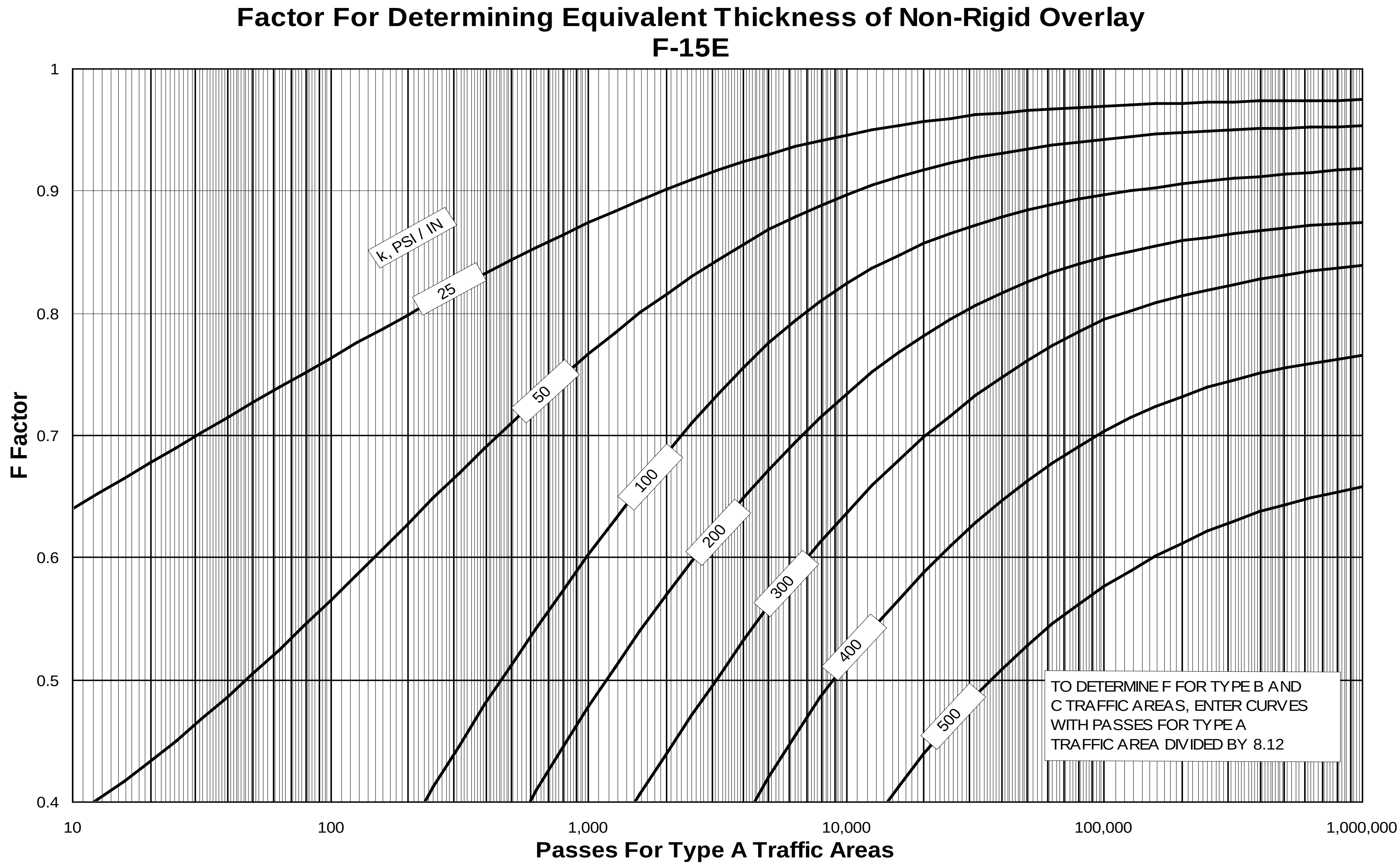

Factor For Determining Equivalent Thickness of Non-Rigid Overlay
C-5A
F Factor
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes For Type A Traffic Areas
k, PSI / IN
25
50
100
200
300
400
500
TO DETERMINE F FOR TYPE B AND
C TRAFFIC AREAS, ENTER CURVES
WITH PASSES FOR TYPE A
TRAFFIC AREA DIVIDED BY 0.83

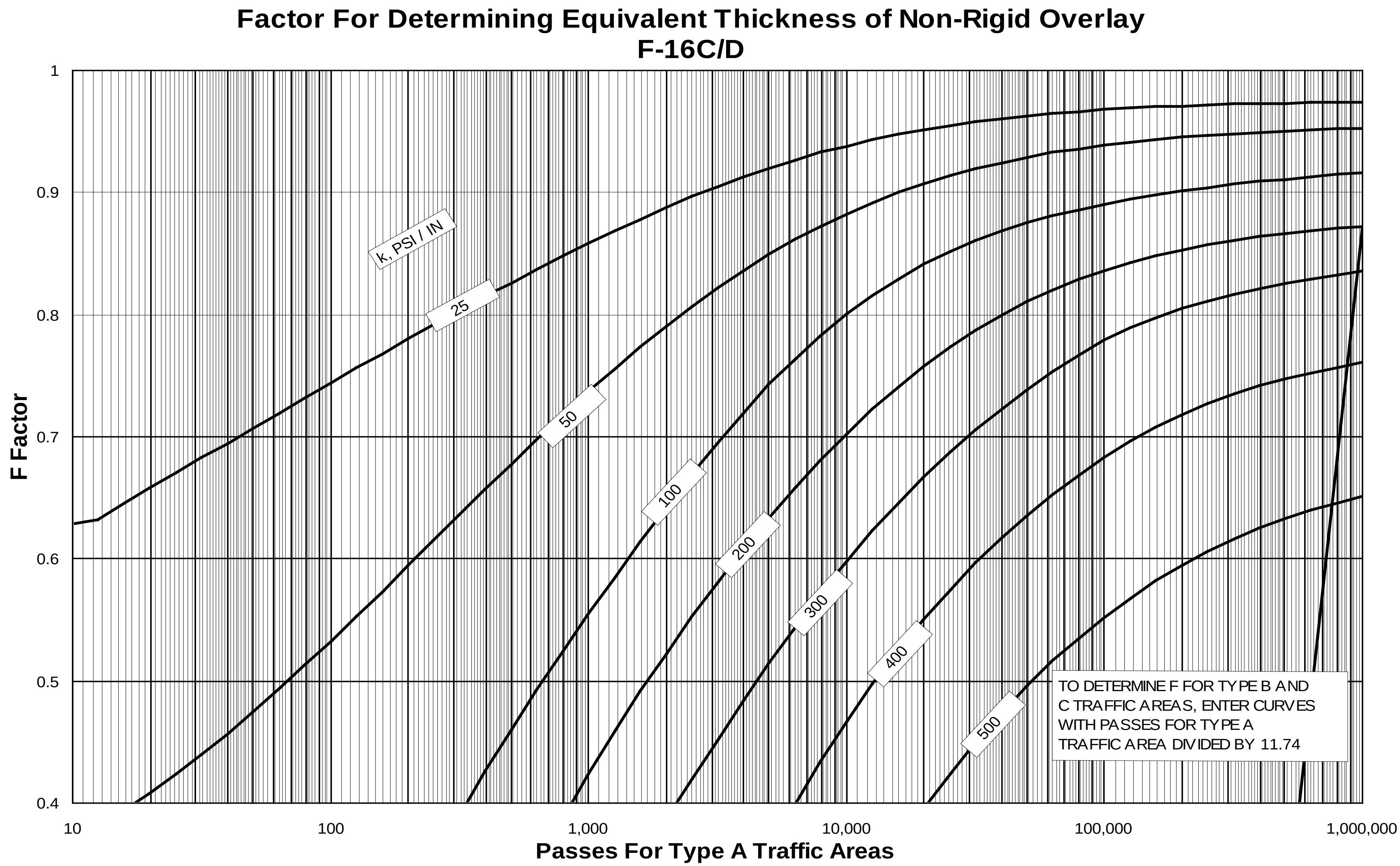

Factor For Determining Equivalent Thickness of Non-Rigid Overlay
C-17
F Factor
Passes For Type A Traffic Areas
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
k, PSI / IN
25
50
100
200
300
400
500
TO DETERMINE F FOR TYPE B AND C TRAFFIC AREAS, ENTER CURVES WITH PASSES FOR TYPE A TRAFFIC AREA DIVIDED BY 1.38

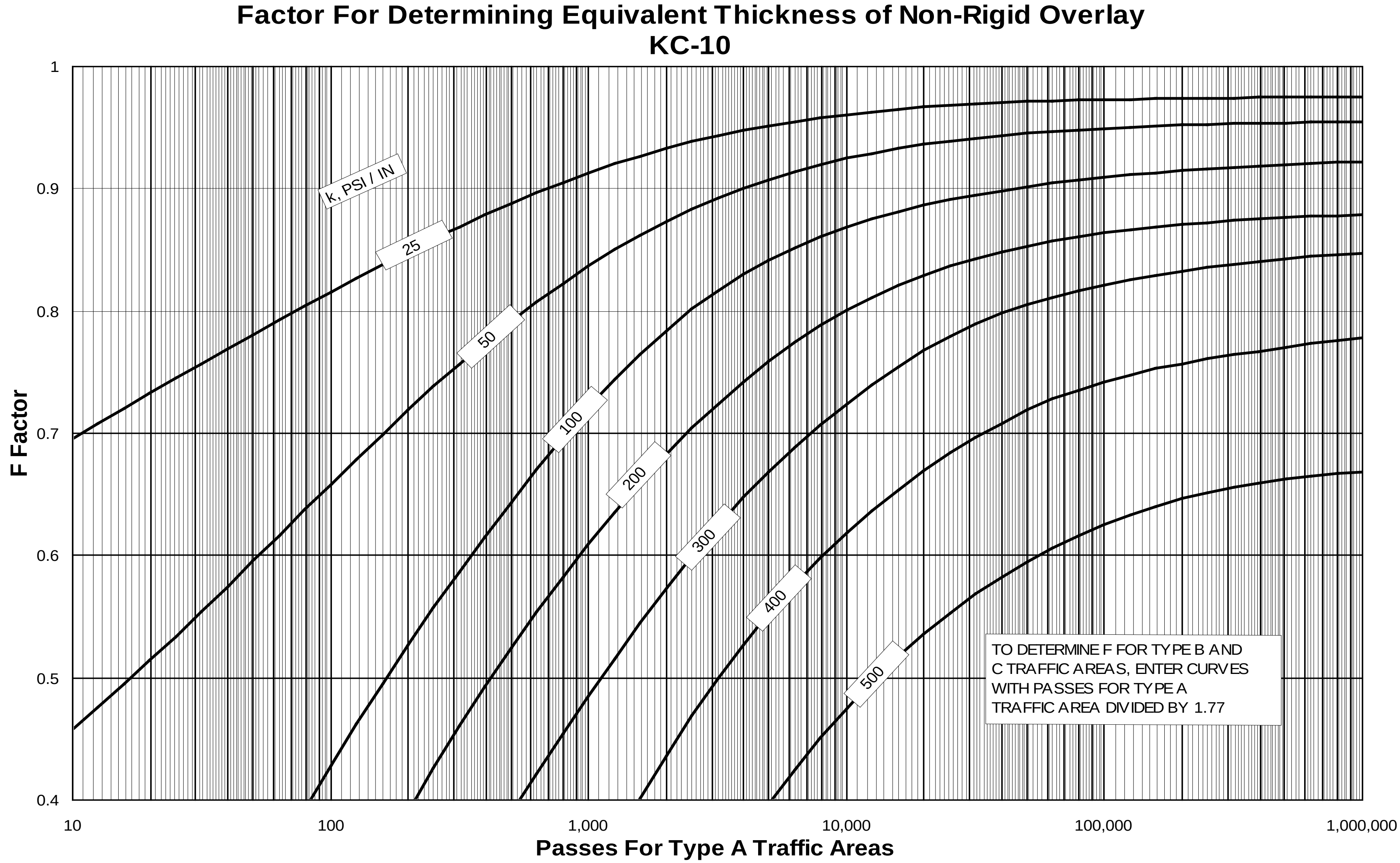

Factor For Determining Equivalent Thickness of Non-Rigid Overlay
C-130H
F Factor
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes For Type A Traffic Areas
k, PSI / IN
25
50
100
200
300
400
500
TO DETERMINE F FOR TYPE B AND
C TRAFFIC AREAS, ENTER CURVES
WITH PASSES FOR TYPE A
TRAFFIC AREA DIVIDED BY 2.20

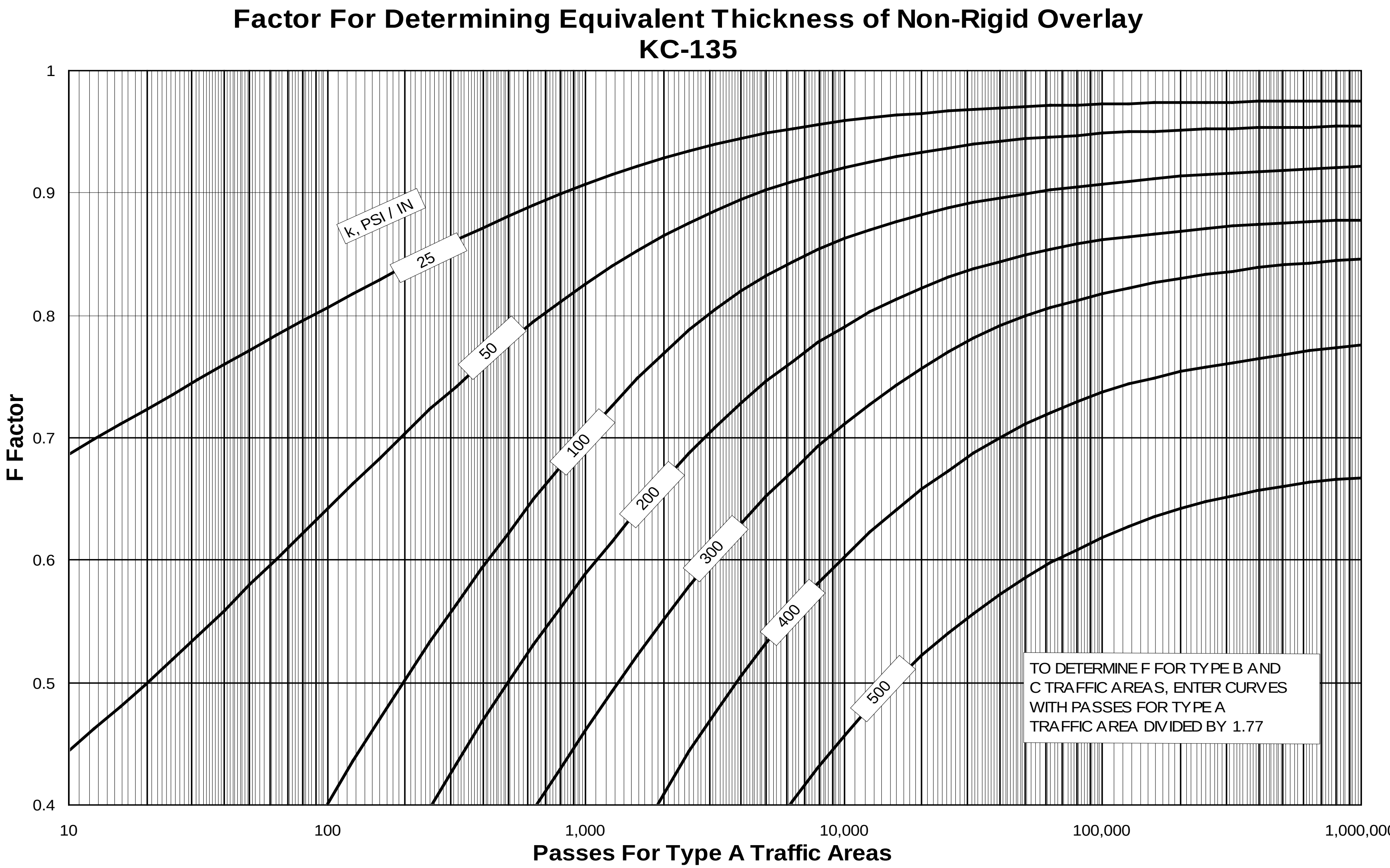
## Factor For Determining Equivalent Thickness of Non-Rigid Overlay C-141




