7.0 PAVEMENT DATA

7.0 PAVEMENT DATA

7.1 General Information

A brief description of the pavement charts that follow will help in their use for airport planning. Each airplane configuration is depicted with a minimum range of four loads imposed on the main landing gear to aid in interpolation between the discrete values shown. All curves for any single chart represent data based on rated loads and tire pressures considered normal and acceptable by current aircraft tire manufacturer's standards. Tire pressures, where specifically designated on tables and charts, are at values obtained under loaded conditions as certificated for commercial use.

Page 116 presents basic data on the landing gear footprint configuration, maximum design taxi loads, and tire sizes and pressures.

Maximum pavement loads for certain critical conditions at the tire-to-ground interface are shown on page 117.

Pavement requirements for commercial airplanes are customarily derived from the static analysis of loads imposed on the main landing gear struts. The chart on page 118 is provided in order to determine these loads throughout the stability limits of the airplane at rest on the pavement. These main landing gear loads are used as the point of entry to the pavement design charts, interpolating load values where necessary.

The flexible pavement design curves (Section 7.5) are based on procedures set forth in Instruction Report No. S-77-1, "Procedures for Development of CBR Design Curves," dated June 1977, and as modified according to the methods described in ICAO Aerodrome Design Manual, Part 3, Pavements, 2nd Edition, 1983, Section 1.1 (The ACN-PCN Method), and utilizing the alpha factors approved by ICAO in October 2007. Instruction Report No. S-77-1 was prepared by the U.S. Army Corps of Engineers Waterways Experiment Station, Soils and Pavements Laboratory, Vicksburg, Mississippi. The line showing 10,000 coverages is used to calculate Aircraft Classification Number (ACN).

Rigid pavement design curves (page 130) have been prepared with the use of the Westergaard equation in general accordance with the procedures outlined in the Design of Concrete Airport Pavement (1955 edition) by Robert G. Packard, published by the American Concrete Pavement Association, 3800 North Wilke Road, Arlington Heights, Illinois 60004-1268. These curves are modified to the format described in the Portland Cement Association publication XP6705-2, Computer Program for Airport Pavement Design (Program PDILB), 1968, by Robert G. Packard.

The following procedure is used to develop rigid pavement design curves such as those shown on page 123.

1. Having established the scale for pavement thickness to the left and the scale for allowable working stress to the right, an arbitrary load line is drawn representing the main landing gear maximum weight to be shown.
2. All values of the subgrade modulus (k-values) are then plotted as shown on page 123.
3. Additional load lines for the incremental values of weight on the main landing gear are then established on the basis of the curve for k = 300, already established.

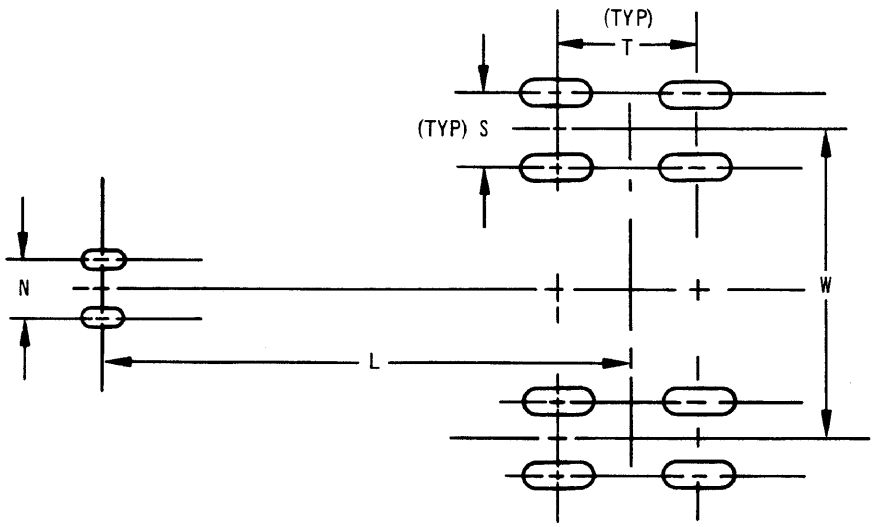
All LCN Curves where shown have been plotted from data in the International Civil Aviation Organization (ICAO) Document 7920-AN/865/2, Aerodrome Manual, Part 2, "Aerodrome Physical Characteristics," 2nd Edition, 1965.

On the same charts showing LCN versus equivalent single wheel load, there are load plots for the 707 family of airplanes showing equivalent single wheel load versus pavement thickness (h) for flexible pavements and versus ℓ (radius of relative stiffness) for rigid pavements.

Procedures and curves provided in the ICAO Aerodrome Manual - Part 2, Chapter 4 are used to determine equivalent single wheel loads for use in making LCN conversion of rigid pavement requirements.

Note: Pavement requirements are presented for loads, tires and tire pressures presently planned for certified commerical usage.

All curves represent data at a constant specified tire pressure.



MODEL	MAXIMUM RAMP WEIGHT	PERCENT OF WEIGHT ON MAIN GEAR	NOSE TIRE SIZE	NOSE TIRE PRESSURE	MAIN GEAR TIRE SIZE	MAIN GEAR TIRE PRESSURE	L	N	S	T	W
707-120B	258,000 LB 117,100 KG	SEE PAGE (118)	(2) 39 X 13	90 PSI 6.34 KG/CM^2	(8) 46 X 16	170 PSI 11.95 KG/CM^2	52 FT 4 IN. 15.95M	1 FT 10 IN. 0.56M	2 FT 10 IN. 0.86 M	4 FT 8 IN. 1.42 M	22 FT 1.2 IN. 6.74 M
707-320, -420	316,000 LB 143,000 KG	SEE PAGE (119)	(2) 39 X 13	115 PSI 8.10 KG/CM^2	(8) 46 X 16	180 PSI 12.68 KG/CM^2	59 FT 0 IN. 17.98M	1 FT 10 IN. 0.56 M	2 FT 10.6 IN. 0.88 M	4 FT 8 IN. 1.42 M	22 FT 1.2 IN. 6.74 M
707-320B	328,000 LB 148,500 KG	SEE PAGE (120)	(2) 39 X 13	115 PSI 8.10 KG/CM^2	(8) 46 X 16	180 PSI 12.68 KG/CM^2	59 FT 0 IN. 17.98 M	1 FT 10 IN. 0.56 M	2 FT 10.6 IN. 0.88 M	4 FT 8 IN. 1.42 M	22 FT 1.2 IN. 6.74 M
707-320C	336,000 LB 152,500 KG	SEE PAGE (121)	(2) 39 X 13	115 PSI 8.10 KG/CM^2	(8) 46 X 16	180 PSI 12.68 KG/CM^2	59 FT 0 IN. 17.98 M	1 FT 10 IN. 0.56 M	2 FT 10.6 IN. 0.88 M	4 FT 8 IN. 1.42 M	22 FT 1.2 IN. 6.74 M

7.2 LANDING GEAR FOOTPRINT
MODELS 707-120B, -320, -320B, -320C, -420

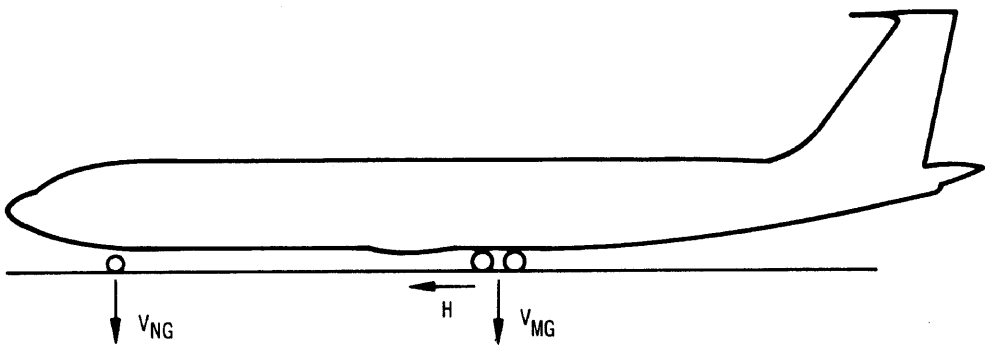
LEGEND:

V_{NG} = MAXIMUM VERTICAL NOSE GEAR GROUND LOAD AT MOST FORWARD C.G.

V_{MG} = MAXIMUM VERTICAL MAIN GEAR GROUND LOAD AT MOST AFT C.G.

