AI Method: Asphalt-Aggregate Mixtures

- Recommended Mix Types
- Mix Design Criteria

Maximum Size Aggregate for Base or Surface			
FAA P 401*		ASTM D 3515**	
mm	(in.)	mm	(in.)
30.0	(1¼)	37.5	(1½)
24.0	(1)	25.0	(1)
19.0	(¾)	19.0	(¾)
12.5	(½)	12.5	(½)

TABLE IV-3
SUGGESTED MATERIALS REQUISITES FOR AIRPORT ASPHALT PAVEMENT MIXTURES

Material	Use	
	Base Course	Surface Course
Grade of Asphalt[1] Viscosity Grade[2]	AC-40 or AR 16000 AC-20 or AR 8000 AC-10 or AR 4000	AC-40 or AR 16000 AC-20 or AR 8000 AC-10 or AR 4000
Penetration Grade[3]	40-50 60-70 85-100	40-50 60-70 85-100
Aggregate Coarse[4]	All crushed aggregate	All crushed aggregate
Fine[4]	Crushed aggregate or a sharp natural sand or a blend of the two	Crushed aggregate or a sharp natural sand or a blend of the two
Added Mineral Filler[5]	Rock dust, slag dust, limestone dust, hydrated lime, hydraulic cement, or equal	Rock dust, slag dust, limestone dust, hydrated lime, hydraulic cement, or equal
Combined Aggregate Sand Equivalent Value[6]	Minimum of 40	Minimum of 50
Final Mixture Filler/asphalt Ratio[7]	Maximum of 1.2	Maximum of 1.2

TABLE IV-4
SUGGESTED CRITERIA FOR MARSHALL METHOD AND HVEEM TEST LIMITS FOR DESIGN OF ASPHALT CONCRETE MIXTURES

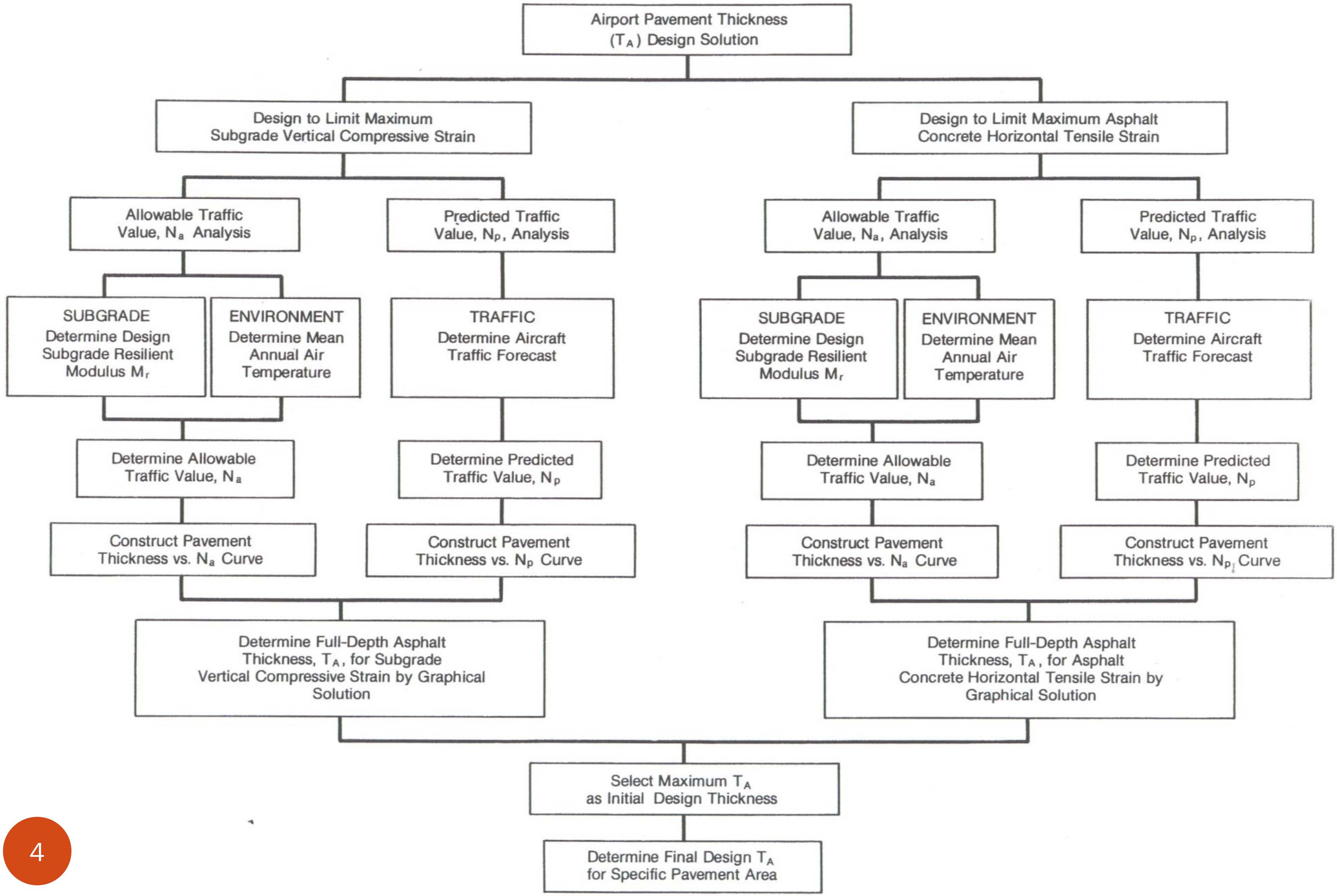
Marshall Method Mix Criteria	Base and Surface Mix	
	Min.	Max.
Compaction, number of blows each end of specimen	75	
Stability, *N (lb.)	8000 1800	—
Flow, 0.25 mm (0.01 in.)	8	16
Percent air voids	3	5
Percent voids in mineral aggregate (VMA)	(see Figure IV-2)	
Hveem Method Mix Criteria +		
Stabilometer Value	37	—
Swell	Less than 0.762 mm (0.030 in.)	

