AIRFIELD PAVEMENT BASE AND SUBBASE CONSIDERATIONS

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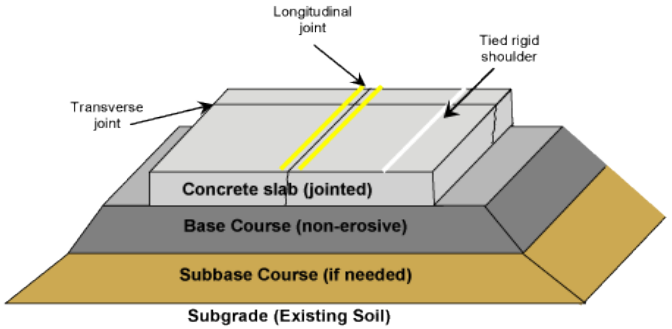
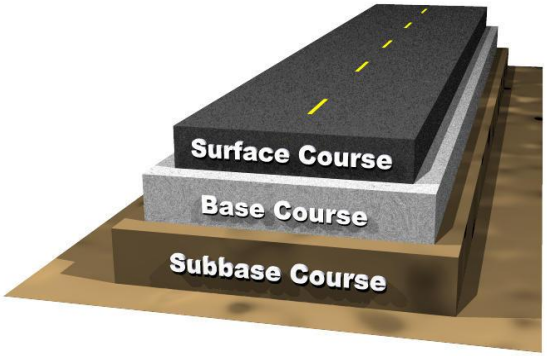
PRESENTATION OUTLINE

- Introduction
- Pavement structural design
- Material requirements
- Construction considerations

INTRODUCTION

- Airfield Pavement Structures
  - Hot Mix Asphalt or Portland Cement Concrete Layer
  - Base Layer
  - Subbase Layer
  - Subgrade





INTRODUCTION

- Base Layer
  - Bound granular material
  - Unbound granular material
- Subbase Layer
  - Unbound granular material

ROLE OF BASE AND SUBBASE LAYER

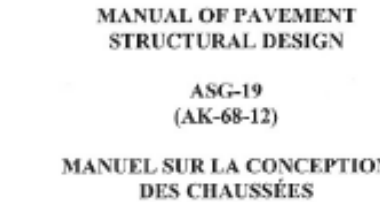
- Contribution to overall structural capacity of pavement
- Provide a construction platform for subsequent layers
- Grade and elevation adjustment
- Drainage
- Protection against frost damage

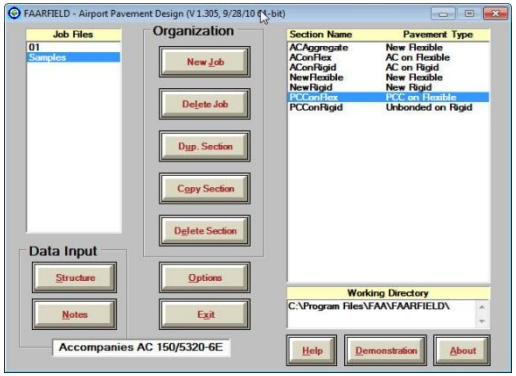
PAVEMENT DESIGN

- Design considerations
  - Anticipated aircraft traffic loading
  - Soil conditions
  - Load bearing capacity
  - Frost protection

PAVEMENT DESIGN

- Design methods
  - Transport Canada
  - Federal Aviation Administration
  - International Civil Aviation Organization
- Design includes
  - Selection of materials for each layer
  - Design of required thickness of each layer





TRANSPORT CANADA

- ASG-19 Manual of Pavement Structural Design
- All materials converted to equivalent granular thicknesses
- Granular layers to provide sufficient thickness of
  - Non-frost susceptible materials
  - Engineered materials to provide adequate load bearing capacity
  - Good drainage characteristics

TRANSPORT CANADA

- Minimum granular base thickness specified for tire pressure of critical aircrafts
- Subbase thickness to account for remaining required total pavement structure thickness