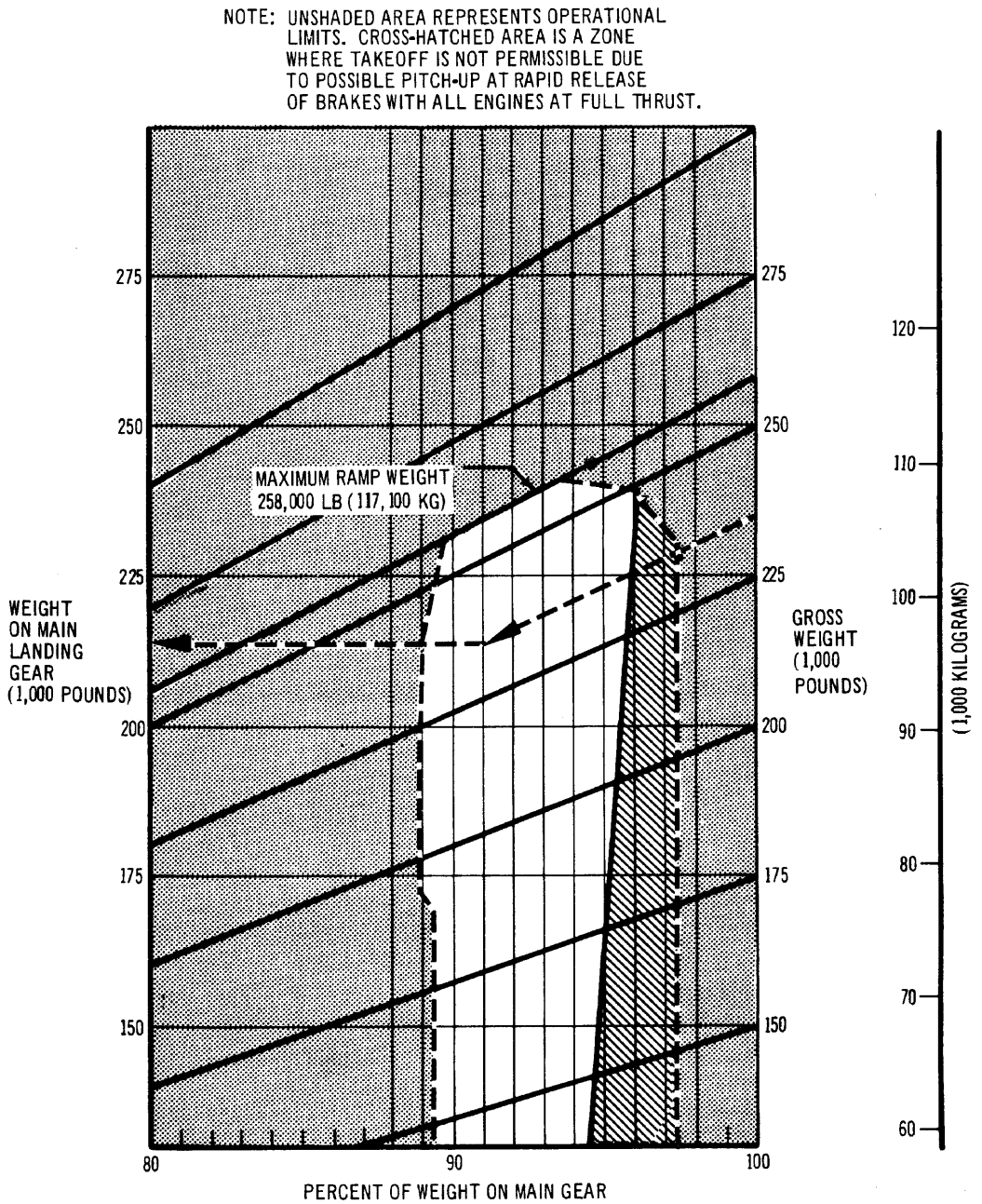
H = MAXIMUM HORIZONTAL GROUND LOAD FROM BRAKING

NOTE: ALL LOADS CALCULATED USING AIRPLANE MAXIMUM GROSS WEIGHT

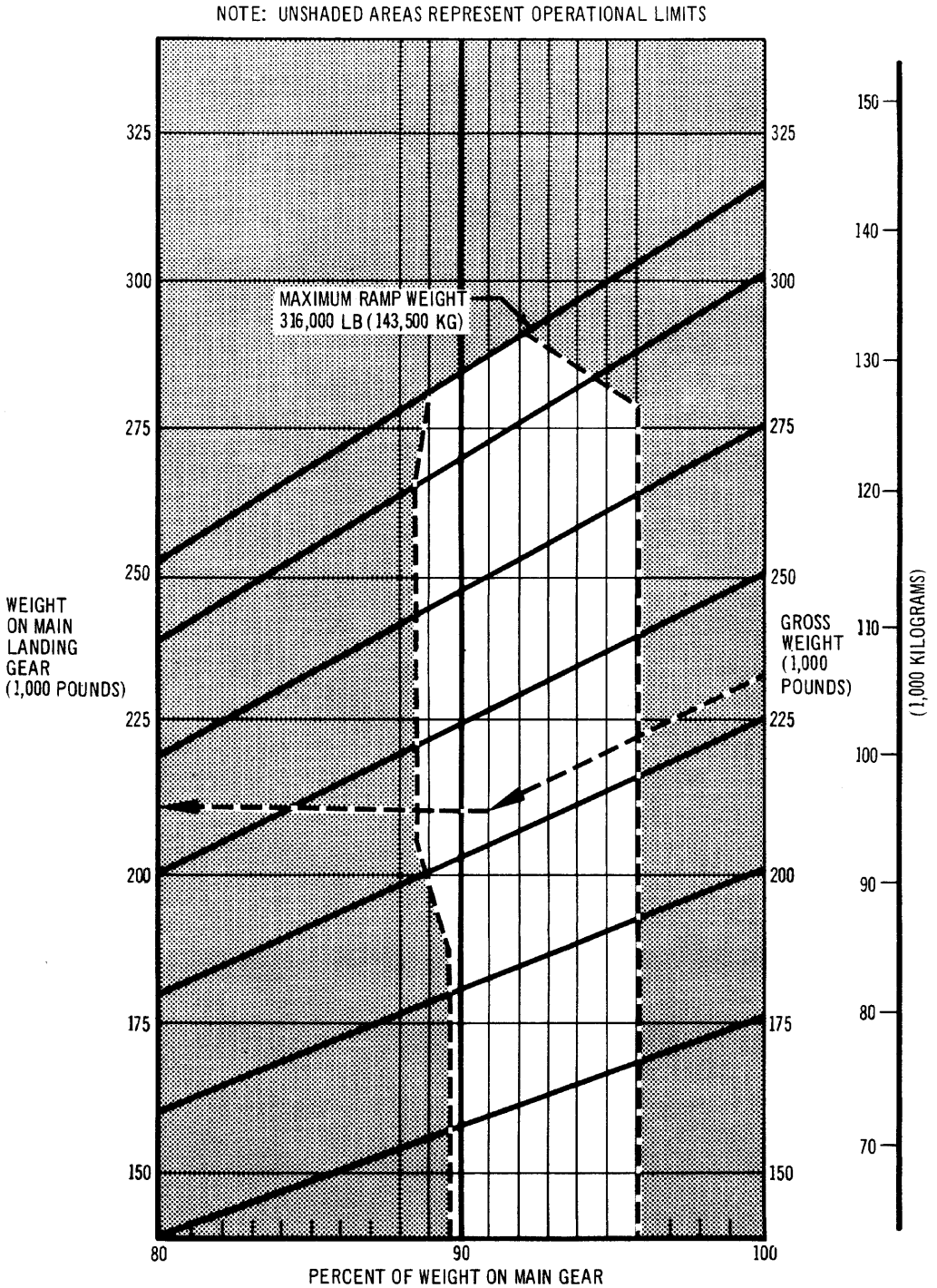


MODEL	MAXIMUM GROSS WEIGHT	V_{NG}				V_{MG} PER STRUT (2)		H (PER STRUT (2)			
		STATIC AT MOST FORWARD C.G.		STATIC + BRAKING @ 10 FT/SEC^2 DECEL.		MAXIMUM LOAD OCCURING AT STATIC AFT C.G.		AT STEADY BRAKING 10 FT/SEC^2 DECEL		AT INSTANTANEOUS BRAKING (COEFF. OF FRICTION 0.8)	
	LB	LB	KG	LB	KG	LB	KG	LB	KG	LB	KG
707-120B	258,000	26,600	12,070	40,880	18,560	120,600	54,750	40,100	18,200	96,500	43,810
707-320, -120	316,000	34,100	15,480	49,280	22,370	145,500	66,060	49,100	22,290	116,250	52,780
707-320B	328,000	34,400	15,620	50,100	22,750	151,000	68,550	51,000	23,150	120,750	54,820
707-320C	336,000	34,600	15,700	51,770	23,500	157,000	71,280	52,150	23,630	125,500	56,930

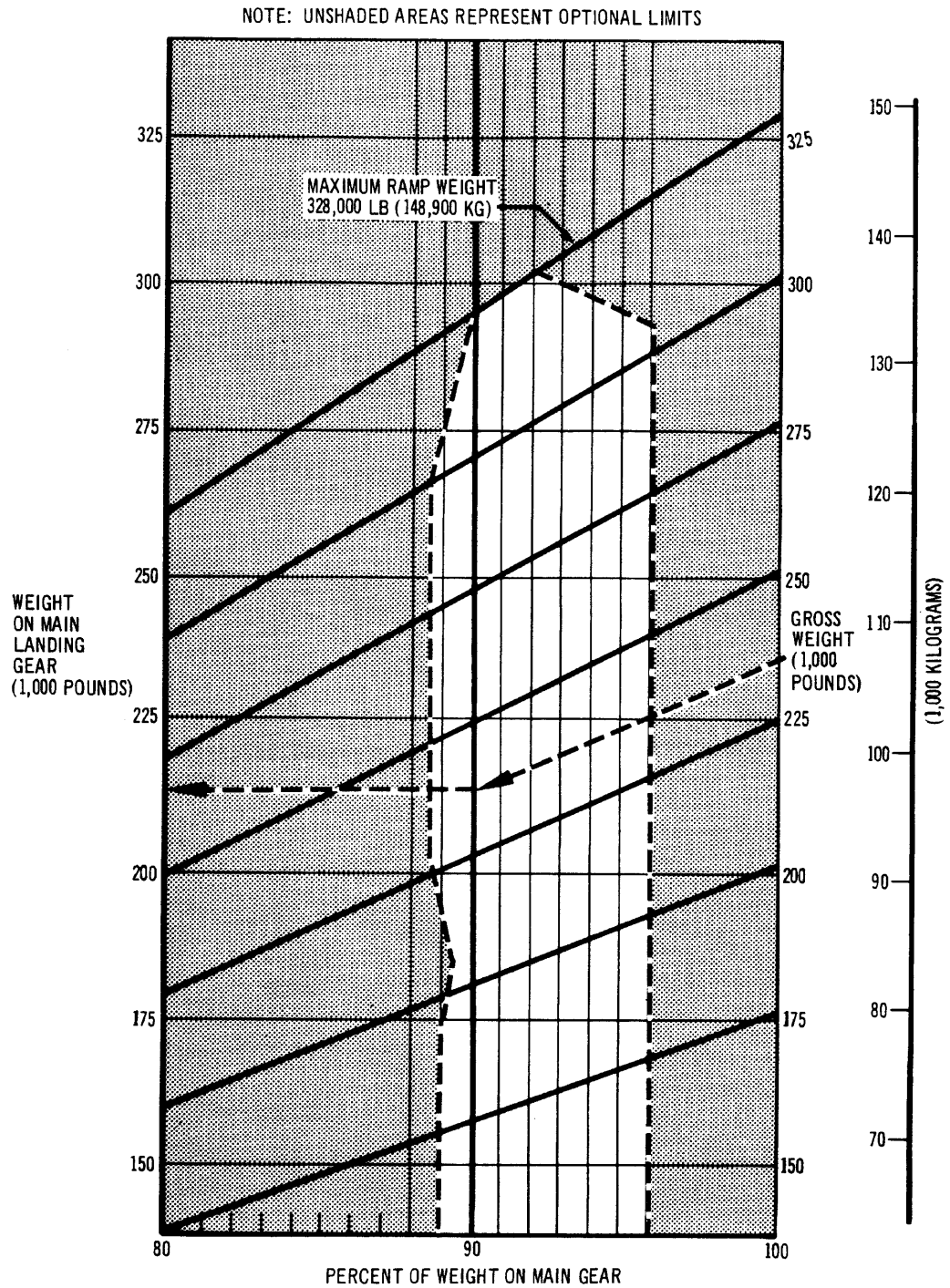
7.3 MAXIMUM PAVEMENT LOADS MODELS 707-120B, -320, -320B, -320C, -420