Note: All criteria, not stability value alone, must be considered in designing an asphalt paving mixture. For details on mix design see *Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types*, Manual Series No. 2 (MS-2), The Asphalt Institute.

*N = Newton

+ Although not a routine part of the Hveem design method, an effort is made to provide a minimum percent air voids of approximately 4 percent.

AI Method: Structural Design



Design Example

- New airport: Full-Depth asphalt pavement
- Critical design location: taxiway 22.9 m (75 ft.) wide
- Design period= 20 years

Subgrade Evaluation
Resilient Modulus, Mr (20 test results)

MPa	psi
72.4	10,500
89.6	13,500
72.4	10,500
62.1	9,000
72.4	10,500
82.7	12,000
103.4	15,000
72.4	10,500
82.7	12,000
89.6	13,500
62.1	9,000
89.6	13,500
82.7	12,000
89.6	13,500
72.4	10,500
89.6	13,500
62.1	9,000
72.4	10,500
82.7	12,000
72.4	10,500

Traffic Forecast

Critical Design Location (taxiway), 5-year periods				
Aircraft	**0-5**	**5-10**	**10-15**	**15-20**
B 767-200	18,000	29,000	44,000	51,000
DC-8-73	7,500	9,000	18,000	36,000
B 747-SP	7,500	11,000	18,000	25,000
DC-10-10 (100%)	1,750	3,500	7,500	14,500
DC-10-10 (89%)	1,750	3,500	7,500	14,500
MD-82	7,500	7,500	3,600	1,600

Mean Monthly Air Temperature

Month	Temp (C)
Jan	5.1
Feb	6.3
Mar	7.2
Apr	17.2
May	22.3
Jun	26.0
Jul	29.4
Aug	26.3
Sep	22.7
Oct	17.2
Nov	9.4
Dec	4.5

Step 1: Determine design subgrade M_r

Test Values		Number equal to or greater than	Percent equal to or greater than
MPa	Psi		
62.1	9,000	20	100
72.4	10,500	17	85
82.7	12,000	10	50
89.6	13,500	6	30
103.4	15,000	1	5

Design subgrade Mr = 72.4 Mpa (10,500 psi.)

Step 2: Mean Annual Air Temperature

Monthly mean temp. = 16.1°C

Step 3: Determine allowable traffic value, N_a for subgrade vertical compressive strain, ε_c

Number of Subgrade Strain (ε_c) Repetitions

100	1,000	10,000	100,000	1,000,000
Thickness, T_A				
325 mm	411 mm	465 mm	498 mm	518 mm

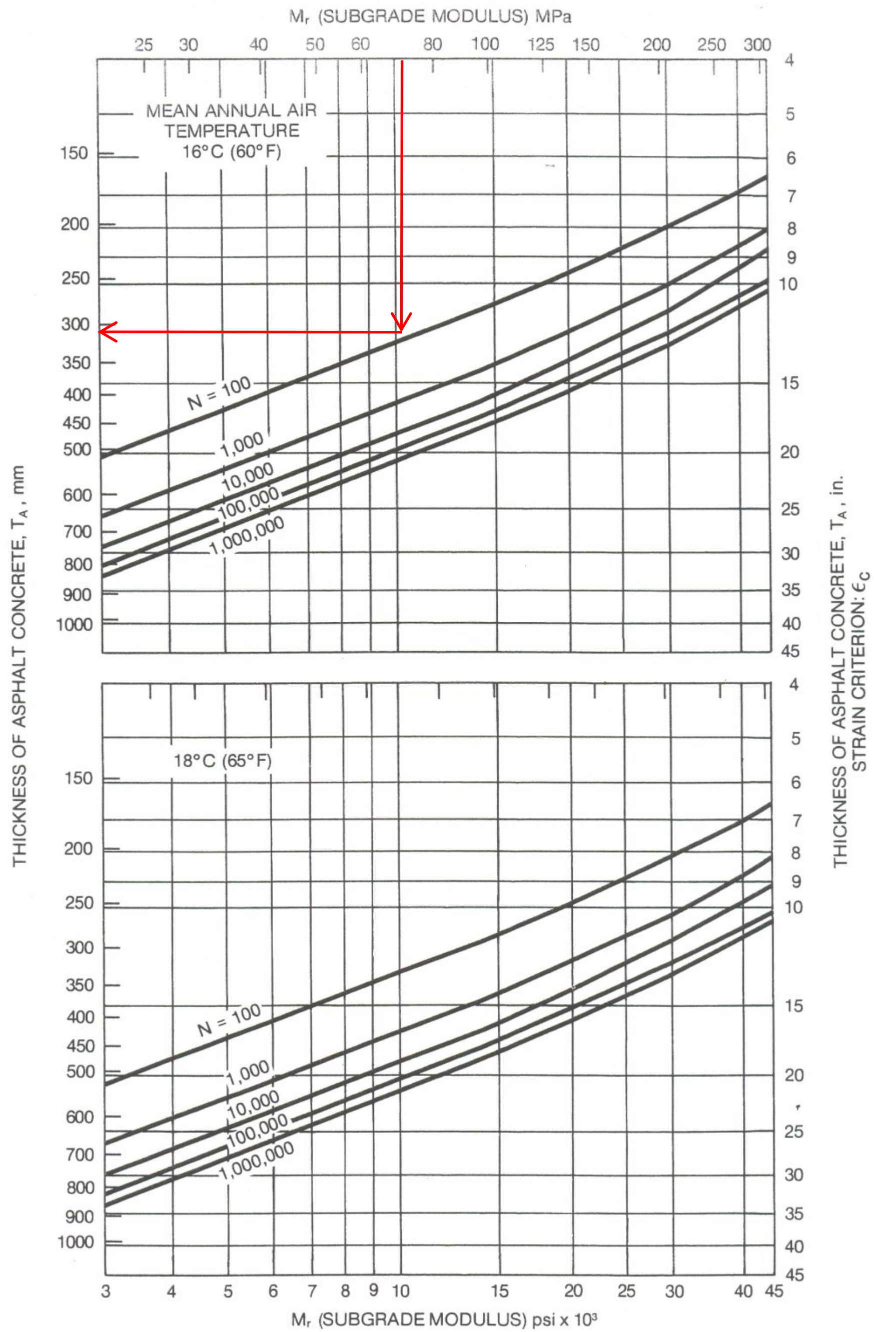


Figure V-3 (continued). Pavement thickness to limit subgrade vertical compressive strain, ϵ_c, under ✈ load repetitions for different environments.