Factor For Determining Equivalent Thickness of Non-Rigid Overlay
F-15E
F Factor
Passes For Type A Traffic Areas
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
K, PSI / IN
25
50
100
200
300
400
500
TO DETERMINE F FOR TYPE B AND
C TRAFFIC AREAS, ENTER CURVES
WITH PASSES FOR TYPE A
TRAFFIC AREA DIVIDED BY 8.12


Factor For Determining Equivalent Thickness of Non-Rigid Overlay
F-16C/D
F Factor
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes For Type A Traffic Areas
K, PSI / IN
25
50
100
200
300
400
500
TO DETERMINE F FOR TYPE B AND C TRAFFIC AREAS, ENTER CURVES WITH PASSES FOR TYPE A TRAFFIC AREA DIVIDED BY 11.74


Factor For Determining Equivalent Thickness of Non-Rigid Overlay
KC-10
F Factor
1
0.9
0.8
0.7
0.6
0.5
0.4
k, PSI / IN
25
50
100
200
300
400
500
TO DETERMINE F FOR TYPE B AND C TRAFFIC AREAS, ENTER CURVES WITH PASSES FOR TYPE A TRAFFIC AREA DIVIDED BY 1.77
10
100
1,000
10,000
100,000
1,000,000
Passes For Type A Traffic Areas


Factor For Determining Equivalent Thickness of Non-Rigid Overlay
KC-135
F Factor
1
0.9
0.8
0.7
0.6
0.5
0.4
10
100
1,000
10,000
100,000
1,000,000
Passes For Type A Traffic Areas
k, PSI / IN
25
50
100
200
300
400
500
TO DETERMINE F FOR TYPE B AND C TRAFFIC AREAS, ENTER CURVES WITH PASSES FOR TYPE A TRAFFIC AREA DIVIDED BY 1.77

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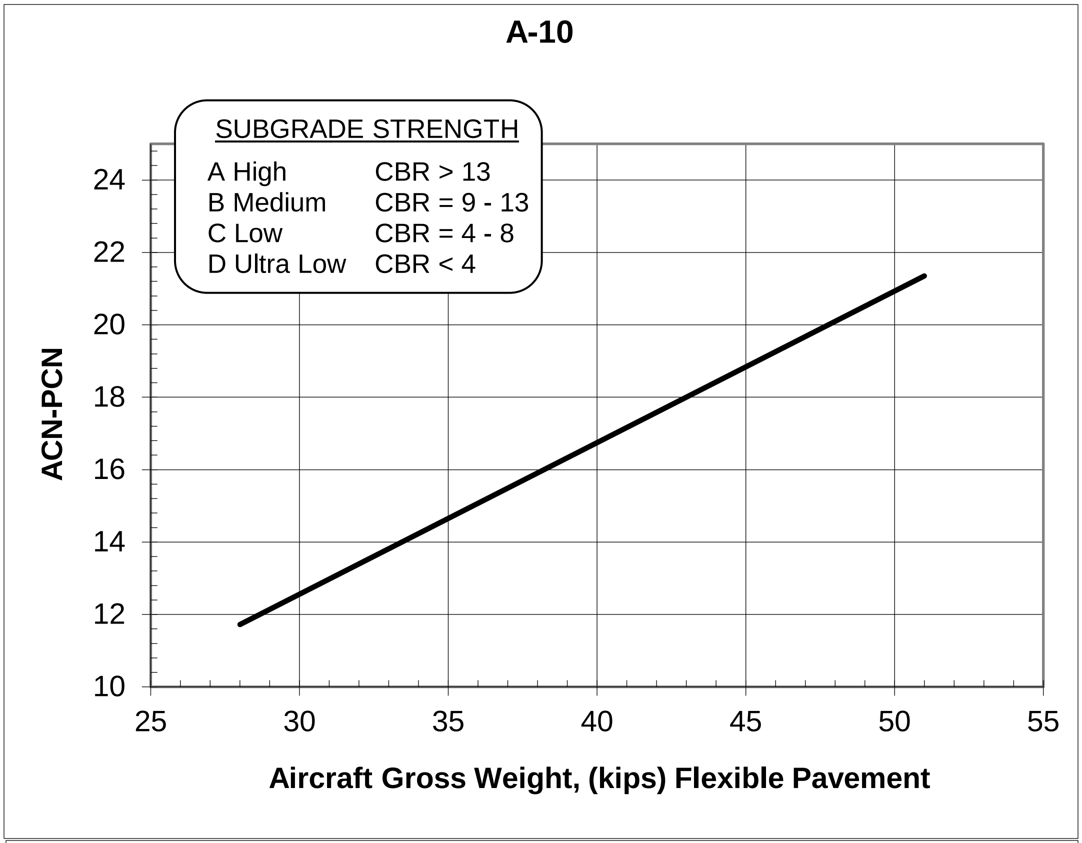
# APPENDIX H ACN/PCN CHARTS

## Figure H-1 ACN/PCN Curves for A-10



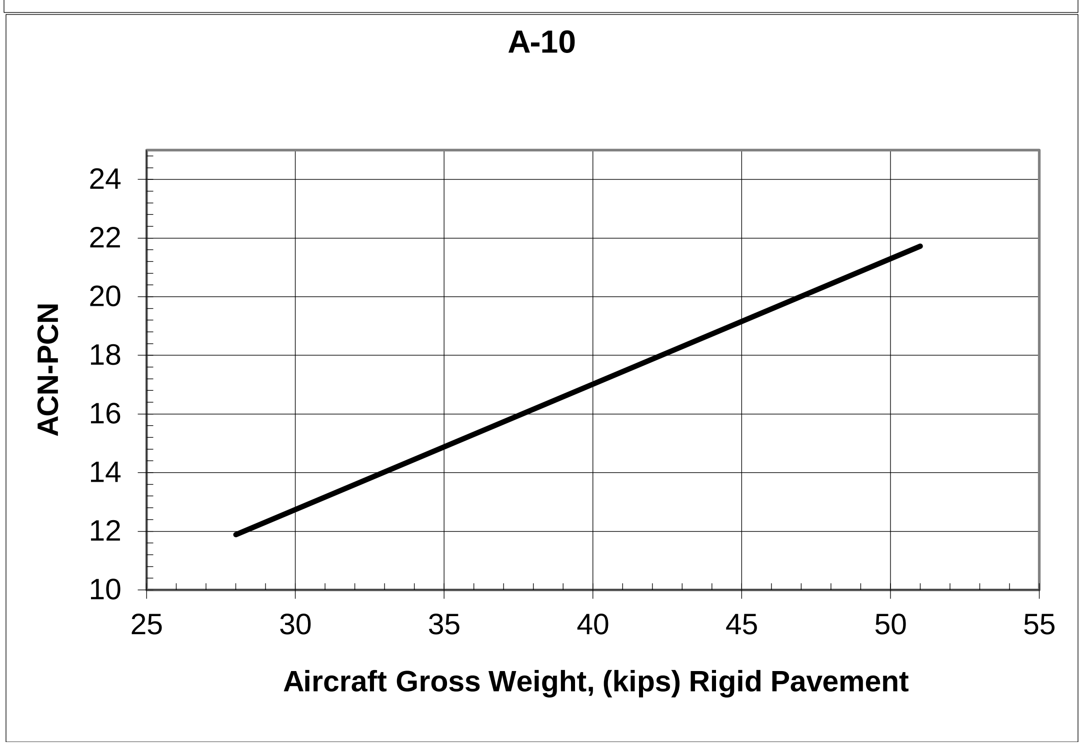
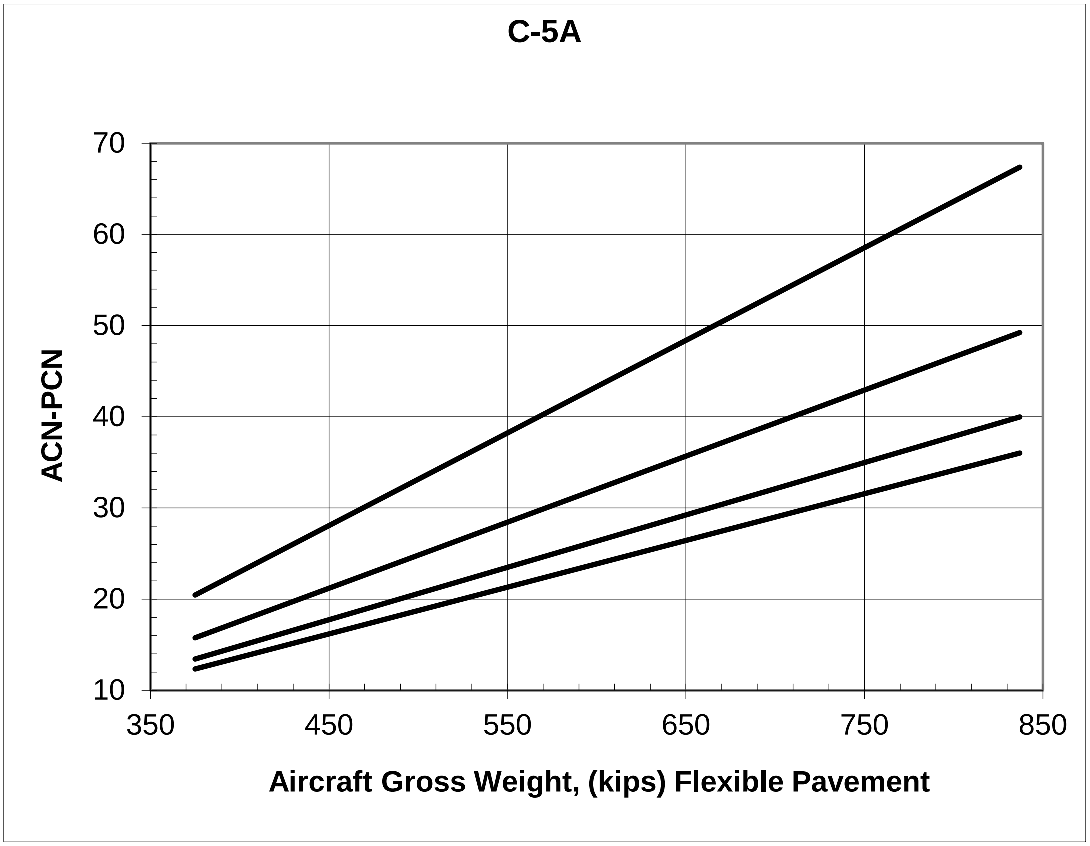



**Figure H-2 ACN/PCN Curves for C-5A**



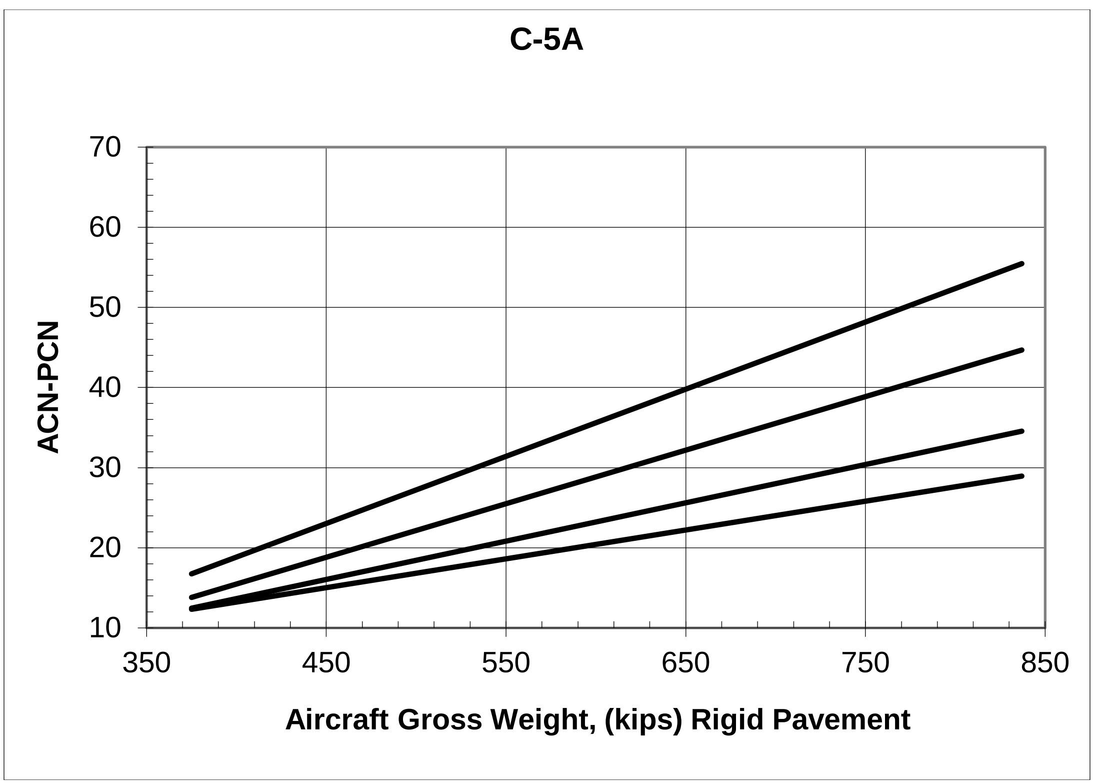
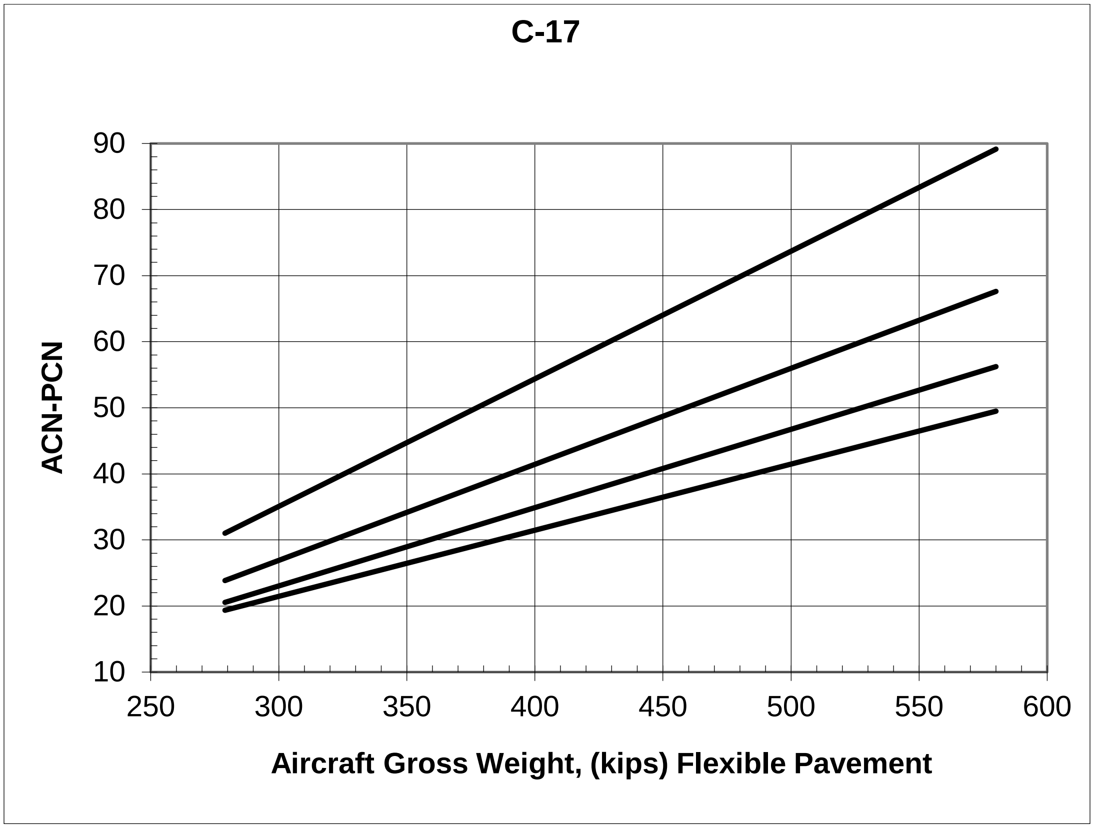