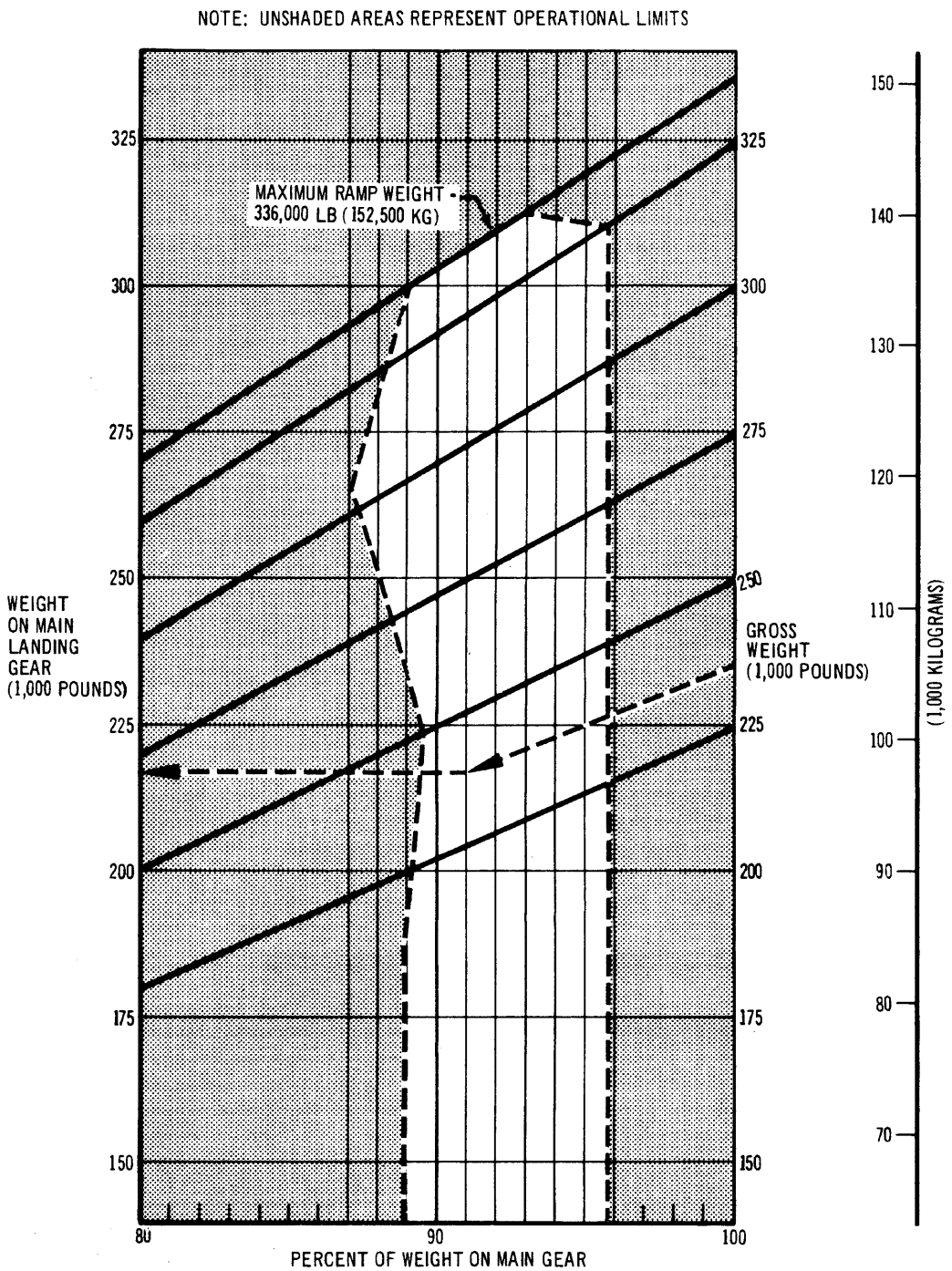
7.4 LANDING GEAR LOADING ON PAVEMENT MODEL 707-120B



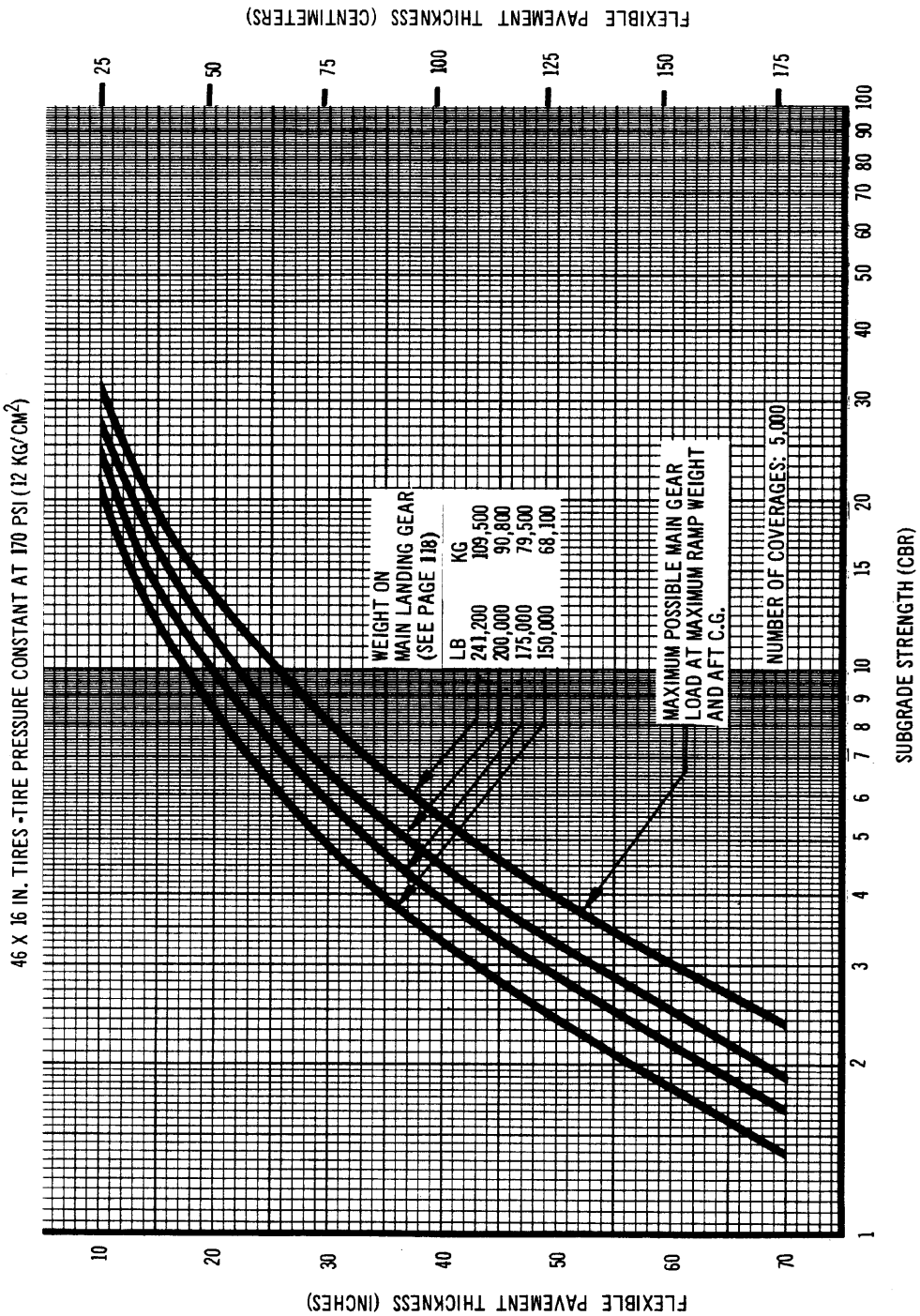
LANDING GEAR LOADING ON PAVEMENT
MODELS 707-320, -420



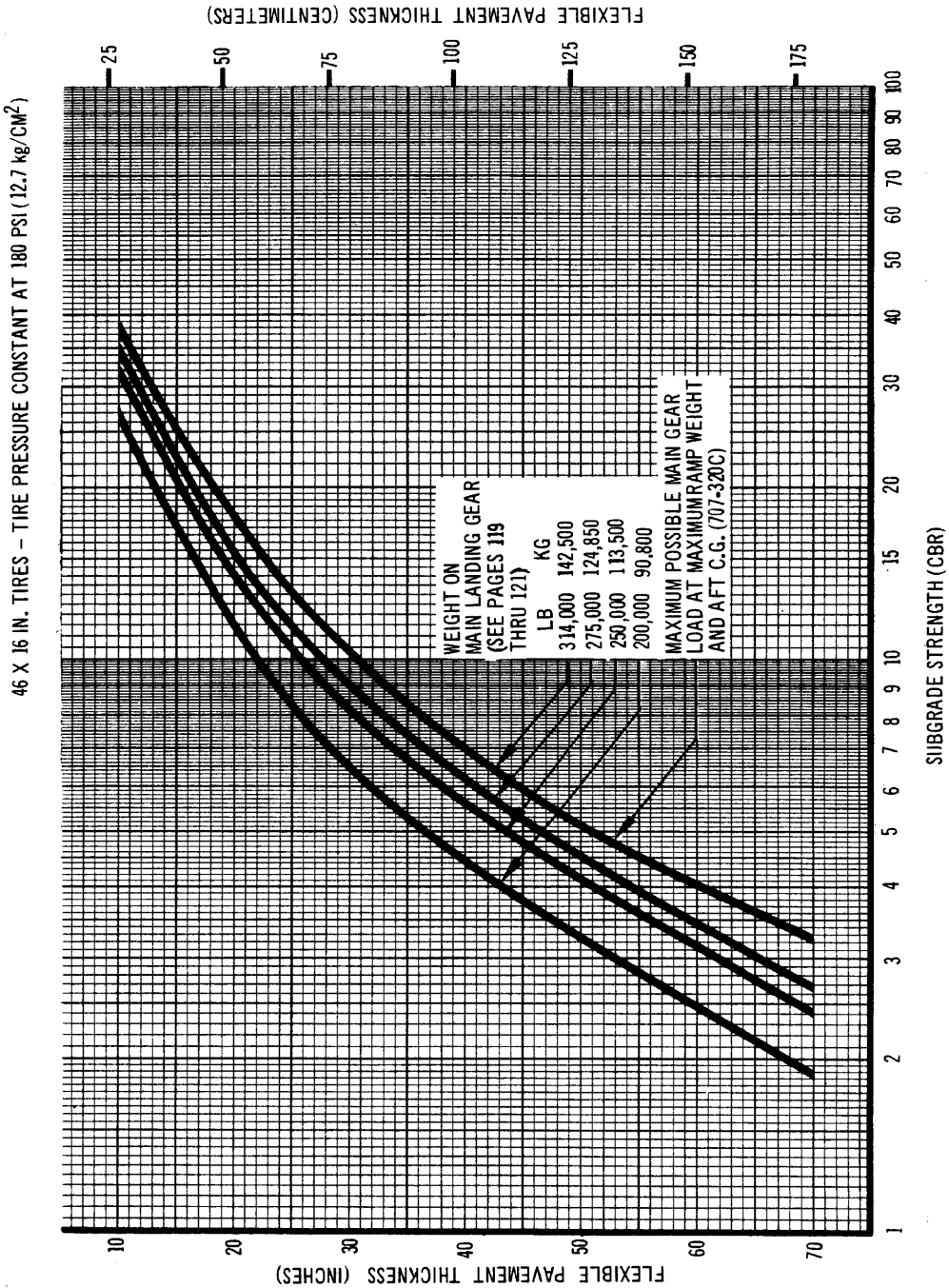
LANDING GEAR LOADING ON PAVEMENT
MODEL 707-320B



LANDING GEAR LOADING ON PAVEMENT
MODEL 707-320C



7.5 FLEXIBLE PAVEMENT REQUIREMENTS - U.S. CORPS OF ENGINEERS DESIGN METHOD (REF. SEFL 165 A)
MODEL 707-120B



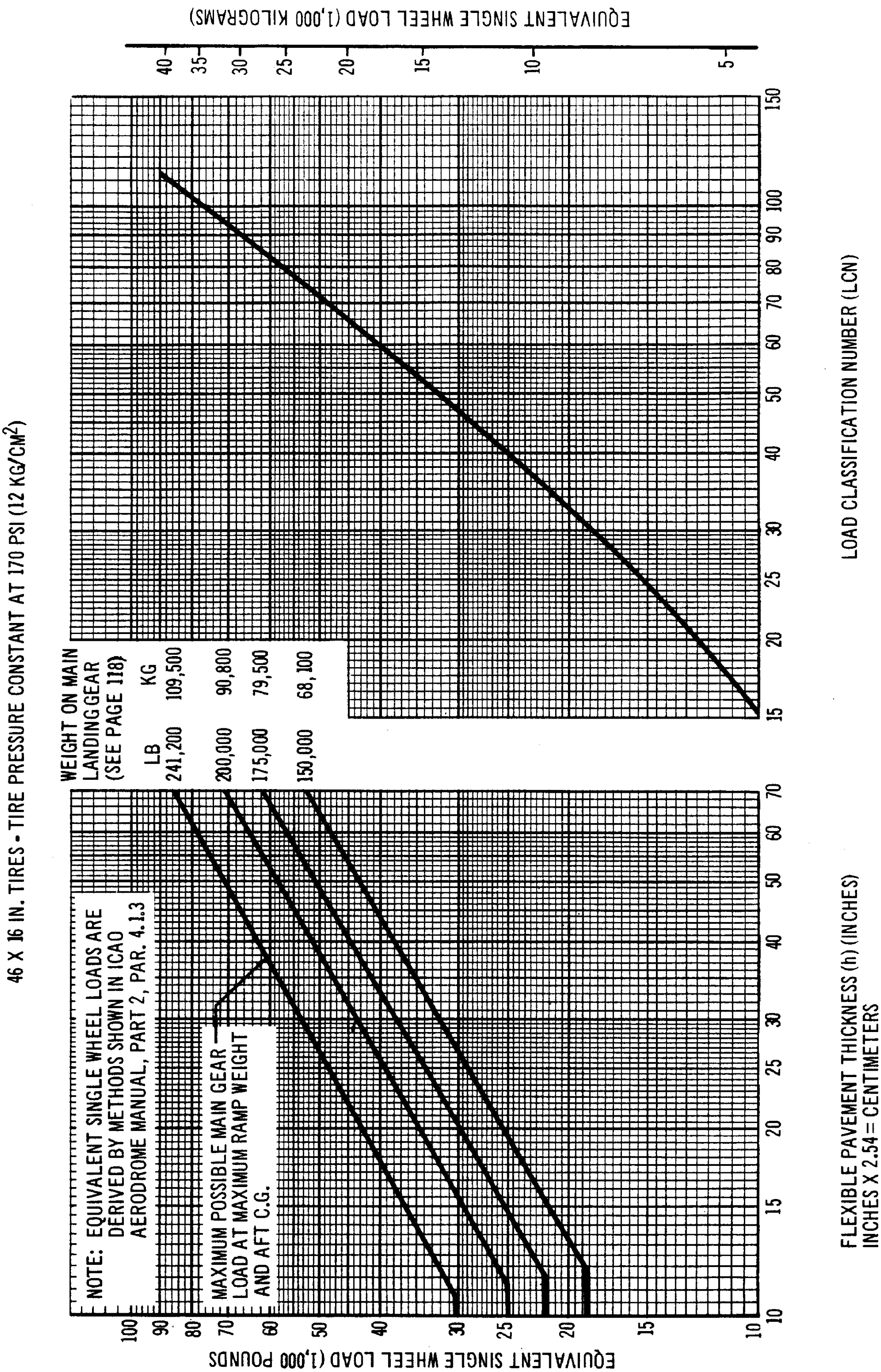
FLEXIBLE PAVEMENT REQUIREMENTS - U.S. CORPS OF ENGINEERS
DESIGN METHOD (REF. SEFL 165A)
MODELS 707-320, -320B, -320C, -420

7.6 FLEXIBLE PAVEMENT REQUIREMENTS — LCN CONVERSION

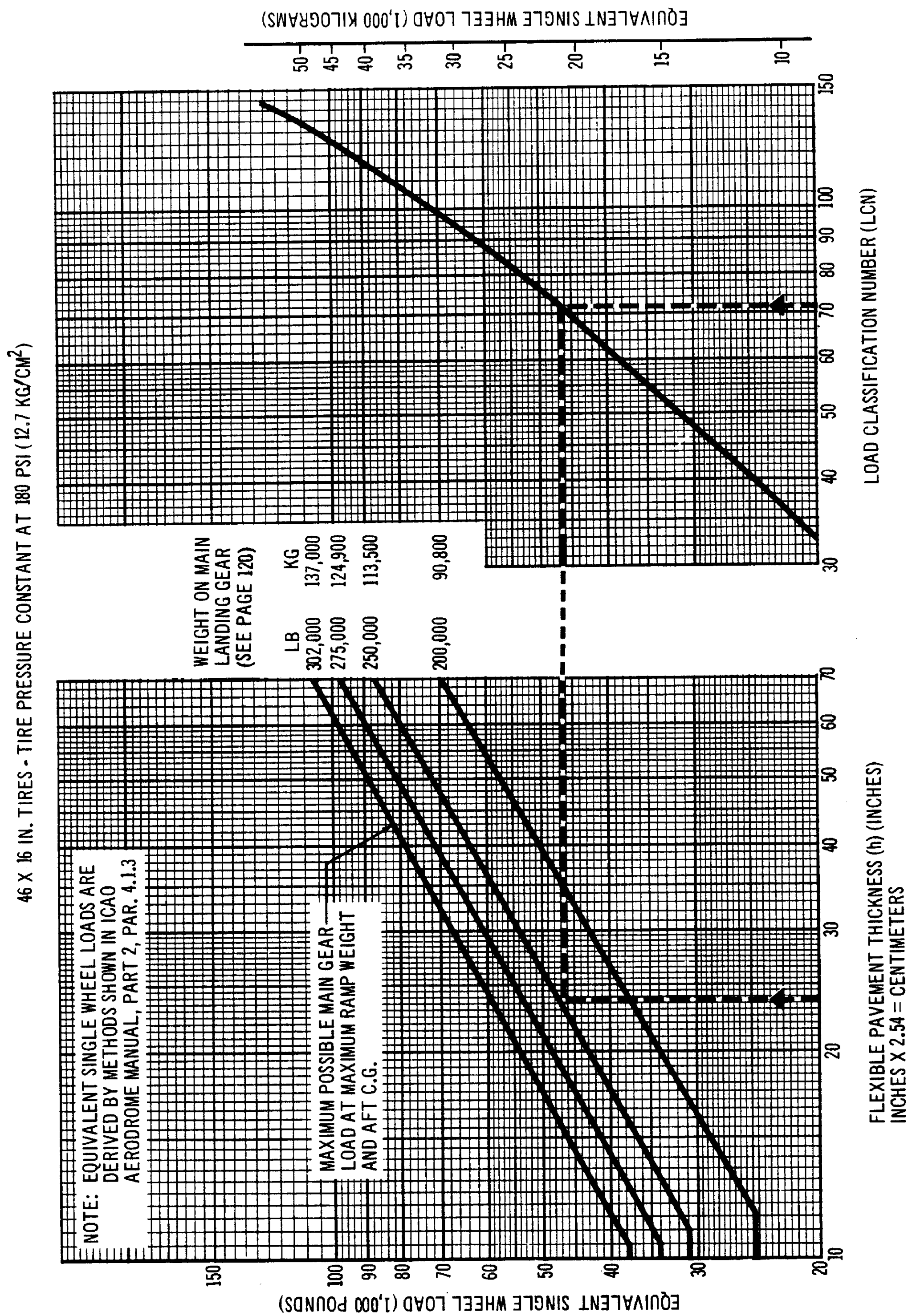
In order to determine the aircraft weight that can be accommodated on a particular flexible pavement, both the LCN of the pavement and the thickness (h) of the pavement must be known.