TRANSPORT CANADA

Pavement Material	Granular Equivalency Factor
Selected granular sub-base	1
Crushed gravel or stone base	1
Waterbound macadam base	1 ½
Bituminous stabilized base	1 ½
Cement stabilized base	2
Asphaltic concrete (good condition)	2
Asphaltic concrete (poor condition)	1 ½
Portland cement concrete (good condition)	3
Portland cement concrete (fair condition)	2 ½
Portland cement concrete (poor condition)	2

TRANSPORT CANADA

Component Layer	DESIGN AIRCRAFT TIRE PRESSURE			
	Less than 0.5 MPa	**0.5 MPa to 0.75 MPa**	**0.75 MPa to 1.0 MPa**	**Greater than 1.0 MPa**
Asphalt Concrete Surface Course (Hot-Mixed)	5.0 cm	6.5 cm	8.0 cm	10.0 cm
Crushed Gravel or Crushed Stone Base Course	15 cm	23 cm	25 cm	30 cm
Selected Granular Sub-base Course	As required in addition to the asphalt and base layers to provide: (a) the total pavement equivalent granular thickness required for structural support. (b) the total pavement depth required for frost protection.			

NOTES:

At grant-in-aid/small airports and other special locations, the pavement required for tire pressures below 0.4 MPa may be designed as a cold-mixed asphalt surfacing. The figures given for hot mix are also the minimum thickness requirements for a cold mix.

In areas of rock cut, the minimum pavement thickness shall be 15 cm of granular base course plus the pavement surface thickness as specified above.

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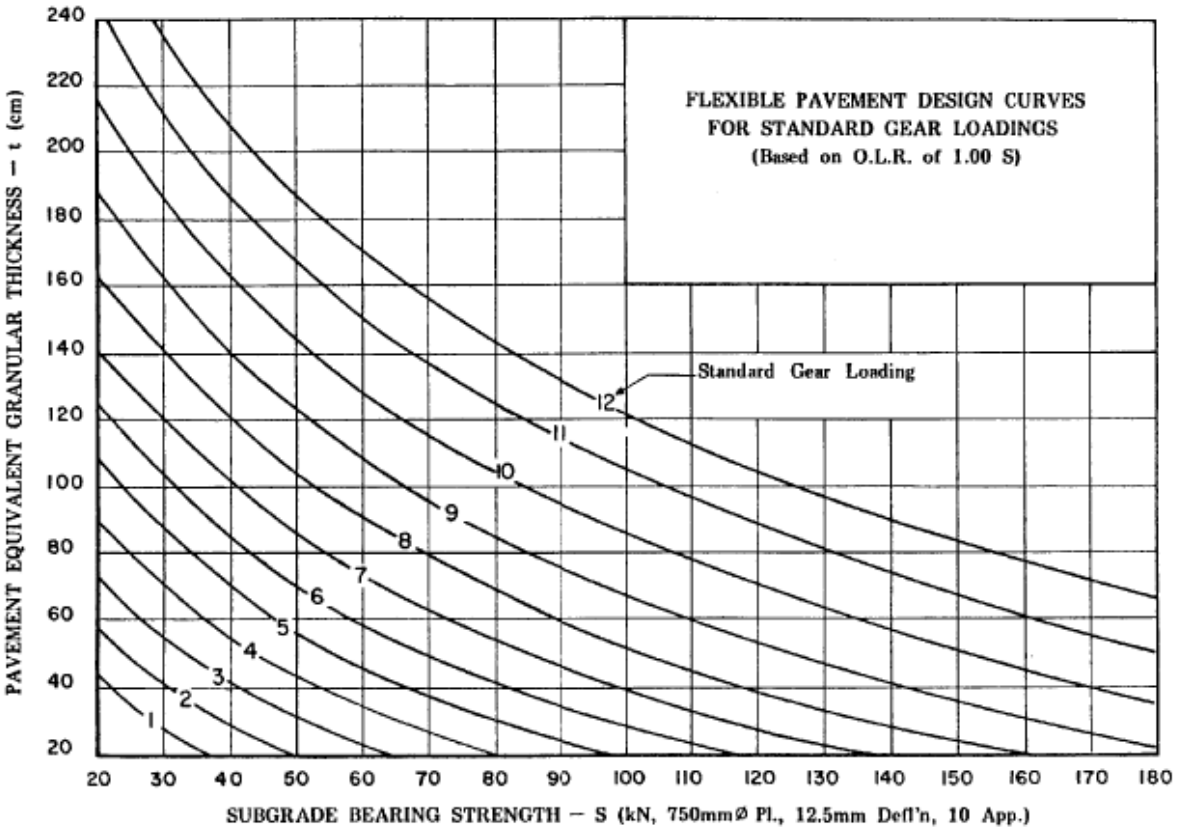

