SULIT

KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN AWAM

PEPERIKSAAN AKHIR

SESI II : 2023/2024

DCC30103: HIGHWAY AND TRAFFIC ENGINEERING

TARIKH : 13 JUN 2024
MASA : 8.30 PAGI – 10.30 PAGI (2 JAM)

Kertas ini mengandungi **SEPULUH (10)** halaman bercetak.
Bahagian A: Subjektif (2 soalan)
Bahagian B: Subjektif (4 soalan)
Dokumen sokongan yang disertakan : Formula

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SECTION A : 50 MARKS

BAHAGIAN A : 50 MARKAH

INSTRUCTION:

This section consists of **TWO (2)** subjective questions. Answer **ALL** questions.

ARAHAN :

*Bahagian ini mengandungi **DUA (2)** soalan subjektif. Jawab **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO2 (a) Concession toll-road of four-lane freeways are designed to be constructed using full-depth asphalt pavement. The average daily traffic is 9870 vehicles of which 15% are commercial vehicles with an un-laden weight of more than 1.5 tons. The design traffic (traffic category) using the JKR 5/85 amendment 2013 method for over 20 years design life of flat terrain, 5% annual traffic growth and a CBR value of 12.1%. Table A1(a) is ADT based on the HPU survey (from 06:00 to 22:00 hours). Select suitable pavement structure for that highway.

Jalan tol konsesi lebuh raya empat lorong direka bentuk untuk dibina menggunakan turapan asfalt kedalaman penuh. Purata trafik harian ialah 9870 kenderaan yang mana 15% adalah kenderaan komersial dengan berat tanpa muatan melebihi 1.5 tan. Trafik reka bentuk (kategori trafik) menggunakan kaedah JKR 5/85 pindaan 2013 selama lebih 20 tahun hayat rekabentuk pada rupa bumi rata, 5% pertumbuhan trafik tahunan dan nilai CBR ialah 12.1%. Jadual A1(a) adalah ADT berdasarkan tinjauan HPU (dari jam 06:00 hingga 22:00). Pilih struktur turapan yang sesuai untuk lebuh raya tersebut.

Table A1(a) / *Jadual A1(a)*

Class / *Kelas*	Traffic Count / *Bilangan Trafik*
CV1	900
CV2	550
CV3	400
CV4	95

[10 marks]

[*10 markah*]

CLO2 (b) Based on the Table A1(b), recommend the timing diagram in designing traffic light control. Assume the amber time is 3 seconds, the lost time is 2 seconds and the inter green period is 5 seconds for both phases.

Berdasarkan Jadual A1(b), cadangkan rajah masa dalam mereka bentuk kawalan lampu isyarat. Andaikan masa kuning ialah 3 saat, masa hilang 2 saat dan masa antara hijau 5 saat untuk kedua-dua fasa.

	North / *Utara*		South / *Selatan*		East / *Timur*		West / *Barat*	
Flow/ *Aliran*	Car/ *Kereta*	300	Car/ *Kereta*	255	Car/ *Kereta*	580	Car/ Kereta	690
	Motorcycle/ *Motosikal*	150	Motorcycle/ *Motosikal*	120	Motorcycle/ *Motosikal*	150	Motorcycle/ *Motosikal*	120
	Bus / *Bas*	45	Bus / *Bas*	40	Bus / *Bas*	50	Bus / *Bas*	40
	Heavy Vehicle / *Kenderaan Berat*	60	Heavy Vehicle / *Kenderaan Berat*	58	Heavy Vehicle / *Kenderaan Berat*	54	Heavy Vehicle / Kenderaan Berat	80
Saturated Flow (pcu/hr)/ *Aliran Tepu (ukp/j)*	1970		1970		3160		3160	

Table A1(b) / *Jadual A1(b)*

[15 marks]

[*15 markah*]

QUESTION 2

SOALAN 2

CLO2 (a) Good traffic management can reduce the percentage of accidents in an area. Explain **FIVE (5)** purposes of traffic management.

