MANUAL OF PAVEMENT
STRUCTURAL DESIGN

ASG-19
(AK-68-12)

MANUEL SUR LA CONCEPTION
DES CHAUSSÉES

Public Works Canada
Architectural and Engineering Services
Air Transportation

Travaux Publics Canada
Services d'architecture et de génie
Tranports aériens

JULY/JUILLET 1992

List of Corrections to ASG-19 (AK-68-12) as of December 1992

Page 9, Table 3.2.1 - Design Aircraft Loadings

The design tire pressure values should be edited as follows:

Aircraft Load Rating	Design Tire Pressure (MPa)
1	Less than 0.50
2	Less than 0.50
3	Less than 0.50
4	0.50 - 0.75
5	0.50 - 0.75
6	0.50 - 0.75
7	0.50 - 0.75
8	0.75 - 1.00

Page 29, Fig 3.4.6

Case 3 - Small Interior Slabs
This note should read "For all interior slabs less than 1/4 of full slab in area, ..."

Page 31, Fig 3.4.8

The minimum reinforcing cover dimensions should read "80 mm Min" of cover not "50 mm Min".

Please forward any additional corrections or comments to:

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1.0 MANAGERIAL SUMMARY

SCOPE

This manual presents standards and guidelines on the structural design of both airside and groundside airport pavements, the design of restoration measures, as well as the design of new pavement facilities.

OBJECTIVE

The objective of this manual is to detail uniform design practices that will ensure the safety, quality, and cost effectiveness of pavement facilities subject to Canadian climatic, construction and operational conditions.

APPLICATION

The standards and guidelines in this manual are applicable to the design of all airport pavement facilities constructed with Airports Group's funds. This manual may also be used for the guidance of provincial, municipal, or private agencies engaged in airport development.

The standards and guidelines presented in this manual are concise statements of requirements. Persons interested in expanded background and theoretical development should refer to AK-77-68-300, Pavement Structural Design - Training Manual, 1987.

2.0 DEFINITIONS

Types of Pavement Structures

The following terms relative to types of pavement structures are used in this manual according to the definitions given here.

Asphalt Pavement - a flexible pavement with a surfacing course bound by asphalt cement.

Composite Pavement - an overlaid concrete pavement that may be considered as flexible or rigid depending on the type and depth of overlay.

Concrete Pavement - a rigid pavement with a surfacing course of Portland cement concrete.

Flexible Pavement - a pavement structure that is designed on the principle of distributing traffic loads to the subgrade, and depends on aggregate interlock, particle friction, and cohesion for stability.

Gravel Pavement - a flexible pavement with a surfacing course of unbound granular material.

Rigid Pavement - a pavement structure that depends on the tensile beam strength of a Portland cement concrete slab for the support of traffic loads.

2.0 DEFINITIONS (cont'd)

Pavement Component Layers

The following terms relative to pavement component layers are used in this manual according to the definitions given here.

Asphalt Surfacing Course - a course consisting of mineral aggregates bound by some type of asphalt material. It usually consists of a hot-mixed asphaltic concrete that is manufactured using a penetration-grade asphalt cement, heated, and mixed with the aggregates prior to placing. Cold mixes may occasionally be used for pavements serving light aircraft only.

Base Course - a layer immediately beneath the surfacing course, which is constructed from well-compacted granular aggregates meeting high standards with respect to stability and durability. The base course contributes to pavement bearing strength, provides a platform for the construction of the surfacing course, and in flexible pavements must have sufficient stability to withstand the high stresses imposed by aircraft tire pressures. Unbound bases are normally employed, but in special cases a stabilized base in which the aggregates are bound with asphalt or Portland cement may be provided.

Portland Cement Concrete Surfacing Course - a course consisting of Portland cement concrete slabs and constructed with concretes manufactured using mineral aggregates and Portland cement. The concretes are pre-mixed prior to placing.

Sub-base Course - a course constructed from selected granular aggregates that are not susceptible to frost action and that have stability and durability requirements that are less demanding than those for base course aggregates. Sub-bases contribute to the pavement structure by providing an increase in bearing strength and frost protection.

Subgrade - the foundation on which the pavement is constructed, consisting of the in situ soil or, in fill sections, imported common material.

Refer to AK-68-23, Pavement Construction Materials and Testing, 1990, for the definition of pavement component layers and materials in terms of specified physical requirements.

2.0 DEFINITIONS (cont'd)

Pavement Design Parameters

The following terms relative to pavement parameters are used in this manual according to the definitions given here.

Aircraft Load Rating (ALR) - a number between 1 and 12 assigned to an aircraft, which is a relative measure of the severity of the load the aircraft will impose on a pavement.

Freezing Index - a measure of the severity of freezing conditions over a winter season. The freezing index is measured in degree-centigrade days (°C days) and is calculated as the summation of daily average air temperatures over the freezing period (with the negative values converted to positive after summation).

Ground Vehicle Loading Group - a number between 1 and 4 assigned to a ground vehicle, which is a relative measure of the severity of the load the vehicle will impose on a pavement.

Subgrade Bearing Strength - the load in kilonewtons (kN) that will produce a deflection of 12.5 mm after 10 repetitions of load when the load is applied to the subgrade surface through a 75O mm diameter rigid plate. The bearing strength is variable with location and time of year, and the value used to characterize subgrade bearing strength is the 25th percentile value exhibited during the spring thaw period (lower quartile, spring-reduced value). Refer to AK-68-31, Pavement Bearing Strength Measurement and Analysis, 1987, for methods of measurement.

Tire Pressure - the tire inflation pressure, measured in megapascals (MPa).

2.0 DEFINITIONS (cont'd)

Pavement Design Variables

The following terms relative to pavement design variables are used in this manual according to the definitions given here.

Flexible Pavement Equivalent Granular Thickness - the thickness of a pavement constructed of granular materials alone that would have a capacity for the distribution of traffic loads to the subgrade equivalent to that of a flexible pavement constructed with layers of various materials having different load characteristics.

Rigid Pavement Bearing Modulus - a measure of the stiffness of supporting layers beneath a concrete slab. It is measured on the surface or the layer immediately beneath the concrete slab by applying a load through a 750 mm diameter plate to produce a deflection of 1.25 mm. The unit load on the plate (in Pa) is then divided by the deflection of 1.25 mm to give a bearing modulus in units of MPa/m.

Rigid Pavement Equivalent Slab Thickness - the thickness of a single concrete slab having load-carrying capacity equivalent to that of an overlaid concrete pavement.

3.0 PAVEMENT STRUCTURAL DESIGN

3.1 DESIGN SELECTION

SCOPE

This section presents guidelines for the selection of pavement structure type and design.

SELECTING PAVEMENT TYPE AND DESIGN

Guidelines

(i) All types of pavement structure that satisfy functional requirements should be considered during design.

(ii) Selection from design alternatives should be based on minimum cost as determined through a cost analysis performed in accordance with AK-76-06-000, Life-Cycle Costing Procedures, 1984.

(iii) Aircraft pavements intended to avoid year-round uninterrupted service should be designed with an asphalt concrete or Portland cement concrete surface, unless technical or economic reasons dictate lower-quality pavement structures.

(iv) For new construction, aircraft pavements subject to turning movements, such as aprons, holding areas, and runway buttons, should be surfaced with Portland cement concrete if the traffic consists of heavy aircraft with tire pressures exceeding 1.0 Mpa.

(v) New asphalt concrete apron surfaces should be provided with a jet fuel resistant slurry seal in areas subject to fuel spills.

3.2 DESIGN PARAMETERS AND VARIABLES

SCOPE

This section presents standards and guidelines for the determination of values for pavement design parameters and variables.

DESIGN AIRCRAFT LOADING CHARACTERISTICS

Standard The type of aircraft expected to use the facility over a minimum of 15 to 20 year period following construction shall be determined from planning studies or the Airport Master Plan, and appropriate values of design aircraft load ratings and tire pressures shall then be selected from Table 3.2.1 - Design Aircraft Loadings.

DESIGN GROUND VEHICLE LOADING CHARACTERISTICS

Guideline Airport road and car-park pavements are usually designed for one of the four loading groups defined in Table 3.2.2 - Design Ground Vehicle Loading. The type of traffic expected to use the pavement facility should be determined from planning studies and an appropriate design ground vehicle loading group should then be selected from this table. To assist in determining the group, refer to the loading characteristics for various types of ground vehicles found at airports listed in Table 3.2.3 - Loading Characteristics of Airport Ground Vehicles.

SUBGRADE BEARING STRENGTH

Standard The subgrade bearing strength used for design purposes shall normally be the lower quartile, spring-reduced value. (Refer to AK-68-31, Pavement Bearing Strength Measurement and Analysis, 1987, for the measurement method.)

Guideline At established airports a subgrade bearing strength value should be available from airfield pavement data records, based on bearing strength tests conducted on pavements at the site. If not available from this source, a subgrade bearing strength value should be selected from Table 3.2.4 - Typical Subgrade Bearing Strengths, based on the subgrade soil classification determined from the project soil survey.

3.2 DESIGN PARAMETERS AND VARIABLES (con't)

SITE AIR FREEZING INDEX

Guidelines (i) The site air freezing index value used to determine pavement frost protection requirements should be a ten-year average.

(ii) At established airports, a site air freezing index value should be available from the airfield pavement data records, based on meteorological observations recorded at the site. If not available from this source, the site air freezing index should be estimated from Figure 3.2.1 - Freezing Indices - Canada.

EQUIVALENT GRANULAR THICKNESS

Standard The equivalent granular thickness of a flexible pavement shall be calculated using the granular equivalency factor listed in Table 3.2.5 - Granular Equivalency Factors for Pavement Materials. The depth of each layer in the pavement shall be multiplied by the granular equivalency factor for the material in that layer, and the sum of these converted layer thicknesses shall be the pavement equivalent granular thickness.

EQUIVALENT SINGLE SLAB THICKNESS

Guideline The equivalent single slab thickness of an overlaid concrete slab should be determined from Figure 3.2.2 - Equivalent Single Slab Thickness of Overlaid Concrete Slab.

RIGID PAVEMENT BEARING MODULUS

Guideline The rigid pavement bearing modulus k is not normally measured directly but is estimated from Figure 3.2.3 - Rigid Pavement Bearing Modulus, based on the subgrade bearing strength and the thickness of the base and sub-base placed between the subgrade and concrete slab. The k value should be limited to 135 MPa/m for new pavement design.

TABLE 3.2.1 - DESIGN AIRCRAFT LOADINGS

Aircraft Load Rating	Design Tire Pressure (MPa)	Aircraft
1	Less than 0.40	Apache/Aztec Dove Beech 18
2	Less than 0.40	King Air
3	Less than 0.40	Lockheed 18
4	0.40 - 0.70	DH 125 DC 3
5	0.40 - 0.70	Gulfstream G159 Dash 7 F27 HS 748 Dart Herald Convair Canso
6	0.40 - 0.70	Convair 440/640
7	0.40 - 0.70	DC-4-M2
8	0.70 - 1.00	Viscount DC-9-15 DC-6B Super Argosy 650

Aircraft Load Rating	Design Tire Pressure (MPa)	Aircraft
9	Greater than 1.00	BAC-1-11-500 B 737 DC-9-32 Hercules C130E
10	Greater than 1.00	Convair 990/880 B-707-120/B DC-9-51 Electra P3 Vanguard DC-7-7C Super Constellation B-767
11	Greater than 1.00	B-747-100 DC-10-10 DC-8 B-707-320/420 Super Hercules Airbus A-300B4 Super VC-10
12	Greater than 1.00	Concorde B-747-200 DC-10-20/30 L-1011 DC-8-63 B-727

NOTE: The above listing is for selected aircraft at maximum operating weight. For the appropriate aircraft load rating, for other aircraft, and aircraft at reduced operating weight, refer to AK-68-30-100, Pavement Evaluation for Aircraft Loadings, 1979.