**Figure H-3 ACN/PCN Curves for C-17**



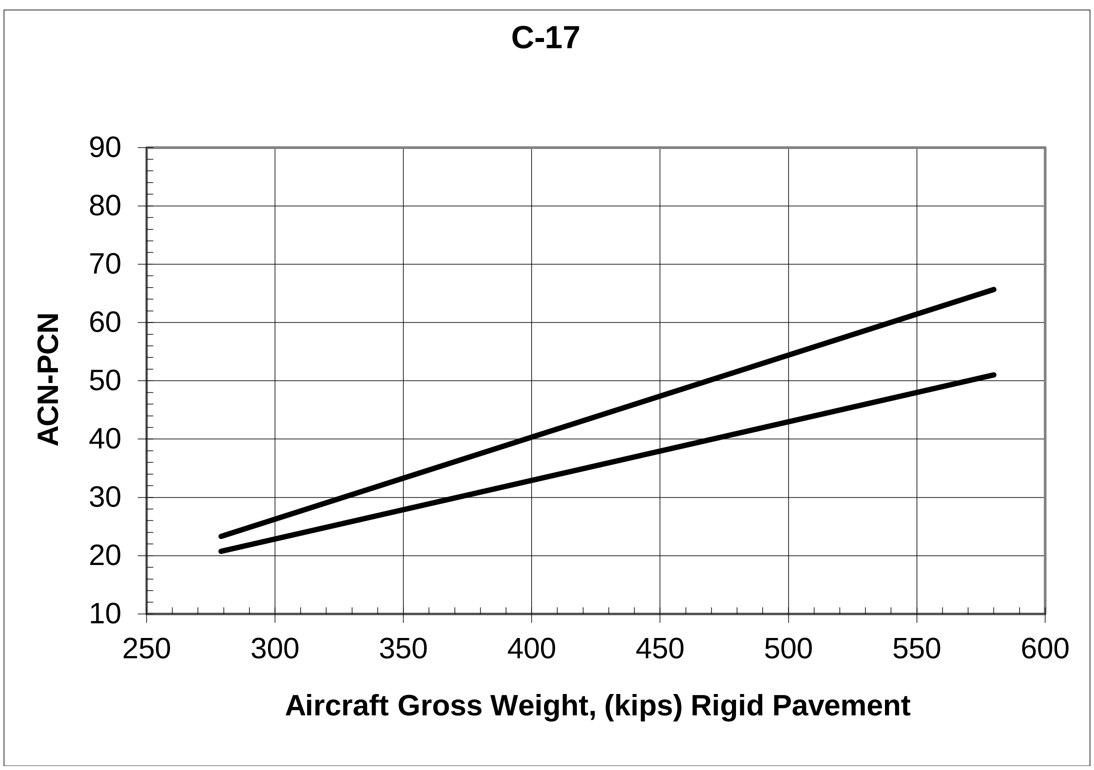
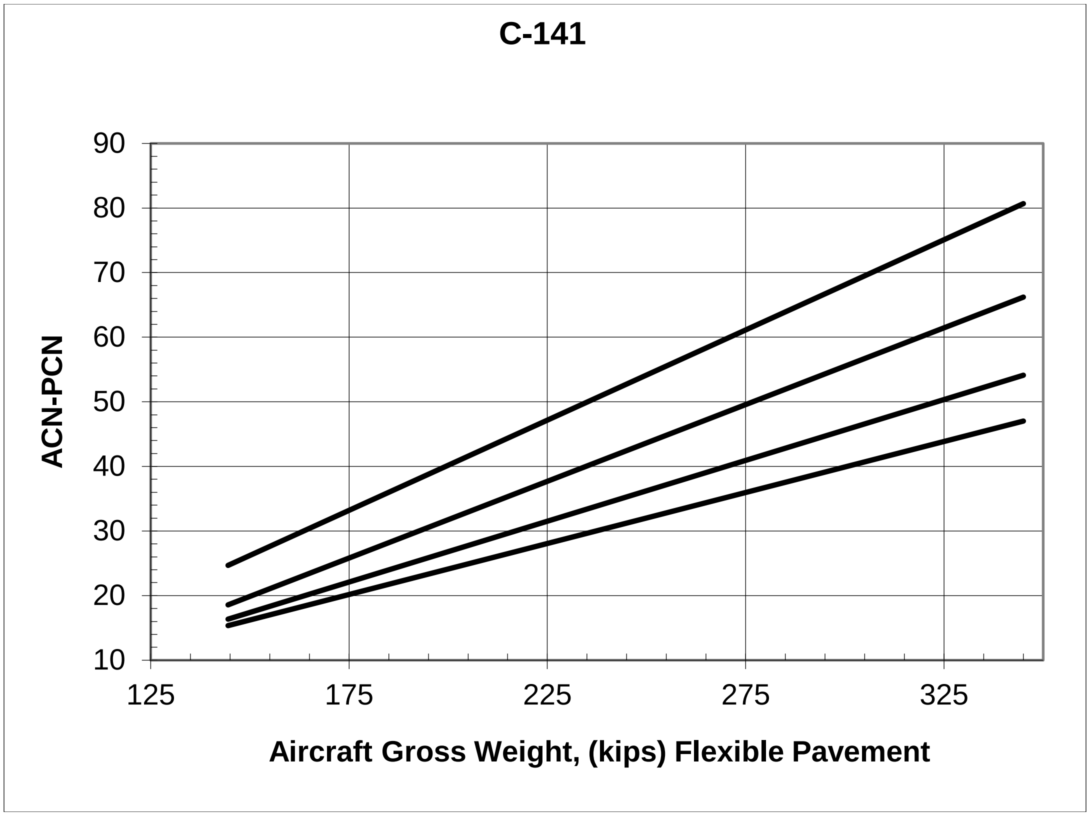



**Figure H-4 ACN/PCN Curves for C-130H**


**Figure H-5 ACN/PCN Curves for C-141**



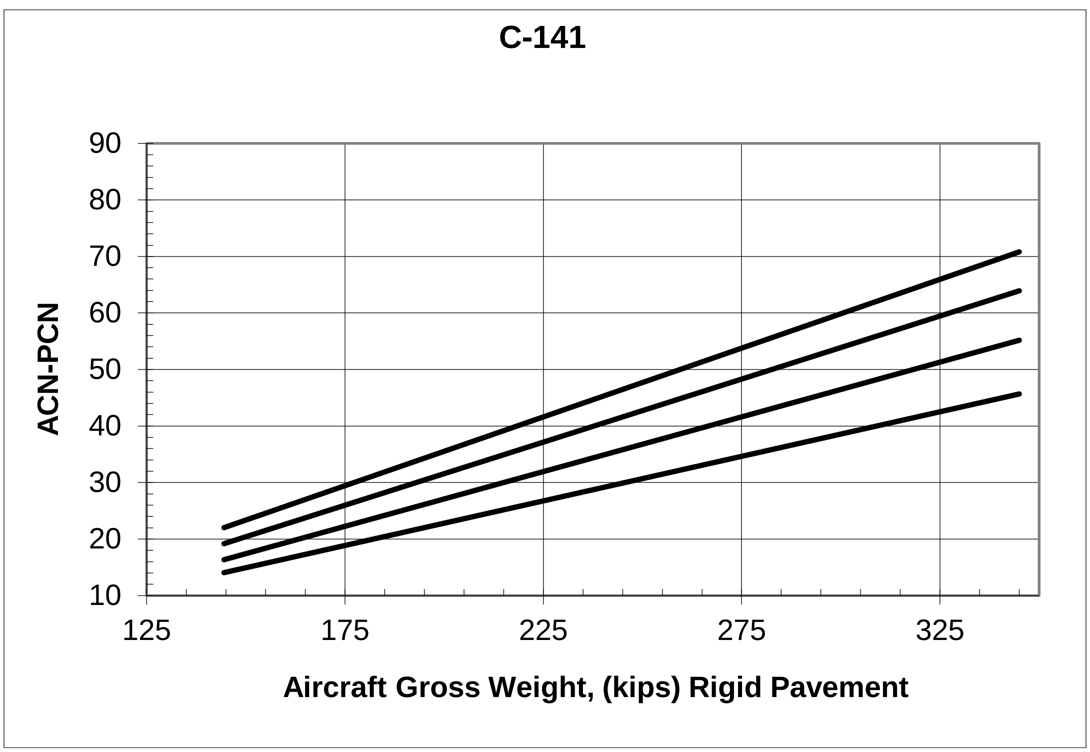
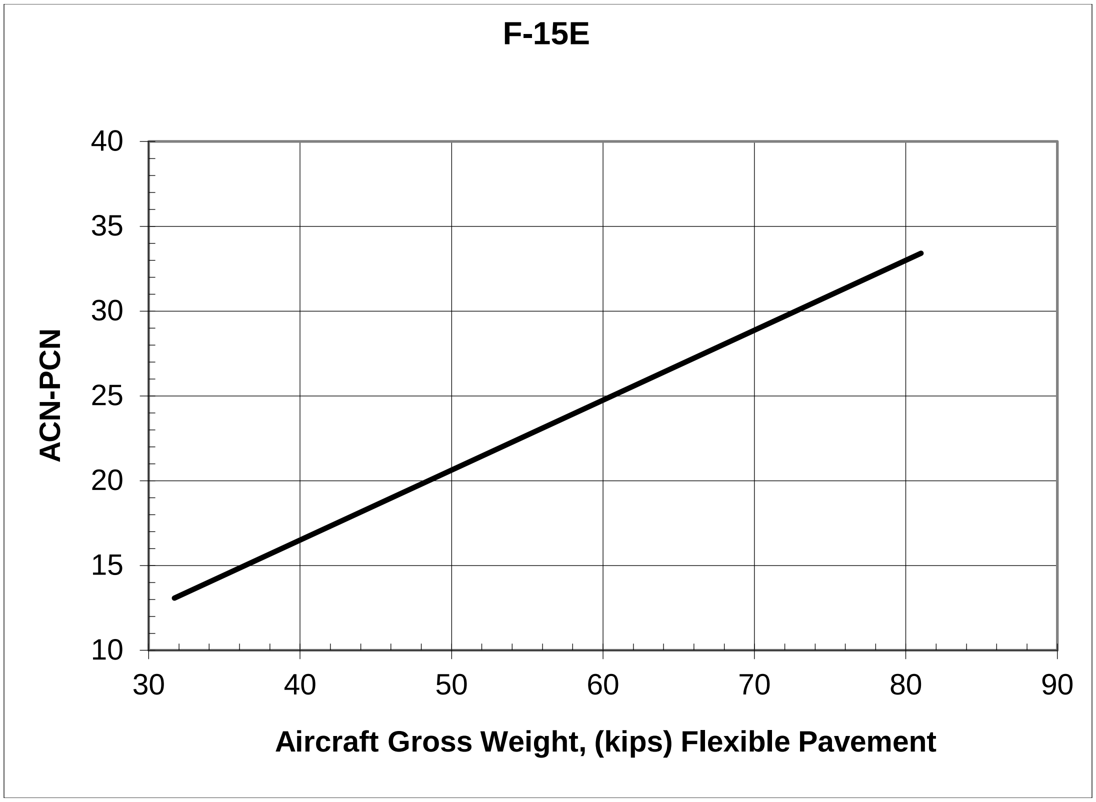



**Figure H-6 ACN/PCN Curves for F-15E**



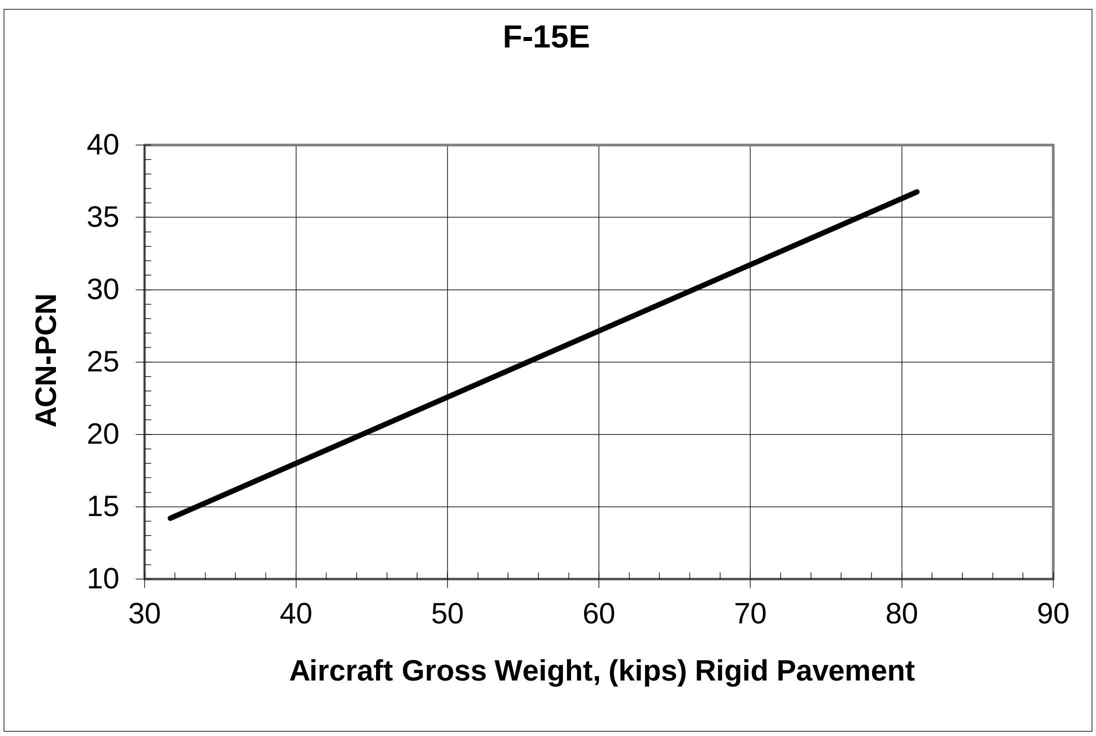
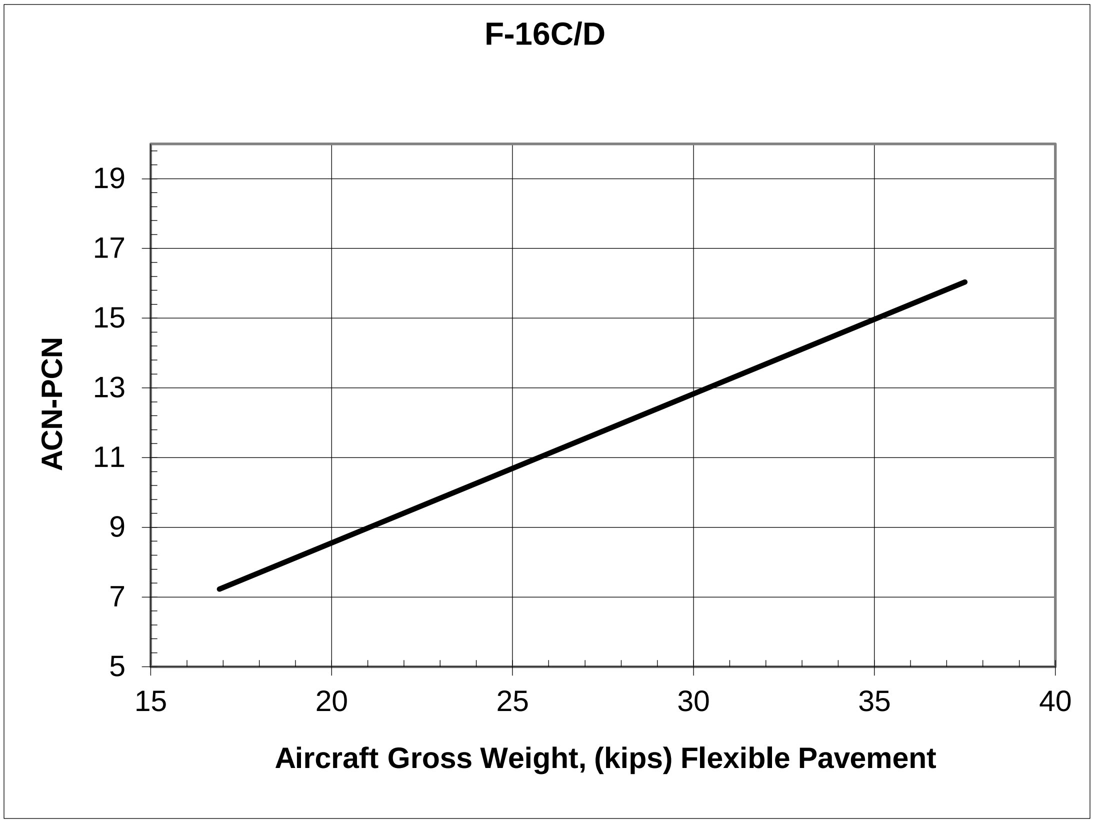