*Pengurusan trafik yang baik boleh mengurangkan peratus kemalangan di sesuatu kawasan. Terangkan **LIMA (5)** tujuan pengurusan trafik.*

[10 marks]

[*10 markah*]

CLO2 (b) There are several common damages in flexible pavements. Classify **FIVE (5)** types of damage in flexible pavement.

*Terdapat beberapa kerosakan yang biasa dalam turapan boleh lentur. Kelaskan **LIMA (5)** jenis kerosakan pada turapan boleh lentur.*

[5 marks]

[*5 markah*]

CLO2 (c) One of the road damage detection techniques is using Automatic Digital Image Processing Technique. This approach makes it possible to examine and assess more damaged areas swiftly. As a road maintenance management team, determine the road maintenance management plan for road damage in Figure A2(c).

Salah satu teknik pengesanan kerosakan jalan adalah menggunakan Teknik Pemprosesan Imej Digital Automatik. Pendekatan ini membolehkan pemeriksaan dan penilaian kawasan yang rosak lebih banyak dengan pantas. Sebagai pasukan pengurusan penyelenggaraan jalan, tentukan plan pengurusan penyelenggaran jalan untuk kerosakan di dalam Rajah A2(c).

Figure A2(c) / *Rajah A2(c)*

[10 marks]

[*10 markah*]

SECTION B : 50 MARKS
BAHAGIAN B :50 MARKAH

INSTRUCTION:
This section consists of **FOUR (4)** subjective questions. Answer **TWO (2)** question only.

ARAHAN:
*Bahagian ini mengandungi **EMPAT (4)** soalan subjektif. Jawab **DUA (2)** soalan sahaja.*

QUESTION 1
SOALAN 1

CLO1 (a) Identify **FIVE (5)** categories of roads in Malaysia.
*Kenal pasti **LIMA (5)** kategori jalan raya di Malaysia.*

[5 marks]
[*5 markah*]

CLO1 (b) As an Assistant Engineer, you are requested to perform tests on aggregate to be used for a road construction. Explain **TWO (2)** tests with their procedures that can be carried out on the aggregates.
*Sebagai seorang pembantu jurutera, anda di kehendaki untuk menjalankan ujian ke atas batu baur yang akan digunakan dalam pembinaan jalan raya. Terangkan **DUA (2)** ujikaji beserta dengan prosedur yang boleh dijalankan ke atas batu baur.*

[10 marks]
[*10 markah*]

CLO1 (c) Bitumen is produced from the distillation of petroleum oil. Bitumen is widely used in the road construction process. Determine **FIVE (5)** functions of bitumen in road construction process.

*Bitumen terhasil daripada proses penyulingan minyak petroleum. Bitumen digunakan secara meluas dalam proses pembinaan jalan raya. Tentukan **LIMA (5)** fungsi bitumen dalam proses pembinaan jalan raya.*

[10 marks]

[*10 markah*]

QUESTION 2

SOALAN 2

CLO1 (a) There are two common types of pavement roads in Malaysia. One of them is flexible pavement. Illustrate the diagram of the flexible pavement with labels.

Terdapat dua jenis turapan biasa untuk jalan raya di Malaysia. Salah satunya ialah turapan boleh lentur. Lakarkan rajah turapan boleh lentur dengan label.

[5 marks]

[*5 markah*]

CLO1 (b) Flexible pavements are constructed from bituminous or unbound material and the stress is transmitted to the sub-grade through the lateral distribution of the applied load. Explain the function of each structural layer of flexible pavement.

Turapan boleh lentur dibina daripada bahan bitumen atau bahan tidak terikat dan tegasan di hantar ke sub gred melalui agihan beban sisi. Terangkan fungsi bagi setiap lapisan struktur turapan boleh lentur.

[10 marks]

[*10 markah*]

CLO1 (c) The road surface must be constructed according to the standards to ensure the road's durability. Explain the construction process of road surfaces for flexible pavement.

Permukaan jalan mesti dibina mengikut piawaian untuk mendapatkan ketahanan jalan yang baik. Terangkan proses pembinaan lapisan permukaan bagi turapan boleh lentur.

