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 : 2025/2026

DCC20312 : PAVEMENT ENGINEERING

TARIKH : 11 MEI 2026
MASA : 8.30 PAGI - 10.30 PAGI (2 JAM)

Kertas ini mengandungi **SEPULUH (10)** halaman bercetak.

Subjektif (4 soalan)

Dokumen sokongan yang disertakan : Formula

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

INSTRUCTION:

This section consists of **FOUR (4)** subjective questions. Answer **ALL** questions.

ARAHAN:

*Bahagian ini mengandungi **EMPAT (4)** soalan subjektif. Jawab **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO1 (c) Identify **FIVE (5)** importance's of road pavement infrastructure.
*Kenal pasti **LIMA (5)** kepentingan infrastruktur turapan jalan.*

[5 marks]
[*5 markah*]

CLO1 (b) Road and pavement development in Malaysia involves various organisations responsible for planning, designing, regulating, constructing, and maintaining pavement infrastructure. Explain **FOUR (4)** organisations involved in pavement engineering in Malaysia.
*Pembinaan dan pembangunan jalan raya di Malaysia melibatkan pelbagai organisasi yang berperanan dalam merancang, mereka bentuk, mengawal, membina, dan menyelenggara turapan jalan. Terangkan **EMPAT (4)** organisasi yang terlibat dalam kejuruteraan turapan di Malaysia.*

[8 marks]
[*8 markah*]

CLO1 (c) Alternative pavement is constructed using recycled or natural materials to produce a strong and durable road surface. These materials can be more economical and sustainable than conventional flexible pavement materials. Explain the construction methods of **THREE (3)** types of alternative pavements

*Turapan alternatif dibina menggunakan bahan kitar semula atau bahan semula jadi untuk menghasilkan permukaan jalan yang kukuh dan tahan lama. Bahan-bahan ini juga boleh menjadi lebih ekonomik dan lestari berbanding bahan turapan lentur konvensional. Terangkan kaedah pembinaan bagi **TIGA (3)** jenis turapan alternatif.*

[12 marks]

[*12 markah*]

QUESTION 2

SOALAN 2

CLO1 (a) Identify **TWO (2)** types of pavement maintenance.

*Kenal pasti **DUA (2)** jenis penyelenggaraan turapan.*

[5 marks]

[*5 markah*]

CLO1 (b) Road pavement may become damaged over time due to traffic, weather, and lack of maintenance. The maintenance method chosen depends on the type and severity of the damage. Explain the appropriate maintenance methods for pavements that are heavily cracked and for pavements that have lost stability and strength.

Turapan jalan boleh mengalami kerosakan dari semasa ke semasa akibat trafik, cuaca, dan kekurangan penyenggaraan. Kaedah penyenggaraan yang dipilih bergantung pada jenis dan tahap kerosakan. Terangkan kaedah penyenggaraan yang sesuai bagi turapan yang mengalami keretakan teruk dan turapan yang telah kehilangan kestabilan serta kekuatan.

[8 marks]

[*8 markah*]

CLO1

(c) Pavement maintenance activities such as pothole patching, resurfacing, crack sealing, and line marking are essential to ensure road safety and serviceability. A road maintenance team is assigned to repair potholes on a two-lane highway with moderate traffic volume. Explain **THREE (3)** potential safety hazards that may occur during the pavement maintenance work and appropriate safety measures that should be implemented to protect workers and road users.

*Aktiviti penyelenggaraan turapan seperti menampal jalan berlubang, menurap semula, menampal retakan dan menanda garisan adalah penting untuk memastikan keselamatan jalan raya dan kebolehkhidmatan. Pasukan penyelenggaraan jalan ditugaskan untuk membaiki jalan berlubang di lebuhraya dua lorong dengan jumlah trafik sederhana. Terangkan **TIGA (3)** potensi bahaya keselamatan yang mungkin berlaku semasa kerja penyenggaraan turapan dan langkah keselamatan yang sesuai yang perlu dilaksanakan untuk melindungi pekerja dan pengguna jalan raya.*

[12 marks]

[*12 markah*]

QUESTION 3

SOALAN 3

CLO2 (a) A Flexible pavement is used on a road that carries heavy traffic loading and is exposed to significant temperature changes. Based on the situation above, explain **TWO (2)** roles of bitumen in helping the pavement perform effectively and achieve a longer service life.

*Turapan lentur digunakan pada satu jalan yang menanggung beban trafik yang tinggi dan terdedah kepada perubahan suhu yang ketara. Berdasarkan situasi di atas, terangkan **DUA (2)** peranan bitumen dalam membantu turapan berfungsi dengan berkesan serta mempunyai jangka hayat yang lebih panjang.*

[5 marks]

[*5 markah*]

CLO2 (b) Bitumen must be tested according to recognized standards to ensure compliance with the required specifications for pavement construction. Explain the purpose of **TWO (2)** laboratory tests for bitumen that affect effective pavement performance.

*Bitumen perlu diuji mengikut piawaian yang diiktiraf bagi memastikan pematuhan terhadap spesifikasi yang ditetapkan untuk pembinaan turapan. Terangkan tujuan **DUA (2)** ujian makmal bagi bitumen yang memberi kesan kepada keberkesanan prestasi turapan.*

[8 marks]

[*8 markah*]

CLO2 (c) A road construction project is designed using Asphaltic Concrete Wearing Course (ACW14) for a heavily trafficked urban road. Six trial mixes with bitumen contents ranging from 4.0% to 6.5% were prepared, and Marshall tests were conducted to assess the performance of each mix. The results are shown in Table 3(c). As a pavement engineer, evaluate the Optimum Bitumen Content (OBC) for the ACW14 mix.