**Figure H-7 ACN/PCN Curves for F-16C/D**



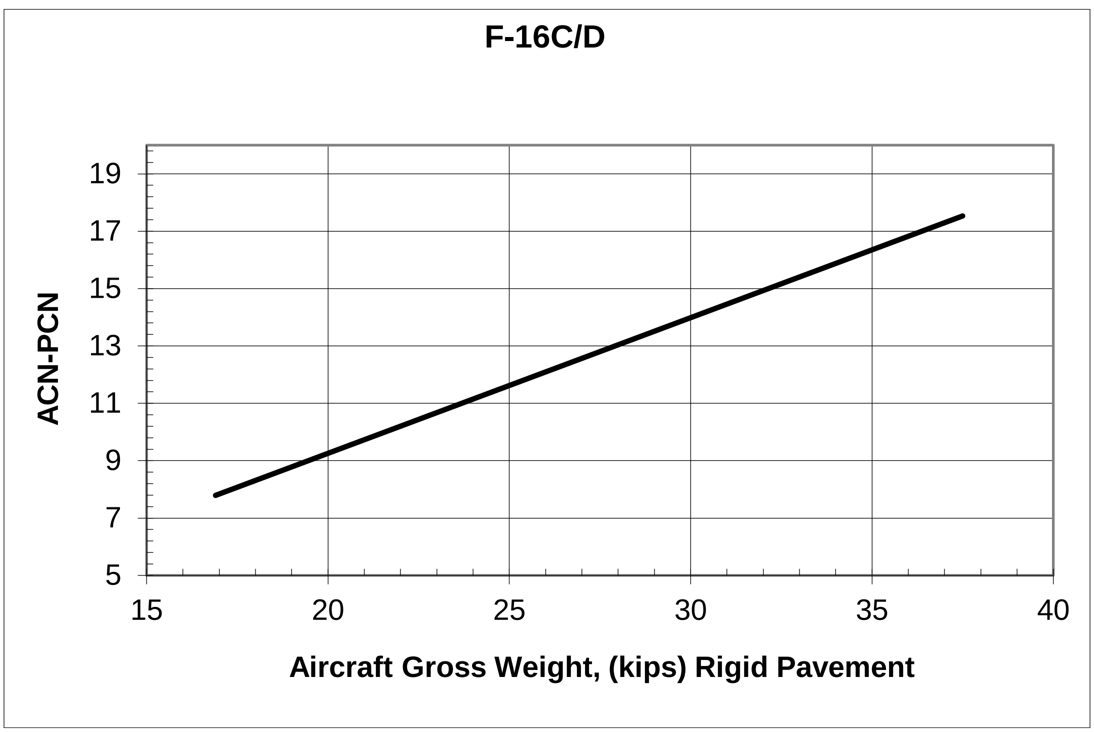
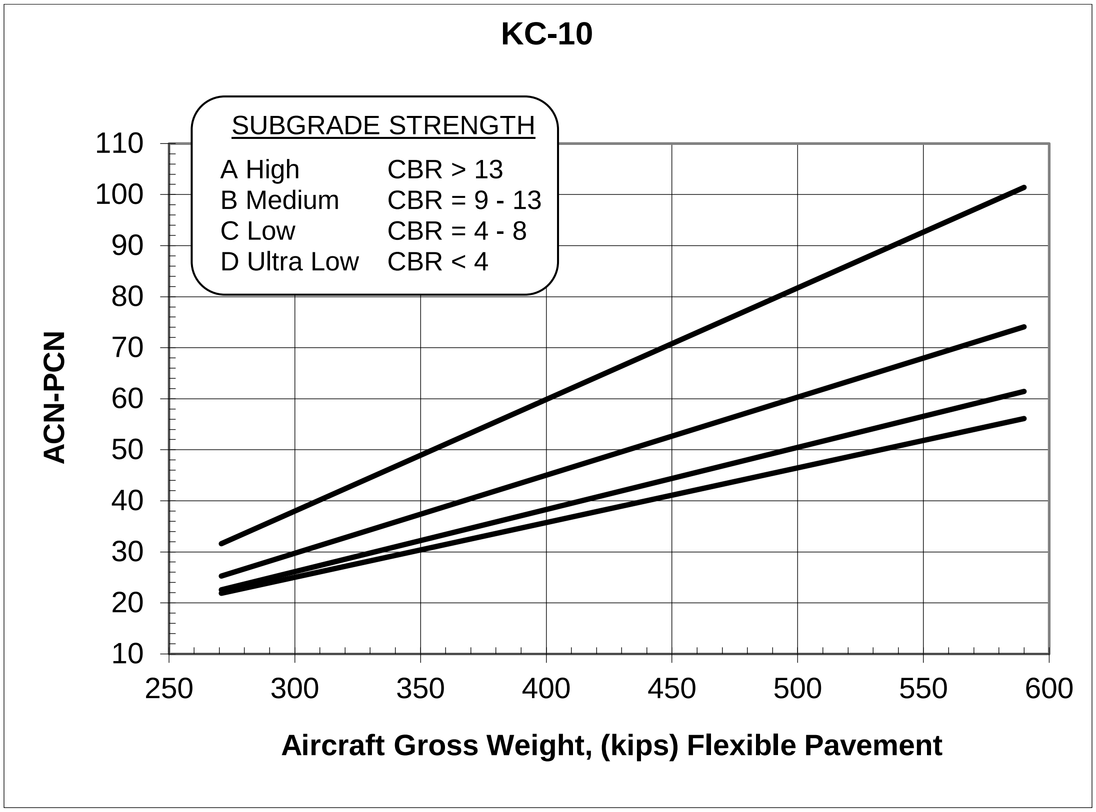



**Figure H-8 ACN/PCN Curves for KC-10**



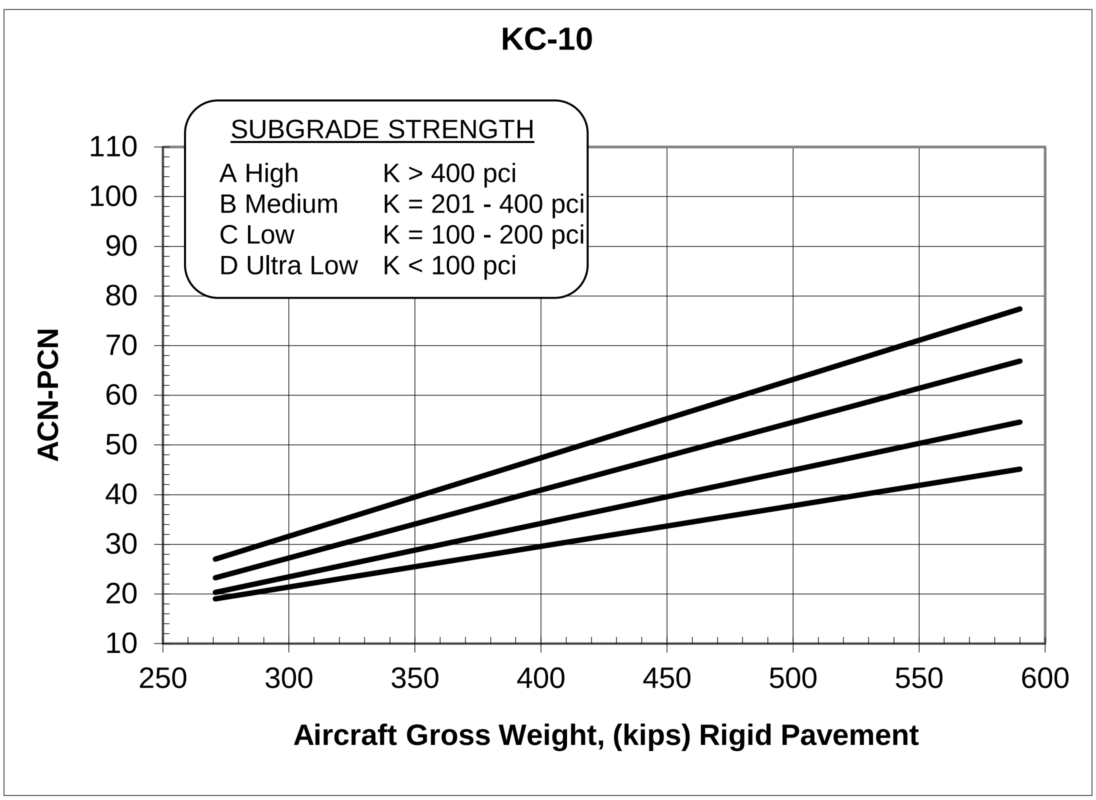
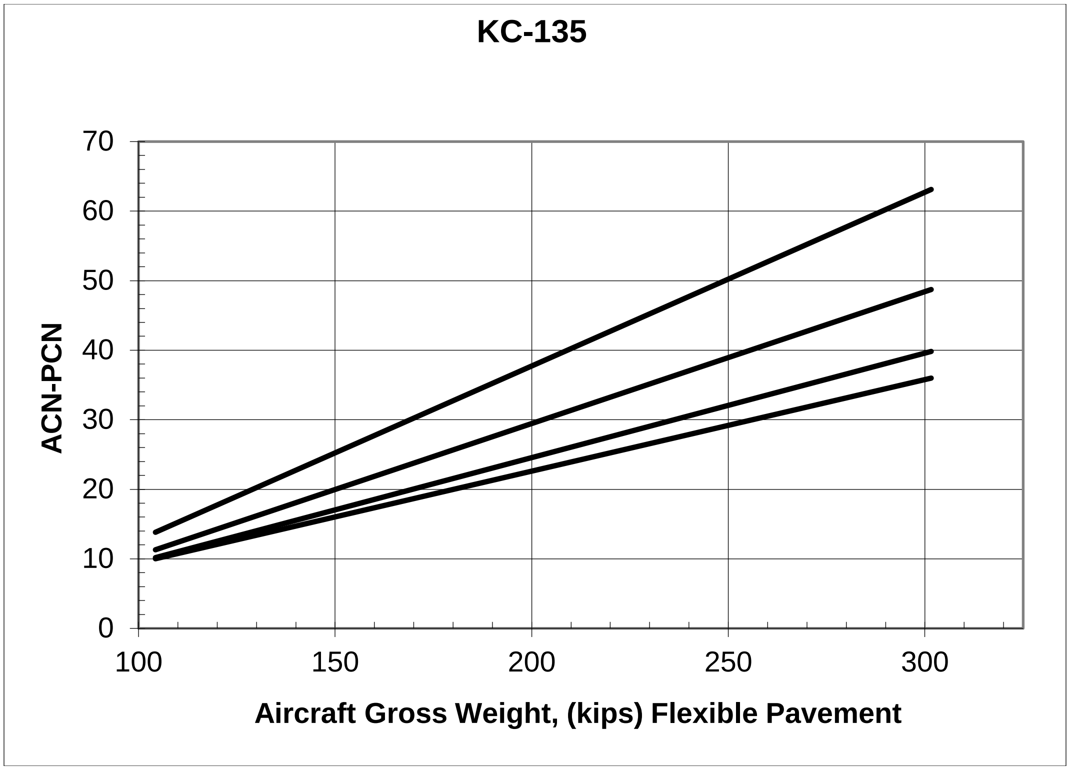
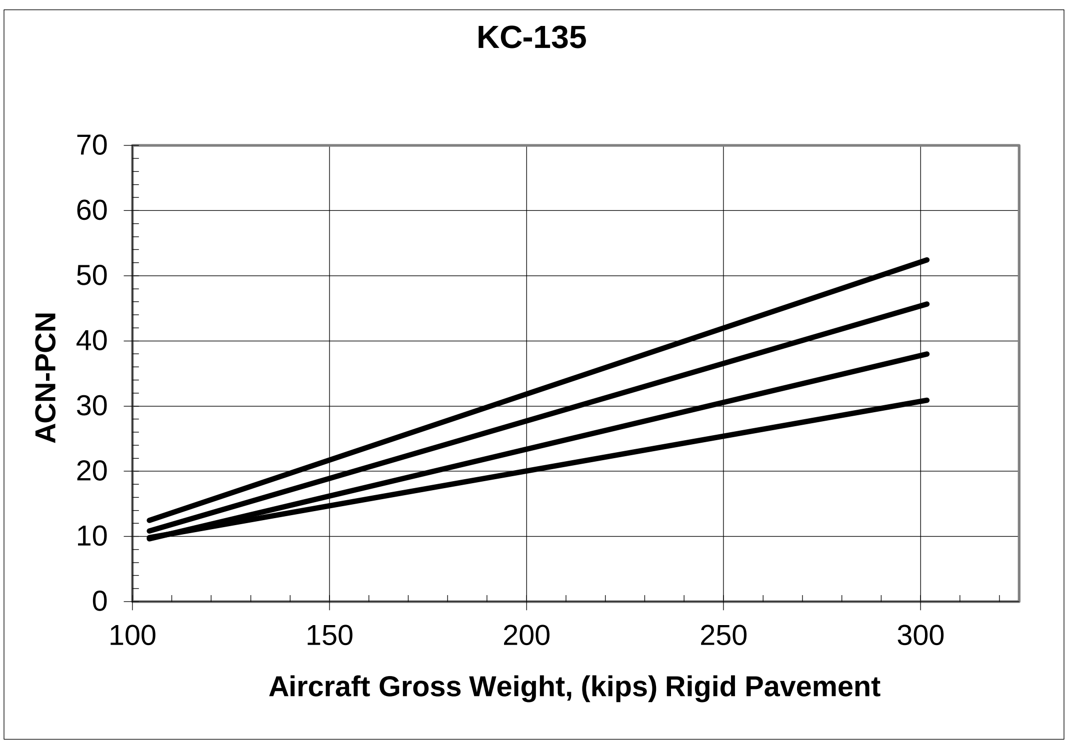



**Figure H-9 ACN/PCN Curves for KC-135**



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# APPENDIX I EXAMPLE EXPEDIENT EVALUATION REPORT

## Marianna Municipal Airport

## ICAO Code: KMAI

## AIRFIELD PAVEMENT SUMMARY

## April 2014

## SUMMARY

At the request of AFSOC Air Warfare Center/A9X, members from the AFCEC Airfield Pavement Evaluation Team along with personnel from the 567 RED HORSE Squadron, the 817 Global Mobility Readiness Squadron, and the 21 and 22 Special Tactics Squadrons conducted a contingency airfield pavement evaluation at Marianna Municipal Airport on 22 April 2014. The purpose of the evaluation was to determine the structural capacity of the airfield. Marianna Municipal Airport is being considered for future training operations. Dynamic Cone Penetrometer (DCP) tests were conducted throughout the airfield to determine the subsurface soil structure (layer strengths and thicknesses). The DCP test locations are shown on the airfield layout included in the body of this report, and the individual DCP test results are located in Attachment 1. These DCP test results, along with other referenced data, were used to calculate the Allowable Passes or Allowable Gross Loads (AGLs) and Pavement Classification Numbers (PCNs) in this report. The airfield pavement evaluation was conducted in accordance with HQ AFCESA (now AFCEC) Engineering Technical Letter (ETL) 02-19, Airfield Pavement Evaluation Standards and Procedures.