[10 marks]

[*10 markah*]

QUESTION 3

SOALAN 3

CLO1 (a) The design of rigid pavement is based on providing a structural cement concrete slab of sufficient strength to resist the loads from traffic. Explain **FIVE (5)** characteristics of rigid pavement.

*Rekabentuk turapan tegar adalah berdasarkan penyediaan papak konkrit simen struktur dengan kekuatan yang mencukupi untuk menahan beban daripada lalu lintas. Terangkan **LIMA (5)** ciri turapan tegar.*

[5 marks]

[*5 markah*]

CLO1 (b) At least five percent of the construction of new roads in Malaysia under *Rancangan Malaysia* ke-10 will use the rigid pavement method. The cost of road construction using the rigid pavement method is more expensive which is between 20 to 50 percent compared to the conventional flexible pavement. Explain in detail the construction of rigid pavement using the Fixed Form Method.

Sekurang-kurangnya lima peratus daripada pembinaan jalan baharu di Malaysia di bawah Rancangan Malaysia ke-10 akan menggunakan kaedah turapan tegar. Kos pembinaan jalan menggunakan kaedah turapan tegar adalah lebih mahal iaitu antara 20 hingga 50 peratus berbanding turapan boleh lentur konvensional. Terangkan secara terperinci pembinaan turapan tegar menggunakan Kaedah 'Fixed Form'.

[10 marks]

[*10 markah*]

CLO1 (c) There are several types of rigid pavements that are usually used in road construction. Determine the **FIVE (5**) advantages and **FIVE (5)** disadvantages of rigid pavement.

*Terdapat beberapa jenis turapan tegar yang biasanya digunakan dalam pembinaan jalan raya. Tentukan **LIMA (5)** kelebihan dan **LIMA (5)** keburukan turapan tegar.*

[10 marks]

[*10 markah*]

QUESTION 4

SOALAN 4

CLO1 (a) According to the Manual on Traffic Control Devices Traffic Sign Applications, there are requirements for traffic control devices. Identify **FIVE (5**) basic characteristics of traffic control devices.

*Menurut 'Manual on Traffic Control Devices Traffic Sign Applications', terdapat keperluan alat peranti kawalan lalu lintas. Kenal pasti **LIMA (5)** ciri asas peranti kawalan trafik.*

[5 marks]

[*5 markah*]

CLO1 (b) Traffic signboards are needed to help control traffic operations and road users. There are three types of traffic signboard categories used in the traffic management system in Malaysia. Illustrate **TWO (2)** examples for each category of traffic signboards.

*Papan tanda diperlukan untuk mengawal operasi lalulintas dan pengguna jalan raya. Terdapat tiga jenis kategori papan tanda trafik yang digunakan di dalam sistem pengurusan lalulintas di Malaysia. Lakarkan **DUA (2)** contoh bagi setiap kategori papan tanda trafik.*

[10 marks]

[*10 markah*]

CLO1 (c) There are numerous colours that have been used in the classification of traffic signboards based on their functions. Explain the meaning of **FIVE (5)** colours used for traffic control devices.

*Terdapat banyak warna yang telah digunakan dalam klasifikasi papan tanda trafik berdasarkan fungsinya. Terangkan maksud **LIMA (5)** warna yang digunakan untuk peranti kawalan lalu lintas.*

[10 marks]

[*10 markah*]

SOALAN TAMAT

FLEXIBLE PAVEMENT DESIGN FORMULA

$$ESAL_{Y1} = ADT \times 365 \times P_{CV} \times LEF \times L \times T$$

$$ESAL_{Y1} = [ADT_{VC1} \times LEF_1 + ADT_{VC2} \times LEF_2 + \ldots + ADT_{VC4} \times LEF_4] \times 365 \times L \times T$$

$$Design\ Traffic\ ESAL_{DES} = ESAL_{Y1} \times \frac{[(1 + r)^n - 1]}{r}$$

$$Design\ Traffic\ ESAL_{DES} = ESAL_{Y1} \times TGF$$

$$Design\ Input\ Value = Mean - (Normal\ Deviate \times Standard\ Deviation)$$

TABLE 2.1: Axle Configuration and Load Equivalence Factors (LEF) based on Traffic Categories used by HPU