In the example for the 707-320B shown on page 126, the flexible pavement thickness is shown at 23.6 inches with an LCN of 72. For these conditions the apparent maximum allowable weight permissible on the main landing gear is 250,000 pounds.

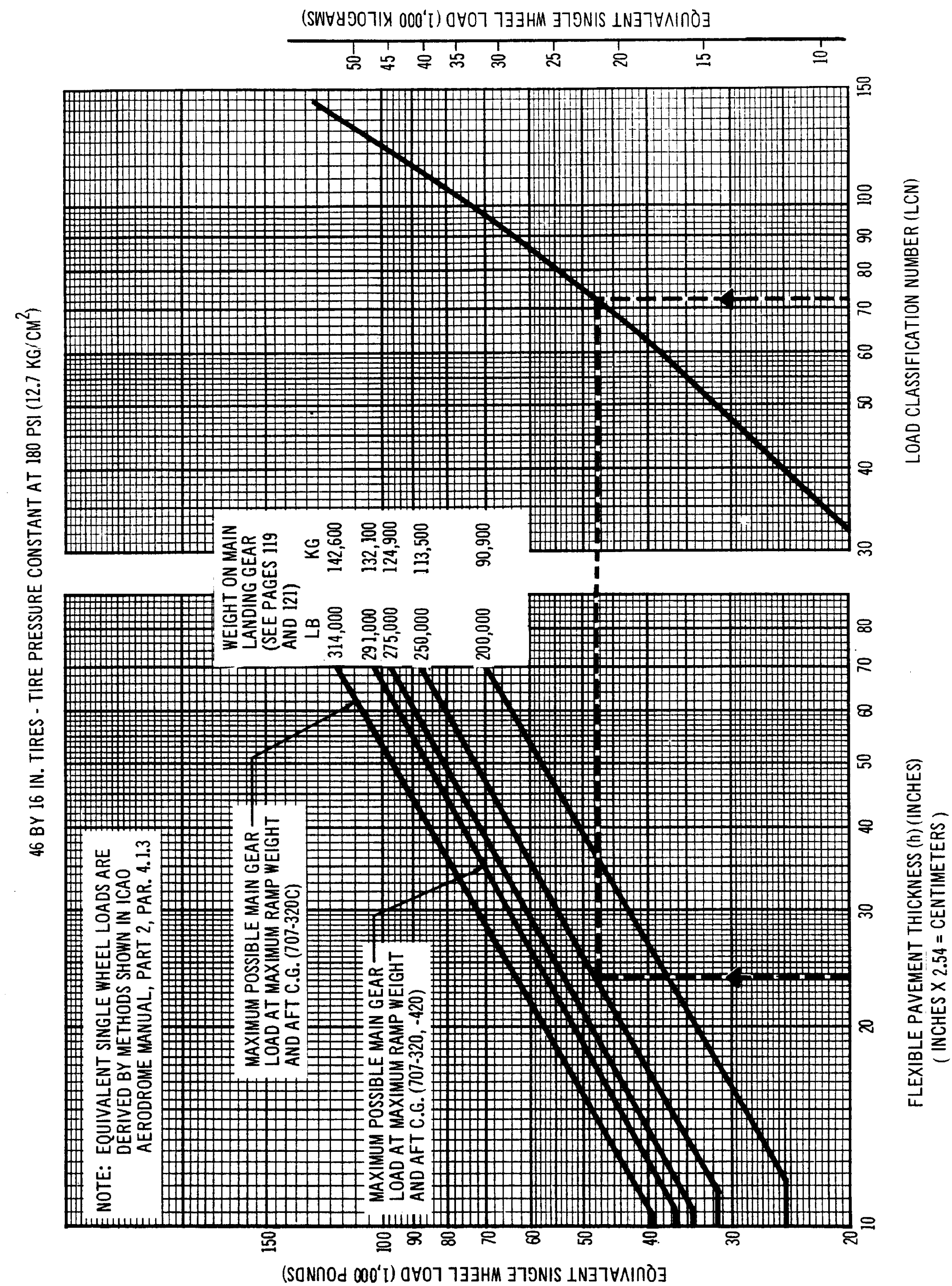
NOTE: Provided that the resultant aircraft LCN is not more than 10 percent above the published pavement LCN, the United Kingdom considers the bearing strength of the pavement to be sufficient for unlimited use by the aircraft. The figure of 10 percent has been chosen as representing the lowest degree of variation in LCN that is significant. (Reference: ICAO Aerodrome Manual, Part 2, Aerodrome Physical Characteristics, Chapter 4, Paragraph 4.1.5.7v.)