| Research/Reference Report(s) | | | |
|---|---|---|---|
| Title | Date | Unit/Org | Referenced Data Types |
| *Airfield Pavement Management Program Report* | May 2011 | FL DOT | Pavement designations, PCI data, and construction history information |
| *MAI Marianna Airport Security Assessment* | Oct 2012 | FL DOT | General airport information |
| *Taxiway A – Construction As-builts* | May 2013 | FL DOT | Taxiway A layer structure |
| *Report of Geotechnical Exploration* | Nov 2013 | Cal-Tech Testing | Pavement thicknesses and sub-surface soil types for Rwy 18/36 and Txys B, C, D and E |

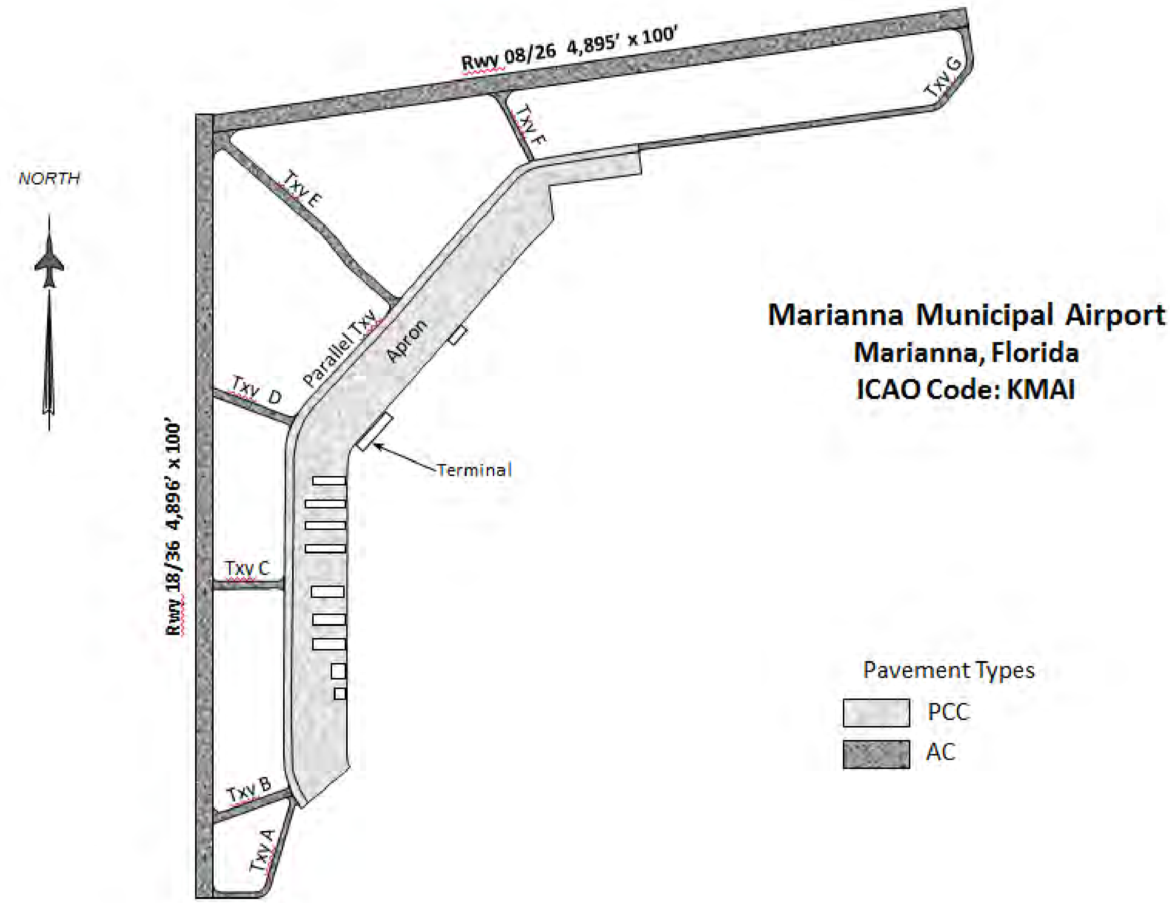


**FIGURE 1, Airfield Designations**

To facilitate structural evaluation, the airfield pavements were divided into sections. A section is an area of pavement having a uniform pavement type, thickness, and condition; as well as the same pavement use, traffic type, construction history, and subsurface layer structure. Marianna Municipal Airport was divided into the sections as shown on the following Airfield Layout/Section Plan, and all references to pavement areas in this report are made to the sections as depicted.

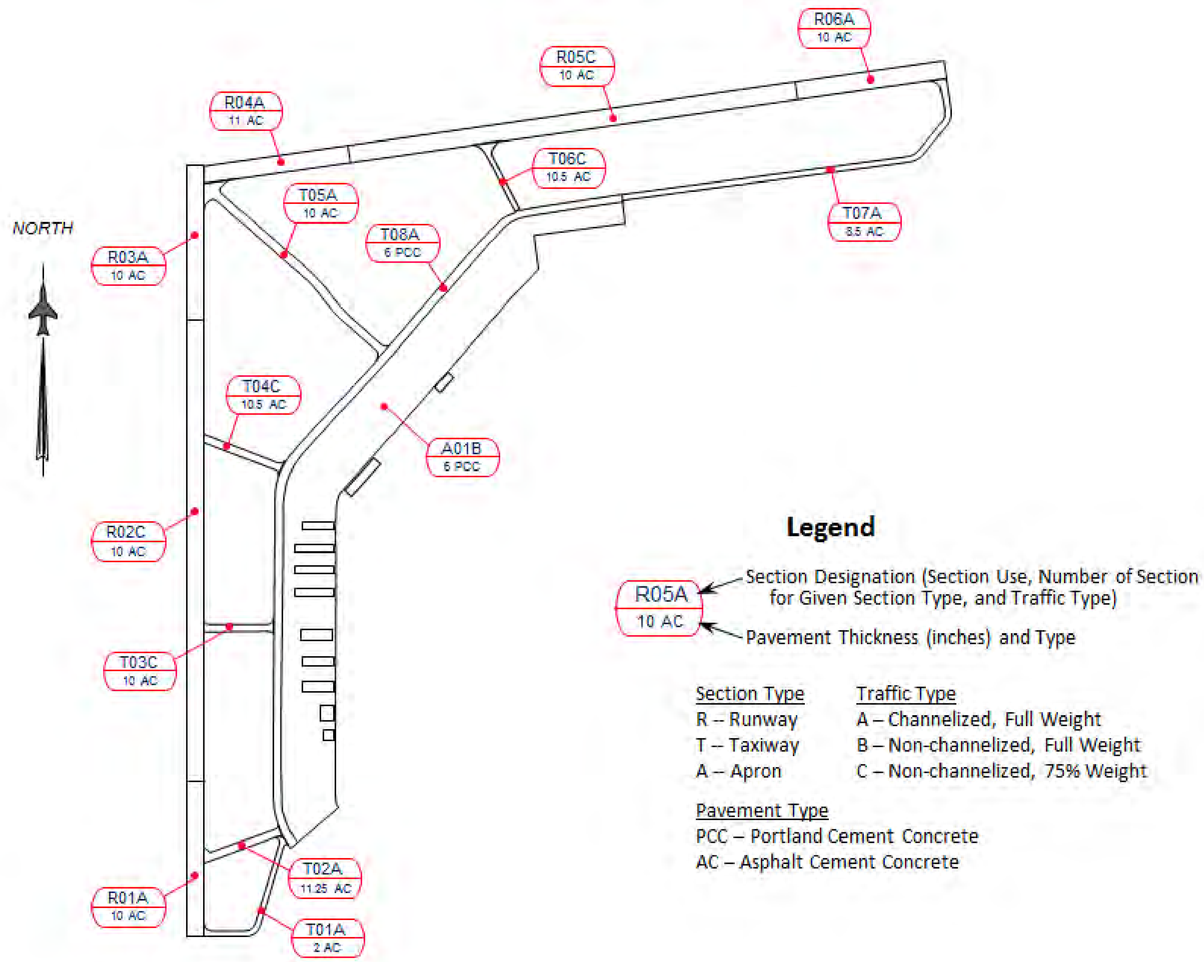


**FIGURE 2, Airfield Layout/Section Plan**

The published PCN for each runway is based upon the maximum allowable weight of a C-17 aircraft operating for 50,000 passes. **For Marianna Municipal Airport, the recommended PCNs are:**

**Runway 18/36: 88 F/C/W/T**

**Runway 08/26: 24 F/B/W/T**

The ACN/PCN (Aircraft Classification Number/Pavement Classification Number) system is the standard method prescribed by the International Civil Aviation Organization (ICAO) for reporting the load bearing capacity of airfield pavements designed to support aircraft weighing more than 12,500 lbs. The ACN is a number expressing the relative effect of an aircraft on a pavement. It is based on the aircraft type, weight, and standard specified subgrade strength, and is expressed in terms of a standard single wheel load. The PCN is a number expressing the bearing strength of the pavement or its ability to support aircraft. It is based on aircraft type, pass level, and standard subgrade strength, and is also expressed in terms of a standard single wheel load. In concept, any aircraft with an ACN equal to or less than the PCN published for a given pavement section can operate on that pavement section subject to any tire pressure limitations.

The ACN/PCN code is a five part code depicting the pavement type, subgrade strength category, tire pressure category, and evaluation method. See Table 1.

**TABLE 1, Explanation of the ACN/PCN Code**

| PCN | Pavement Type | Subgrade Strength | Tire Pressure | Method of PCN Determination |
|---|---|---|---|---|
| Numerical Value | R = Rigid<br>F = Flexible | A = High<br>B = Medium<br>C = Low<br>D = Ultra Low | W = Unlimited<br>X = High<br>Y = Medium<br>Z = Low | T = Technical Evaluation<br>U = Using Aircraft |

| Subgrade Strength Code | Flexible Pavement (CBR) | Rigid Pavement (K) |
|---|---|---|
| A | CBR $\geq$ 13 | K $\geq$ 442 |
| B | 8 < CBR < 13 | 221 < K < 442 |
| C | 4 < CBR $\leq$ 8 | 92 < K $\leq$ 221 |
| D | CBR $\leq$ 4 | K $\leq$ 92 |

| Tire Pressure | |
|---|---|
| Code | PSI |
| W | No Limit |
| X | 182 - 254 |
| Y | 74 – 181 |
| Z | 0 - 73 |

For example, if the reported PCN for a pavement section is **42/R/C/W/T, "42"** indicates the PCN number, **"R"** indicates that it is a rigid pavement, **"C"** indicates a low subgrade strength, **"W"** indicates there are no tire pressure limitations, and **"T"** indicates that a technical evaluation was performed to determine the PCN.

Although the procedures used to determine ACNs are standardized and well accepted by the member nations, the method used to determine a PCN is not prescribed by the ICAO. Each airport authority or agency decides which aircraft and pass level to use when calculating their PCNs. The agency determines the aircraft allowable gross load at the expected traffic level by using either a technical evaluation or from previous experience of operating aircraft. This calculated allowable gross load is then entered in the appropriate aircraft ACN chart to determine the reportable PCN.

When the ACN/PCN system was introduced to the Air Force engineering community it was determined, in council with all of the major command (MAJCOM) pavement engineers, that all Air Force PCNs would be based upon a standard aircraft and pass level. **For all Air Force evaluations, the reported PCNs are based upon the**

**allowable weights for a C-17 operating for 50,000 passes.** Using this standard gives Air Force engineers the ability to compare the load bearing capabilities of pavements located at different locations throughout the world and greatly enhances mobility considerations. Other organizations throughout the international community base their PCNs on different aircraft and pass levels. When a PCN is reported, the aircraft and pass level used to determine the PCN are usually not provided and, in some cases, the source of the reported PCN is not known. There is no process available to correlate these many values to values we can reliably use in planning operations. As a result this can be very misleading to mission planners when assessing airport capabilities for aircraft deployments.

Because PCNs are aircraft and pass level dependent, proposed aircraft operations should not be limited by ACN/PCN ratios, but rather by the aircraft specific weight/pass combinations contained in Tables 2 and 3.

**TABLE 2, Allowable Pass Levels**

| **Section** | **Report PCN [1]** | **Allowable Passes[2 and 3]** (# of passes at maximum weight before 100% of the remaining pavement life is used) | | | | | |
|---|---|---|---|---|---|---|---|
| **Aircraft** | | **F-15C/D** | **C-5** | **CV-22** | **KC-10** | **KC-135** | **E-3** |
| Max Weight (in pounds) | | 68,000 | 840,000 | 60,500 | 590,000 | 323,000 | 325,000 |
| R01A | 108 F/A/W/T | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| R02C | 88 F/C/W/T | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| R03A | 87 F/B/W/T | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| R04A | 67 F/B/W/T | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| R05C | 30 F/B/W/T | 100,000+ | 30,293 | 1,754 | 501 | 12,062 | 8,392 |
| R06A | 24 F/B/W/T | 47,270 | 7,623 | 1,918 | 161 | 2,230 | 1,416 |
| T01A | 1 F/A/Y/T | 11 | 14 | 1,750 | 3 | 9 | 6 |
| T02A | 194 F/A/W/T | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| T03C | 53 F/C/W/T | 100,000+ | 100,000+ | 100,000+ | 23,866 | 100,000+ | 100,000+ |
| T04C | 51 F/B/W/T | 100,000+ | 100,000+ | 100,000+ | 30,352 | 100,000+ | 100,000+ |
| T05A | 30 F/B/W/T | 100,000+ | 35,667 | 100,000+ | 590 | 10,678 | 6,315 |
| T06C | 58 F/B/W/T | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| T07A | 38 F/B/W/T | 100,000+ | 100,000+ | 100,000+ | 2,813 | 86,817 | 47,274 |
| T08A | 1 R/C/W/T | 18 | 4 | 217 | 5 | 13 | 9 |
| A01B | 2 R/C/W/T | 43 | 9 | 528 | 16 | 44 | 31 |

| Aircraft | | C-130J | | | C-17 | | |
|---|---|---|---|---|---|---|---|
| Weight (in pounds) | | 125,000 | 150,000 | 175,000 | 450,000 | 500,000 | 585,000 |
| R01A | 108 F/A/W/T | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| R02C | 88 F/C/W/T | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| R03A | 87 F/B/W/T | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| R04A | 67 F/B/W/T | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| R05C | 30 F/B/W/T | 100,000+ | 100,000+ | 21,385 | 25,234 | 8,263 | 2,008 |
| R06A | 24 F/B/W/T | 98,527 | 15,621 | 4,431 | 5,141 | 2,105 | 671 |
| T01A | 1 F/A/Y/T | 51 | 30 | 20 | 12 | 9 | 6 |
| T02A | 194 F/A/W/T | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| T03C | 53 F/C/W/T | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 48,606 |
| T04C | 51 F/B/W/T | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| T05A | 30 F/B/W/T | 100,000+ | 100,000+ | 31,749 | 30,014 | 9,563 | 2,250 |
| T06C | 58 F/B/W/T | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| T07A | 38 F/B/W/T | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 74,028 | 11,649 |
| T08A | 1 R/C/W/T | 44 | 25 | 17 | 6 | 4 | 3 |
| A01B | 2 R/C/W/T | 162 | 94 | 63 | 13 | 10 | 7 |