Vehicle		Load Equivalence Factor (LEF)
HPU Class Designation	Class	
Cars and Taxis	C	0
Small Lorries and Vans (2 Axles)	CV1	0.1
Large Lorries (2 to 4 Axles)	CV2	4.0
Articulated Lorries (3 or more Axles)	CV3	4.4
Buses (2 or 3 Axles)	CV4	1.8
Motorcycles	MC	0
Commercial Traffic (Mixed)	CV%	3.7

TABLE 2.2: Lane Distribution Factors

Number of Lanes (in ONE direction)	Lane Distribution Factor, L
One	**1.0**
Two	**0.9**
Three or more	**0.7**

Note: *Traffic in the primary design lane (one direction) decreases with increasing number of lanes.*

TABLE 2.3: Terrain Factors

Type of Terrain	Terrain Factor, T
Flat	**1.0**
Rolling	**1.1**
Mountainous/Steep	**1.3**

Note: *As terrain changes from flat to mountainous topography, the percentage of road sections with steep slopes and with curves increases, thus increasing stresses and strains in pavement structures due to breaking, acceleration and cornering of commercial vehicles.*

TABLE 2.4: Total Growth Factors (TGF)

Design Period (Years)	Annual Growth Rate (%)					
	2	3	4	5	6	7
10	10.95	11.46	12.01	12.58	13.18	13.82
15	17.29	18.60	20.02	21.58	23.28	25.13
20	24.30	26.87	29.78	33.06	36.79	41.00
25	32.03	36.46	41.65	47.73	54.86	63.25
30	40.57	47.58	56.08	66.44	79.06	94.46

TABLE 2.5: Traffic Categories used in this Manual (ESAL = 80 kN)

Traffic Category	Design Traffic (ESAL x 10^6)	Probability (Percentile) Applied to Properties of Sub-Grade Materials
▪ T 1	**≤ 1.0**	≥ 60%
▪ T 2	**1.1 to 2.0**	≥ 70%
▪ T 3	**2.1 to 10.0**	≥ 85%
▪ T 4	**10.1 to 30.0**	≥ 85%
▪ T 5	**> 30.0**	≥ 85%

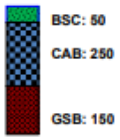
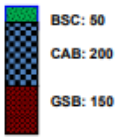
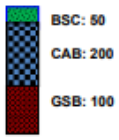
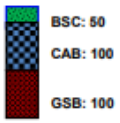
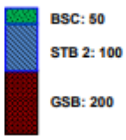
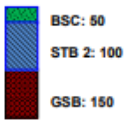
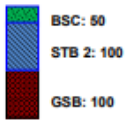
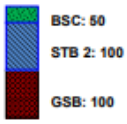
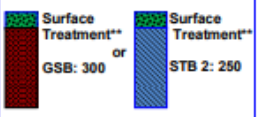
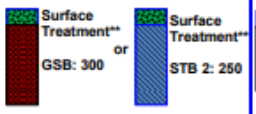
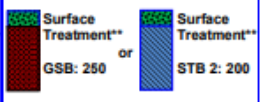
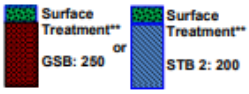
TABLE 2.6: Classes of Sub-Grade Strength (based on CBR) used as Input in the Pavement Catalogue of this Manual

Sub-Grade Category	CBR (%)	Elastic Modulus (MPa)	
		Range	Design Input Value
▪ SG 1	**5 to 12**	50 to 120	**60**
▪ SG 2	**12.1 to 20**	80 to 140	**120**
▪ SG 3	**20.1 to 30.0**	100 to 160	**140**
▪ SG 4	**> 30.0**	120 to 180	**180**