TABLE 3.2.2 - DESIGN GROUND VEHICLE LOADING

Design Loading Group	Typical Usage	Tire Gear Configuration	Gear Load (kN)	Wheel Spacing Dual (cm)	Wheel Spacing Tandem (cm)	Tire Pressure (MPa)	Minimum Pavement Thickness Requirements
1	<u>Local Airports</u> Cars Light Trucks	Single Dual Dual - Tandem	20 24 40	- 30 30	- - 120	0.50 0.50 0.50	6.5 cm asphaltic concrete (A.C.) 15-23 cm base
2	<u>Regional Airports</u> Buses Some Trucks Maintenance Vehicles Some Fuel Tankers	Single Dual Dual - Tandem	40 50 80	- 40 30	- - 120	0.70 0.60 0.60	6.5 cm A.C. 23 cm base
3	<u>National Airports</u> Heavy Trucks Fuel Tankers Heavy Maintenance	Single Dual Dual - Tandem	70 80 120	- 40 30	- - 130	0.70 0.60 0.70	8.0 cm A.C. 25 cm base
4	<u>International Airports</u> Heavy Fuel Tankers Heavy Service	Single Dual Dual - Tandem	100 110 170	- 40 40	- - 140	0.80 0.70 0.80	8.0 cm A.C. 25 cm base

TABLE 3.2.3 - LOADING CHARACTERISTICS OF AIRPORT GROUND VEHICLES

Vehicle		Gross Weight (kN)	Gear Load (kN)	Wheel Spacing Dual (cm)	Wheel Spacing Tandem (cm)	Tire Pressure (MPa)	Vehicle Loading Group
EMERGENCY							
Small Foam		73.9	23.6	32	-	0.38	1
Crash Rescue		65.8	18.5	-	-	0.31	1
1000 gal. Foam		169.0	59.2	-	142	0.62	2
2000 gal. Foam		287.6	77.7	-	-	0.62	4
MAINTENANCE							
Small Snow-plow		92.1	27.8	-	-	0.59	2
Lg. Snow-plow		109.4	32.5	-	-	0.59	2
7200 Snow Blower		126.8	37.8	-	-	0.69	2
Snow Blast Blower		151.2	40.8	-	-	0.59	2
Spreader Truck		276.0	106.6	33	142	0.69	3
FUEL TANKERS							
Imperial	7000	329.2	93.6	33	132	0.62	3
	8000	400.3	88.8	33	137	0.69	3
	9500	415.9	109.6	30	122	0.55	3
	11000		111.2	36	130	0.55	3
	12500	600.5	118.0	30	122	0.62	3
Petrofina	12000	542.9	82.4	36	122	0.59	2
Shell	4500	249.1	100.0	38	-	0.62	4
	7100	378.1	111.2	41	-	0.62	4
	11600	511.6	73.6	36	119	0.48	2
	15000	582.7	133.2	33	127	0.69	4
Standard	3500						
	14000		77.8	28	-	0.55	3
		640.5	146.8	36	132	0.62	4
OTHERS							
Planemate		361.6	90.4	-	-	0.48	4
Pass Car		Var.	Var.	-	-	Var.	1
Transport Truck		(axle group)					
Front axle		53.4	26.7	-	-	0.70	3
Single axle		97.6	48.8	32	-	0.70	3
Tandem axle		177.6	88.8	30	180	0.70	3
Triple axle		266.4	133.2	30	244+488	0.70	3
TOW TRACTORS							
Lectra Haul	T150						
International	T180F	747.3	186.8	-	-	1.03	4
	T225SL						
	T300SL	114.8	28.7	-	-	0.52	
	T300SL	142.3	35.6	-	-	0.52	
	T500S	218.0	54.5	-	-	0.76	
	T800S	177.9	44.5	-	-	0.62	
	T800S	489.3	122.3	-	-	0.72	4
		689.5	172.4	-	-	0.97	4
		520.4	130.1	-	-	0.72	4

TABLE 3.2.4 - TYPICAL SUBGRADE BEARING STRENGTHS

Subgrade Soil Type	Usual Spring Reduction % *	Subgrade Bearing Strength (kN)		
		Fall Range	Design Value	
			Fall	Spring
GW - well-graded gravel	0	290-400	290	290
GP - poorly graded gravel	10	180-335	220	200
GM - gravel with silty fines	25	135-335	180	135
GC - gravel with clay fines	25	110-245	145	110
SW - well-graded sand	10	135-335	180	160
SP - poorly graded sand	20	110-200	135	110
SM - sand with silty fines	45	95-190	120	65
SC - sand with clay fines	25	65-155	85	65
ML - silt with low liquid limit	50	90-180	110	55
CL - clay with low liquid limit	25	65-135	85	65
MH - silt with high liquid limit	50	25-90	40	20
CH - clay with high liquid limit	45	25-90	55	30

*** Note:** When the water table is within 1 m of the pavement surface, the % spring reduction factor should be increased by 10% for each soil type except GW and GP.

TABLE 3.2.5
GRANULAR EQUIVALENCY FACTORS FOR PAVEMENT MATERIALS

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

NOTE: The equivalent granular thickness of a layer is calculated by multiplying the layer thickness by the granular equivalency factor for the material in the layer.

Example

Given - pavement structure: 8 cm A.C. + 25 cm base + 20 cm sub-base
Problem - to determine the equivalent granular thickness

Solution

Layer Component		Granular Equivalency Factor	Equivalent Granular Thickness
8 cm A.C.	x	2	16 cm
25 cm base	x	1	25 cm
20 cm sub-base	x	1	20 cm
			61 cm (total equivalent granular thickness)