Step 4: Determine allowable traffic value, N_a for asphalt concrete horizontal tensile strain, ε_t

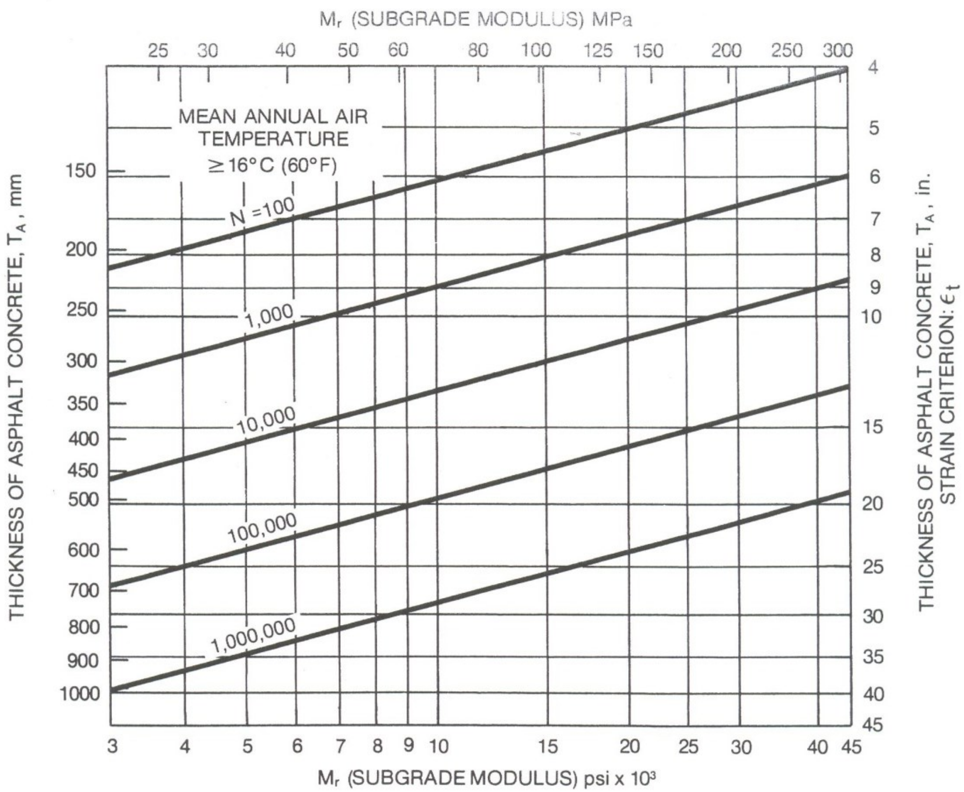


Figure V-4 (continued). Pavement thickness to limit asphalt concrete horizontal tensile strain, ϵ_t, under load repetitions for different environments

Number of Tensile Strain (ε_t) Repetitions

100	1,000	10,000	100,000	1,000,000
Thickness, T_A				
152 mm	231 mm	333 mm	485 mm	719 mm

Step 5: Determine predicted traffic value, N_p for subgrade vertical compressive strain, ε_c