**TABLE 3, Allowable Pass Levels for Other AFSOC Requested Aircraft**

| Section | Allowable Passes (# of passes at each given weight before 100% of the remaining pavement life is used) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Aircraft | C-21A Learjet 35 | C-27J Spartan | C-41A CASA 212 | C-145 M-28 | C-146 Dornier | CN-235 Mil Version | U-28A PC-12 | CH-47 | UH-60 |
| Max Weight (in pounds) | 18,300 | 70,107 | 17,857 | 16,532 | 30,843 | 36,376 | 10,450 | 50,000 | 16,300 |
| R01A | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| R02C | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| R03A | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |

| **TABLE 3, Allowable Pass Levels for Other PACAF Requested Aircraft** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Section | **Allowable Passes** (# of passes at each given weight before 100% of the remaining pavement life is used) | | | | | | | | |
| Aircraft | F-22 Raptor Mission Wgt | F-22 Raptor Max Wgt | F-35A JSF CTOL | KC-46A Pegasus | | | | | |
| Max Weight (in pounds) | 63,900 | 84,200 | 67,950 | 416,000 | | | | | |
| R01A | 100,000+ | 100,000+ | 100,000+ | 100,000+ | | | | | |
| R02C | 100,000+ | 100,000+ | 100,000+ | 100,000+ | | | | | |
| R03A | 100,000+ | 100,000+ | 100,000+ | 100,000+ | | | | | |

| **TABLE 3, Allowable Pass Levels for Other USAFE/AFAFRICA Requested Aircraft** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Section | **Allowable Passes** (# of passes at each given weight before 100% of the remaining pavement life is used) | | | | | | | | |
| Aircraft | A-10 Thunderbolt | AN-12 Russian Cub | B-747-8 | C-37A Gulfstream V | C-40B Clipper | CH-47 Chinook | F-15E Strike Eagle | F-16C Fighting Falcon | F-22 Raptor |
| Max Weight (in pounds) | 50,000 | 134,480 | 978,000 | 90,500 | 171,000 | 50,000 | 81,000 | 37,500 | 63,900 |
| R01A | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| R02C | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| R03A | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| Aircraft | F-35A JSF CTOL | HH-60G Pave Hawk | IL-76M/F Candid | KC-46A Pegasus | MQ-1C Gray Eagle | MQ-9A Reaper | RQ-4B Global Hawk | U-2S Dragon Lady | UH-60 Black Hawk |
| Max Weight (in pounds) | 67,950 | 22,000 | 463,000 | 416,000 | 3,600 | 10,500 | 32,250 | 37,500 | 16,300 |
| R01A | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| R02C | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |
| R03A | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ | 100,000+ |

Note: Although the passes levels calculated for some of the listed aircraft were quite high, they were capped at 100,000.

Notes, Tables 2 and 3:

1. PCNs are based on the USAF standard of 50,000 passes of a C-17

2. The pass levels and PCNs reported in this table were derived using contingency testing methods in a limited number of test locations, thus the projected number of passes and PCNs are not reliable for sustained or long-term operations. Therefore, based upon the evaluation tools and test locations used in this evaluation, this airfield is approved for the pass levels indicated in this table, but not to exceed 100 / 1,000 passes. More extensive testing is required if operations will exceed these levels.

3. The allowable passes are based only on the weight bearing capabilities of the pavement structures. Refer to the Restrictions/Limitations section for additional constraints which may impact aircraft operations.

4. When the tire pressure code in the reported PCNs for asphalt sections is “X” or “Y”, it is due to the thin asphalt surface, and/or the weathered and raveled condition, which could cause FOD damage to fighter aircraft.

Contingency Evaluations are classified as expedient, sustainment, or permanent in ETL 02-19. The evaluation methods used and the number of field tests performed influence the reliability of the evaluation results.

***Expedient Evaluation:*** Assessment of airfield structural capability to support 100 passes of a particular aircraft at its maximum weight or the number of passes to support the initial surge of mission aircraft.

***Sustainment Evaluation:*** Assessment of airfield structural capability to support sustained aircraft operations—generally 5,000 passes of a particular aircraft at its maximum weight, or the number of passes required to support the mission aircraft throughout the anticipated operation.

***Permanent Evaluation:*** Assessment of airfield structural capability to support long-term aircraft operations—generally 50,000 passes or more of a particular aircraft at its maximum weight. The results of a permanent evaluation may also be presented as an AGL table that depicts the airfield load-bearing capability in terms of multiple aircraft, divided into 14 aircraft groups.

| TABLE 4, Applicability of Evaluation Results | | | |
|---|---|---|---|
| **Evaluation Tools** | **Test Locations** | **Reliability of Results** | **Limitations Placed on Evaluation Results** |
| DCP Only | Expedient Criteria | VERY LOW | Limit operations to those prescribed by the allowable pass table in this evaluation, but not to exceed 100 passes |
| Hilti Drill and DCP | Expedient Criteria | LOW | Limit operations to those prescribed by the allowable pass table in this evaluation, but not to exceed 100 passes |
| | Sustainment Criteria | LOW | Limit operations to those prescribed by the allowable pass table in this evaluation, but not to exceed 1,000 passes |
| Core Drill and DCP or ADCP | Sustainment Criteria | MEDIUM | Limit operations to those prescribed by the allowable pass table in this evaluation, but not to exceed 5,000 passes |
| | Permanent Criteria | MEDIUM | No limitations placed upon operations beyond those prescribed by the allowable pass table in this evaluation |
| HWD and Core Drill or HWD and ADCP | Permanent Criteria | VERY HIGH | No limitations placed upon operations beyond those prescribed by the allowable pass table in this evaluation |

Note: Test locations required for each evaluation type are described in ETL 02-19

## RESTRICTIONS / LIMITATIONS

**Based upon the thin pavement and weak soil support structure, the Portland cement concrete apron (A01B) and parallel taxiway (T08A) are not considered structurally suitable for sustained operations of a C-130 aircraft (even at reduced weights). Taxiway A (section T01A) was constructed for use only by general aviation (<12,500 lb) aircraft, and should also be avoided during any training operations.** Such operations would likely cause excessive damage to the airfield pavement and render it unusable for the general aviation aircraft that currently operate there. Although they are structurally capable, the deteriorated surfaces on sections R04A, R05C, R06A, T06C, and T07A, increase their FOD potential. Exercise caution when operating on them.

Although Tables 2 and 3 indicate allowable passes for each of the included aircraft based upon the structural or loading bearing capability of the existing pavements, none of the runways at Marianna Municipal Airport are long enough to support F-15, C-5, KC-10, KC-135, or E-3 operations.

## OBSERVATIONS

In conjunction with the structural evaluation, an assessment is usually made of the pavement's surface condition identifying distress types, severities, and densities. This assessment considers surface distresses only. Pavement condition assessments are classified as Standard, Simplified (Contingency), or Cursory. Although the evaluation methods are similar, the number of sample units inspected and procedures used greatly influence the reliability of the results. If the assessment is accomplished using the 'Project Level' sampling methods as described in Unified Facilities Criteria (UFC) 3-260-16, O&M Manual: Standard Practice for Airfield Pavement Condition Surveys and/or the 'Standard' sampling methods as described in ASTM D5340-11, Standard Test Method for Airport Pavement Condition Index Surveys, it is classified as a Standard PCI assessment. If the assessment is accomplished using the UFC 'Network Level' sampling methods and/or the ASTM 'Lesser' sampling procedures, it is classified as a Simplified (Contingency) PCI assessment. If the number of inspected sampling units fails to meet the minimum requirements in order to be considered either a Simplified or Standard PCI evaluation the assessment is classified as a Cursory PCI assessment. In any case a pavement condition index (PCI) and rating is assigned to each pavement section. The PCI is helpful in estimating pavement performance and in the case where a pavement section is rated "Very Poor" or below (PCI < 40), its load-carrying capability is reduced by 25 percent. The standard pavement distresses used in a pavement condition assessment, along with their appropriate severity levels, are defined in UFC 3-260-16 and ASTM D5340-11. The pavement condition ratings reflected in this report were determined using standard/simplified/cursory inspection methods.

A recent detailed PCI survey report was available for Marianna Municipal Airport so this work was not duplicated. PCI ratings from that report are depicted in the following plan. The rating for Taxiway A (section T01A) was not included in the 2011 Airfield Pavement Management Program Report because T01A was constructed at a later date.

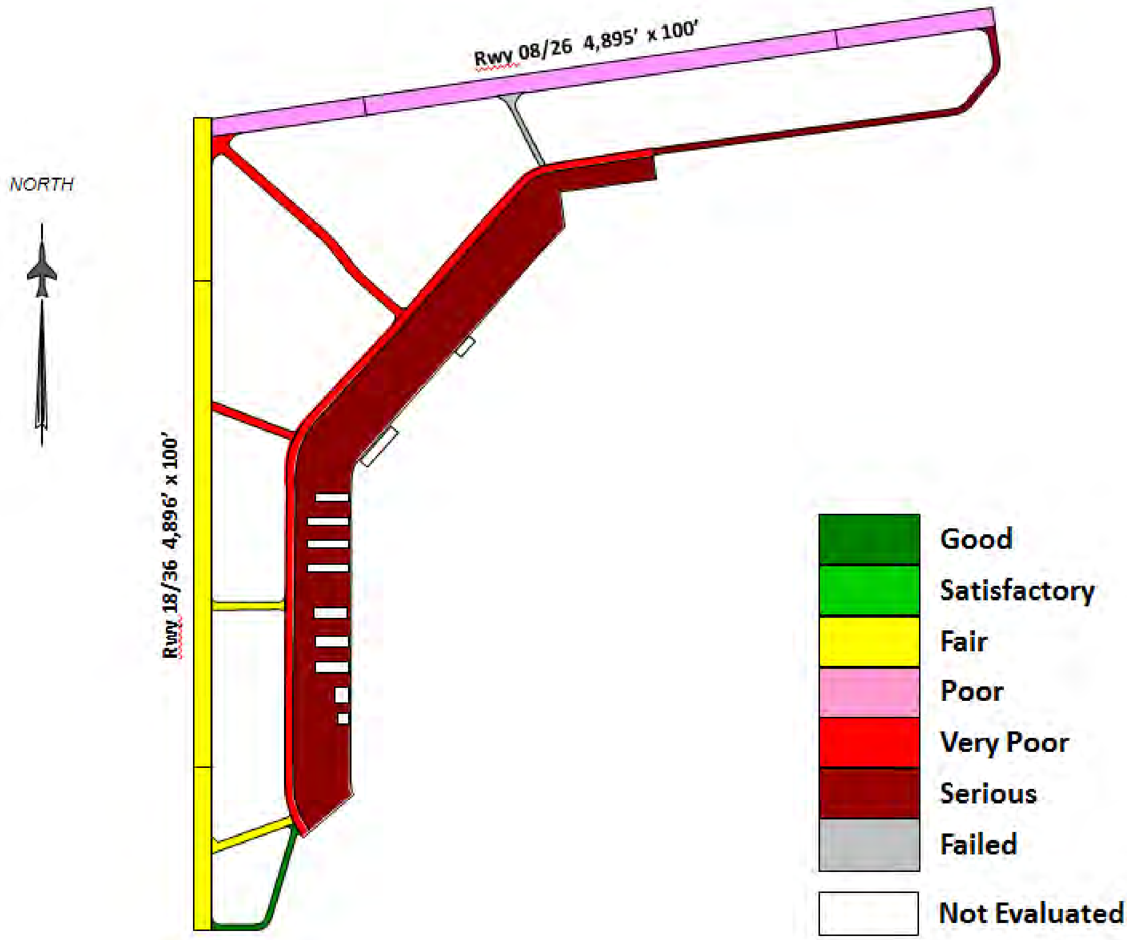


**FIGURE 3, Pavement Condition Index Ratings**

| **TABLE 5, Pavement Condition Index (PCI) Rating Scale** | | | |
|---|---|---|---|
| **Condition** | | **Rating** | **Definition** |
| Good | | 86 - 100 | Pavement has minor or no distresses and will require only routine maintenance. |
| Satisfactory | | 71 - 85 | Pavement has scattered low-severity distresses that should need only routine maintenance. |
| Fair | | 56 - 70 | Pavement has a combination of generally low- and medium-severity distresses. Maintenance and repair needs should be routine to major in the near term. |
| Poor | | 41 - 55 | Pavement has low-, medium-, and high-severity distresses that probably cause some operational problems. Maintenance and repair needs should range from routine to reconstruction in the near term. |
| Very Poor | | 26 - 40 | Pavement has predominantly medium- and high-severity distresses causing considerable maintenance and operational problems. Near-term maintenance and repair needs will be intensive. |
| Serious | | 11 - 25 | Pavement has mainly high-severity distresses that cause operational restrictions. Repair needs are immediate. |
| Failed | | 0 - 10 | Pavement deterioration has progressed to the point that safe aircraft operations are no longer possible. Complete reconstruction is required. |

A pavement section’s PCI does not always correlate directly with its structural capability. The PCI may indicate that the surface of the pavement rates high with very few distresses, but DCP tests of the subsurface soil structure may reveal low strengths and inadequate support of the pavement when subjected to the projected aircraft loadings. Conversely, a pavement may be structurally capable of supporting high loads or pass levels, but operations may be limited due to the type, severity, and density of surface distresses. Following is a summary of the PCI results and a discussion of the major distresses identified.

It is important to monitor and track the surface condition of pavements to identify pavement problems early and plan appropriate repairs. A continual evaluation program can also help determine the most cost-effective maintenance and repair actions. Of more direct impact to this structural evaluation, the value of knowing the pavement’s PCI is quite significant. First, the PCI is a tool that helps identify potential structural problems. Second, is the impact of a low PCI on the pavement’s structural capability. Allowable pass levels and PCNs included in this report for sections T04C, T05A, T06C, T07A, T08A, and A01B were reduced due to the low PCI values reported for these pavement sections.

**TABLE 6, Summary of Pavement Condition Index Results**

**Flexible Pavement (AC) Distresses**

| Airfield Section | Condition Rating | Alligator or Fatigue Cracking * | Bleeding | Block Cracking * | Corrugation | Depression | Jet Blast Erosion * | Joint-Reflection Cracking * | Longitudinal/Transverse Cracking * | Oil Spillage * | Patching/Utility Cut Patch * | Polished Aggregate | Raveling * | Rutting | Shoving of Asphalt by PCC * | Slippage Cracking * | Swell | Weathering * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R01A | Fair | | | | | L | | | LM | | | | | | | | | L |
| R02C | Fair | | | | | L | | | LMH | L | | | | | | | | L |
| R03A | Fair | | | LM | | L | | | LM | | | | | | | | | L |
| R04A | Poor | | | LM | L | | | | | | | | LM | | | | | LM |
| R05C | Poor | | | LM | L | | | | | | | | LM | | | | | LM |
| R06A | Poor | | | LM | | | | | L | | | | M | | | | | M |
| T01A | Good | | | | | | | | | | | | | | | | | |
| T02A | Fair | | | LM | | | | | LM | | M | X | | | | | | LM |
| T03C | Fair | | | | | | | | LMH | | | | | | | | | L |
| T04C | V Poor | | | LM | | | | | LM | | M | | | | | | | L |
| T05A | V Poor | | | | | | | | LMH | | | X | | | | | | L |
| T06C | Failed | M | | | | | | | | | | | M | | | | | |
| T07A | Ser | M | | M | | | | | | | | | M | | | | | |

**Rigid Pavement (PCC) Distresses**

| Airfield Section | Condition Rating | Blowup * | Corner Break * | Longitudinal, Transverse Cracking * | Durability " D" Cracking * | Joint Seal Damage * | Patch, Small (< 5 sf) * | Patch, Large/Utility Cut (> 5 sf) * | Popouts * | Pumping * | Scaling / Map Cracking * | Settlement / Faulting | Shattered Slab / Intersecting Cracks * | Shrinkage Cracking | Spalling, Joints * | Spalling, Corner * | Alkali Silica Reaction (ASR) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T08A | V Poor | | LM | LMH | | LM | L | LH | | | L | LM | | X | LM | L | |
| A01B | Ser | | H | MH | | LMH | L | | | | L | LM | LMH | X | LMH | LM | |

Notes: 1. The **bold** distresses indicate those that are usually related to problems in the pavement structure and their identification is important in assessing the pavement load-carrying capability.