FIGURE 3.2.1 - FREEZING INDICES - CANADA

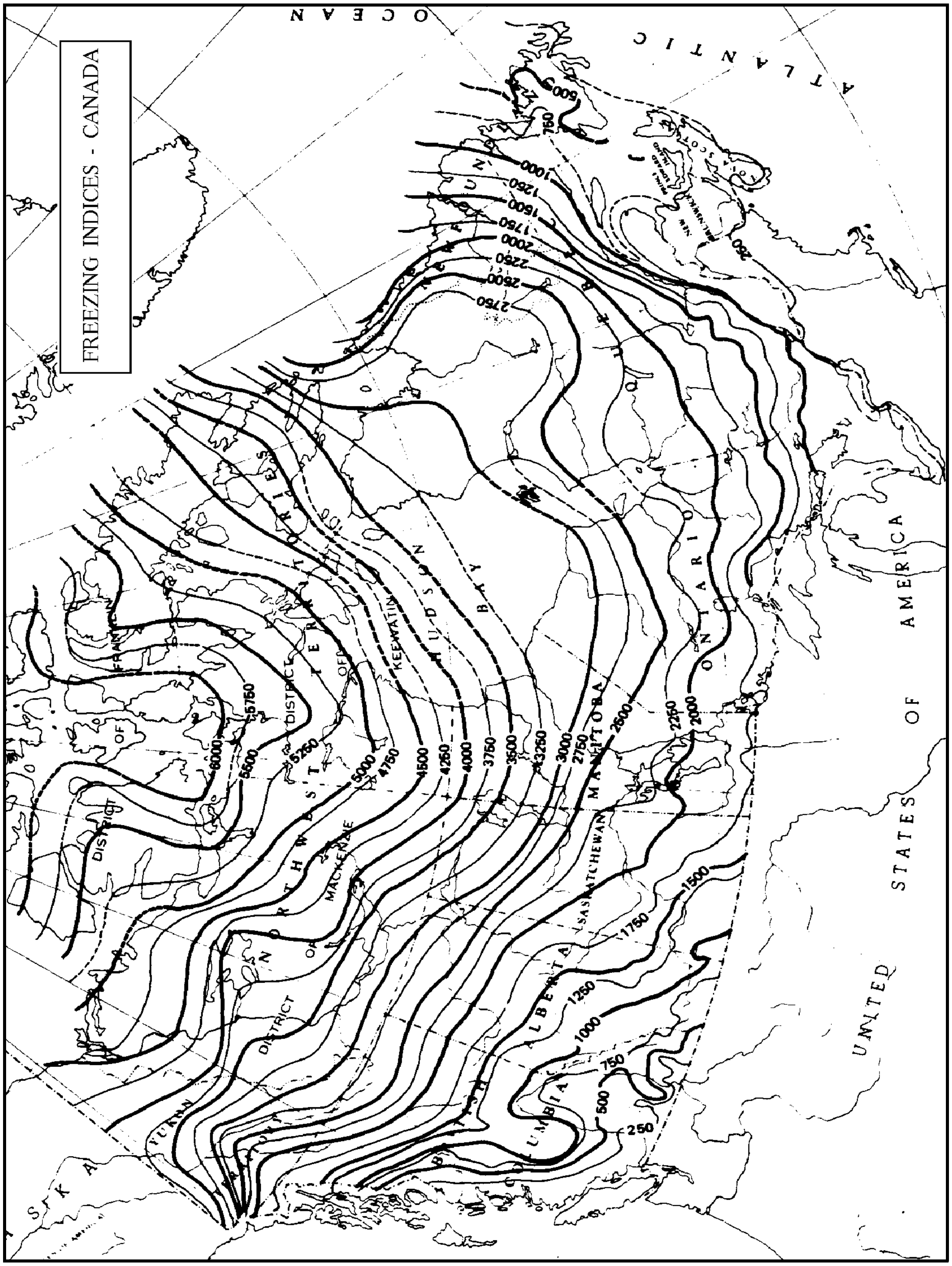


FIGURE 3.2.2
EQUIVALENT SINGLE SLAB THICKNESS OF OVERLAID CONCRETE SLAB

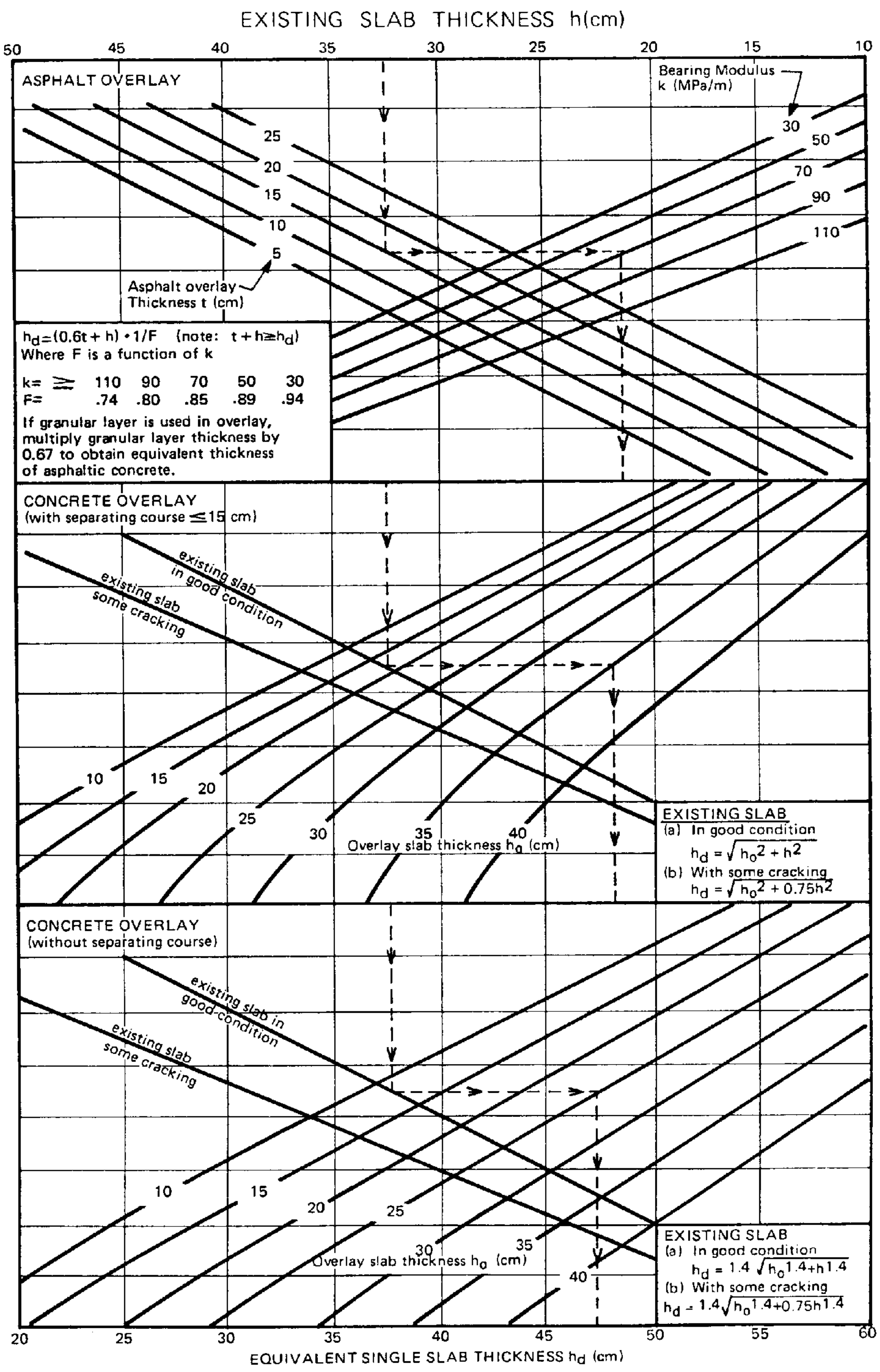
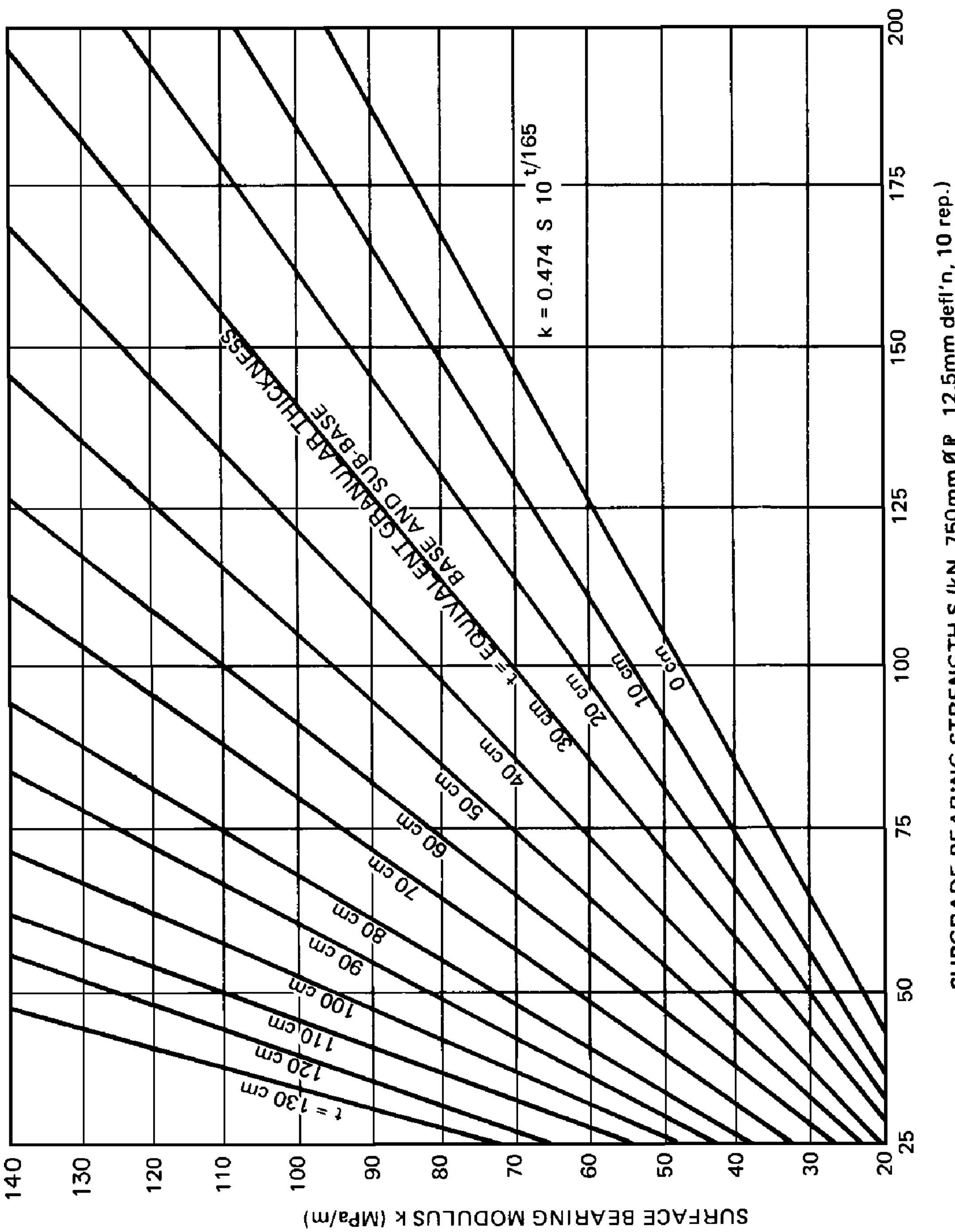


FIGURE 3.2.3 - RIGID PAVEMENT BEARING MODULUS



3.3 PAVEMENT FROST PROTECTION

SCOPE

This section presents standards related to the provision of frost protection in the design of pavement structures.

FROST PROTECTION REQUIREMENTS

Standard

When frost protection is to be incorporated into the design of a pavement structure, the depth of pavement structure shall not be less than that shown in Figure 3.3.1 - Minimum Pavement Thickness For Frost Protection. Where the subgrade contains pockets of highly frost-susceptible soil that are limited in area, the pockets shall be excavated to a depth of at least 1 m, but preferably to the full depth of frost penetration.

A pavement structure that experiences subgrade frost penetration shall be designed for frost protection, unless reasons such as the following exist for deleting the requirement:

(i) the subgrade soil is non-frost-susceptible (gravel or sand with less than 10 per cent by weight of material passing the 0.075 mm sieve);

(ii) other pavements without frost protection exist at the site and have performed satisfactorily;

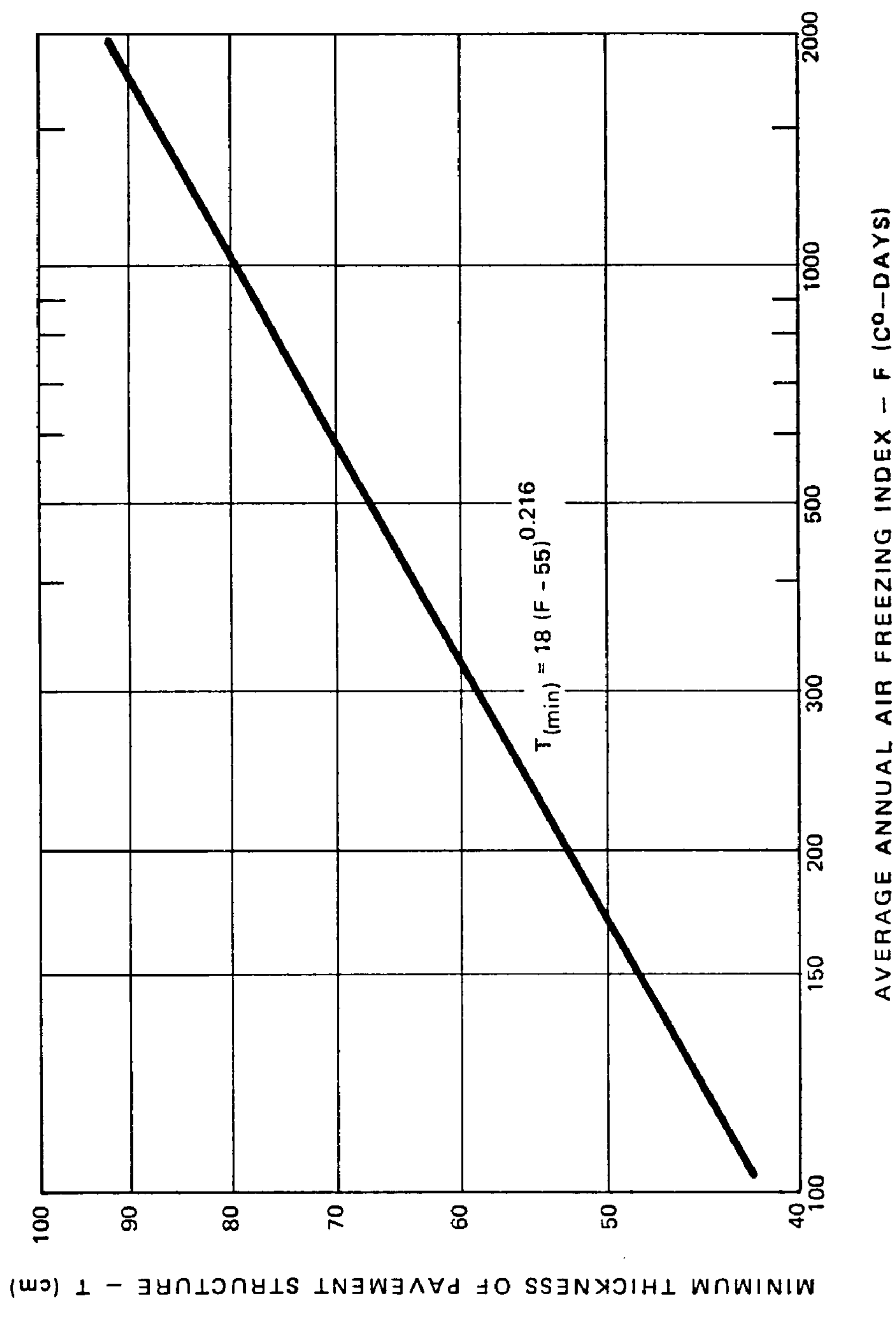
(iii) the pavement is to be surfaced with gravel or other unbound material, and roughness can be easily corrected by regrading;

(iv) the facility is to be temporary, intended to provide service for not more than five years;

(v) the facility will be little used and low levels of serviceability can be tolerated;

(vi) frost protection is too costly for the initial construction funds available and the owner is prepared to accept a facility with a shorter service life and a lower level of service. (Note: This option is usually more costly on a life-cycle basis, but stretches out cash flow requirements.)

FIGURE 3.3.1
MINIMUM PAVEMENT THICKNESS FOR FROST PROTECTION



3.4 DESIGN OF AIRFIELD PAVEMENTS

SCOPE

This section presents standards and guidelines on the structural design of airport pavements intended to support aircraft traffic.

FLEXIBLE PAVEMENT DESIGN REQUIREMENTS

Standards

(i) The depth of the flexible pavement structure provided shall be the greater of:

(1) the frost protection requirement given in Section 3.3 - Pavement Frost Protection.

(2) the structural thickness requirement given in Figure 3.4.1 - Flexible Airfield Pavement Structural Thickness Requirements.

(ii) For pavements surfaced with asphalt concrete, the depth of the pavement structure shall be divided into layers of asphalt concrete, base course, and sub-base course, in accordance with Table 3.4.1 - Minimum Layer Thickness for Flexible Aircraft Pavements.

(iii) For granular-surfaced pavements, the depth of the pavement structure shall be divided into base and sub-base courses, with the base course not less than 15 cm thick.

Guideline

The top of a base course to be surfaced with asphaltic concrete should be prime coated with liquid asphalt material in accordance with AK-68-23, Pavement Construction Materials and Testing, 1990.

3.4 DESIGN OF AIRFIELD PAVEMENTS (con't)

RIGID PAVEMENT DESIGN REQUIREMENTS

Standards

(i) Subject to the minimum thicknesses given in (ii) below, the thickness of the Portland cement concrete slab and the thickness of the base plus sub-base shall be determined through the iteration procedure outlined below.

(1) The slab thickness shall be determined in accordance with Figure 3.4.2 - Rigid Airfield Pavement Slab Thickness Requirements. For the first iteration, the bearing modulus k shall be assumed to be equal to 75 MPa/m.

(2) The thickness of the base plus sub-base shall be determined by subtracting the slab thickness from the total depth of the pavement structure required for frost protection, in accordance with Section 3.3 - Pavement Frost Protection. If frost protection is not required, the minimum base thickness of 15 cm shall be used.

(3) The bearing modulus k on top of the thickness of the base plus sub-base shall be determined in accordance with Figure 3.2.3 - Rigid Pavement Bearing Modulus.

(4) With the bearing modulus determined in (3), the above steps shall be repeated until the bearing modulus determined in (3) is equal to that assumed in (1), or until the difference is insufficient to cause change to thickness requirements.

(ii) The thickness of the Portland cement concrete slab provided shall not be less than 23 cm, and the thickness of the base course shall not be less than 15 cm.