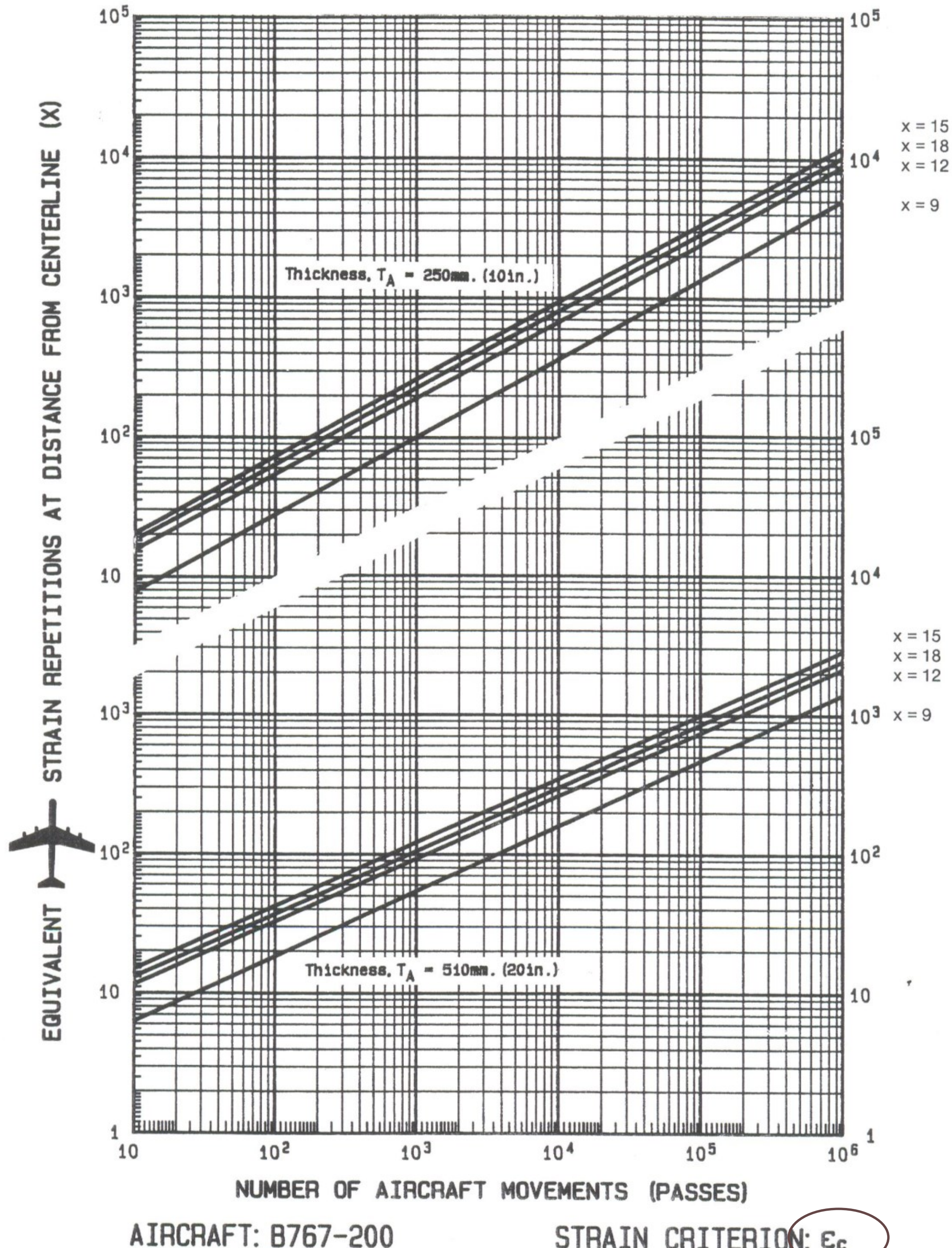
TRAFFIC FORECAST WORKSHEET

Critical Design Location (taxiway) Movements, 5-year Periods

	0-5		5-10		10-15		15-20	
Aircraft	Col. A	Col. B	Col. A	Col. B	Col. A	Col. B	Col. A	Col. B
1. B767-200	18,000	18,000	29,000	47,000	44,000	91,000	51,000	142,000
2. DC-8-73	7,500	7,500	9,000	16,500	18,000	34,500	36,000	70,500
3. B747-SP	7,500	7,500	11,000	18,500	18,000	36,500	25,000	61,500
4. DC-10-10(100%)	1,750	1,750	3,500	5,250	7,500	12,750	14,500	27,250
5. DC-10-10(80%)	1,750	1,750	3,500	5,250	7,500	12,750	14,500	27,250
6. MD-82	7,500	7,500	7,500	15,000	3,600	18,600	1,600	20,200
7.								
8.								
9.								
10.								

Col. A = Estimated number of movements for each aircraft type within the 5-year period indicated.
Col. B = Cumulated number of movements for each aircraft type through maximum time period indicated.
NOTE: Record cumulated number of movements for each aircraft type (Col. B) for the selected design period on Aircraft Worksheet No. 2.

ε_c



ε_c

NUMBER OF EQUIVALENT STRAIN REPETITIONS

TYPE OF STRAIN: ε_c

DESIGN PERIOD: 20 YEARS

AIRCRAFT	MOVEMENTS IN DESIGN PERIOD	DISTANCE FROM CENTERLINE, x: 1.8m (6 ft)	2.7m (9 ft)	3.7m (12 ft)	4.6m (15 ft)	5.5m (18 ft)
THICKNESS, T_A = 250 mm (10 in.)						
1. B767-200	142,000	—	1,600	3,300	4,100	3,700
2. DC-8-73	70,500	28,000	59,000	59,000	28,000	6,000
3. B747-SP	61,500	8,000	6,900	5,100	6,200	8,000
4. DC-10-10 (100%)	27,250	—	20,000	180,000	600,000	800,000
5. DC-10-10 (80%)	27,250	—	1,700	7,500	18,000	21,000
6. MD-82	20,200	1,100	1,300	950	400	—
7.						
8.						
9.						
10.						
SUM		37,100	90,500	255,850	656,700	(838,700)
THICKNESS, T_A = 510 mm (20 in.)						
1. B767-200	142,000	—	530	900	1,200	1,000
2. DC-8-73	70,500	28,000	59,000	59,000	28,000	6,000
3. B747-SP	61,500	1,700	1,600	1,200	1,500	1,700
4. DC-10-10 (100%)	27,250	—	5,100	33,000	100,000	130,000
5. DC-10-10 (80%)	27,250	—	370	900	1,500	1,700
6. MD-82	20,200	400	450	350	190	—
7.						
8.						
9.						
10.						
SUM		30,100	67,050	95,350	132,390	(140,400)
THICKNESS, T_A = 760 mm (30 in.)						
1. B767-200	142,000	—	300	490	590	540
2. DC-8-73	70,500	28,000	59,000	59,000	28,000	6,000
3. B747-SP	61,500	2,400	2,100	1,700	1,900	2,400
4. DC-10-10 (100%)	27,250	—	2,700	16,000	40,000	50,000
5. DC-10-10 (80%)	27,250	—	140	310	480	530
6. MD-82	20,200	100	110	90	60	—
7.						
8.						
9.						
10.						
SUM		30,500	64,350	(77,590)	71,030	59,470
THICKNESS, T_A = 1020 mm (40 in.)						
1. B767-200	142,000	—	230	350	420	390
2. DC-8-73	70,500	28,000	59,000	59,000	28,000	6,000
3. B747-SP	61,500	17,000	14,000	9,200	12,000	17,000
4. DC-10-10 (100%)	27,250	—	1,900	9,900	24,000	29,000
5. DC-10-10 (80%)	27,250	—	100	210	320	350
6. MD-82	20,200	20	21	19	15	
7.						
8.						
9.						
10.						
SUM		45,020	75,251	(78,679)	64,755	52,740

NOTE: Circle the maximum sum for each thickness. Each circled number and its corresponding thickness is used to