2. The distresses followed by an asterisk are those that may produce FOD. Although they all may not significantly impact the computed allowable passes, they may limit the operational capability of the pavement.

3. Distress Severity Levels: L = Low M = Medium H = High

Overall the airport exhibited pavement distresses common to climate cycling and age conditions. The asphalt concrete pavement sections distresses include; weathering and raveling, block cracking, longitudinal and transverse cracking, patches, polished aggregate, and oil spillage.

Runway 18/36, generally exhibited low to medium severity longitudinal and transverse cracking (see Photo 1) in addition to low severity weathering distresses (see Photo 2). Longitudinal cracks are apparent along the paving joints. No load based distresses were encountered on the runway.

Runway 8/26, exhibited low to medium severity block cracking, weathering and raveling Distresses (see Photos 3 and 4). Also, some small areas of corrugation were noticed during the inspection. Based on conversations with airport staff, RW 8/26 has been overlaid with thin layers of “E-Crete” (less than ¼”) twice over the last decade. The E-Crete overlay reflects the underlying asphalt block cracking distresses. The curling effect caused by this crack reflection results in the retention of water, or creation of “bird baths”, after storm events. The ride ability of the runway is greatly affected by the curling due to the block cracking distresses. In multiple areas the E-Crete layers have raveled completely off thus exposing the underlying pavement to the elements. The intrusion of water between the E-Crete and asphalt further exacerbate the curling and degradation of the overall runway pavement. The deteriorated “E-Crete” layers that have been curling due to the intrusion of water and the climate cycling create significant separations or voids between the overlay layer and the original pavement.

The asphalt surfaced taxiways overall exhibit distresses attributed to the climate cycling in the area and the age of the pavement. Section T07A; specifically the asphalt pavement from beginning at the end of the concrete apron to the connection to the 26-end of Runway 8/26, exhibited medium to high severity block cracking, medium severity raveling, and medium severity alligator cracking (see Photos 5 and 6) and rated in serious condition. The surface appeared quite weathered, but this was not counted due to the severity of the raveling in the same area. Section T01A is relatively new and no surface distresses were noted during the inspection. Sections T02A and T03C could be repaired with a mill and overlay, but sections T04C, T05A, T06C, and T07A should be reconstructed.

The PCC apron (Section A01B) and the adjacent PCC taxiway (Section T08A) are in serious and very poor condition with numerous structurally related distresses identified (see Photos 7, 8 9, and 10). The sections have been poorly maintained and at this point are beyond repair short of reconstruction.

Photo 1, Typical Low Severity Longitudinal Cracking on Section R02C, RWY 18/36

Photo 2, Typical Medium Severity Transverse Cracking and Low Severity Weathering on Section R02C, RWY 18/36

Photo 3, Low Severity Block Cracking on Section R04A, RWY 08/26

Photo 4, Medium Severity Block Cracking on Section R05C, RWY 08/26 (Note the Curling Edges)

Photo 5, Medium Severity Block Cracking and Raveling on Section T07A

Photo 6, Medium Severity Block Cracking and Raveling on Section T07A

Photo 7, Longitudinal/Transverse Cracking, Joint Seal Damage, and Joint Spalling on Section A01B

Photo 8, Typical Joint Seal Damage and Joint Spalling on Section A01B

Photo 9, Longitudinal/Transverse Cracking and Joint Spalling on Section A01B

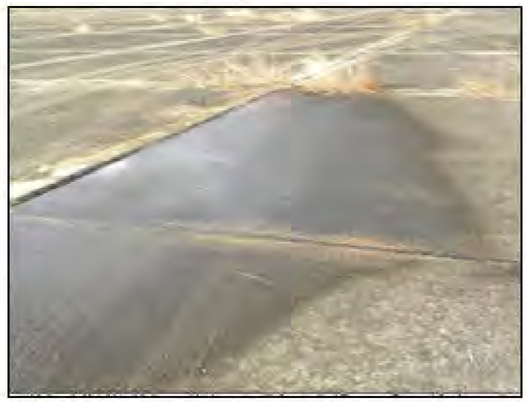

Photo 10, Joint Seal Damage and Settlement/Faulting on Section A01B

## ANALYSIS

A total of 63 Dynamic Cone Penetrometer (DCP) tests were conducted on the airfield. A 1-inch diameter hole was drilled through the pavement to allow access for these tests. Once the holes were drilled, a hooked rod was used to measure the pavement thicknesses. The pavement thickness at each test location, rounded to the nearest ¼ inch, is shown on Figure 4, Dynamic Cone Penetrometer Test Location plan.

Sections A01B and T08A are constructed with Portland cement concrete slabs, generally 12.5' wide x 25' long. All other sections are constructed with asphalt cement concrete (AC) surfaces. In the Work History Report section of the 2011 Florida DOT Airfield Pavement Management Program report for Marianna Municipal Regional Airport, no pavement thicknesses are given for the pavement sections. Fortunately, the airfield has been used predominantly by small general aviation and rotary wing aircraft, so damage to the airfield pavements has been limited.

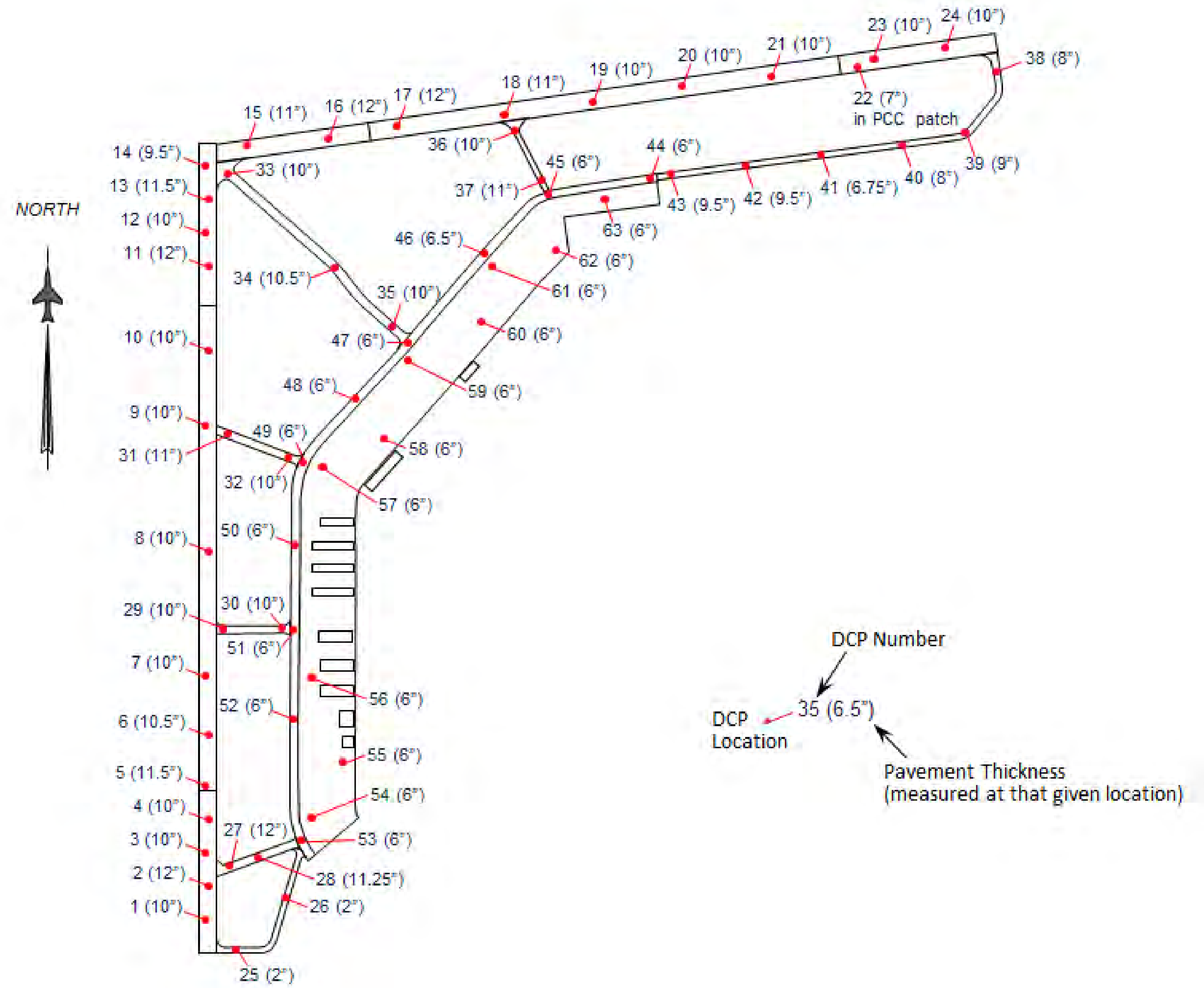


**FIGURE 4, Dynamic Cone Penetrometer Test Locations**

In flexible (asphalt) pavement evaluation, it is customary to define the strength of the subsurface soil layers in terms of California Bearing Ratios (CBRs). For the evaluation of rigid (Portland cement concrete) pavements, plate bearing tests are conducted to determine the soil support capability or resistance to deformation under a loaded concrete slab. The strength of the soil is expressed as the modulus of subgrade reaction (K). When plate bearing tests cannot be performed, measured CBRs can be converted to K values. Actual CBR and plate bearing tests are both labor and equipment intensive. They are also quite time consuming. The time required to determine the in-situ strength of the various soil layers to a depth of 1 meter may be over 4 hours at a single location. Several cone type penetrometers have been developed over the years to obtain the in-situ soil strength data with depth in less time.

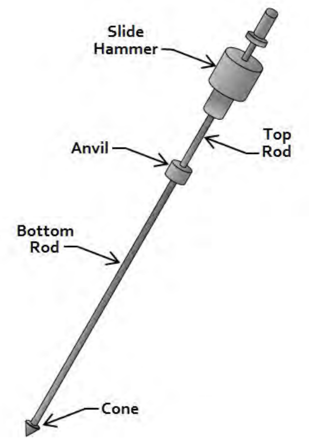


**FIGURE 5, DCP**

The standard DCP in use today throughout the DoD is a slide-hammer type penetrometer. The four main components of the DCP are the cone, rod, anvil, and hammer. Energy is applied to the cone tip, through the rod, by dropping a 17.6-pound (8-kilogram) hammer a distance of 22.6 inches (575 millimeters) against the anvil. The diameter of the cone is 0.16 inch (4 millimeters) larger than that of the rod to ensure that only tip resistance is measured. By assessing the recorded number of hammer blows necessary to advance the cone into the soil, the soil strength is quantified in terms of a DCP index. The DCP index is the ratio of the depth of penetration to the number of blows of the hammer and has been empirically correlated to the CBR and K-value.

The subsurface layer structures reflected in Table 7, PPD are not based upon design/construction documents or construction history information, as none of this information is available. The layers are based upon the DCP data collected at each location. For pavement sections where one or two DCP tests were conducted it was relatively simple to establish the appropriate layer structures. For the pavement sections that contain multiple DCP test results, the test results were compared and data taken from the low end of the results was selected to represent the pavement sections. Specifically:

Section R01A contained DCPs 1, 2, 3, and 4. All indicated a consistent CBR of +80 for the base course layer. The remaining layers indicated similar thicknesses and strengths so low averages were used to represent the section.

Section R02C contained DCPs 5, 6, 7, 8, 9, and 10. Average base and top subbase thicknesses and strengths were used. DCPs 8 and 9 indicated the presence of weaker lower subbase and subgrade strengths. These lower strengths were used to evaluate the section.

Section R03A contained DCPs 11, 12, 13, and 14. The base course CBRs were consistently +80. Low averages of the indicated subbase and subgrade strengths were used to evaluate the section.

Section R04A contained DCPs 15 and 16. DCP 16 indicated a layer structure that was considerably weaker than DCP 15, so the DCP 16 structure was used to represent the section.

Section R05C contained DCPs 17, 18, 19, 20, and 21. All the DCPs produced similar layer structures with little variation, so averages of the layer thicknesses and strengths were used to evaluate the section.

Section R06A contained DCPs 22, 23, and 24. DCP 22 was taken in a PCC patch and was not considered to be representative of the section. DCP 23 and 24 were similar, so averages of these layer thicknesses and strengths were used to evaluate the section.

Section T01A contained DCPs 25 and 26. DCP 25 indicated a layer structure that was considerably weaker than DCP 26, so the DCP 25 structure was used to represent the section.

Section T02A contained DCPs 27 and 28. Both DCPs indicated similar structures. The base course and the layer located immediately above the subgrade were high on both DCP tests so these layers were capped at 80 CBR. Averages of the remaining layers of both DCPs were used to evaluate the section.

Section T03C contained DCPs 29 and 30. The base course was high on both DCP tests so this layer was capped at 80 CBR. The remaining layers on DCP 30 had lower CBRs so these were used to evaluate the section.

Section T04C contained DCPs 31 and 32. There was also an obvious change in the quality of the AC pavement on Taxiway D (section T04C). The top 4 inches had to be drilled through, but the remaining 6 inches is somewhat deteriorated as it could be easily penetrated by the DCP. The layer structure at DCP 31 was significantly weaker so it was used to represent the section.

Section T05A contained DCPs 33, 34, and 35. The layer structure at DCP 35 was significantly weaker so it was used to represent the section.

Section T06C contained DCPs 36 and 37. The CBRs of the two subbase layers immediately beneath the base course on DCP 37 were considerably lower than those found on DCP 36, so the DCP 37 structure was used to evaluate the section.

Section T07A contained DCPs 38 through 43. None of these DCPs indicated a strong layer structure. Low averages of the layer thicknesses and strengths from all the DCPs were used to represent the section.

Section T08A contained DCPs 44 through 53. Due to the variability of the data, a low average of the test results was used to evaluate the section.

Section A01B contains DCPs 54 through 63. The layer structures at all of the DCP locations were very consistent so averages of the layer thicknesses and strengths were used to represent the section.

The principal parameters used in determining allowable gross loads (AGLs) and/or allowable passes are pavement type(s), thicknesses, and flexural strength (for PCC pavements only), and soil strengths and thicknesses for all subsurface layers. Results of field tests are compiled in Table 7, Summary of Physical Property Data (PPD). The data presented Table 7, PPD were selected as the most representative values of thickness and strength for each pavement section.

The pavement thickness shown in Table 7, for each pavement section was determined by comparing the thicknesses of all tests conducted within that given pavement section and selecting the thickness that best typified the section. For Runway 18/36 and its connecting taxiways, reliable pavement thicknesses were also available from the Report of Geotechnical Exploration, dtd 19 Nov 2013, prepared by Cal-Tech Testing, Inc. Due to the location of the airport, a flexural strength of 700 psi was assumed for the Portland cement concrete pavements during the evaluation.