FIGURE 3.4.1
FLEXIBLE AIRFIELD PAVEMENT STRUCTURAL THICKNESS REQUIREMENTS

TRANSPORT CANADA

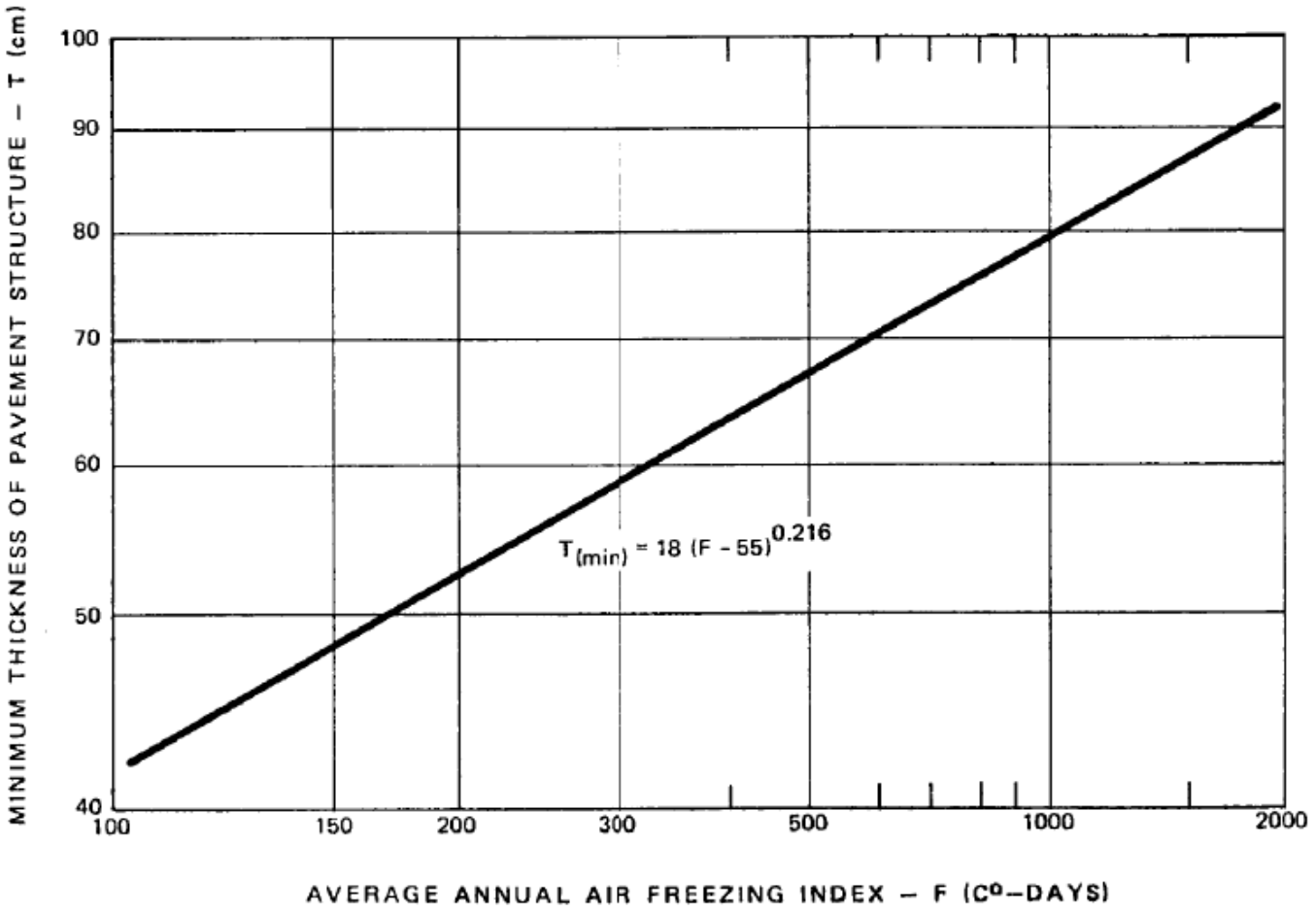

FIGURE 3.3.1