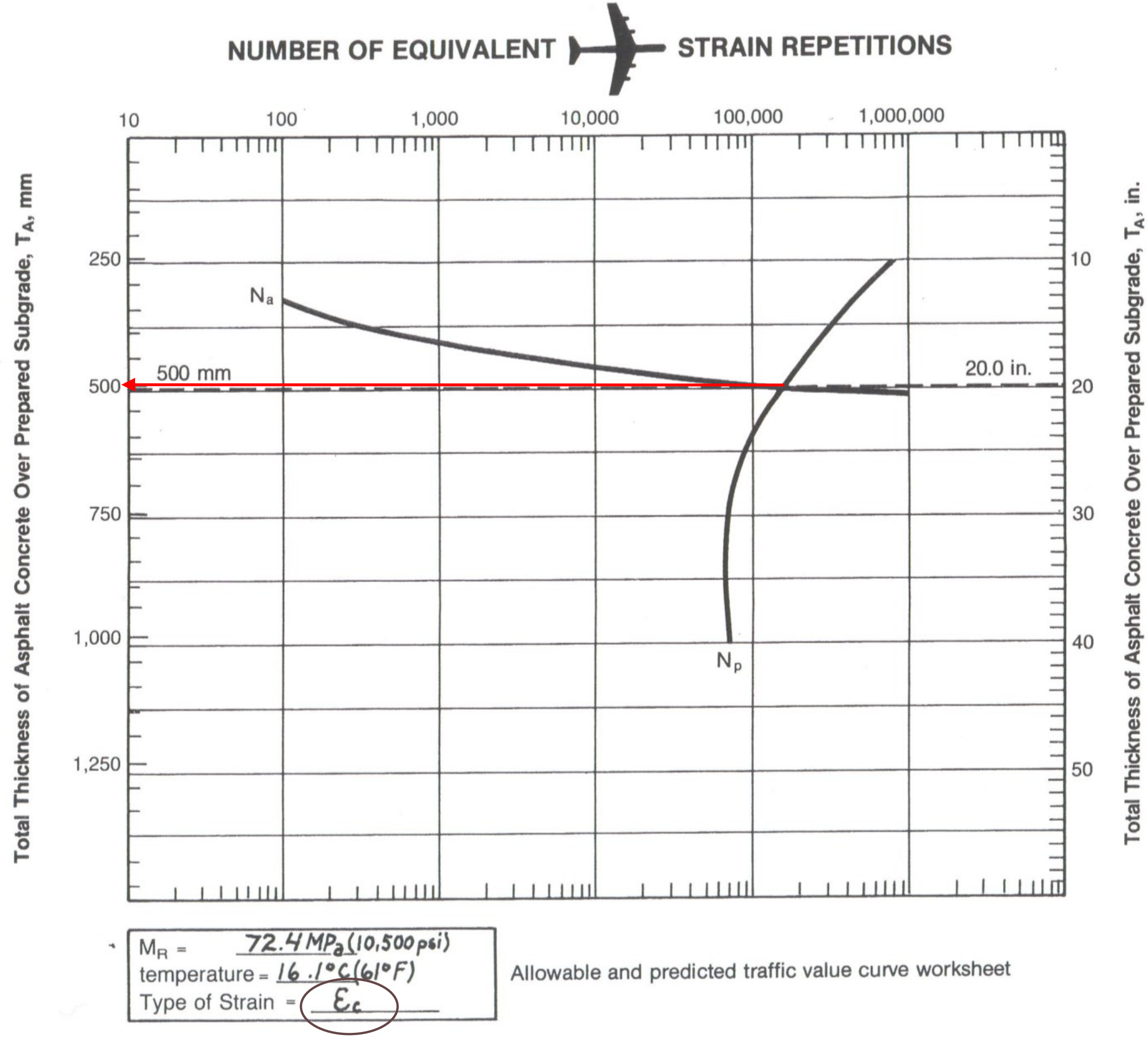


Figure V-13. Allowable traffic value and predicted traffic value curves for ϵ_c, design example

*Intersection of N_p and N_a → **500 mm** thickness → for subgrade ε_c*

Step 6: Determine predicted traffic value, N_p for asphalt concrete horizontal tensile strain, ε_t