TABLE 3.1: Conceptual Outline of Pavement Structures used in this Manual

Pavement Structure	**Traffic Category (based on million ESALs @ 80 kN)**				
	≤ 1	***1 to 2***	***2.1 to 10***	***10.1 to 30***	***> 30***
	T 1	**T 2**	**T 3**	**T 4**	**T 5**
▪ **Combined Thickness of Bituminous Layers**	**5 cm**	**10 cm**	**18 cm**	**20 cm**	**24 cm**
Crushed Aggregate Road Base + Sub-Base for Sub-Grade CBR of:					
○ **5 to 12**	**25+15 cm**	**20+15 cm**	**20+20 cm**	**NR**	**NR**
○ **12.1 to 20**	**20+15 cm**	**20+15 cm**	**20+20 cm**	**20+20 cm**	**20+20 cm**
○ **20.1 to 30**	**20+10 cm**	**20+10 cm**	**20+15 cm**	**20+15 cm**	**20+15 cm**
○ **> 30**	**20 cm**	**20+10 cm**	**20+10 cm**	**20+10 cm**	**20+10 cm**

FIGURE 3.1: Pavement Structures for Traffic Category T 1: < 1.0 million ESALs (80 kN)

Pavement Type	Sub-Grade Category			
	SG 1: CBR 5 to 12	SG 2: CBR 12.1 to 20	SG 3: CBR 20.1 to 30	SG 4: CBR > 30
Conventional Flexible: Granular Base				
Deep Strength: Stabilised Base				
Stabilised Base with Surface Treatment*				

Notes:

* *Full Depth Asphalt Concrete Pavement is not recommended for this Traffic Category.*

** *Single or Double Layer Chip Seal or Micro-Surfacing.*

FIGURE 3.2: Pavement Structures for Traffic Category T 2: 1.0 to 2.0 million ESALs (80 kN)

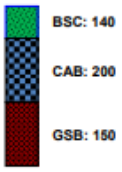
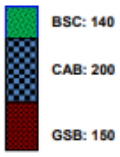
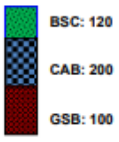
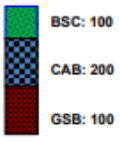
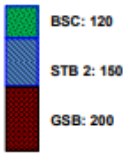
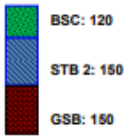
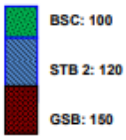
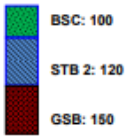
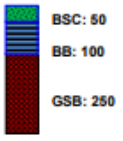
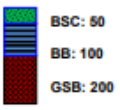
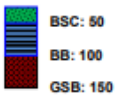
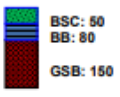
Pavement Type	Sub-Grade Category			
	SG 1: CBR 5 to 12	SG 2: CBR 12.1 to 20	SG 3: CBR 20.1 to 30	SG 4: CBR > 30
Conventional Flexible: Granular Base				
Deep Strength: Stabilised Base				
Full Depth: Asphalt Concrete Base				

FIGURE 3.3: Pavement Structures for Traffic Category T 3: 2.0 to 10.0 million ESALs (80 kN)

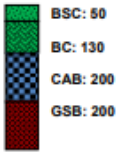
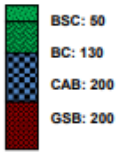
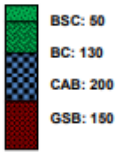
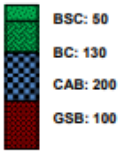
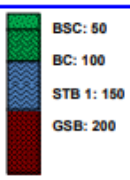
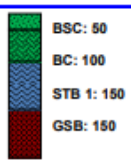
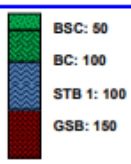
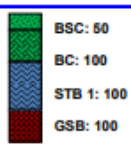
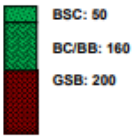
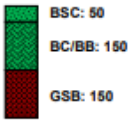
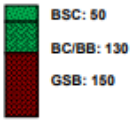
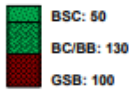
Pavement Type	Sub-Grade Category			
	SG 1: CBR 5 to 12	SG 2: CBR 12.1 to 20	SG 3: CBR 20.1 to 30	SG 4: CBR > 30
Conventional Flexible: Granular Base				
Deep Strength: Stabilised Base				
Full Depth: Asphalt Concrete Base				