7.6 FLEXIBLE PAVEMENT REQUIREMENTS - LCN CONVERSION MODEL 707-120B



FLEXIBLE PAVEMENT REQUIREMENTS - LCN CONVERSION
MODEL 707-320B



FLEXIBLE PAVEMENT REQUIREMENTS - LCN CONVERSION
MODELS 707-320, -320C, -420

7.7 RIGID PAVEMENT REQUIREMENTS — PORTLAND CEMENT ASSOCIATION DESIGN METHOD

Rigid pavement requirements, herein presented, are based upon two Portland Cement Association practices:

1. The former, standard manual method of counting unit moment blocks on the Pickett and Ray influence charts (Reference: Portland Cement Association publication "The Design of Concrete Airport Pavement" dated 1955)
2. The new computerized version of the above as described in document XP-6705 "Computer Program for Airport Pavement Design" by Robert G. Packard, Portland Cement Association, 1967

Higher stresses for equivalent pavement thicknesses are obtained by the computerized method. These occur because of the following:

1. Increased Radius of Influence

   The effect of influence from adjacent wheels by the manual method was limited to approximately 2 times ℓ (the radius of relative stiffness). The computer utilizes the Westergaard equation directly and includes influence from all wheels within a radius of 3 times ℓ .

2. Maximizing Process

   It has been common practice when using the manual count method to align the landing gear footprint on the major axis of the influence chart with one wheel centered over the origin. While this practice does not necessarily produce the maximum possible moment, the values obtained have been considered practical since the procedure eliminates arduous repetitive manual summations of moment blocks.

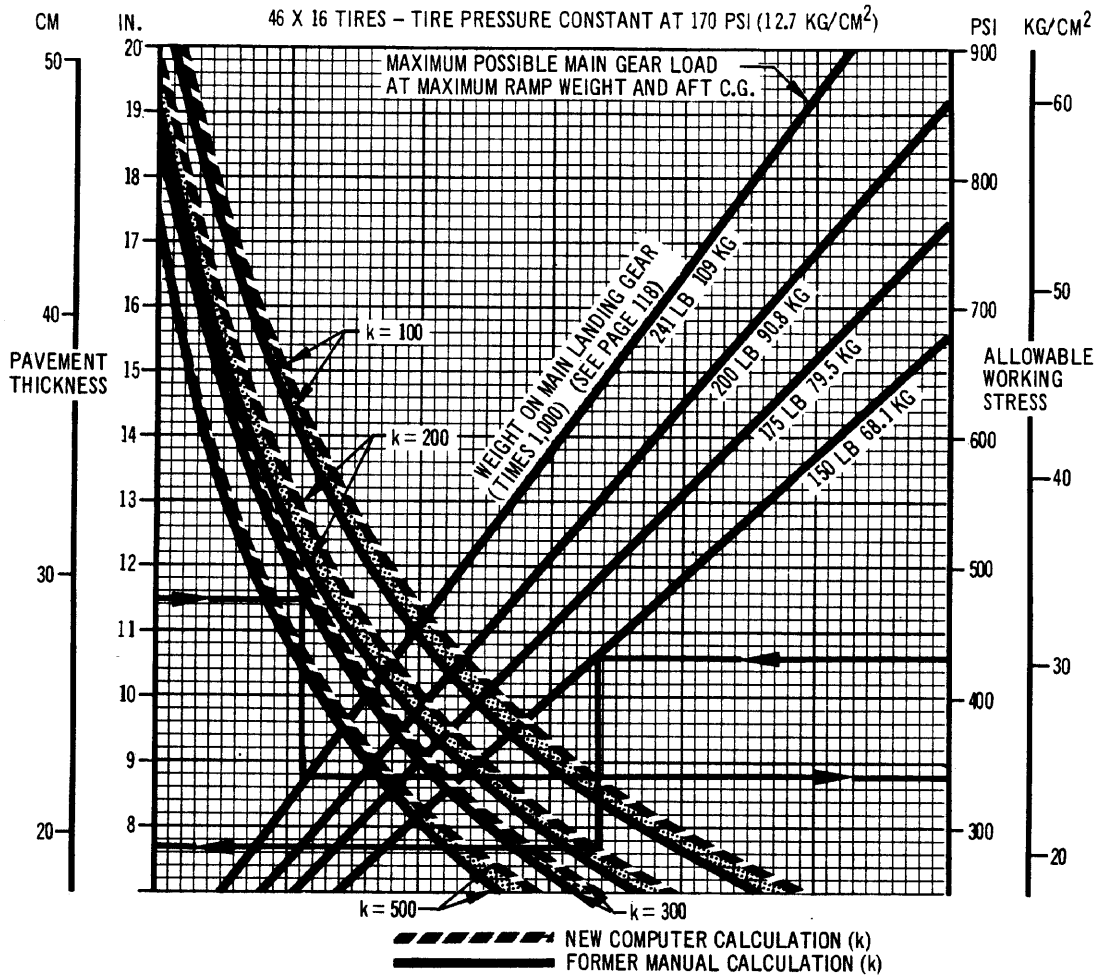
   The computer determines the actual maximum stress values by a combination of shifting the footprint in relationship to the origin and by angular rotation of the footprint.

3. Difference in Footprint Shape

   An elliptical contact area is used in the computerized version to represent

a single-wheel footprint instead of a rectangle with rounded ends. The variance in moment attributed to this change is minor.

Actual pavement stress for any given model of airplane has not increased. The state of the art in calculation of pavement stress has advanced to permit prediction of stress values to a higher degree of certainty. This permits a proportionate decrease in design stress safety factor.

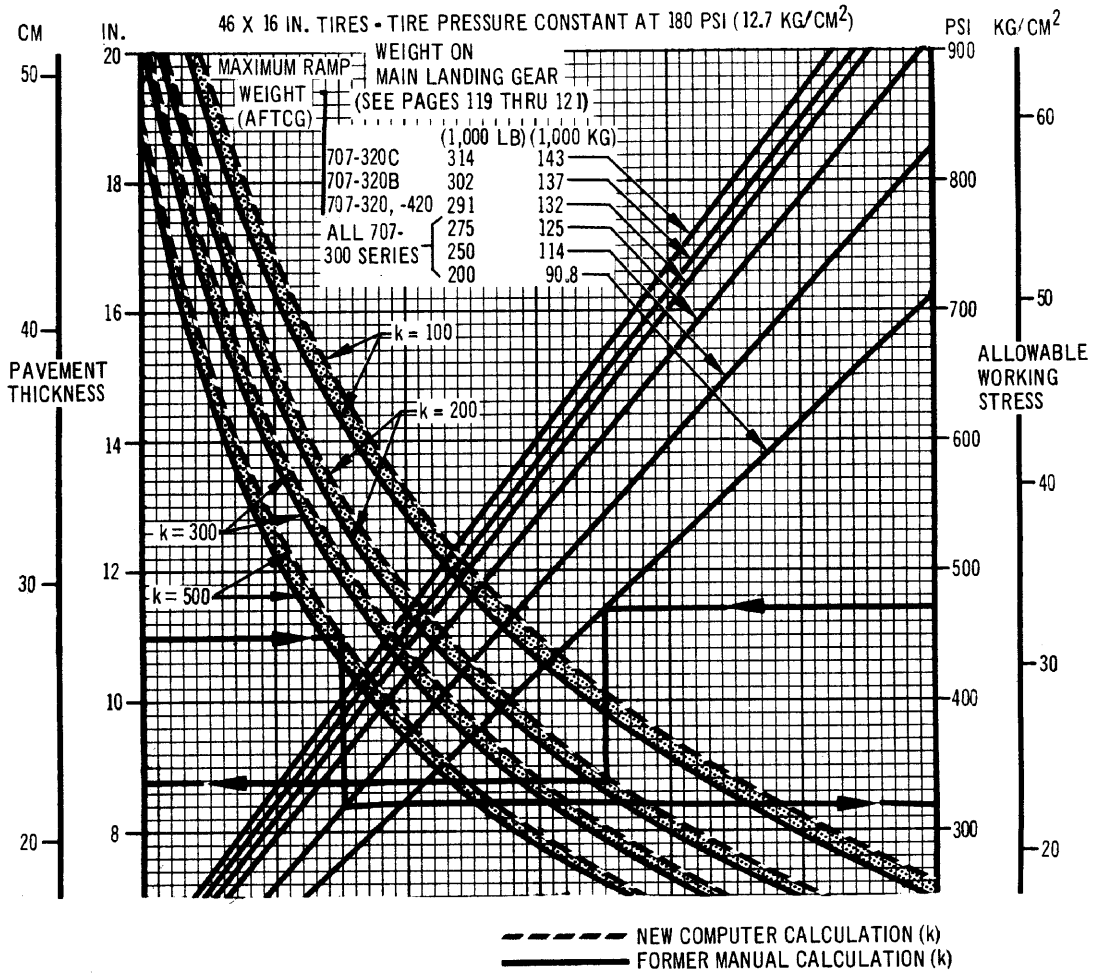


NOTE: THE VALUES OBTAINED BY USING THE MAXIMUM LOAD REFERENCE LINE AND ANY VALUE OF k ARE EXACT. FOR LOADS LESS THAN MAXIMUM, THE CURVES ARE EXACT FOR k = 300 BUT DEVIATE SLIGHTLY FOR OTHER VALUES OF k.

REFERENCES: "DESIGN OF CONCRETE AIRPORT PAVEMENT" AND "COMPUTER PROGRAM FOR AIRPORT PAVEMENT DESIGN" (PROGRAM PDILB) PORTLAND CEMENT ASSN.

NOTICE: DUE TO CHANGES PER NEW COMPUTER METHOD, VALUES OF STRESS ARE HIGHER THAN OBTAINED BY STANDARD MANUAL METHOD. (SEE PAGE 128)

RIGID PAVEMENT REQUIREMENTS
PORTLAND CEMENT ASSOCIATION DESIGN METHOD
MODEL 707-120B



NOTES: THE VALUES OBTAINED BY USING THE MAXIMUM LOAD REFERENCE LINE AND ANY VALUE OF k ARE EXACT. FOR LOADS LESS THAN MAXIMUM, THE CURVES ARE EXACT FOR k = 300 BUT DEVIATE SLIGHTLY FOR OTHER VALUES OF k.