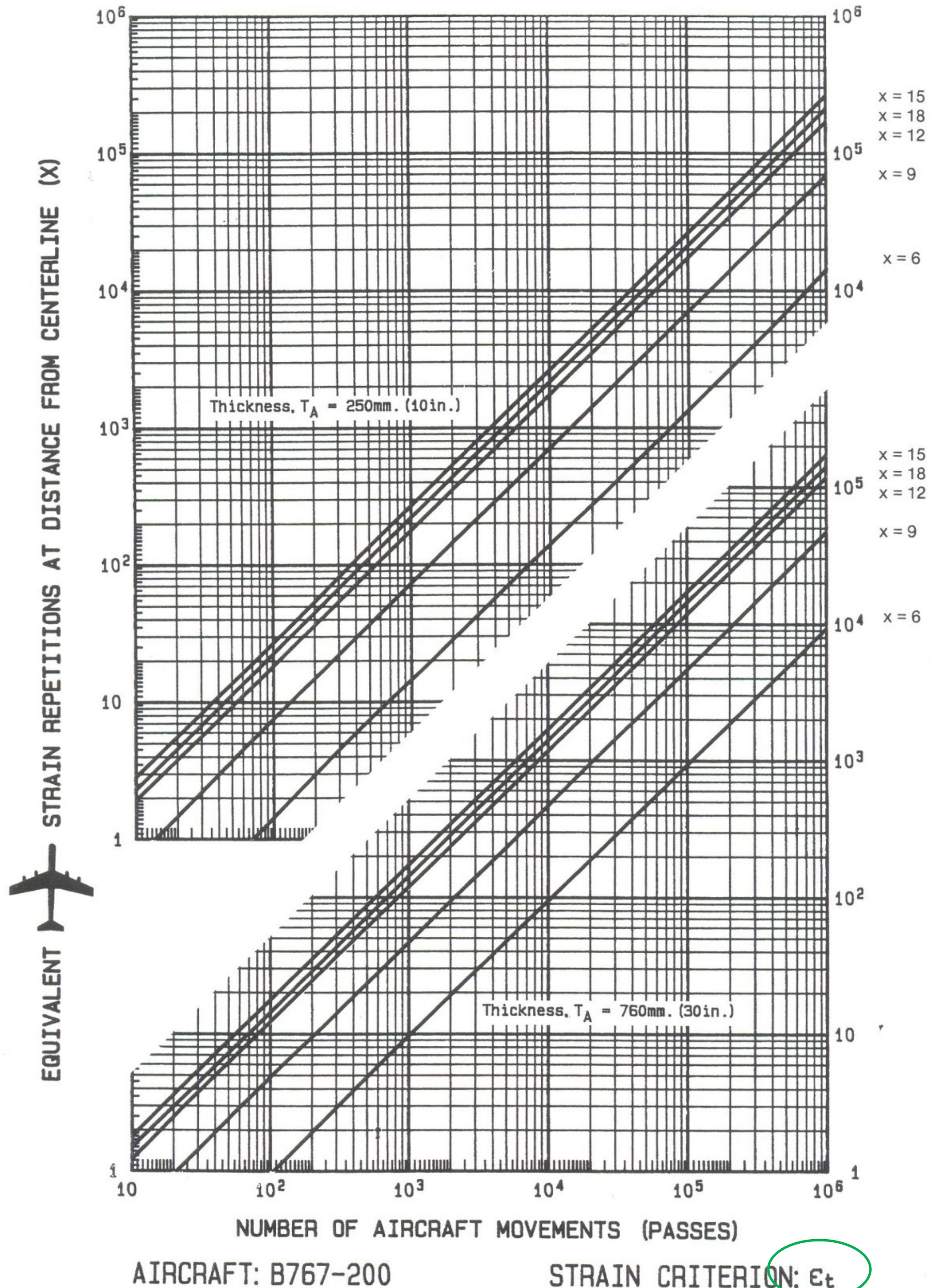
TRAFFIC FORECAST WORKSHEET

Critical Design Location (taxiway) Movements, 5-year Periods

	0-5		5-10		10-15		15-20	
Aircraft	Col. A	Col. B	Col. A	Col. B	Col. A	Col. B	Col. A	Col. B
1. B767-200	18,000	18,000	29,000	47,000	44,000	91,000	51,000	142,000
2. DC-8-73	7,500	7,500	9,000	16,500	18,000	34,500	36,000	70,500
3. B747-SP	7,500	7,500	11,000	18,500	18,000	36,500	25,000	61,500
4. DC-10-10(100%)	1,750	1,750	3,500	5,250	7,500	12,750	14,500	27,250
5. DC-10-10(80%)	1,750	1,750	3,500	5,250	7,500	12,750	14,500	27,250
6. MD-82	7,500	7,500	7,500	15,000	3,600	18,600	1,600	20,200
7.								
8.								
9.								
10.								

Col. A = Estimated number of movements for each aircraft type within the 5-year period indicated.
Col. B = Cumulated number of movements for each aircraft type through maximum time period indicated.
NOTE: Record cumulated number of movements for each aircraft type (Col. B) for the selected design period on Aircraft Worksheet No. 2.

ε_t



ε_t

NUMBER OF EQUIVALENT STRAIN REPETITIONS

TYPE OF STRAIN: ε_t

DESIGN PERIOD: 20 YEARS

AIRCRAFT	MOVEMENTS IN DESIGN PERIOD	DISTANCE FROM CENTERLINE, x: 1.8m (6 ft)	2.7m (9 ft)	3.7m (12 ft)	4.6m (15 ft)	5.5m (18 ft)
THICKNESS, T_A = 250 mm (10 in.)						
1. B767-200	142,000	2,000	10,000	26,000	37,000	31,000
2. DC-8-73	70,500	20,000	39,000	39,000	20,000	5,000
3. B747-SP	61,500	24,000	21,000	15,000	18,000	24,000
4. DC-10-10 (100%)	27,250	–	3,400	12,000	23,000	26,000
5. DC-10-10 (80%)	27,250	–	1,600	5,600	11,000	13,000
6. MD-82	20,200	4,400	5,500	3,500	1,100	–
7.						
8.						
9.						
10.						
SUM		50,400	80,500	101,100	(110,100)	99,000
THICKNESS, T_A = 760 mm (30 in.)						
1. B767-200	142,000	1,400	6,500	17,000	24,000	20,000
2. DC-8-73	70,500	20,000	39,000	39,000	20,000	5,000
3. B747-SP	61,500	34,000	31,000	22,000	27,000	34,000
4. DC-10-10 (100%)	27,250	–	2,800	10,000	17,000	21,000
5. DC-10-10 (80%)	27,250	–	1,000	3,300	6,300	7,200
6. MD-82	20,200	900	1,100	700	220	–
7.						
8.						
9.						
10.						
SUM		56,300	81,400	92,000	(94,520)	87,200
THICKNESS, T_A = 1270 mm (50 in.)						
1. B767-200	142,000	1,100	5,500	15,000	20,000	16,000
2. DC-8-73	70,500	20,000	39,000	39,000	20,000	5,000
3. B747-SP	61,500	54,000	49,000	35,000	43,000	54,000
4. DC-10-10 (100%)	27,250	–	2,000	6,800	13,000	15,000
5. DC-10-10 (80%)	27,250	–	650	2,300	4,200	5,000
6. MD-82	20,200	240	300	190	60	–
7.						
8.						
9.						
10.						
SUM		75,340	96,450	98,290	(100,260)	95,000
THICKNESS, T_A = mm (in.)						
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
SUM						

NOTE: Circle the maximum sum for each thickness. Each circled number and its corresponding thickness is used to