Guideline

For larger projects at international airports, the base course for concrete pavements serving heavy aircraft traffic should be cement-stabilized and 20 cm in depth.

3.4 DESIGN OF AIRFIELD PAVEMENTS (con't)

RIGID PAVEMENT JOINT AND STEEL REINFORCEMENT DETAILS

Standards

(i) The joint pattern in Portland cement concrete surfaces shall conform to the following requirements.

(1) Contraction joints shall be located at intervals of 6 m.

(2) Construction joints on runways and taxiways shall be located to provide a paving bay width of 7.5 m for slab thicknesses greater than 30 cm and 6 m for slab thicknesses equal to or less than 30 cm. On aprons, paving bay widths of 6 m should generally be used but widths may be increased to 7.5 m if slip-form paving equipment is to be used and the slab thickness exceeds 30 cm.

(3) A construction joint shall be located along the centre-line of runways and taxiways.

(4) Outside bays adjacent to shoulder shall be cut or formed to half bay width. This requirement may be deleted if shoulders are paved to a width not less than 6.0 m, or when pavement is not subject to frost penetration.

(5) Jointing patterns shall be designed to eliminate as far as possible the mismatching of joints and the creation of small panel sizes.

(ii) Joint and reinforcement details shall be designed in accordance with Figure 3.4.3, Figure 3.4.4, Figure 3.4.5, Figure 3.4.6, Figure 3.4.7, Figure 3.4.8 and Figure 3.4.9.

(iii) Jet-fuel-resistant joint sealant conforming to CAN/CGSB 19.20 shall be used to fill joints in apron areas. Hot-poured joint sealant conforming to ASTM specification D3405 shall be used to fill joints in other areas.

3.4 DESIGN OF AIRFIELD PAVEMENTS (con't)

SHOULDERS AND BLAST PADS

Guideline — Shoulders and blast pads adjacent to aircraft operational surfaces should be designed in accordance with the details given in Figure 3.4.9 - Standard Details for Airfield Pavement Shoulders and Figure 3.4.10 - Typical Sections for Paved Shoulders and Blast Pads.

DESIGN COMPATIBILITY

Standard — Notwithstanding the requirements stated above, when a new pavement that constitutes an expansion of an existing pavement is constructed, the design of the new pavement shall be compatible with the design of the existing adjacent pavements that will share the same traffic.

TABLE 3.4.1 - MINIMUM LAYER THICKNESS FOR FLEXIBLE AIRCRAFT PAVEMENTS

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.

FIGURE 3.4.1
FLEXIBLE AIRFIELD PAVEMENT STRUCTURAL THICKNESS REQUIREMENTS

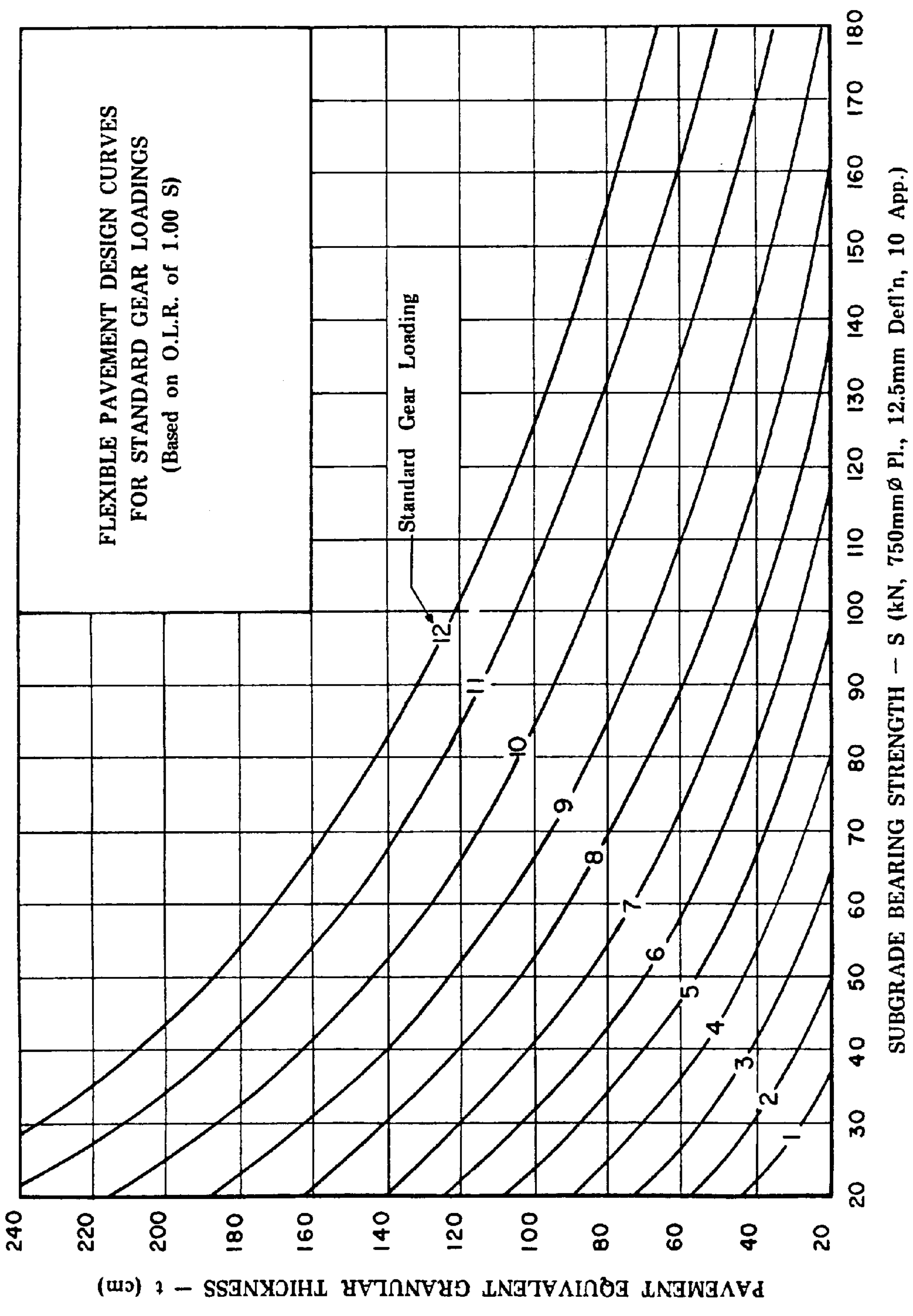


FIGURE 3.4.2
RIGID AIRFIELD PAVEMENT SLAB THICKNESS REQUIREMENTS

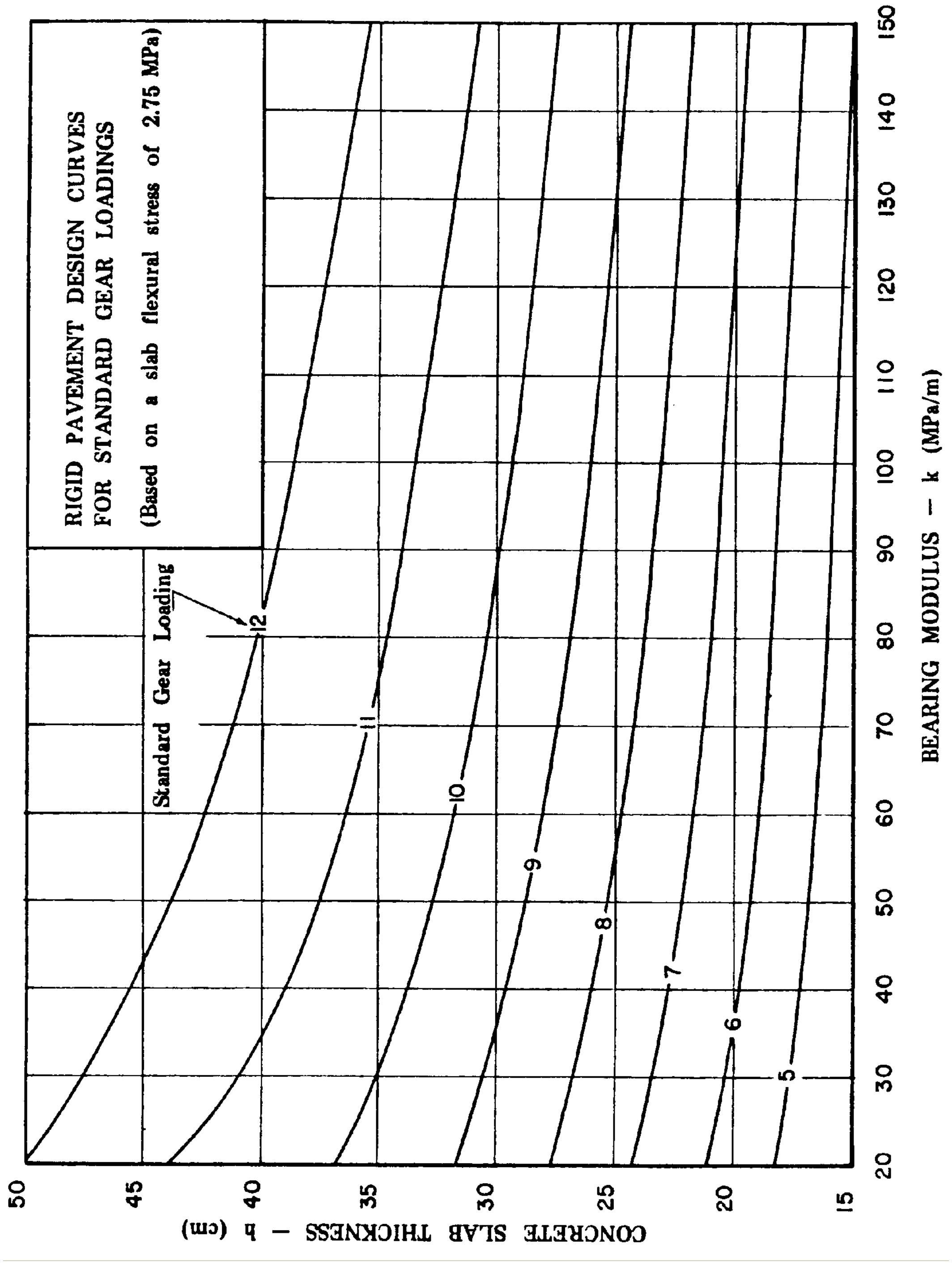
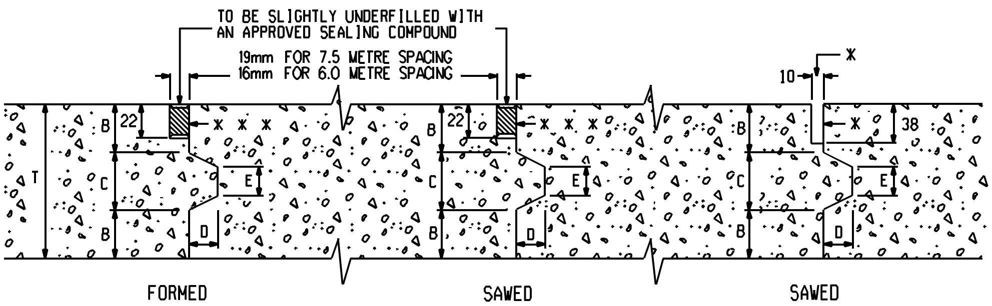
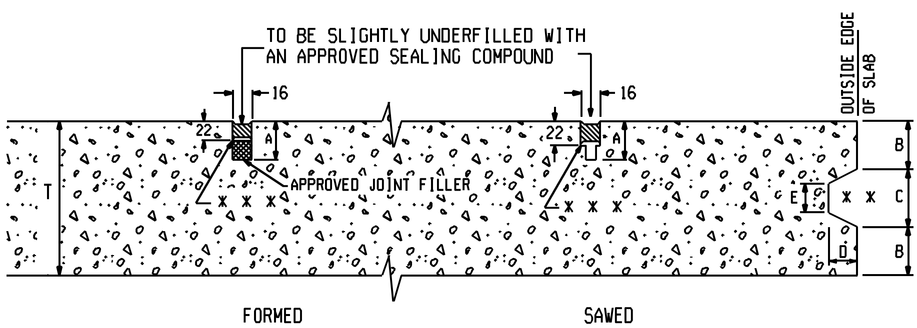


FIGURE 3.4.3
CONCRETE JOINT CONSTRUCTION DETAILS
CONSTRUCTION AND CONTRACTION JOINTS



CONSTRUCTION JOINTS



CONTRACTION JOINTS

JOINT DIMENSIONS					
T	A	B	C	D	E
150	44	B = 0.40 T	C = 0.20 T	D = 0.10 T	E = 0.15 T
175	50				
200	57				
225	64				
250	70				
275	75				
300	82				
325	89				
350	95				
375	100				
400	108				
425	115				

* PREFORMED NEOPRENE SEAL, LUBRICANT ADHESIVE AND METHOD OF INSTALLATION SUBJECT TO PRIOR APPROVAL OF THE ENGINEER.