MINIMUM PAVEMENT THICKNESS FOR FROST PROTECTION

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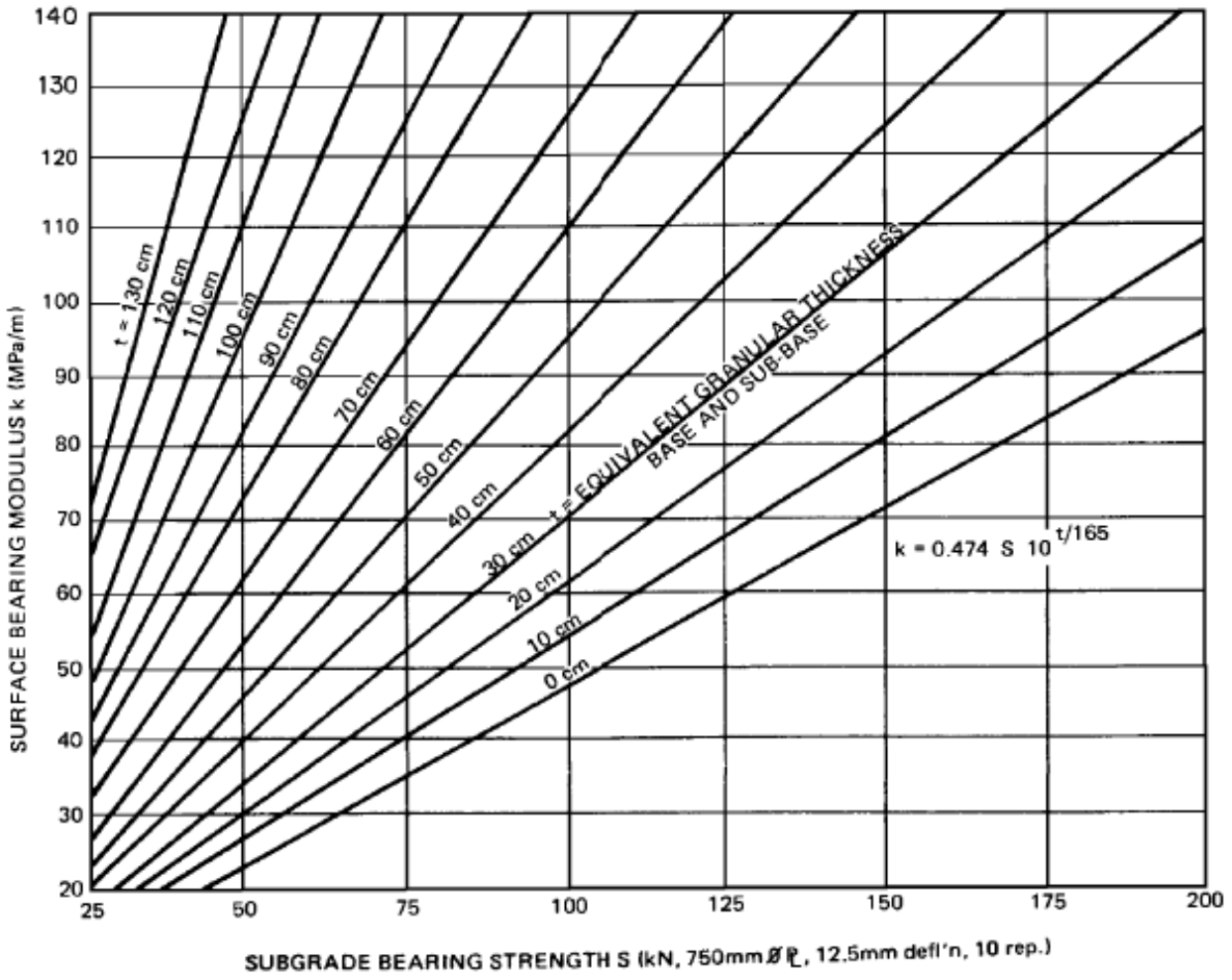