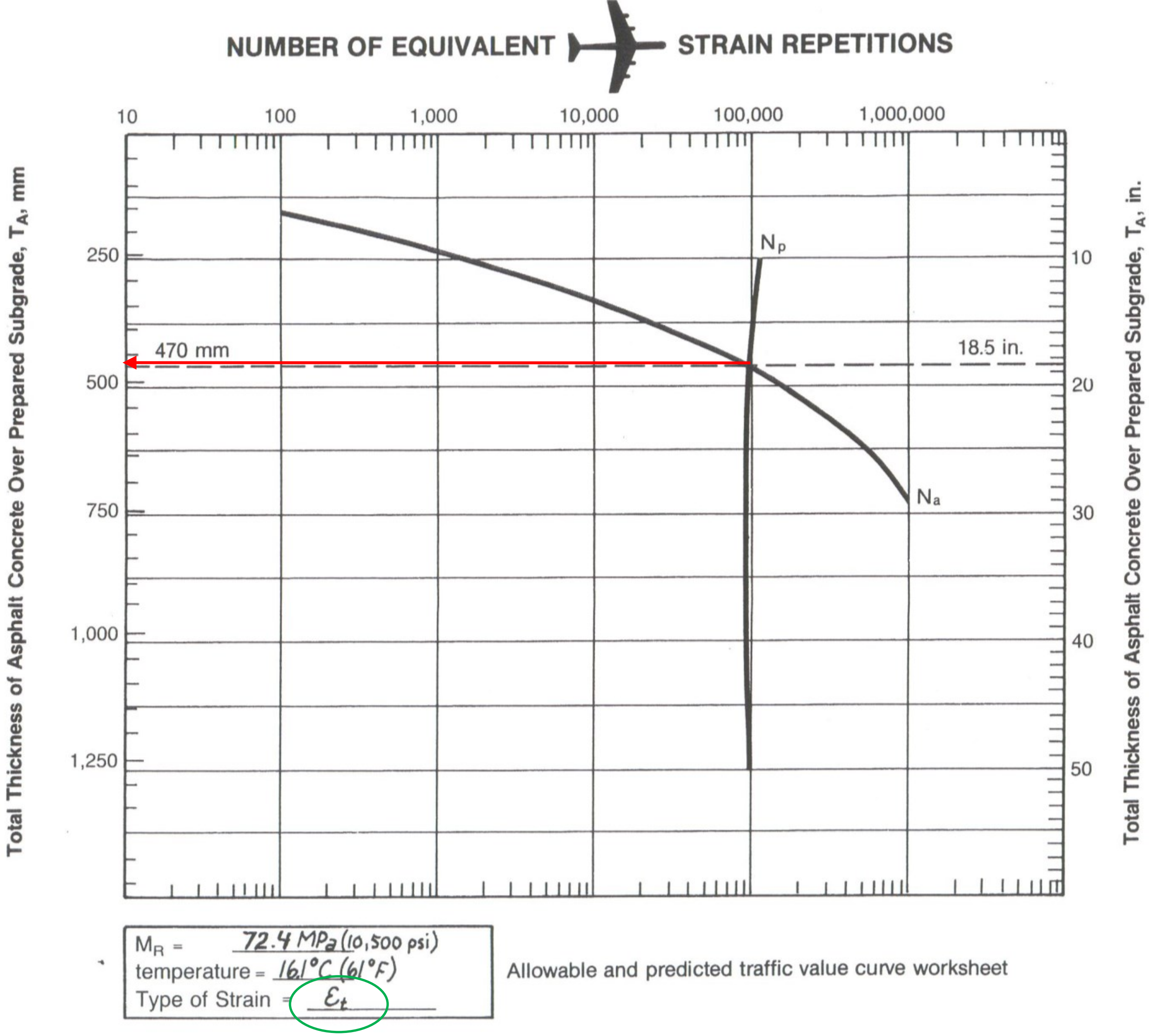
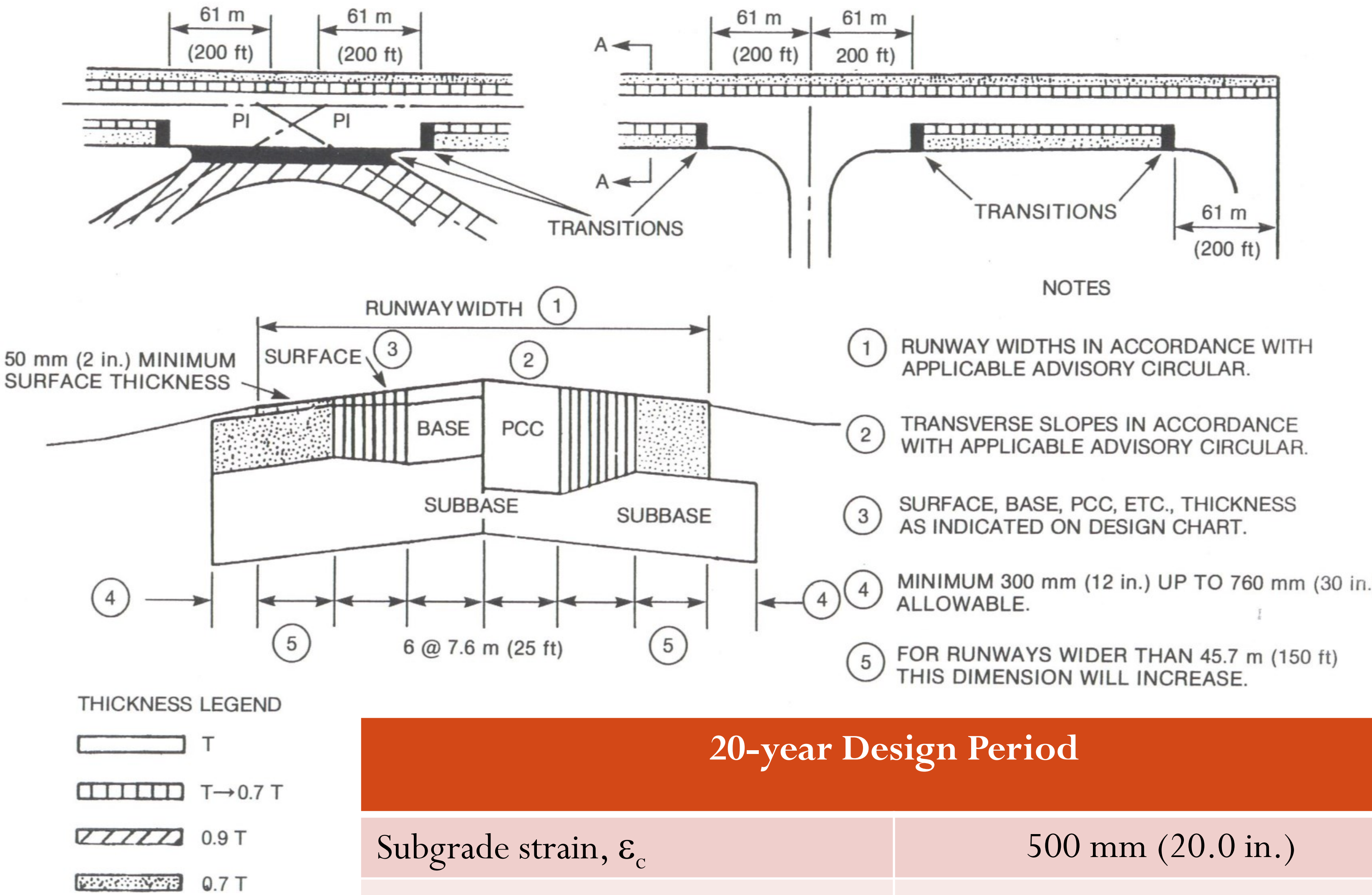