* * A MALE OR FEMALE KEYWAY SHALL BE FORMED ALONG THE OUTSIDE OF ALL EXTERIOR SLABS.

* * * SUITABLE BACK-UP TAPE TO BE APPROVED BY ENGINEER PRIOR TO USE.

NOTE: ALL DIMENSIONS IN MILLIMETRES

FIGURE 3.4.4
CONCRETE JOINT CONSTRUCTION DETAILS
JOINTS BETWEEN EXISTING AND NEW PAVEMENTS - 1

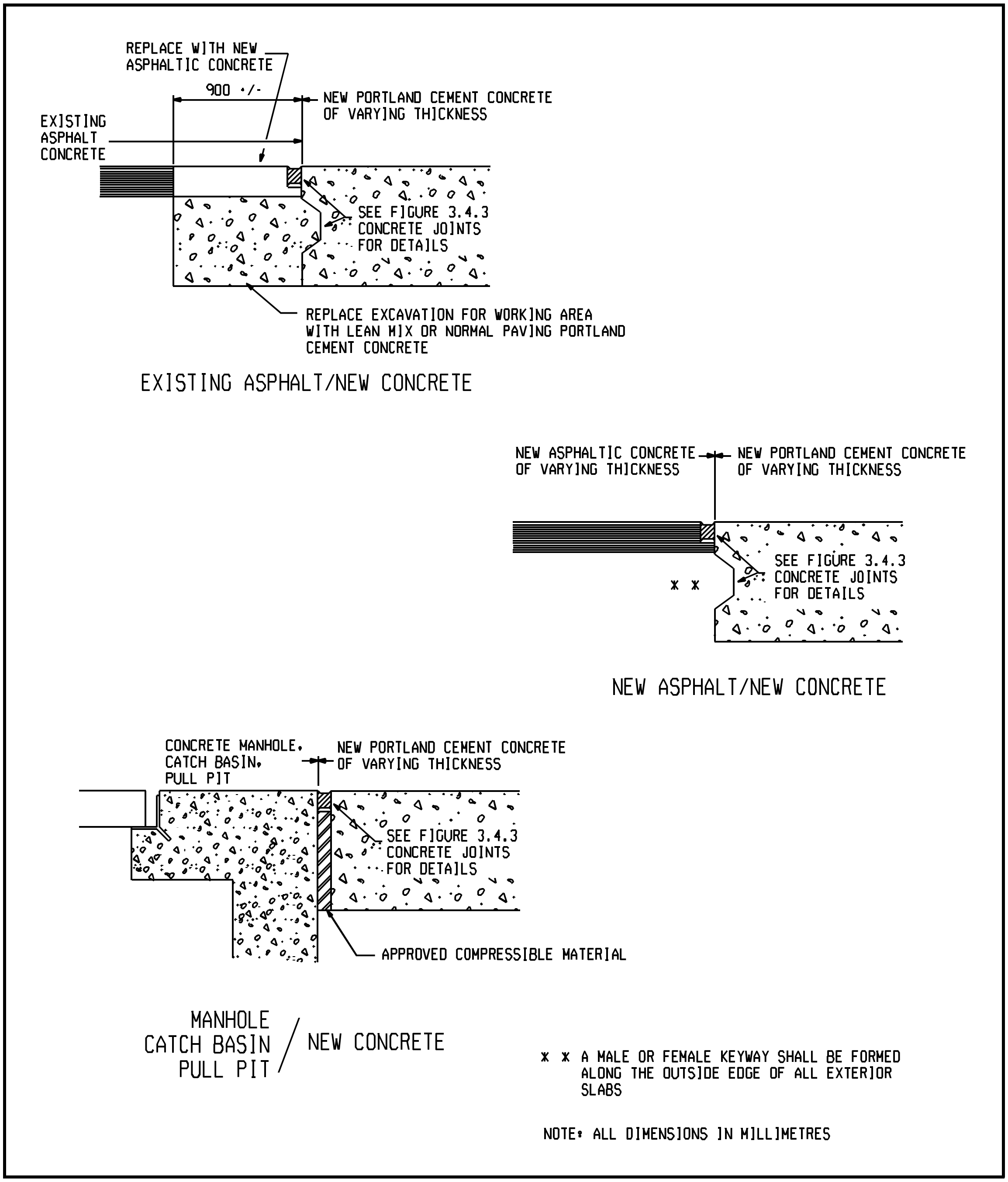


FIGURE 3.4.5
CONCRETE JOINT CONSTRUCTION DETAILS
JOINTS BETWEEN EXISTING AND NEW PAVEMENTS - 2

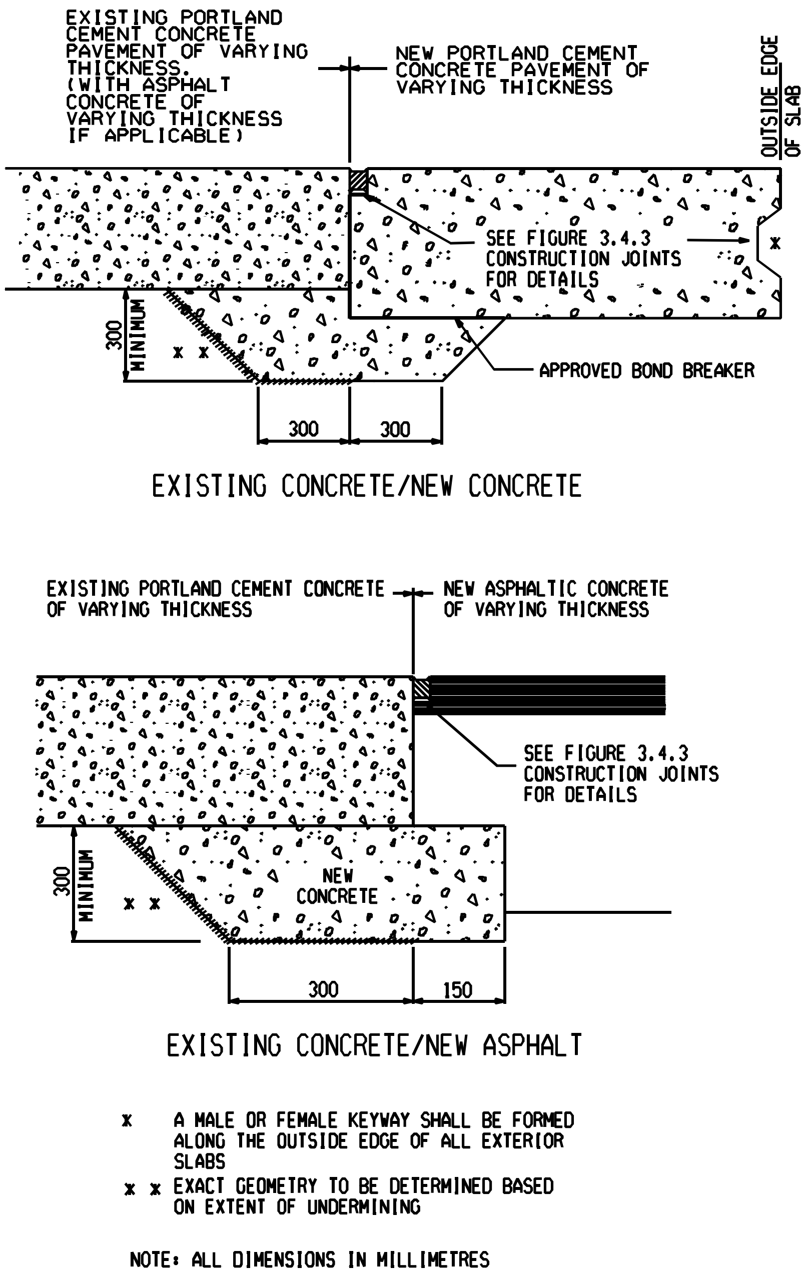


FIGURE 3.4.6
CONCRETE JOINT CONSTRUCTION DETAILS
SLAB DETAILS - 1

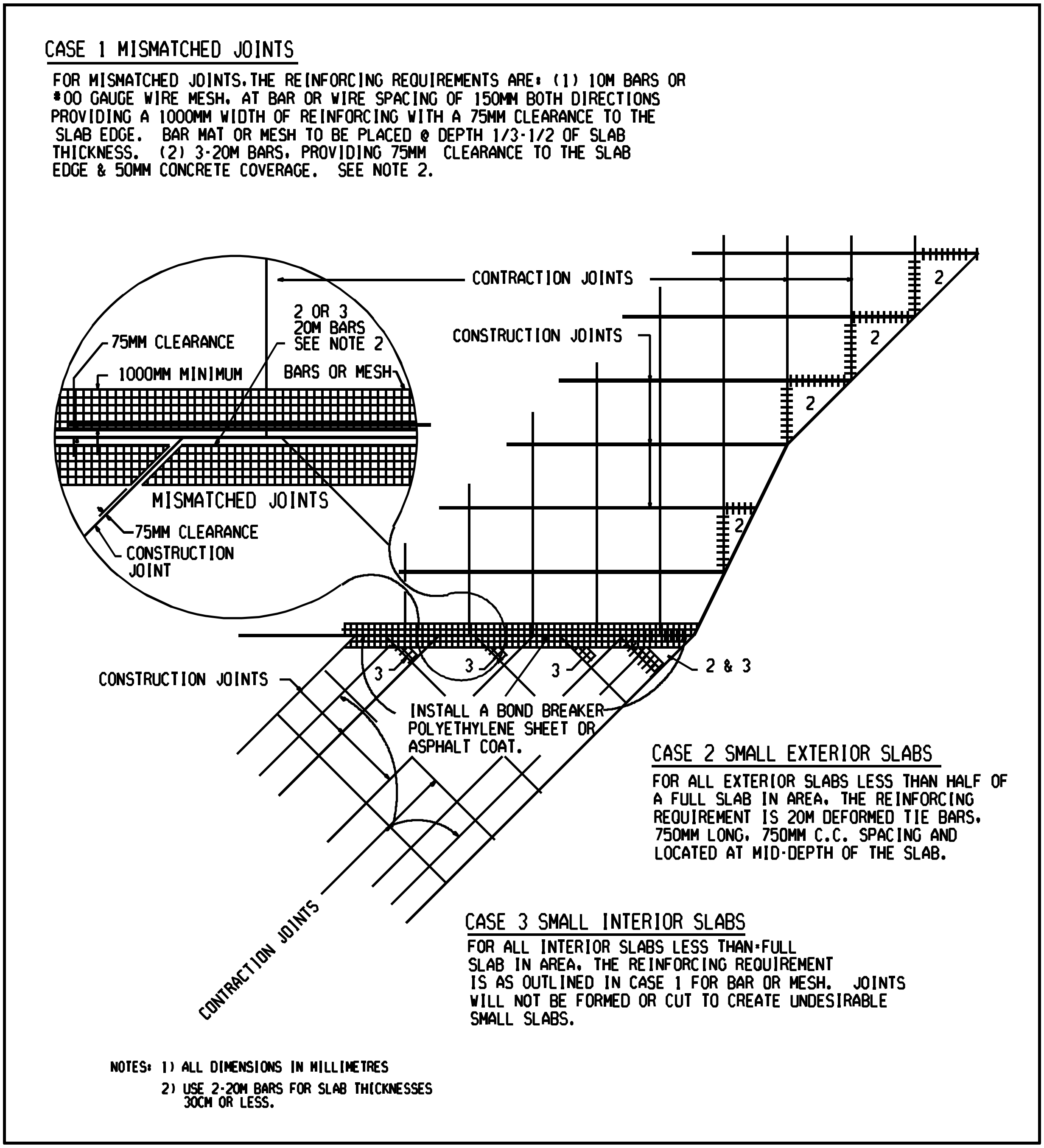


FIGURE 3.4.7