FIGURE 3.2.3 - RIGID PAVEMENT BEARING MODULUS

TRANSPORT CANADA

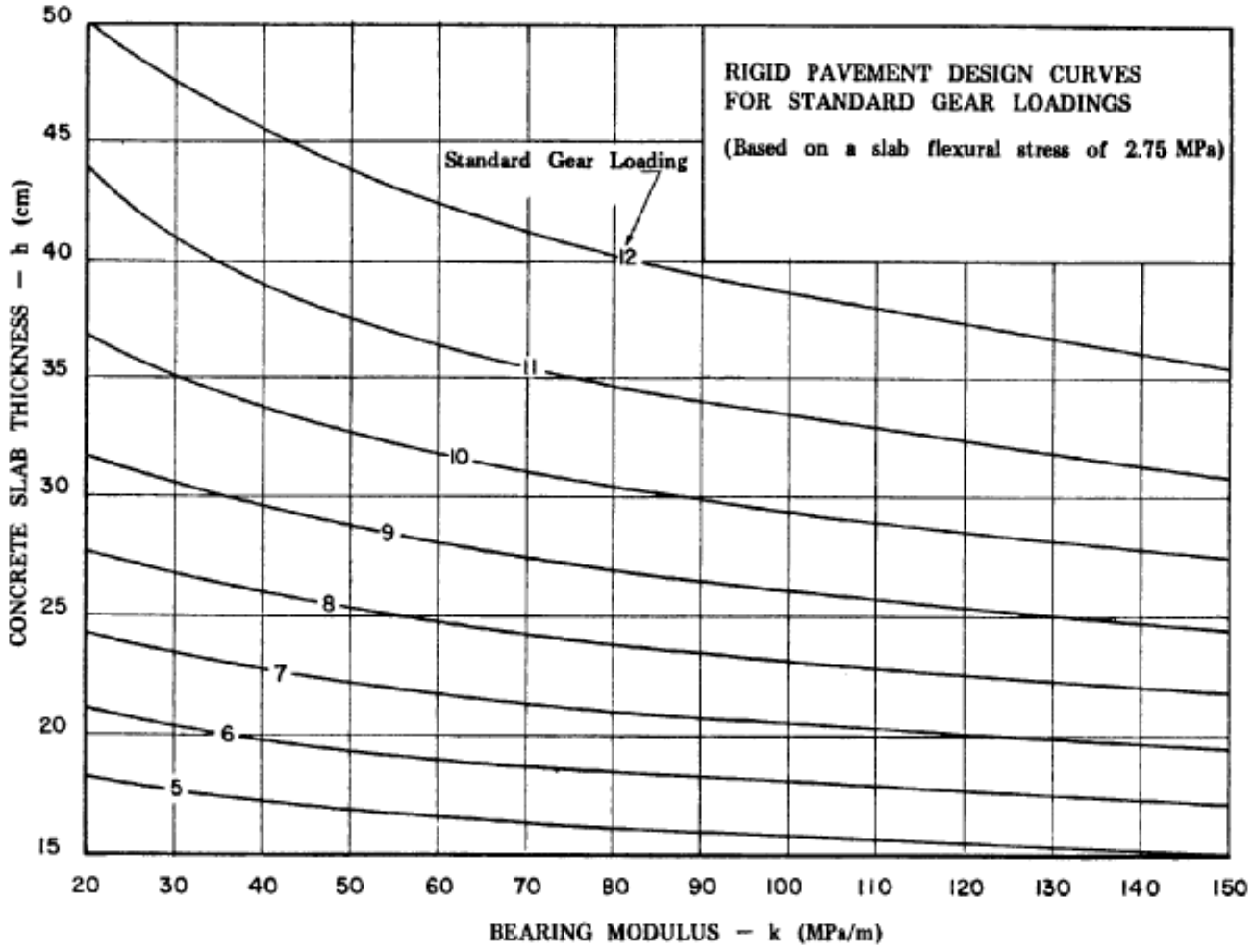
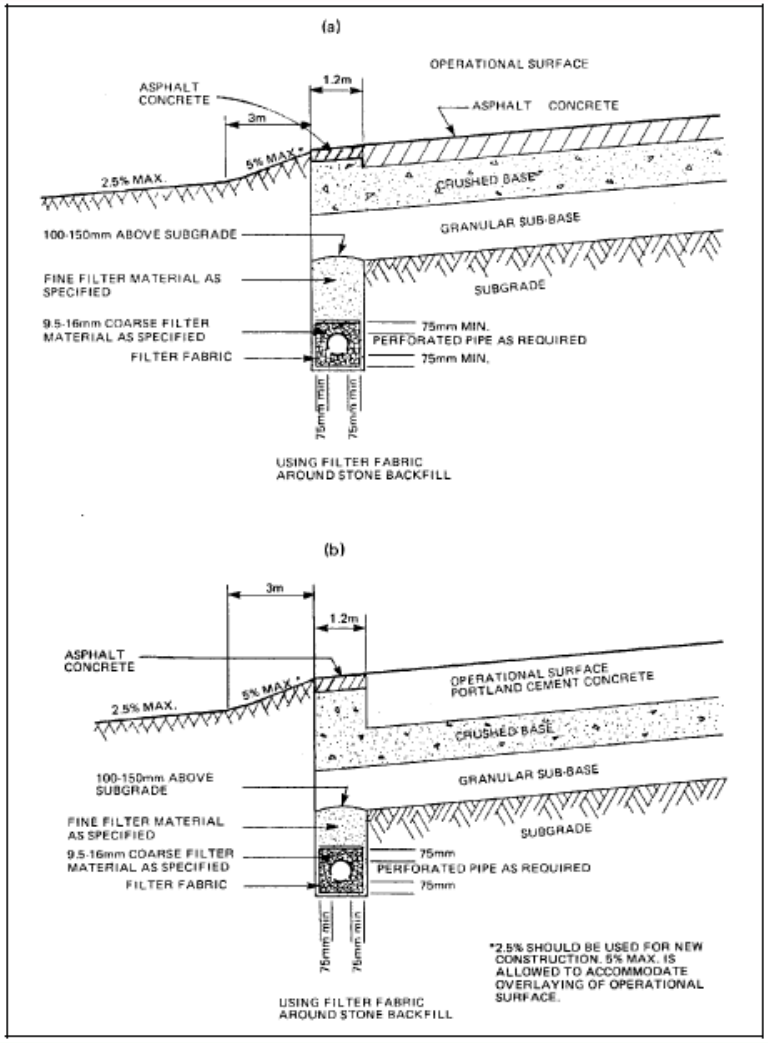
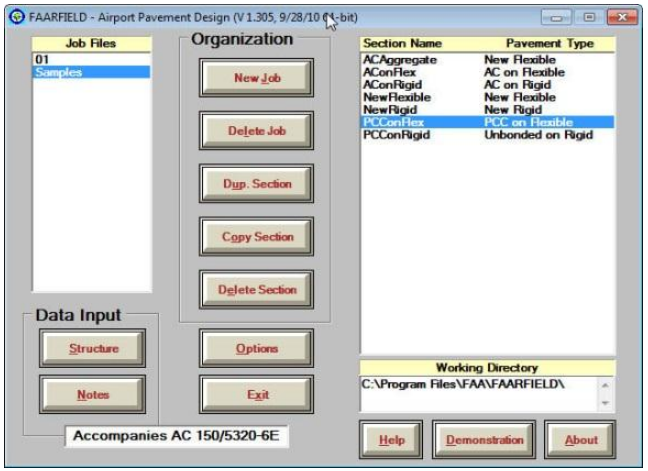


FIGURE 3.4.2
RIGID AIRFIELD PAVEMENT SLAB THICKNESS REQUIREMENTS

TRANSPORT CANADA



- FAARFIELD software
- Purpose of base and subbase is to distribute load over wider area on subgrade surface