Figure V-15. Allowable traffic value and predicted traffic value curves for ϵ_t, design example

*Intersection of N_p and N_a → **470 mm** thickness → for asphalt concrete $\boldsymbol{\varepsilon_t}$*

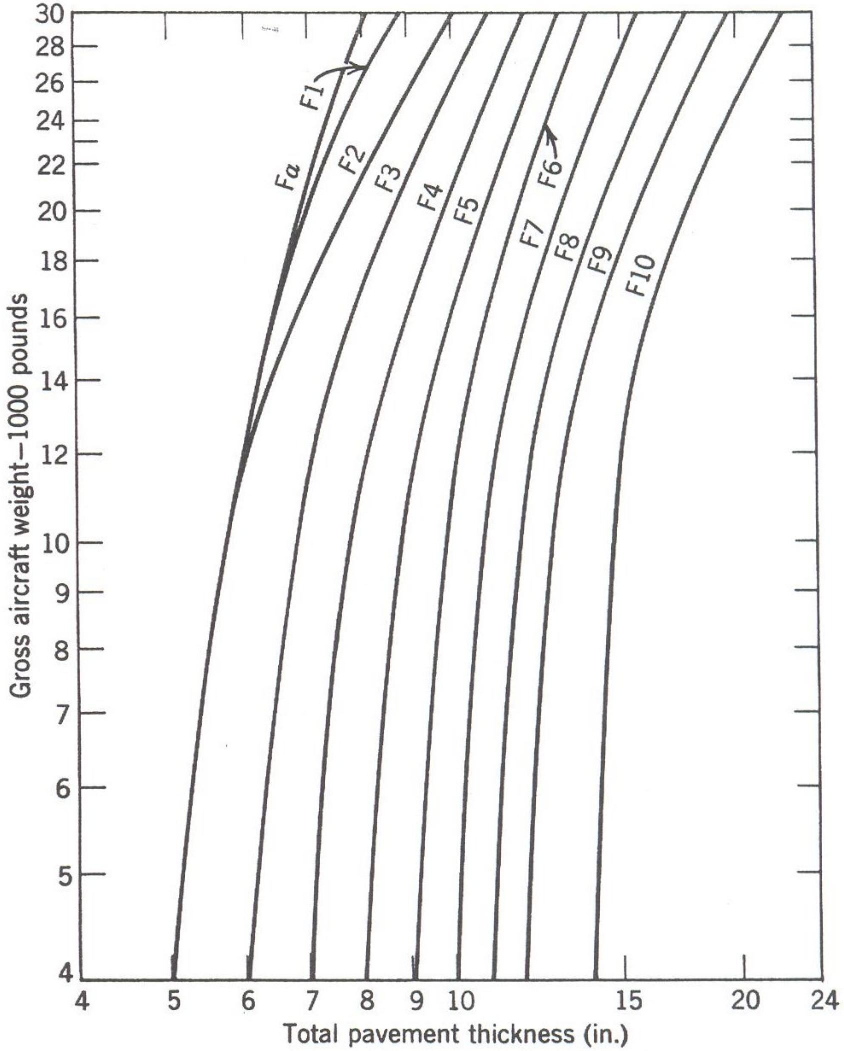
Step 7: Thickness Requirement



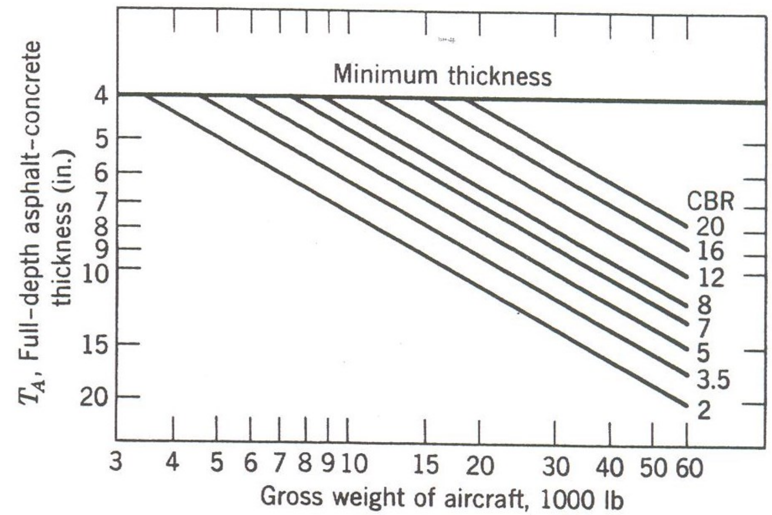
20-year Design Period	
Subgrade strain, ε_c	500 mm (20.0 in.)
Asphalt Concrete strain, ε_t	470 mm (18.5 in.)
Design thickness, T_A	500 mm (20.0 in.)

Secondary Airports

- FAA Design Curve – applicable for aircraft with gross weight less than 30,000 lbs and for 5,000 coverages. (Figure 14.32 textbook)
- AI Design Curve – Full-depth asphalt concrete, for aircraft up to 60,000 gross weight. (Figure 14.33 textbook)



Federal Aviation Administration design curves—light aircraft.



The Asphalt Institute design curves—light aircraft. (From TAI-IS-154.)