REFERENCES: "DESIGN OF CONCRETE AIRPORT PAVEMENT" AND "COMPUTER PROGRAM FOR AIRPORT PAVEMENT DESIGN" (PROGRAM PDILB) PORTLAND CEMENT ASSN

NOTICE: DUE TO CHANGES PER NEW COMPUTER METHOD, VALUES OF STRESS ARE HIGHER THAN OBTAINED BY FORMER STANDARD MANUAL METHOD. (SEE PAGE 125)

RADIUS OF RELATIVE STIFFNESS (ℓ)

VALUES OF ℓ IN INCHES

FOR E=4,000,000 P.S.I. AND μ = 0.15

RADIUS OF RELATIVE STIFFNESS $= \ell = \sqrt[4]{\frac{E\,d^3}{12(1-\upsilon^2)k}} = 24.1652 \sqrt[4]{\frac{d^3}{k}}$

d IN IN.	k=50	k =100	k=150	k=200	k=250	k=300	k=350	k=400	k=500
6	34.84	29.30	26.47	24.63	23.30	22.26	21.42	20.72	19.59
6.5	36.99	31.11	28.11	26.16	24.74	23.64	22.74	22.00	20.80
7	39.11	32.89	29.72	27.65	26.15	24.99	24.04	23.25	21.99
7.5	41.19	34.63	31.29	29.12	27.54	26.32	25.32	24.49	23.16
8	43.23	36.35	32.85	30.57	28.91	27.62	26.58	25.70	24.31
8.5	45.24	38.04	34.37	31.99	30.25	28.91	27.81	26.90	25.44
9	47.22	39.71	35.88	33.39	31.58	30.17	29.03	28.08	26.55
9.5	49.17	41.35	37.36	34.77	32.89	31.42	30.23	29.24	27.65
10	51.10	42.97	38.83	36.14	34.17	32.65	31.42	30.39	28.74
10.5	53.01	44.57	40.28	37.48	35.45	33.87	32.59	31.52	29.81
11	54.89	46.16	41.71	38.81	36.71	35.07	33.75	32.64	30.87
11.5	56.75	47.72	43.12	40.13	37.95	36.26	34.89	33.74	31.91
12	58.59	49.27	44.52	41.43	39.18	37.44	36.02	34.84	32.95
12.5	60.41	50.80	45.90	42.72	40.40	38.60	37.14	35.92	33.97
13	62.22	52.32	47.27	43.99	41.61	39.75	38.25	36.99	34.99
13.5	64.00	53.82	48.63	45.26	42.80	40.89	39.35	38.06	35.99
14	65.77	55.31	49.98	46.51	43.98	42.02	40.44	39.11	36.99
14.5	67.53	56.78	51.31	47.75	45.16	43.15	41.51	40.15	37.97
15	69.27	58.25	52.63	48.98	46.32	44.26	42.58	41.19	38.95
15.5	70.99	59.70	53.94	50.20	47.47	45.36	43.64	42.21	39.92
16	72.70	61.13	55.24	51.41	48.62	46.45	44.70	43.23	40.88
16.5	74.40	62.56	56.53	52.61	49.75	47.54	45.74	44.24	41.84
17	76.08	63.98	57.81	53.80	50.88	48.61	46.77	45.24	42.78
17.5	77.75	65.38	59.48	54.98	52.00	49.68	47.80	46.23	43.72
18	79.41	66.78	60.35	56.16	53.11	50.74	48.82	47.22	44.66
19	82.70	69.54	62.84	58.48	55.31	52.84	50.84	49.17	46.51
20	85.95	72.27	65.30	60.77	57.47	54.92	52.84	51.10	48.33
21	89.15	74.97	67.74	63.04	59.62	56.96	54.81	53.01	50.13
22	92.31	77.63	70.14	65.28	61.73	58.98	56.75	54.89	51.91
23	95.44	80.26	72.52	67.49	63.83	60.98	58.68	56.75	53.67
24	98.54	82.86	74.87	69.68	65.90	62.96	60.58	58.59	55.41

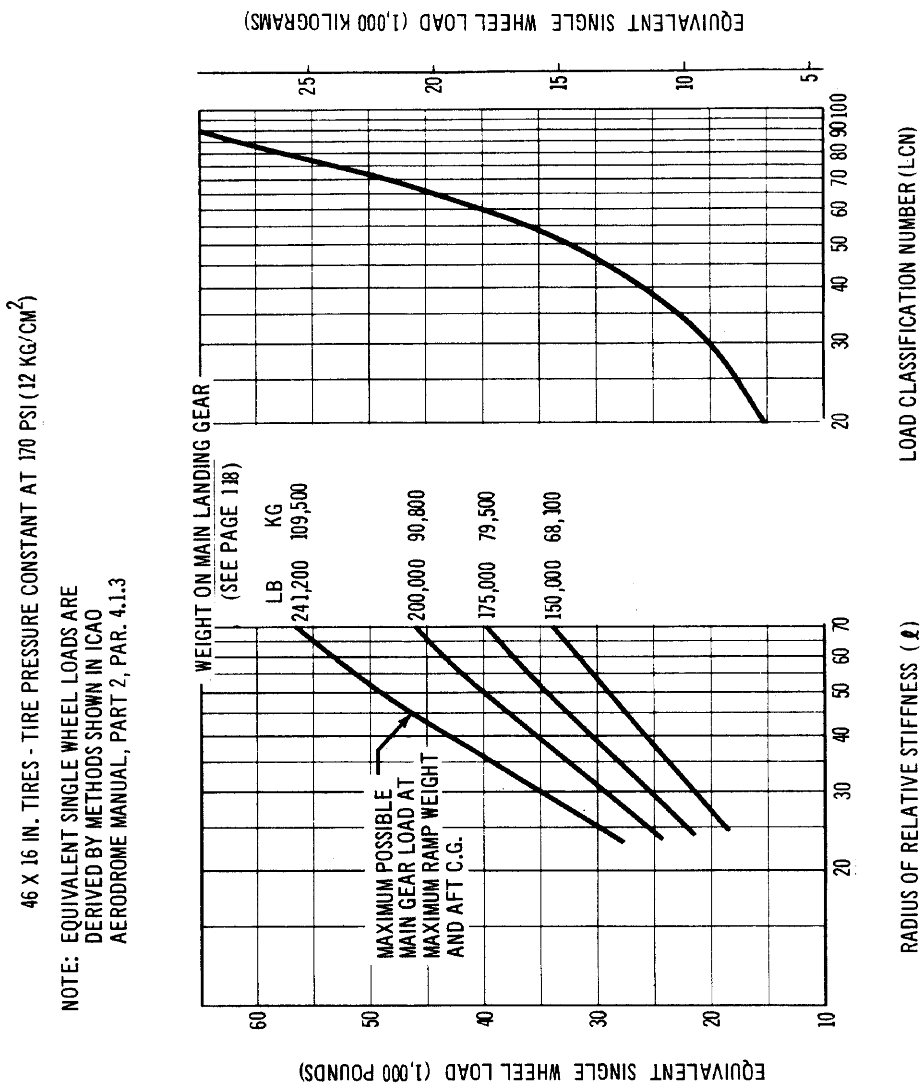
RADIUS OF RELATIVE STIFFNESS (REFERENCE: PORTLAND CEMENT ASSOCIATION)

7.8 RIGID PAVEMENT REQUIREMENTS — LCN CONVERSION

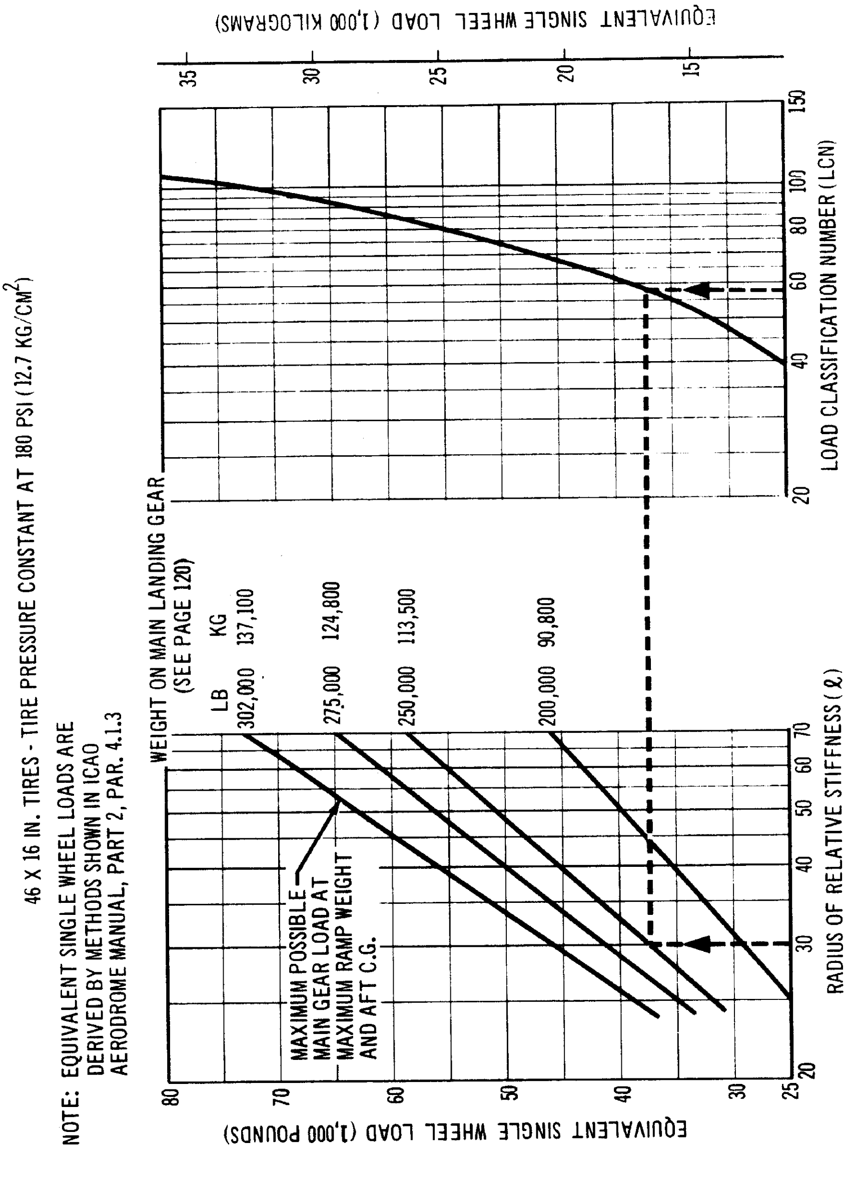
In order to determine the aircraft weight that can be accommodated on a particular rigid pavement, both the LCN of the pavement and the radius of relative stiffness (ℓ) of the pavement must be known.

In the example for the 707-320B shown on page 132, the rigid pavement radius of relative stiffness (ℓ) is shown at 30 with an LCN of 58. For these conditions, the apparent maximum allowable weight permissible on the main landing gear is 250,000 pounds.