CONCRETE JOINTS CONSTRUCTION DETAILS
SLAB DETAILS - 2

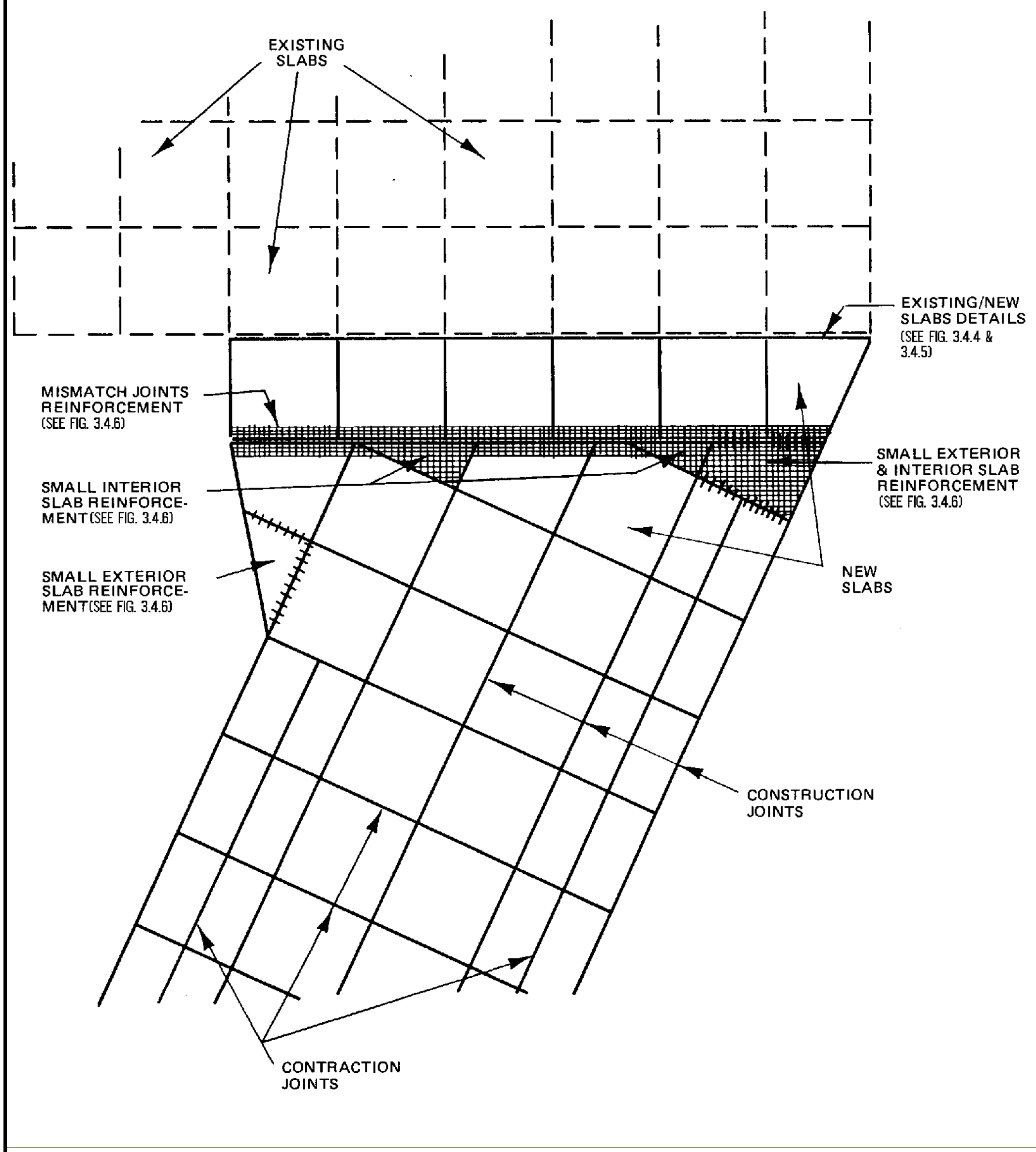
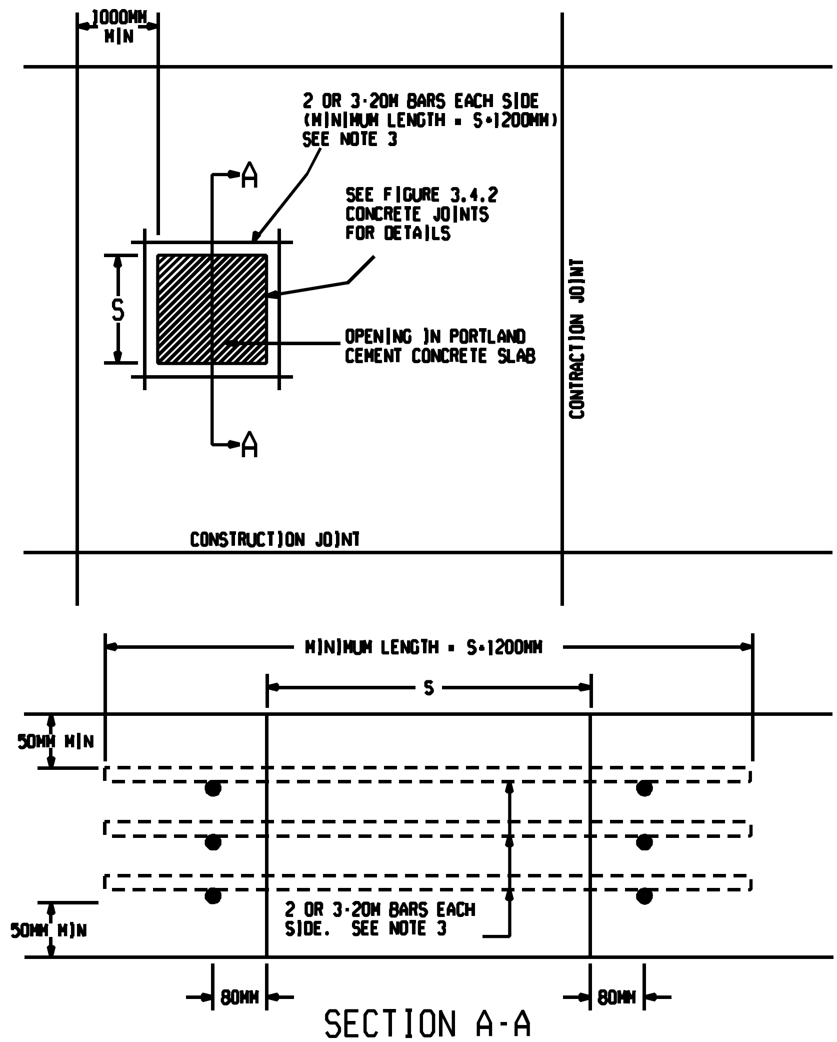


FIGURE 3.4.8
CONCRETE SLAB REINFORCEMENT AROUND INTERIOR MANHOLES AND CATCH BASINS



NOTES:
1) ALL DIMENSIONS ARE IN MILLIMETRES.
2) ABOVE DETAIL APPLIES WHEN LOCATING OF MANHOLES AND CATCH BASINS IN INTERIOUR OF SLAB CANNOT BE AVOIDED. PREFERED LOCATION WOULD BE AT SLAB CORNER
3) USE 2-20M BARS FOR SLAB THICKNESS 30 CM OR LESS

FIGURE 3.4.9
STANDARD DETAILS FOR AIRFIELD PAVEMENT SHOULDERS

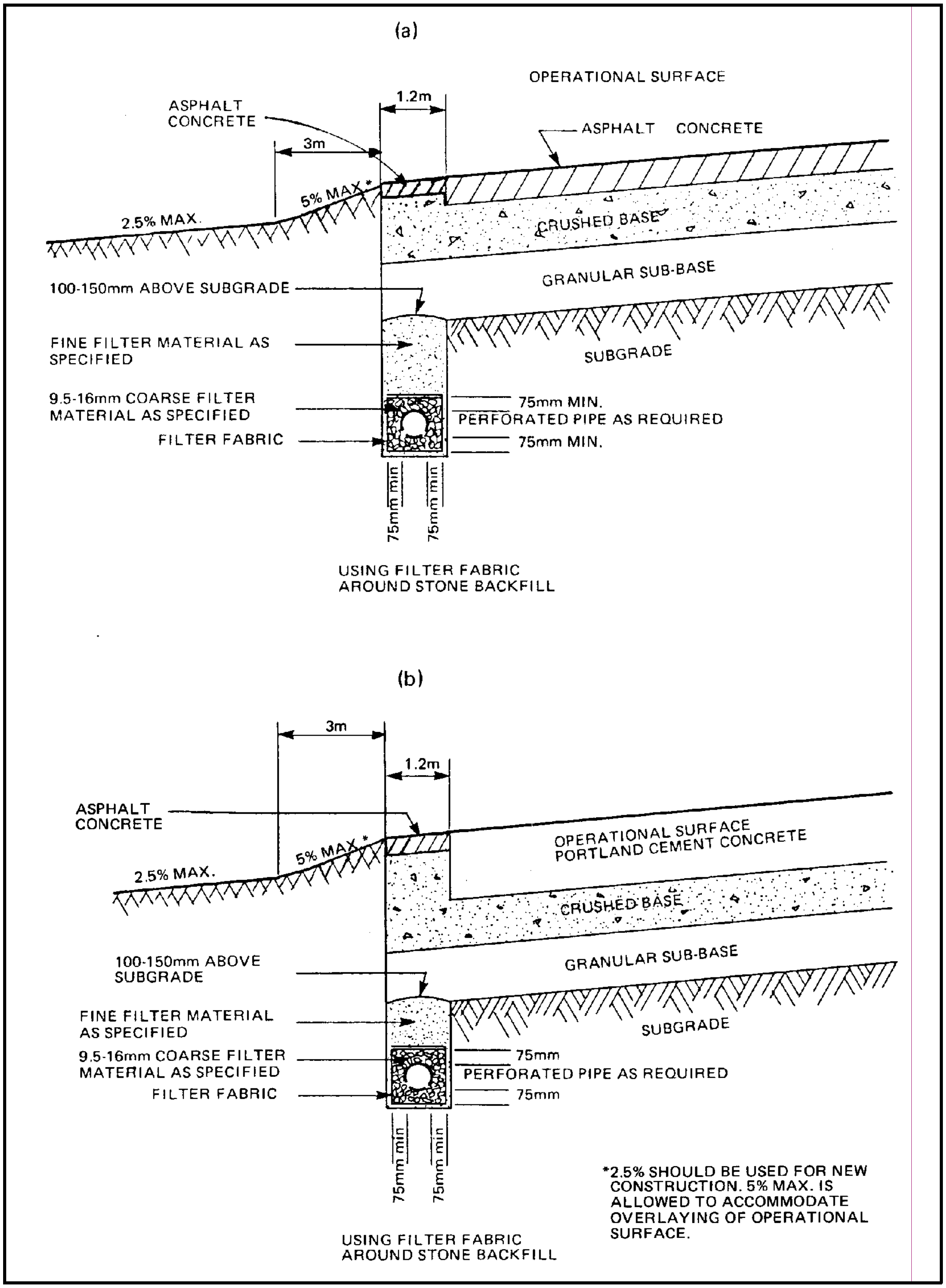
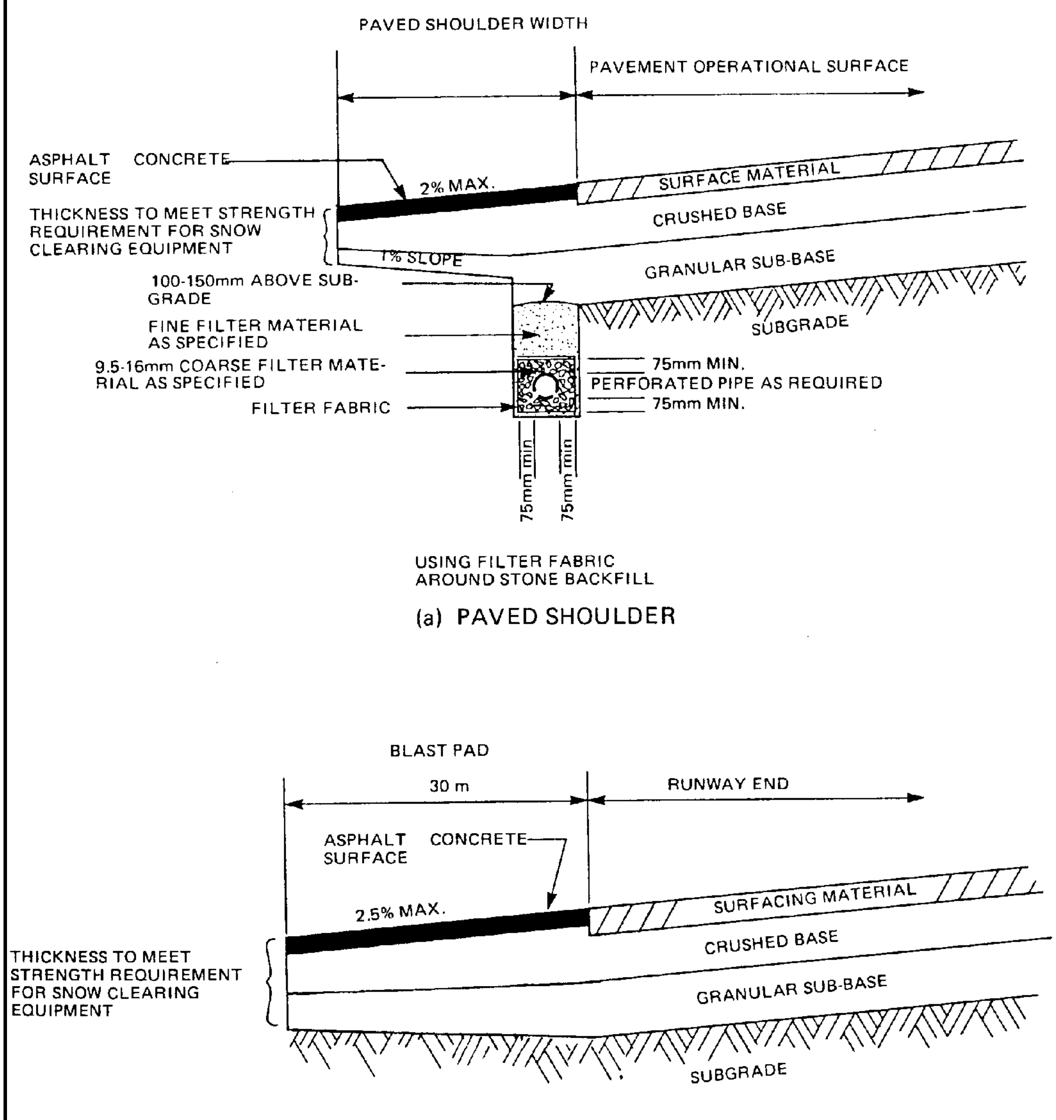