FEDERAL AVIATION ADMINISTRATION

- Base and subbase materials are characterized by their modulus
  - Automatically calculated using procedure developed by US Army Corps Waterways Experiment Station
  - Depends on modulus and thickness of underlying layer
- Minimum base course thickness depending on aircraft load and type

FEDERAL AVIATION ADMINISTRATION

TABLE 3-9. MINIMUM AGGREGATE BASE COURSE THICKNESS

Gear Type	Design Load Range		Minimum Base Course (P-209) Thickness	
	lbs	(kg)	in.	(mm)
S	30,000 - 50,000	(13 600 – 22 700)	4	(100)
	50,000 - 75,000	(22 700 – 34 000)	6	(150)
D	50,000 - 100,000	(22 700 – 45 400)	6	(150)
	100,000 - 200,000*	(45 400 – 90 700)	8	(200)
2D	100,000 - 250,000*	(45 400 – 113 400)	6	(150)
	250,000 - 400,000*	(113 400 – 181 000)	8	(200)
2D (B757, B767)	200,000 - 400,000*	(90 700 – 181 000)	6	(150)
2D or 2D/D1 (DC10, L1011)	400,000 - 600,000*	(181 000 – 272 000)	8	(150)
2D/2D2 (B747)	400,000 - 600,000*	(181 000 – 272 000)	6	(150)
	600,000 - 850,000*	(272 000 – 385 600)	8	(200)
2D/D1 or 2D/2D1(A340)	568,000 – 840,400	(257 640 – 381 200)	10	(250)
2S (C130)	75,000 - 125,000	(34 000 – 56 700)	4	(100)
	125,000 - 175,000*	(56 700 – 79 400)	6	(150)
3D (B777)	537,000 – 777,000*	(243 500 – 352 440)	10	(250)
3D (A380)	1,239,000 – 1,305,125*	(562 000 – 592 000)	9	(230)

*Values are listed for reference. However, when the traffic mixture contains airplanes exceeding 100,000 lbs. (45 400 kg) gross weight, a stabilized base is required.

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MATERIAL SPECIFICATIONS

- Engineered materials required to have specific properties
- Specification for material needs to ensure that material placed meets design assumption
- Material specifications include
  - Physical property requirements for aggregates
    - Abrasion resistance
    - Proportion of crushed faces
    - Resistance to chemical damage
    - Proportion of lightweight particles
    - Particle shape
  - Gradation requirement for aggregates

TRANSPORT CANADA SPECIFICATION

- ASG – 06 Pavement Materials Construction and Testing

Property	ASTM Test Method	Sub-base (2)	Base (3)	Base Levelling Material (4)	Cement Stabilized Base
Gradation (sieve/% passing)					
75 mm	C136	100			
50 mm	C136		100		
37.5 mm	C136		75-100		100
25 mm	C136			100	
19.0 mm	C136		50-75	75-100	75-100
9.5 mm	C136		40-65	50-75	
4.75 mm	C136		30-50	30-50	35-65
2.00 mm	C136				20-50
0.425 mm	C136	0-30	10-30	10-30	
0.300 mm	C136				10-30
0.150 mm	C136				0-10
0.075 mm	C117	0-8	3-8	3-8 (5)	
Crushed Content (%) min.					
50 to 37.5 mm			60		
37.5 to 19.0 mm			60	60	
19.0 to 4.75 mm			60	60	
Liquid Limit (%) max.	D4318	25	25	25	25
Plasticity Index (%) max.	D4318	6	6	6	6
Abrasion Loss (%) max.	C131	50	45	45	50
Soundness loss (%) max. Coarse aggregate (>4.75 mm) Fine aggregate (<4.75 mm)	C88 (6)				 12 16
Flat or Elongated Particles (%) max. (7)	D4791	15	15	15	15

FAA AGGREGATE BASE SPECIFICATION

Sieve Size	Design Range Percentage by Weight
2 inch (50 mm)	100
1-1/2 inch (38 mm)	95-100
1 inch (25 mm)	70-95
3/4 inch (19 mm)	55-85
No. 4 (4.75 mm)	30-60
No. 40 (0.45 mm)	10-30
No. 200 (0.075 mm)	0-8