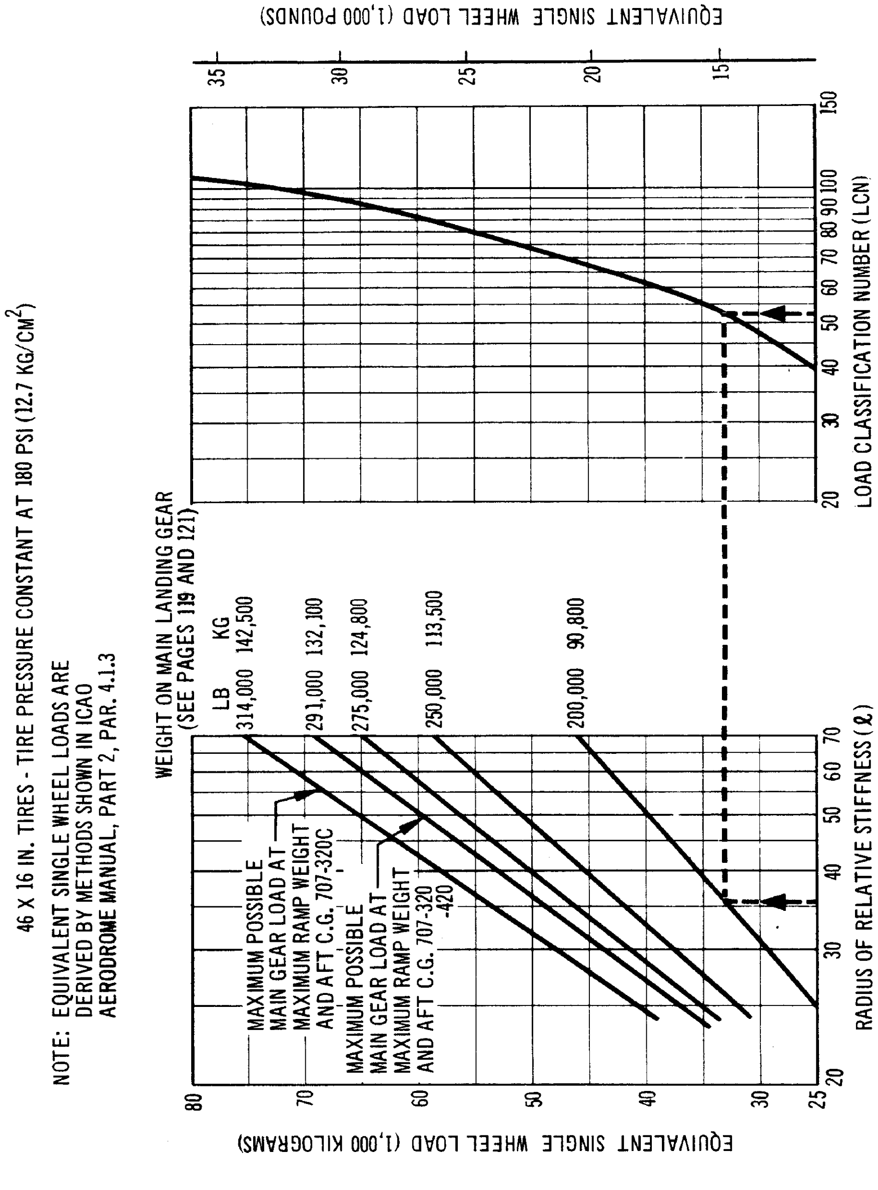
NOTE: Provided that the resultant aircraft LCN is not more than 10 percent above the published pavement LCN, the United Kingdom considers the bearing strength of the pavement to be sufficient for unlimited use by the aircraft. The figure of 10 percent has been chosen as representing the lowest degree of variation in LCN that is significant. (Reference: ICAO Aerodrome Manual, Part 2, Aerodrome Physical Characteristics, Chapter 4, Paragraph 4.1.5.7v.)



RIGID PAVEMENT REQUIREMENTS - LCN CONVERSION
MODEL 707-120B



RIGID PAVEMENT REQUIREMENTS - LCN CONVERSION
MODEL 707-320B



RIGID PAVEMENT REQUIREMENTS - LCN CONVERSION
MODELS 707-320, -320C, -420

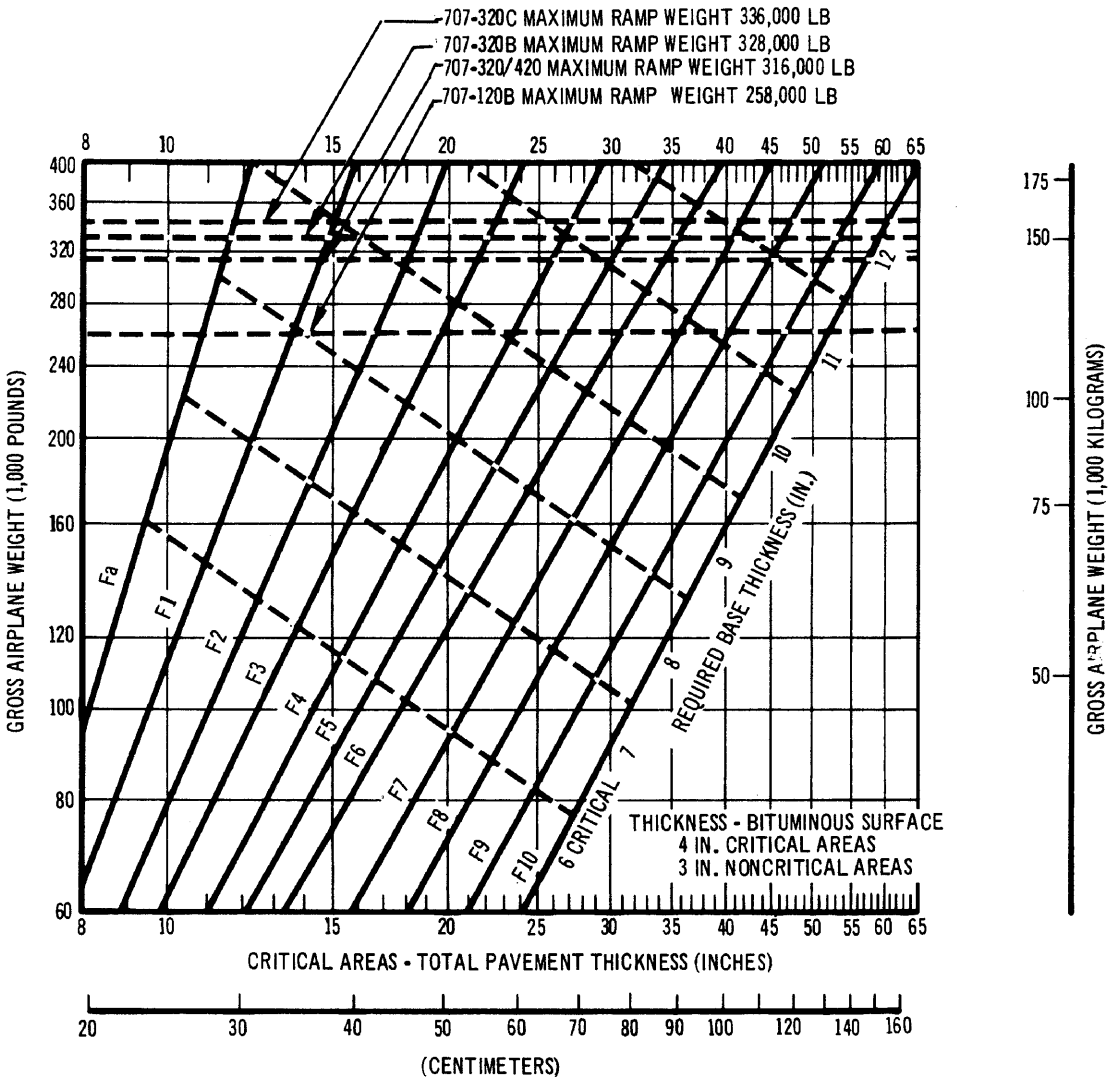
7.9 FAA METHOD

The charts on pages 138 and 139 are developed directly from pages in FAA Advisory Circular AC 150/5320-6A, dated May 9, 1967.

Pavement thicknesses are shown for gross aircraft weight, irrespective of landing gear configuration and tire pressure. The following general assumptions were made by the FAA in preparing the charts:

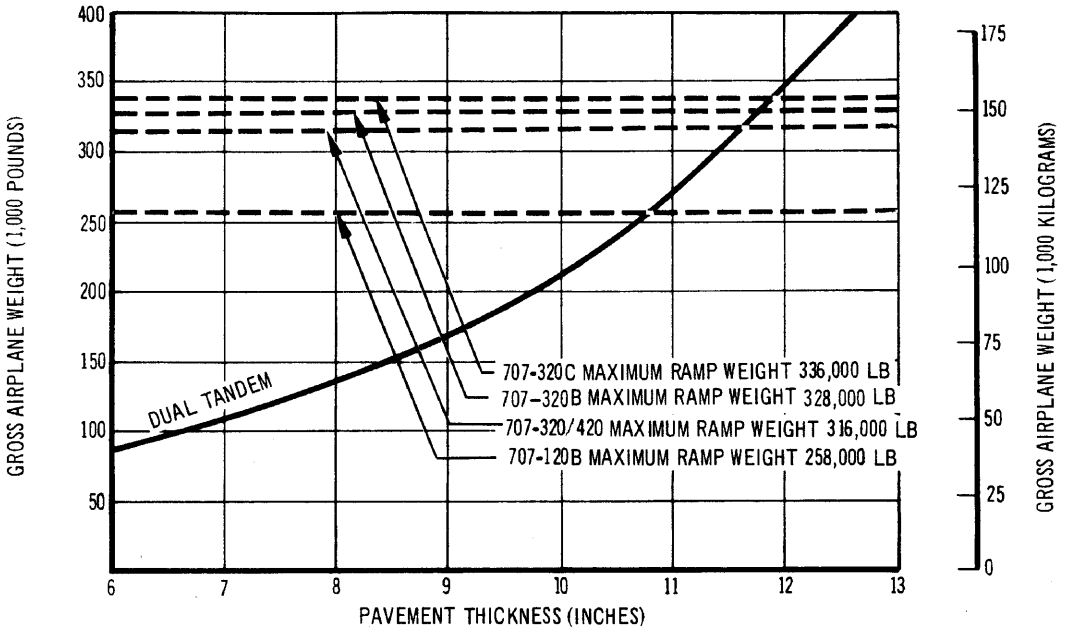
1. Ninety five percent of the gross aircraft weight is assumed to be supported by the main gear.
2. Dual-tandem wheel spacings are not given specifically, but certain design compromises are made as described in the Advisory Circular Appendix 1 in order to develop the curves shown.

The subgrade ratings for pavements are shown as standard FAA designations. These ratings and their derivation are fully described in the Advisory Circular mentioned above.