FIGURE 3.4.10
TYPICAL SECTIONS FOR PAVED SHOULDERS AND BLAST PADS



(a) PAVED SHOULDER

(b) BLAST PAD

3.5 DESIGN OF ROADS AND CAR-PARKS

SCOPE

This section presents standards and guidelines on the structural design of pavements for airport roads and car-parks.

FLEXIBLE PAVEMENT DESIGN REQUIREMENTS

Standards

(i) The depth of the flexible pavement structure provided shall be the greater of:

(1) the frost protection requirement given in Section 3.3 - Pavement Frost Protection.

(2) the structural thickness requirement given in Figure 3.5.1 - Flexible Road and Car-Park Pavements Structural Thickness Requirements.

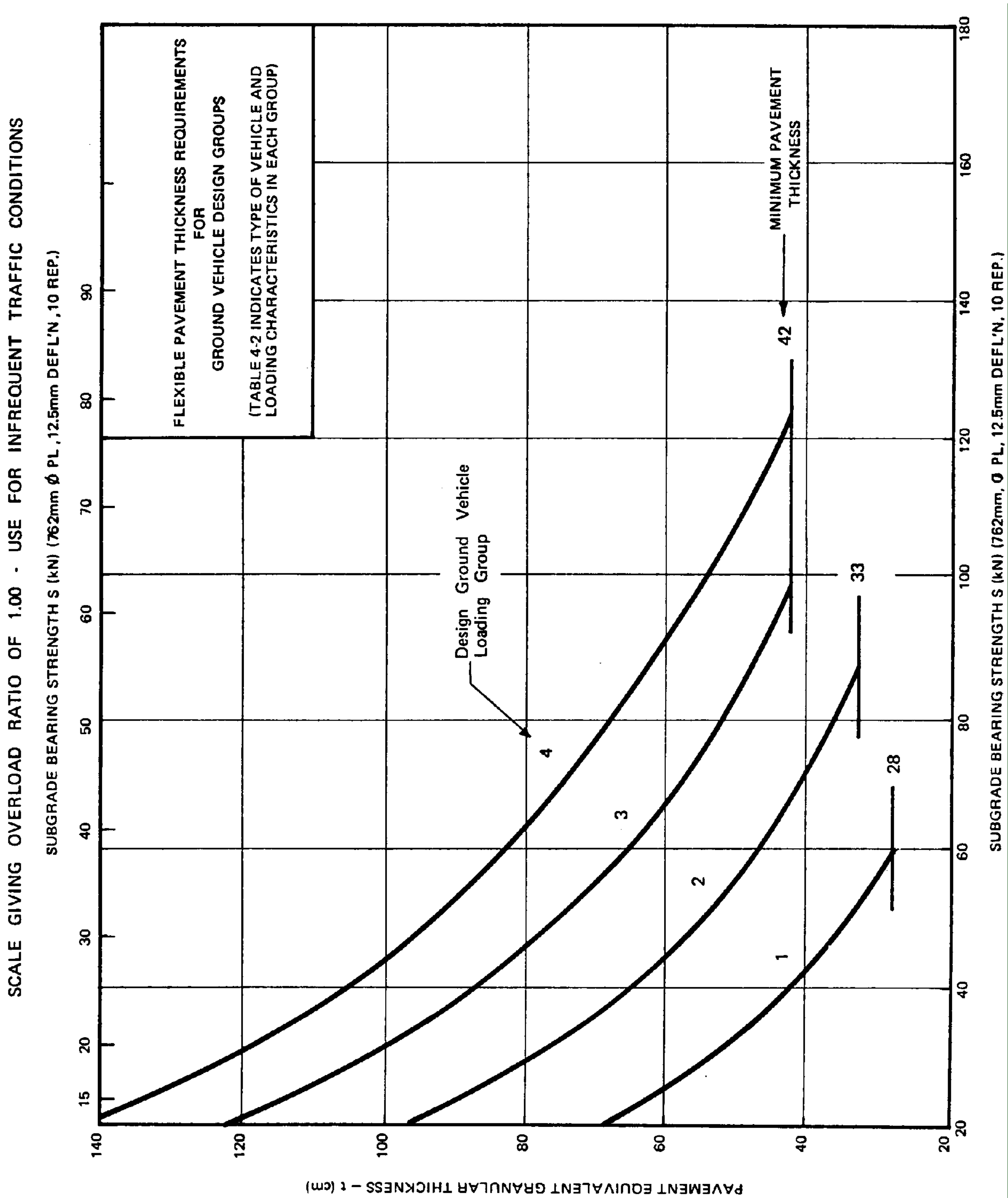
(ii) For asphalt-surfaced pavements, the depth of the flexible pavement structure shall be divided into layers of asphalt concrete, base course, and subbase course, in accordance with Table 3.2.2 - Minimum Layer Thickness for Flexible Aircraft Pavements.

RIGID PAVEMENT DESIGN REQUIREMENTS

Standard

Rigid pavements for airport roads and car-parks shall be designed in accordance with the design procedures of the Portland Cement Association or the highway department of the province in which the site is located.

FIGURE 3.5.1
FLEXIBLE ROAD AND CAR-PARK PAVEMENTS
STRUCTURAL THICKNESS REQUIREMENTS



3.6 PAVEMENT RESTORATION

SCOPE

This section presents standards and guidelines on design procedures and requirements for the restoration of pavement structures.

DESIGN ALTERNATIVE SELECTION

Standard — The selection from alternatives for restoration shall be based on considerations of traffic disruption and life-cycle costs. Refer to AK-76-06-000, Life-Cycle Costing Procedures, 1984.

RESTORATION ALTERNATIVES FOR ASPHALT SURFACES

Guideline — Alternatives to be considered for the restoration of asphalt surfaces should include the following.

(i) Recycling - central plant or in-place hot-mixed recycling of the existing asphalt surface or a portion thereof. When bearing strength increases are not required, recycling is probably the low cost option, although disruption to traffic may be greater than in the case of an overlay.

(ii) Overlay - results in the least disruption to traffic. An overlay is the most usual method of restoration when strengthening is required, and may be cost competitive with recycling in other cases.

(iii) Reconstruction - significantly more costly than other restoration methods and usually undertaken only when subsurface deficiencies exist and restoration cannot be performed satisfactorily unless these deficiencies are corrected. Reconstruction may also be necessitated by grade limitations.

(iv) Seal Coat - should generally be considered as a possible restoration method only for low-volume roads (annual average daily traffic (AADT) < 2000). Slurry seals may be considered as a temporary (one to three year) corrective measure for airfield pavements when sufficient funds are not immediately available for more permanent restoration measures.

3.6 PAVEMENT RESTORATION (con't)

RESTORATION ALTERNATIVES FOR CONCRETE SURFACES

Guideline

Alternatives to be considered for the restoration of concrete surfaces should include the following.

(i) Asphalt Overlay - the usual method adopted for the restoration of a concrete surface as it usually results in the least cost and the least disruption to traffic.

(ii) Concrete Overlay - may be adopted in lieu of an asphalt overlay on a concrete-surfaced pavement when it is desirable for the pavement surface to remain concrete (e.g., apron gate positions at large airports). A concrete overlay may be placed directly on an existing concrete surface without a separation course if the existing concrete surface is in reasonably good structural condition with little or no cracking otherwise, a separation course should be used.

(iii) Reconstruction - restoration by reconstruction should be considered only when subsurface deficiencies must be corrected or when grade restrictions preclude the use of an overlay.

OVERLAY THICKNESS FOR ASPHALT-SURFACED FLEXIBLE PAVEMENT

Standards

(i) The depth of the overlay placed shall provide a pavement structure with an equivalent granular thickness not less than that required for a new flexible pavement.

(ii) The depth of overlay shall not be less than one lift of a thickness of 5 cm.

For pavement-required grade corrections, two lifts with a combined thickness of no less than 8 cm shall be used in traffic areas. Grade corrections shall be effected in the lower lift.

(iii) Prior to overlay, the existing surface shall be tack-coated with asphalt material, in accordance with AK-68-23, Pavement Construction Materials and Testing, 1990.

3.6 PAVEMENT RESTORATION (con't)

OVERLAY THICKNESS FOR CONCRETE SURFACED PAVEMENT

Standards

(i) Except as outlined in (iii) and (iv), the depth of overlay shall provide a pavement structure with an equivalent slab thickness not less than the slab thickness required for a new concrete pavement.

(ii) If the overlay is asphalt, the depth of the overlay shall not be less than 5 cm. If the overlay is concrete, the depth of the overlay shall not be less than 15 cm.

(iii) If the overlay is of asphalt construction and the depth of the overlay exceeds 25 cm or the depth of the existing slab, the resulting composite pavement structure shall be considered as a flexible pavement, with the overlay thickness requirement given in Section 3.6, Overlay Thickness for Asphalt-Surfaced Flexible Pavement, paragraph (i).

(iv) If the overlay is concrete with a separation course exceeding 15 cm in thickness, the overlay slab shall be considered independent from the lower slab and shall have a thickness not less than that required for a new rigid pavement.

3.6 PAVEMENT RESTORATION (con't)

ADDITIONAL DESIGN CONSIDERATIONS FOR ASPHALT OVERLAYS

<u>Guidelines</u>

(i) Preference should be given to full-depth asphalt overlays. If a thick overlay of 20 cm of equivalent granular thickness or greater is required for strengthening or grade purposes, consideration may be given to a sandwich overlay (granular lift followed by asphalt) if a significant cost saving is demonstrated.