- Physical Property Requirements
  - LA Abrasion ≤ 45%
  - $MgSO_4$ Soundness ≤ 18%
  - Flat and Elongated ≤ 15%
  - 2-faces Crushed > 90%
  - 1-face Crushed = 100%

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FAA CEMENT STABILIZED BASE SPECIFICATION

Sieve Size	Percentage by Weight Passing Sieves	
	Gradation A	Gradation B
2 inch (50 mm)	100 [1]	100 [1]
No. 4 (4.75 mm)	45 - 100	55 - 100
No. 10 (1.80 mm)	37 - 80	45 - 100
No. 40 (450 µm)	15 - 50	25 - 80
No. 80 (210 µm)	0 - 25	10 - 35

- Aggregate Properties
  - LA Abrasion ≤ 40%
  - $MgSO_4$ Soundness ≤ 15%
  - Liquid limit ≤ 25
  - Plastic limit ≤ 6
- Mix Properties
  - 7-day Compressive Strength
    - 3 MPa minimum
    - 5.5 MPa maximum
  - 28-day Compressive Strength
    - 7 MPa maximum

FAA SUBBASE SPECIFICATION

Sieve Size	Percentage by weight passing sieves
3 inch (75 mm)	100
No. 10 (2.0 mm)	20-100
No. 40 (0.450 mm)	5-60
No. 200 (0.075 mm)	0-8

- Material requirements
  - Hard durable particles
  - Free of clay lumps
  - Free of vegetative matter
  - Free of deleterious material
  - Liquid limit ≤ 25%
  - Plastic limit ≤ 6%
- Pit run material is acceptable

FAA BASE AND SUBBASE SPECIFICATION

- CBR requirement
  - Base course – minimum 80
  - Subbase – minimum 20

FAA BASE AND SUBBASE SPECIFICATION

- Equivalency factors for subbase course
  - P-208 Aggregate Base Course 1.0 – 1.5
  - P-209 Crushed Aggregate Base Course 1.2 – 1.8
- Equivalency factors for stabilized subbase
  - P-301 Soil Cement Base Course 1.0 – 1.5
  - P-304 Cement Treated Base Course 1.6 – 2.3

FAA BASE AND SUBBASE SPECIFICATION

- P-209, Crushed Aggregate Base Course
- Equivalency factors for base course
  - P-208 Aggregate Base Course 1.0
- Equivalency factors for stabilized base
  - P-304 Cement Treated Base Course 1.2 - 1.6

BASE AND SUBBASE SPECIFICATION

- Customized base and subbase specifications
  - Locally available materials
  - Tighter requirements for heavier aircrafts
  - Additional requirements
    - Enhanced drainage (drainage blankets)

CONSTRUCTION CONSIDERATIONS

- Construction methods should produce a final product that meets the design assumptions
- Approved methods of construction included in specifications
- Quality Control (QC) and Quality Assurance (QA)

CONSTRUCTION CONSIDERATIONS

- Compaction requirements

		Minimum Compaction (%)
Subbase – unbound		98
Base	- unbound	100
	- bound	98

CONSTRUCTION CONSIDERATIONS

- QC testing

	Minimum Testing Frequency
Base placing	
Moisture-density relationship	2 per material type
Gradation and crushed content	2 per day
Base stockpiling	
Gradation and crushed content	2 per day
Atterberg limits	1 per week
Subbase placing	
Moisture-density relationship	2 per material type
Gradation	1 per day
Atterberg limits	1 per week

CONSTRUCTION CONSIDERATIONS

- Minimum field density testing

- Subbase 1 per 3,000 m2/lift
- Base 1 per 3,000 m2/lift

CONSTRUCTION CONSIDERATIONS

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- Granular materials and aggregate production

CONSTRUCTION CONSIDERATIONS

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CONSTRUCTION CONSIDERATIONS

- High permeability granular base

CONSTRUCTION CONSIDERATIONS

- Sub-drains construction

SUMMARY

- Base and subbase layers significantly impact pavement long term performance
  - Structural contribution
  - Drainage
  - Frost protection

- Do it right the first time
  - Addressing base and subbase deficiencies is difficult and expensive


THANK YOU !
QUESTIONS ?
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