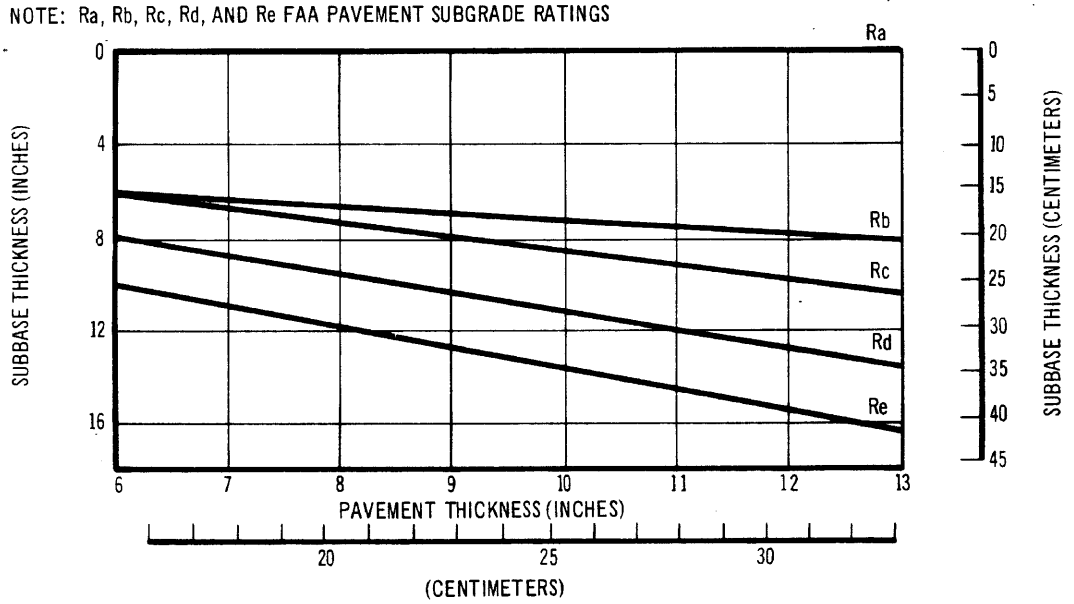


NOTE:
- PAVEMENT SUBGRADE RATINGS (Fa, F1, F2, ETC.) ARE REPRESENTED BY THE DIAGONAL LINES IN THE CHART. INTERSECTION OF A LINE DENOTING SUBGRADE WITH WEIGHT DETERMINES PAVEMENT THICKNESS.
- CHART ADAPTED FROM PAGE 31 (AND 32), PAR. 17 CHAP. 3 OF FAA ADVISORY CIRCULAR AC 150/5320-6A, DATED 9 MAY 1967.

FLEXIBLE PAVEMENT REQUIREMENTS - FAA METHOD
MODELS 707-120B, -320, -320B, -320C, -420



NOTE: Ra, Rb, Rc, Rd, AND Re FAA PAVEMENT SUBGRADE RATINGS



NOTE: CHART ADAPTED FROM PAGE 31 (AND 32),
PAR. 17 CHAP. 3 OF FAA ADVISORY CIRCULAR
AC 150/5320-6A, DATED 9 MAY 1967.

PAVEMENT REQUIREMENTS - FAA METHOD
MODEL 707-120B, -320, -320B, -320C, -420

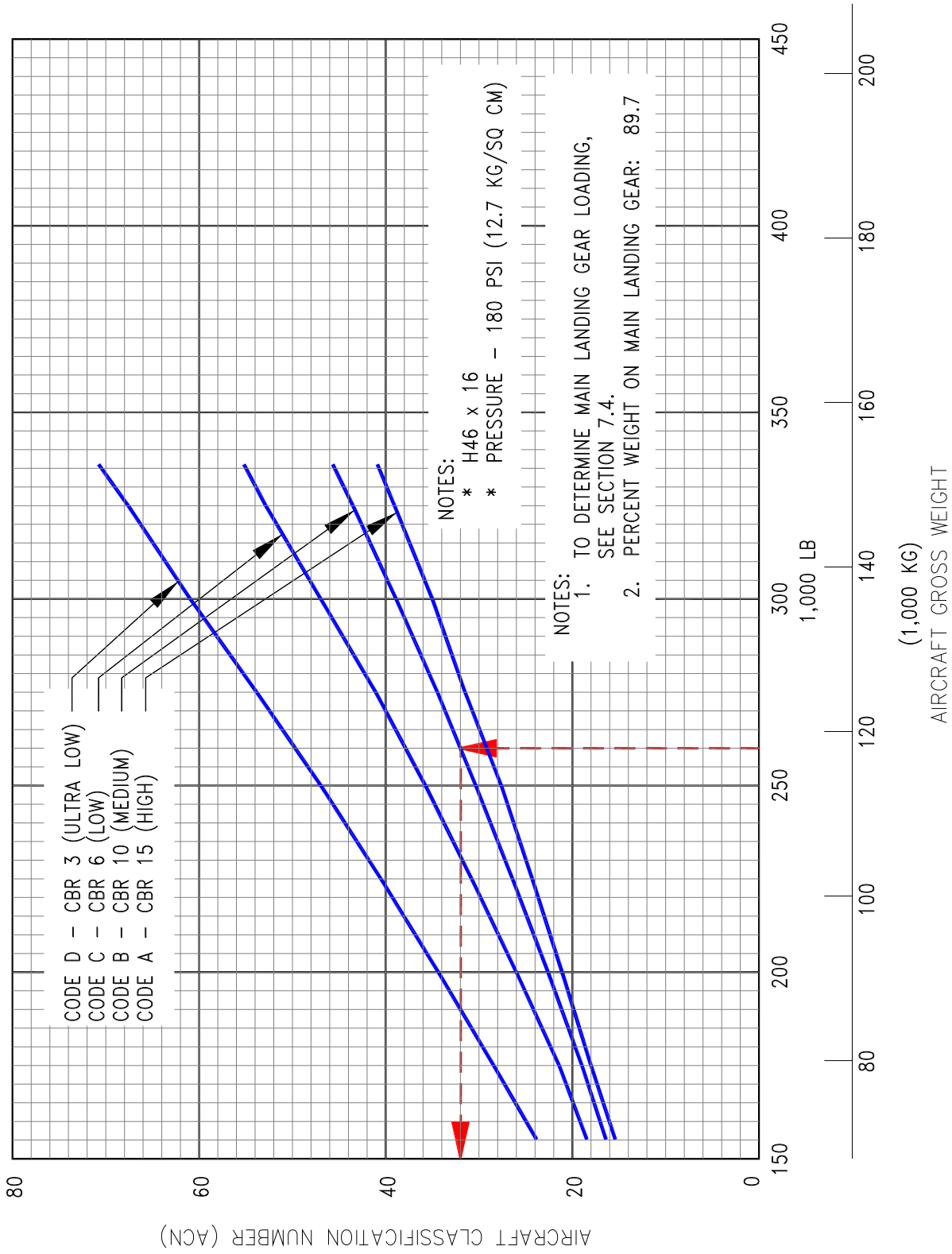
7.10 ACN/PCN Reporting System - Flexible and Rigid Pavements

To determine the ACN of an aircraft on flexible or rigid pavement, both the aircraft gross weight and the subgrade strength category must be known. In the chart in 7.10.1, for an aircraft with gross weight of 260,000 lb on a (Code B), the flexible pavement ACN is 32. Referring to 7.10.2, the same aircraft on a medium strength subgrade rigid pavement has an ACN of 33.5.

The following table provides ACN data in tabular format similar to the one used by ICAO in the "Aerodrome Design Manual Part 3, Pavements." If the ACN for an intermediate weight between maximum taxi weight and minimum weight of the aircraft is required, Figures 7.10.1 through 7.10.2 should be consulted.

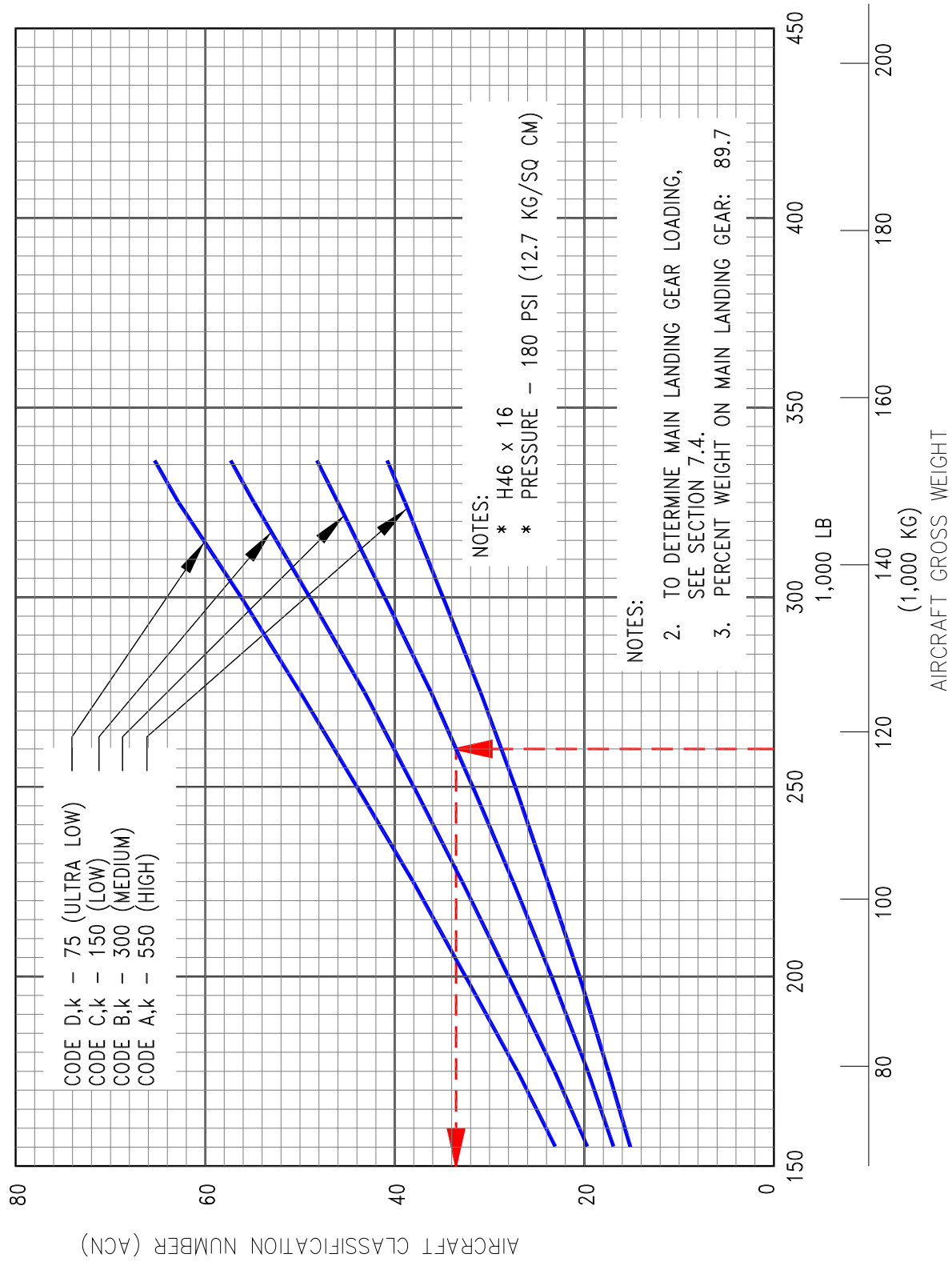
				ACN FOR RIGID PAVEMENT SUBGRADES – MN/m^3				ACN FOR FLEXIBLE PAVEMENT SUBGRADES – CBR			
AIRCRAFT TYPE	MAXIMUM TAXI WEIGHT MINIMUM WEIGHT (1) LB (KG)	LOAD ON ONE MAIN GEAR LEG (%)	TIRE PRESSURE PSI (MPa)	HIGH 150	MEDIUM 80	LOW 40	ULTRA LOW 20	HIGH 15	MEDIUM 10	LOW 6	ULTRA LOW 3
707-320C	336,000(152,400)	28.50	180 (1.24)	41	46	55	71	41	48	57	66
	155,100(70,400)			16	16	18	24	15	17	20	23

(1) Minimum weight used solely as a baseline for ACN curve generation.



7.10.1 AIRCRAFT CLASSIFICATION NUMBER - FLEXIBLE PAVEMENT

MODEL 707-320C



7.10.2 AIRCRAFT CLASSIFICATION NUMBER - RIGID PAVEMENT

MODEL 707-320C