**Table 7, Summary of Physical Property Data**

| FACILITY | | | PAVEMENT | | | BASE COURSE | | | SUBBASE | | | SUBGRADE | | PCC Section Eval Eff-K |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feature | Ident | Cond | Thick (in) | Type | Flex (psi) | Thick (in) | Type | CBR or K value | Thick (in) | Type | CBR or K value | Type | CBR or K value | |
| R01A | Rwy 18/36 | Fair | 10 | AC | -- | 7 | Sand Clay | 80 | 4 | Unk | 35 | Unk | 15 | -- |
| | | | | | | | | | 19 | UNK | 20 | | | |
| R02C | Rwy 18/36 | Fair | 10 | AC | -- | 6 | Sand Clay | 80 | 12 | Unk | 32 | Unk | 5 | -- |
| | | | | | | | | | 8 | UNK | 10 | | | |
| R03A | Rwy 18/36 | Fair | 10 | AC | -- | 7 | Sand Clay | 80 | 9 | Unk | 20 | Unk | 12 | -- |
| R04A | Rwy 08/26 | Poor | 11 | AC | -- | 6 | Sand Clay | 30 | 9 | Unk | 14 | Unk | 9 | -- |
| R05C | Rwy 08/26 | Poor | 10 | AC | -- | 9 | Unk | 9 | 14 | Unk | 6 | Unk | 5 | -- |
| R06A | Rwy 08/26 | Poor | 10 | AC | -- | 7 | Unk | 12 | 5 | Unk | 27 | Unk | 5 | -- |
| | | | | | | | | | 10 | UNK | 8 | | | |
| T01A | Txy A | Good | 2 | AC | -- | 4 | Sand Clay | 30 | 4 | Unk | 10 | Unk | 10 | -- |
| | | | | | | 4 | Unk | 17 | 14 | UNK | 20 | | | |
| T02A | Txy B | Fair | 11.25 | AC | -- | 5 | Sand Clay | 80 | 6 | SC | 55 | SC | 50 | -- |
| | | | | | | 8 | SC | 35 | 9 | SC | 80 | | | |
| T03C | Txy C | Fair | 10 | AC | -- | 6 | Sand Clay | 80 | 7 | SC | 17 | SC | 5 | -- |
| | | | | | | | | | 6 | SC | 12 | | | |
| T04C | Txy D | V Poor | 10.5 | AC | -- | 4 | Sand Clay | 25 | 10 | SC | 12 | SC | 15 | -- |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T05A | Txy E | V Poor | 10 | AC | -- | 5 | Sand Clay | 70 | -- | Unk | -- | Unk | 12 | -- |
| T06C | Txy F | Failed | 10.5 | AC | -- | 5 | Unk | 70 | 5 | Unk | 10 | Unk | 50 | -- |
| | | | | | | 4 | UNK | 20 | 18 | Unk | 80 | | | |
| T07A | Txy G | Ser | 8.5 | AC | -- | 4 | Unk | 45 | 7 | Unk | 35 | Unk | 12 | -- |
| T08A | Parallel Txy | V Poor | 6 | PCC | 700 | 8 | Unk | 150 | 10 | Unk | 200 | Unk | 120 | 150 |
| | | | | | | | | | 9 | Unk | 160 | | | |
| A01B | Apron | Ser | 6 | PCC | 700 | 9 | Unk | 185 | 20 | Unk | 135 | Unk | 100 | 185 |

Notes: 1. For flexible pavement (AC) section, the soil layer thicknesses and strengths shown were determined from DCP tests. The soil strengths are given in terms of CBRs.

2. For rigid pavement (PCC) sections, the soil layer K-values shown were determined from DCP vs. CBR, and CBR vs. K-value correlations. The correlated K-value for each layer is shown, along with the layer thickness. The lowest effective K-value actually used to evaluate the pavement section may be recorded in an additional column to the right of the actual pavement layer structure data as shown above to clarify the data presented. (Ref. ETL 02-19)

3. The subsurface soils were not extracted and laboratory classified, so the soil types are not described using standard Unified Soil Classification System (USCS) symbols. In cases where the soils are identified with USCS symbols, the symbols were taken from Cal-Tech Testing's Report of Geotechnical Exploration, dtd 19 Nov 2013.

Allowable passes based upon the section data in the Summary of Physical Property Data table were determined using PCASE software version 2.09.03.

**EVALUATION TEAM MEMBERS**

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**ATTACHMENT 1: DCP TEST RESULTS**

## ATTACHMENT 2: PCASE GENERATED REPORTS (Optional)

## ATTACHMENT 3: PCI SAMPLE SURVEY RESULTS (Optional)

# APPENDIX J GLOSSARY

## J-1 ACRONYMS

| | |
|---|---|
| AC | asphalt concrete |
| ACN | aircraft classification number |
| ACP | airfield cone penetrometer |
| ADCP | automated dynamic cone penetrometer |
| AFJMAN | Air Force Joint Manual |
| AFJPAM | Air Force Joint Pamphlet |
| AGL | allowable gross load |
| AI | airfield index |
| AFSOC | Air Force Special Operations Command |
| ASTM | American Society for Testing and Materials |
| CBR | California bearing ratio |
| CDV | corrected deduct value |
| DBST | double bituminous surface treatment |
| DCP | dynamic cone penetrometer |
| DF | design factor |
| DOD | Department of Defense |
| EN | evaluation number |
| ETL | Engineering Technical Letter |
| FAIR | frost area index of reaction |
| FASSI | frost area soil support index |
| FM | Field Manual |
| FOD | foreign object damage |
| ft | foot |

| | |
|---|---|
| ft2 | square foot |
| HDV | highest individual deduct value |
| HMA | hot-mixed asphalt |
| ICAO | International Civil Aviation Organization |
| in. | inch |
| kg | kilogram |
| LCG | load classification group |
| LCN | load classification number |
| LL | liquid limit |
| LZ | landing zone |
| m | meter |
| m2 | square meter |
| mm | millimeter |
| P/C | pass/coverage |
| PCASE | Pavement-Transportation Computer Aided Structural Engineering |
| PCC | portland cement concrete |
| PCI | pavement condition index |
| PCN | pavement classification number |
| PI | plasticity index |
| PL | plastic limit |
| PPD | physical property data |
| psi | pound per square inch |
| RED HORSE | Rapid Engineers Deployable Heavy Operations Repair Squadron Engineers |
| RRM | rolling resistant material |

| | |
|---|---|
| SCI | structural condition index |
| SPACI | semi-prepared airfield condition index |
| TDV | total deduct value |
| UFC | Unified Facilities Criteria |
| USACE | U.S. Army Corps of Engineers |
| USAF | U.S. Air Force |
| USCS | Unified Soil Classification System |

## J-2 TERMS

***Aircraft Classification Number (ACN):*** A number that expresses the relative structural effect of an aircraft on different pavement types for specified standard subgrade strengths in terms of a standard single-wheel load. The ACN is numerically defined as twice the derived single wheel load (expressed in thousands of kilograms) at a standard tire pressure of 181 psi, which requires the same pavement thickness as the actual main gear of the aircraft for a given limiting stress or number of load repetitions.

***Airfield Cone Penetrometer (ACP):*** Probe-type field-expedient instrument that gives an index of soil strength, in terms of an airfield index (AI). This AI can then be used to estimate a CBR value.

***Airfield Index (AI):*** A numerical reading, ranging from 1 to 15 (CBR 1 to 18), taken from an airfield cone penetrometer (ACP), indicating the strength of fine-grained soils.

***Allowable Gross Load (AGL):*** The load on the critical aircraft that can be supported by the pavement for the desired number of passes.

***Allowable Passes****:* The number of passes of an aircraft operating at a specific weight that the pavement will support before failure.

***Base or Subbase Courses****:* Natural or processed materials placed on the subgrade beneath the pavement.

***California Bearing Ratio (CBR):*** An empirical measure of soil strength used in the conventional design and evaluation of flexible pavement and unsurfaced airfields. To determine a CBR, a dynamic load is applied to a piston whose end is 3 square inches in area, forcing it to penetrate the soil at a rate of 0.05 inch/minute. The load required in psi to force penetration gives the modulus of shear that is converted to a CBR using established load factors. Penetration into a crushed, well-graded limestone serves as the benchmark material with a CBR of 100.

***Channelized Traffic:*** Traffic distribution, or pass-to-coverage ratio, is primarily a function of tire width and allowable lateral wander. Channelized traffic areas are those where the aircraft traffic is concentrated in a narrow path with limited (70 inches [1.8 m] wide) wander. “A” traffic areas are designed for channelized traffic.

***Compacted Subgrade****:* The upper part of the subgrade, which is compacted to a density greater than the portion of the subgrade below.

***Composite Pavement:*** A “sandwich pavement” consisting of a rigid pavement overlay placed on top of an existing pavement consisting of a nonrigid overlay on a rigid pavement base. The nonrigid overlay may be bituminous pavement for its full depth or a combination of bituminous pavement and granular material.

***Coverage:*** This term has different meanings for rigid and flexible pavements. For rigid pavements, coverage is a measure of the number of maximum stress applications that occur within the pavement due to the applied traffic. A coverage occurs when each point in the pavement within the limits of the traffic lane has been subjected to maximum stress. For flexible pavements, coverage is a measure of the number of maximum stress applications that occur on the surface of the pavement due to the applied traffic. A coverage occurs when all points on the pavement surface within the traffic lane have been subjected to one application of maximum stress. Thus, a twin-tandem gear produces two applications of stress on the surface of a flexible pavement, but produces only one maximum stress application within a rigid pavement if the tandem spacing was small and produces two maximum stresses if the tandem spacing was large.

***DCP Index:*** A ratio of the depth of penetration per each hammer blow of the dynamic cone penetrometer (DCP), indicating the strength of soils. This DCP index can be correlated to a CBR value.

***Double Bituminous Surface Treatment (DBST):*** A thin bituminous surface course, often found on less-trafficked areas such as overruns, consisting of a layer of uniform graded stone covered with a layer of bituminous emulsion, followed by a second layer of smaller size uniform graded stone and covered by another bituminous layer.

***Dynamic Cone Penetrometer (DCP):*** A probe-type instrument consisting of a cone-tipped rod driven into the soil by a sliding hammer. The DCP provides an indication of soil strength in terms of a DCP index.

***Effective K-value:*** Rigid pavements are evaluated using the K-value or index of the support provided by the soil immediately beneath the concrete slab. Often, K-values are measured directly on subgrade materials that may then be covered by granular base or drainage layer materials before placing the surface slab. These intermediate layers between the subgrade and the slab provide additional support. The measured K-value of a subsurface layer is converted to an effective K-value based upon the thickness of the intermediate layers to take into account the additional support they provide.

***Equivalent Single Wheel Load (ESWL):*** The load on a single wheel with the same contact radius as the gear wheels that will produce the same maximum deflection as the whole gear assembly and the same soil strain or stress at a specified depth within the pavement structure.

***Expedient Evaluation:*** Assessment of airfield structural capability to support 100 passes of a particular aircraft at its maximum weight or the number of passes to support the initial surge of mission aircraft.

***Failure Criteria:*** Condition or degree of distress used in pavement design to identify when a pavement structure has reached its end-of-life or terminal condition, which is referred to as “failure.”

> ***Flexible Pavement Failure:*** A 1-inch (25-mm) rut, measured on the surface, including both the permanent deformation and surface upheaval, but may be caused by failure of any layer within the pavement structure. A flexible pavement may also be considered functionally failed if surface cracking destroys the waterproofing provided by the bituminous surface.
>
> ***Rigid Pavement Failure:*** Air Force evaluations are based upon extended-life criteria where 50% of the slabs are cracked into approximately six pieces at the end of traffic. This is also referred to as “shattered slab failure.” Army evaluations are based upon standard life criteria where 50% of the slabs are cracked into two or more pieces at the end of traffic. This is also referred to as “initial failure” or “first crack failure.”
>
> ***Semi-prepared Surface Failure:*** A 3-inch (75-mm) rut, measured on the surface, including both the permanent deformation and surface upheaval, but may be caused by failure of any layer within the pavement structure.

***Feature:*** A unique portion of the airfield pavement distinguished by traffic area, pavement type, pavement surface thickness and strength, soil layer thickness and strength, construction period, and surface condition.

***Flexible Pavement:*** A pavement with a bituminous surface course and one or more supporting base or subbase courses placed over a prepared subgrade.

***Flexural Strength***: For portland cement concrete (PCC), the breaking strength of a simply supported beam that is subjected to vertical loading. Also known as the modulus of rupture, it approximates the tensile strength of the concrete.

***Frost Area Index of Reaction (FAIR):*** An index of soil strength used in lieu of a K-value to evaluate rigid pavement during thaw-weakened periods.

***Frost Area Soil Support Index (FASSI):*** An index of soil strength used in lieu of a CBR to evaluate flexible pavement during thaw-weakened periods.

***K-Value (Modulus of Subgrade Reaction):*** An index used to rate the support provided by a soil layer beneath a concrete (PCC) slab. A K-value is determined during a plate-bearing test by placing an incrementally increasing load on a set of stacked plates and measuring the resulting deflection of the bottom plate. This deflection is corrected for load deformation and plate bending to determine the actual volume of soil displaced under load. The K-value is the proportion of the applied load or vertical stress to the area of deformation and is expressed in psi per inch of deformation or PCI.

***Landing Zone (LZ):*** A paved or semi-prepared airfield used to conduct operations in an airfield environment similar to forward operating locations.

***Load Classification Number (LCN):*** A number expressing the relative effect of an aircraft on a pavement system or the bearing strength of a pavement.

***Non-channelized Traffic:*** Traffic distribution, or pass-to-coverage ratio, is primarily a function of tire width and allowable lateral wander. Non-channelized traffic areas are those where the aircraft traffic is concentrated in a broader path with less limited (140 inches [3.5 m] wide) wander. B and C traffic areas are designed for non-channelized traffic.

***Passes:*** The number of aircraft movements across an imaginary transverse line placed within 500 feet [152 m] of the end of the runway. For taxiways and aprons, passes are determined by the number of aircraft movements across a line on the primary taxiway that connects the runway and parking apron.

***Pass/Coverage Ratio:*** The number of passes of a particular aircraft required to produce one coverage of the traffic lane. This is primarily a function of tire width and allowable lateral wander. This number is different for each aircraft due to gear configurations and also varies for rigid and flexible pavement because of the way the loads are distributed in the pavement.

***Pavement Classification Number (PCN):*** A number that expresses the relative load-carrying capability of a pavement in terms of a standard single-wheel load.

***Pavement-Transportation Computer Aided Structural Engineering (PCASE):*** A collection of road, airfield, and railroad design and evaluation computer software programs developed by the U.S. Army Corps of Engineers (USACE), written using current USACE criteria and technology.

***Pavement Condition Index (PCI):*** A numerical rating resulting from an airfield condition survey that represents the severity of surface distresses.

***Permanent Evaluation:*** Assessment of airfield structural capability to support long-term aircraft operations—generally 50,000 passes or more of a particular aircraft at its maximum weight. The results of a permanent evaluation may also be presented as an AGL table that depicts the airfield load-bearing capability in terms of multiple aircraft, divided into 14 aircraft groups.

***Rigid Pavement:*** A pavement consisting of a nonreinforced portland cement concrete (PCC) surface course resting directly on a prepared subgrade, granular base course, or stabilized layer.

***Semi-prepared Airfield:*** An airfield without a paved (rigid or flexible) surface. The surface may be aggregate, unsurfaced, or stabilized material. The structure typically consists of three layers: the existing subgrade, a subbase, and a base or surface course. A semi-prepared airfield may or may not have a subbase or a base. If the existing material (the subgrade) is determined to be capable of supporting aircraft operations, no subbase or base will be required.

***Structural Condition Index (SCI):*** A numerical rating resulting from an airfield condition survey that is calculated based only upon structural or load-related pavement distresses.

***Subgrade**:* The natural in-place soil upon which a pavement, base, or subbase course is constructed.

***Sustainment Evaluation:*** Assessment of airfield structural capability to support sustained aircraft operations—generally 5,000 passes of a particular aircraft at its maximum weight, or the number of passes required to support the mission aircraft throughout the anticipated operation.

***Type A Traffic Area:*** Area of the airfield designed to support full or maximum weight of the aircraft, with channelized traffic.

***Type B Traffic Area:*** Area of the airfield designed to support full or maximum weight of the aircraft, with non-channelized traffic.

***Type C Traffic Area:*** Area of the airfield designed to support a reduced (75% of maximum) weight of the aircraft, with non-channelized traffic.

***Unified Soil Classification System (USCS):*** System developed by the U.S. Army Corps of Engineers (USACE) to group or classify soils based upon particle size, gradation, and plasticity characteristics, and rates their suitability as airfield construction materials.

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# APPENDIX K REFERENCES


## AIR FORCE

## ARMY

https://transportation.erdc.dren.mil/tsmcx/criteria.aspx

TSC Report 13-2, *Aircraft Characteristics for Airfield Pavement Design and Evaluation—Air Force and Army Aircraft*

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## ASTM

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