(ii) When the transverse grade of a runway is less than that permitted by licensing standards, tapering of the overlay towards the runway edges should be considered for improved surface drainage and reduction of asphalt quantities. When tapering, the nominal thickness of overlay should be provided as a minimum in the wheel paths.

(iii) When a runway is to remain operational during overlay construction, design should observe the temporary ramping requirements given in Figure 3.6.1 - Construction Details for Overlaying Operational Runways.

(iv) Prior to the placing of an overlay any requirements for major maintenance, such as the repair of localized failed areas and the sealing (with hot-poured sealant) and levelling of major cracks should be satisfied. Cold-poured crack sealant on the pavement surface or in wider cracks should be removed and resealed with materials approved by the Engineer prior to the placing of an asphalt overlay.

(v) For pavement serving jet aircraft, feathering should not be employed when traversing to adjacent pavement areas. Milling and butt jointing should be performed in accordance with Figure 3.6.2 - Butt Joint Construction Details.

FIGURE 3.6.1
CONSTRUCTION DETAILS FOR OVERLAYING OPERATIONAL RUNWAYS

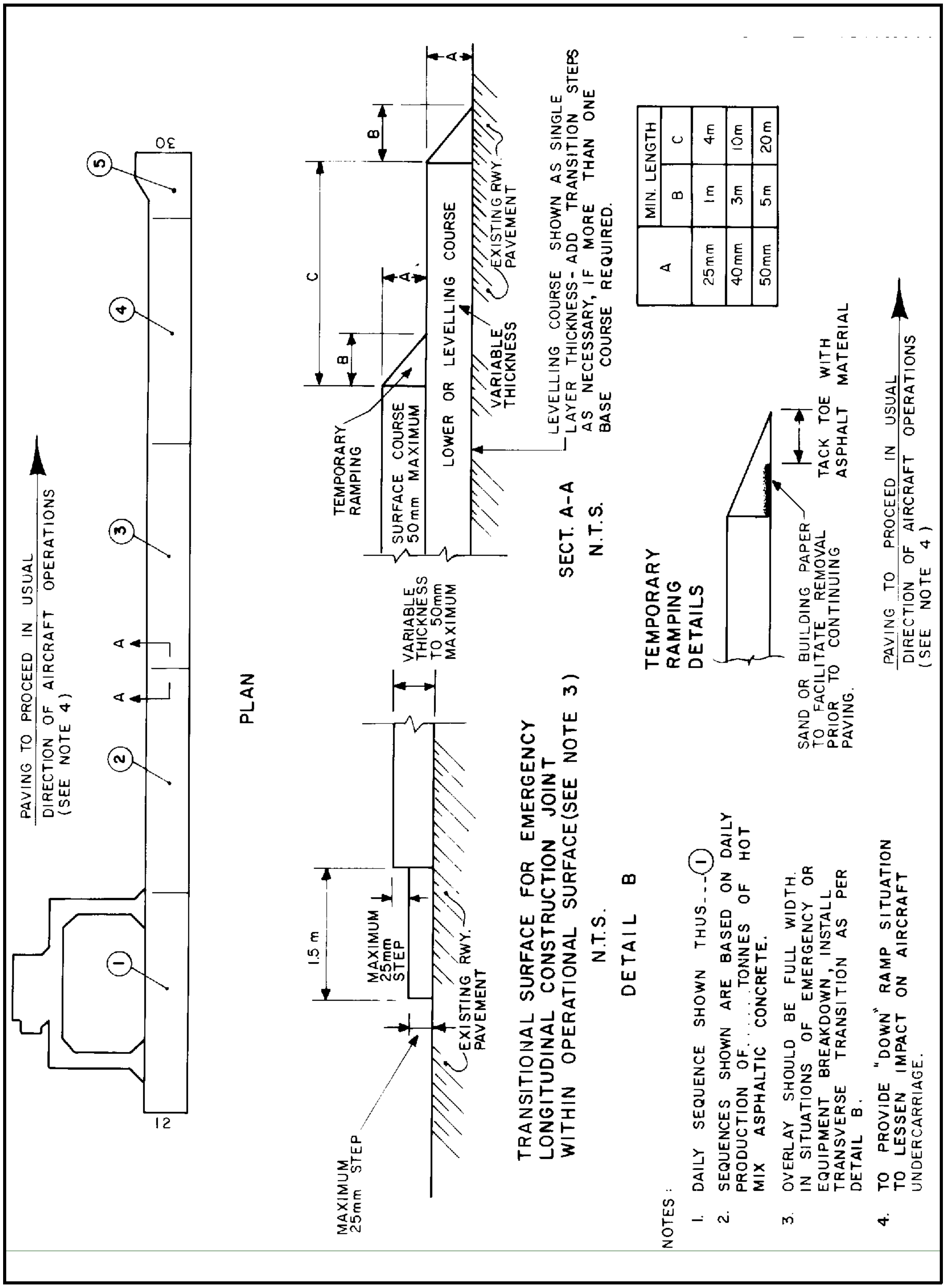
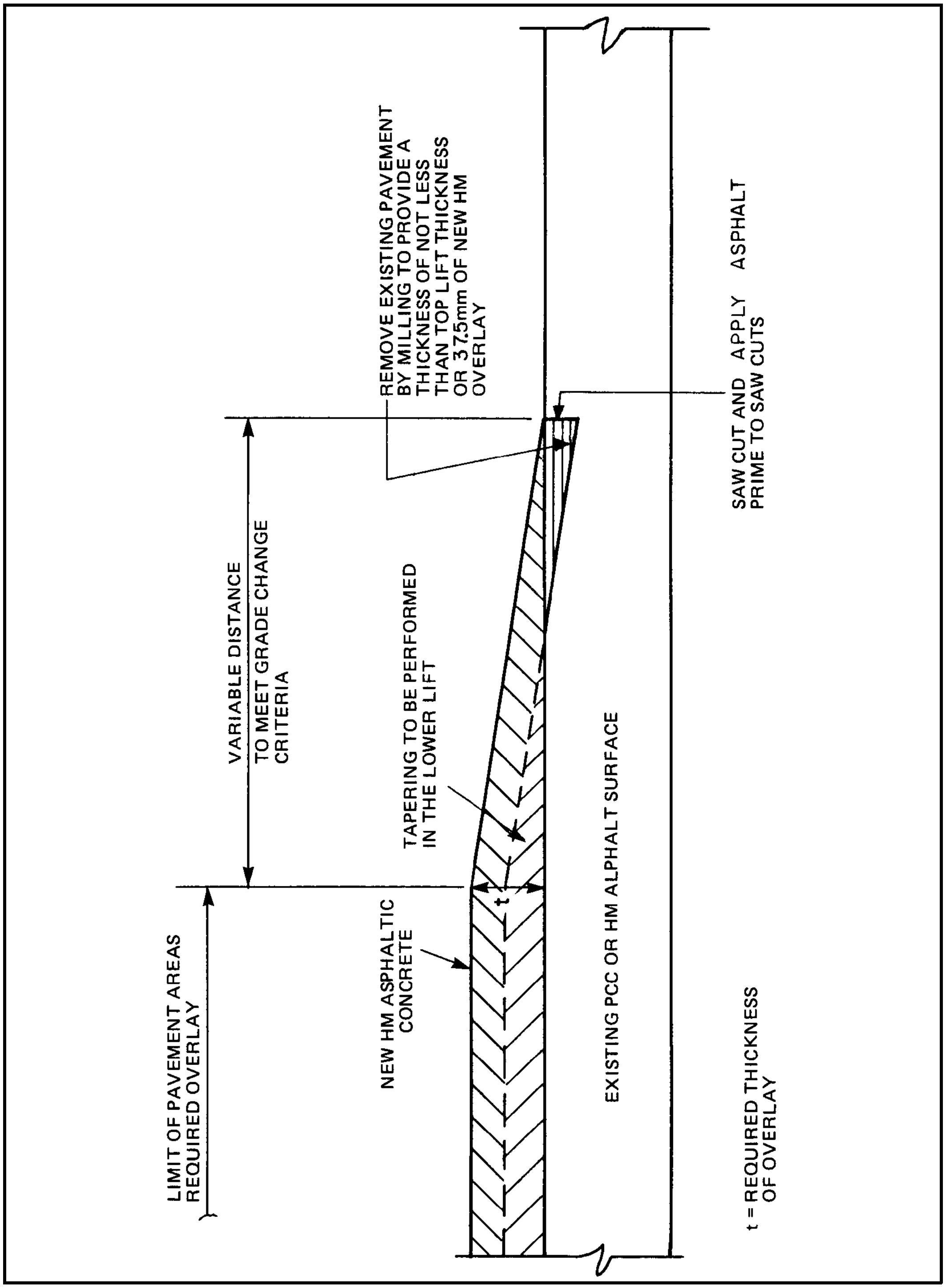


FIGURE 3.6.2
BUTT JOINT CONSTRUCTION DETAILS



3.7 DESIGN BRIEF

DESIGN BRIEF - GENERAL

Guideline The design brief should serve as a base from which all work changes to the project related to design and construction are made. It should be prepared by the designers at the final design stage of a pavement project. The Regional Project Manager should be familiar with the design brief to the extent that all possible design implications should be explored and evaluated prior to making the final decision of work changes proposed during construction. The design brief should consist of:

(i) General Project Information;

(ii) Pavement Design Parameters;

(iii) Pavement Design Alternatives;

(iv) Grade Requirements.

3.7 DESIGN BRIEF (con't)

GENERAL PROJECT INFORMATION

Guideline — The general project information should be consistent with that stated in the project brief and should include:

(i) Project Scope;

(ii) General description of project (dimensions, area, pavement type, etc.);

(iii) Special site conditions including use of existing facilities, land area, height zoning restriction and building limit lines;

(iv) Construction restraints including runway closure, night time construction, underground facilities, provision of temporary facilities, seasonal restrictions, potential delivery problems, maintenance of essential services and environmental considerations; i.e. Storm Water Management restrictions

(v) Related work including electrical, drainage and pavement marking;

(vi) Proposed aggregate/borrow sources including location and haul route, estimated available volume, special production considerations, history of use, special concerns and alternative sources.

PAVEMENT DESIGN PARAMETERS

Guidelines

(i) Design aircraft loading (ALR), subgrade bearing strength and site air freezing index are the parameters which should be included with the design brief.

(ii) Reference should be made to Section 3.2 - Design Parameters and Variables, for the determination of values for these pavement design parameters.

3.7 DESIGN BRIEF (con't)

PAVEMENT DESIGN ALTERNATIVES

Guideline During planning and programming of a new pavement facility or the rehabilitation of an existing pavement, several design alternatives should be considered. In general, the design alternative recommended for construction should be the one with the lowest life cycle cost over an analysis period of 30 years. Life Cycle Cost includes initial construction costs, estimated maintenance and rehabilitation costs and should be discounted to their present day value. (Refer to AK-76-06, Life Cycle Costing Procedures, 1984) For each alternative, the design details should include:

(i) Design intents (rigid or flexible, frost or structural);

(ii) Pavement components layers and estimated cost of the pavement structure;

(iii) Rehabilitation requirements over a 30-year period and their cost discount to their present value at years rehabilitations estimated;

(iv) Annual maintenance requirements and the accumulated costs discounting to their present value over a 30-year period;

(v) Total estimated life cycle cost;

(vi) Description of operational restrictions.

3.7 DESIGN BRIEF (con't)

GRADE REQUIREMENTS

Guideline The following grade requirements should be included with the design brief:

(i) Original and final design elevations;

(ii) Final design grades- longitudinal and transverse;

(iii) Locations of transitions- cut and fill;

(iv) Excavation logistics complete with estimated usable and waste quantities;

(v) Quantities of the pavement component layers;

(vi) Areas requiring special grading details- e.g. runway/taxiway intersection;

(vii) Surface preparation requirements including asphalt levelling, crack repairs, surface cleaning and tack/prime coat application.

(viii) Licensing standards for gradients should be as specified in TP 312, Aerodrome Standards and Recommended Practices.

(ix) Drain invert restrictions to meet field drainage (Storm water management objectives).

INDEX

INDEX (con't)