FIGURE 3.4: Pavement Structures for Traffic Category T 4: 10.0 to 30.0 million ESALs (80 kN)

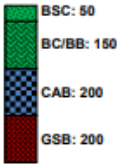
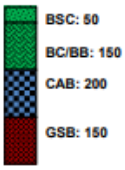
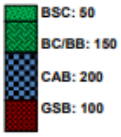
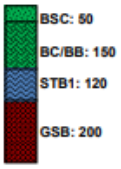
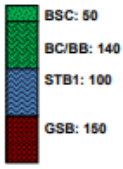
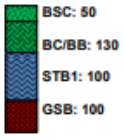
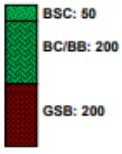
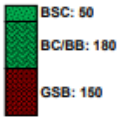
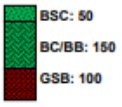
Pavement Type	Sub-Grade Category			
	SG 1: CBR 5 to 12	SG 2: CBR 12.1 to 20	SG 3: CBR 20.1 to 30	SG 4: CBR > 30
Conventional Flexible: Granular Base				
Deep Strength: Stabilised Base				
Full Depth: Asphalt Concrete Base				

FIGURE 3.5: Pavement Structures for Traffic Category T 5: > 30.0 million ESALs (80 kN)

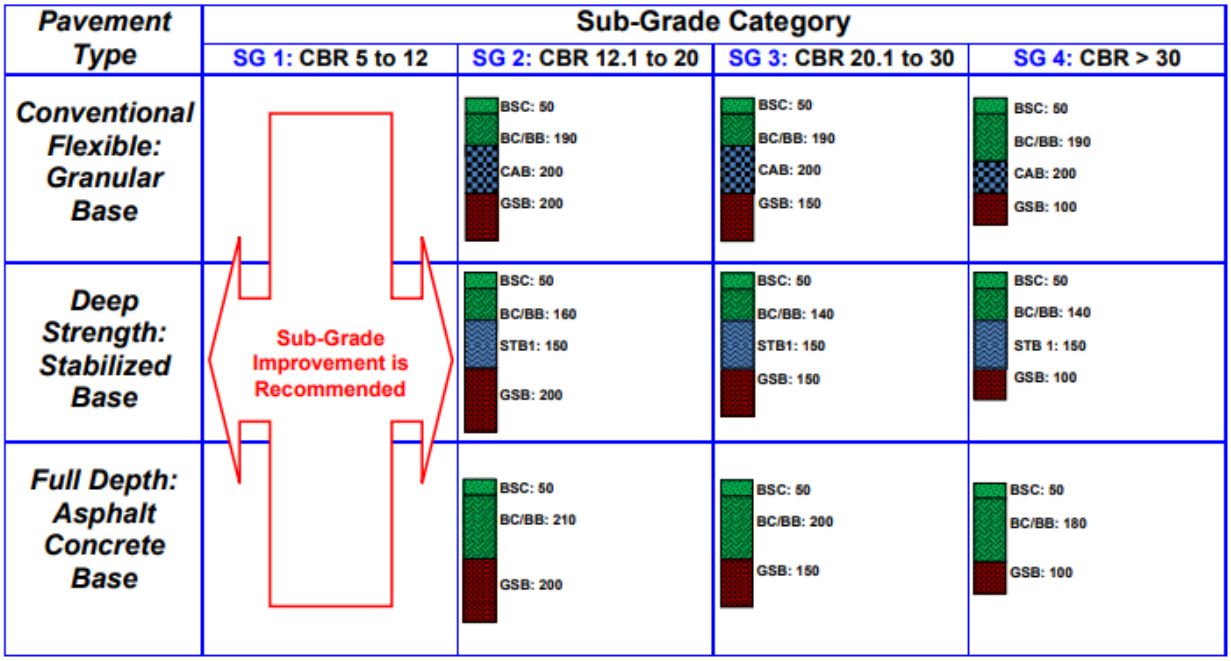
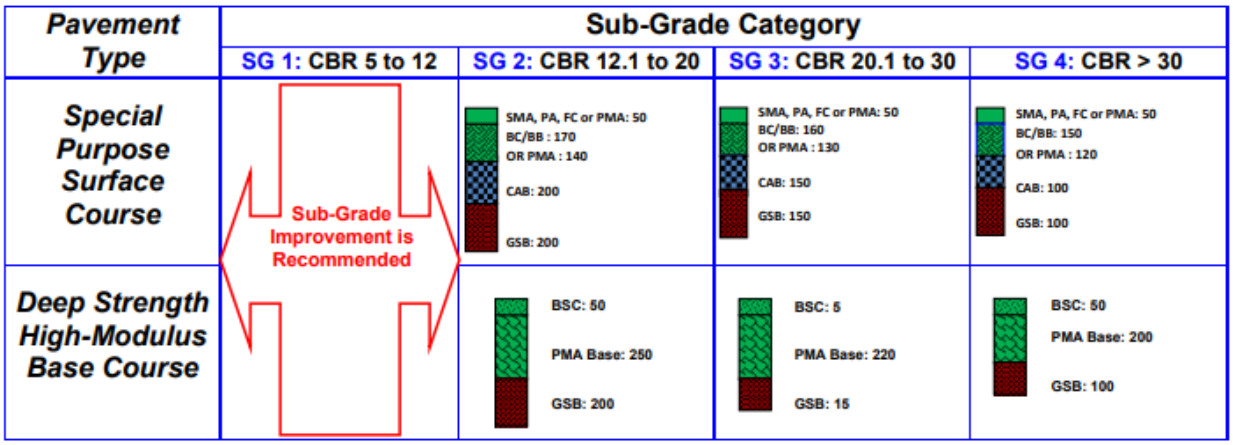


FIGURE 3.6: Pavement Structures for Traffic Category T 5: > 30.0 million ESALs (80 kN)
(Use of Polymer Modified Asphalt)



JUNCTION DESIGN FORMULA

$$S = 525W \; or \; S = 160W$$

$$L = \sum Lost\ Time + \sum (Intergreen\ time - yellow\ time)$$

$$C_o = \frac{1.5L + 5}{1 - Y}$$

$$y = \frac{Q}{S}$$

$$g_{phase} = \frac{y_{phase}}{Y}(C_o - L)$$

$$G_{phase} = g_{phase} + lost\ time - yellow\ time$$

Table 6-I

Relationship between effective lane width and saturation flow

w (m)	3.0	3.25	3.5	3.75	4.0	4.25	4.5	4.75	5.0	5.25
s (pcu/h)	1845	1860	1885	1915	1965	2075	2210	2375	2560	2760

Table 6-5

Conversion factors to pcu's

Vehicle Type	Equipment pcu value
Passenger cars	1.00
Motor cycles	0.33
Light vans	1.75
Medium lorries	1.75
Heavy lorries	2.25
Buses	2.25

Table 6-2

Correction factor for the effect of gradient

Correction Factor, Fg	Description
0.85	for upward slope of 5%
0.88	for upward slope of 4%
0.91	for upward slope of 3%
0.94	for upward slope of 2%
0.97	for upward slope of 1%
1.00	for level grade
1.03	for downward slope of 1%
1.06	for downward slope of 2%
1.09	for downward slope of 3%
1.12	for downward slope of 4%
1.15	for downward slope of 5%

Table 6-3

Correction Factor for the effect of turning radius

Correction Factor, Ft	Description
0.85	for turning radius R < 10 m
0.90	for turning radius where 10 m < R < 15 m
0.96	for turning radius where 15 m < R < 30 m

Table 6-4

Correction factors for turning traffic

% turning traffic	Factor for right-turn, Fr	Factor for left-turn, F1
5	0.96	1.00
10	0.93	1.00
15	0.90	0.99
20	0.87	0.98
25	0.84	0.97
30	0.82	0.95
35	0.79	0.94
40	0.77	0.93
45	0.75	0.92
50	0.73	0.91
55	0.71	0.90
60	0.69	0.89