(Appendix 2 must be submitted together with the answer script.)

Satu projek pembinaan jalan direkabentuk menggunakan Asphaltic Concrete Wearing Course (ACW14) bagi jalan bandar yang menerima beban trafik yang tinggi. Enam campuran percubaan dengan kandungan bitumen antara 4.0% hingga 6.5% telah disediakan, dan ujian Marshall telah dijalankan untuk menilai prestasi setiap campuran. Keputusan ujian tersebut ditunjukkan dalam Jadual 3(c). Sebagai seorang jurutera turapan, nilaikan Kandungan Bitumen Optimum (OBC) bagi campuran ACW14 tersebut.

(Lampiran 2 hendaklah disertakan bersama skrip jawapan.)

Table 3(c) / *Jadual 3(c)*

Bitumen Content/ *Kandungan Bitumen* (%)	Density/ *Ketumpatan* (Mg/cu.m3)	Stability/ *Kestabilan* (kg)	Flow/ *Aliran* (mm)	Void in Mix / *Lompang Udara dalam Campuran* (%)	Void in Aggregate Filled with Bitumen/ *Lompang udara terisi Bitumen* (%)
4.0	2.315	1200	2.6	8	52
4.5	2.324	1300	2.8	6.5	60
5.0	2.333	1380	3.0	5.2	68
5.5	2.340	1360	3.2	4.2	74
6.0	2.337	1300	3.5	3.5	79
6.5	2.330	1220	3.8	3.9	80

[12 marks]

[*12 markah*]

QUESTION 4

SOALAN 4

CLO2 (a) A municipal council plans to construct a new access road to an industrial area. The road will carry moderate to heavy trucks and the subgrade soil has moderate strength. The engineer must select a suitable type of flexible pavement to ensure durability and cost-effectiveness. Identify **TWO (2)** suitable types of flexible pavement that can be used for this road.

*Sebuah majlis perbandaran merancang untuk membina jalan akses baharu ke kawasan perindustrian. Jalan tersebut akan menerima beban trafik daripada lori pada tahap sederhana hingga berat, manakala tanah subgred mempunyai kekuatan sederhana. Bagi memastikan ketahanan dan keberkesanan kos, jurutera perlu memilih jenis turapan lentur yang sesuai. Kenal pasti **DUA (2)** jenis turapan lentur yang sesuai untuk jalan ini.*

[5 marks]

[*5 markah*]

CLO2 (b) A new two-lane road is being constructed in a semi-urban area to accommodate increasing traffic from residential and commercial developments. During construction, several problems were observed, such as uneven compaction, segregation of asphalt mix, and inadequate drainage. These issues may reduce pavement performance and shorten its service life. Explain **FOUR (4)** important stages in flexible pavement construction, starting from subgrade preparation to asphalt layer construction.

*Sebuah jalan baharu dua lorong sedang dibina di kawasan separa bandar bagi menampung pertambahan trafik daripada pembangunan kawasan perumahan dan komersial. Semasa pembinaan, beberapa masalah telah dikenal pasti seperti pemadatan yang tidak sekata, pengasingan campuran asfalt, dan sistem saliran yang tidak mencukupi. Masalah ini boleh menjejaskan prestasi turapan serta memendekkan jangka hayat perkhidmatannya. Terangkan **EMPAT (4)** peringkat penting dalam pembinaan turapan lentur, bermula daripada penyediaan subgred hingga pembinaan lapisan asfalt.*

[8 marks]
[*8 markah*]

CLO2 (c) A new federal road is proposed to connect a developing industrial area in Malaysia. The road is expected to carry heavy commercial vehicles over a 20-year design life. Classify the traffic category design for 4 lane freeway with an Average Daily Traffic (ADT) of 8756 vehicles, which 15% is unladen commercial weight >1.5 tons. ADT based on Highway Planning Unit (HPU) surveys (from 06:00 to 22:00 hours) is given as Table 4(c). Terrain is flat and annual traffic growth rate is 5%.

Sebuah jalan persekutuan baharu dicadangkan untuk menghubungkan kawasan perindustrian yang sedang membangun di Malaysia. Jalan itu dijangka membawa kenderaan komersial berat sepanjang hayat reka bentuk 20 tahun. Kelaskan reka bentuk kategori trafik untuk lebuh raya 4 lorong dengan purata lalulintas harian trafik sebanyak 8756 kenderaan, berat komersial tanpa muatan >1.5 tan adalah 15%. Purata Trafik Harian (ADT) berdasarkan tinjauan Unit Perancang Lebuhraya (HPU) (dari jam 06:00 hingga 22:00) diberikan seperti Jadual 4(c). Rupa bumi adalah rata dan kadar pertumbuhan trafik tahunan ialah 5%.

Table 4(c) / *Jadual 4(c)*

Class / *Kelas*	ADT based on HPU / *ADT berdasarkan HPU*
CV1	263
CV2	197
CV3	197
CV4	131
CV5	131
CV6	131
CV7	105
CV8	92
CV9	66

[12 marks]

[*12 markah*]

SOALAN TAMAT

Appendix 1 / *Lampiran 1*

Table and Formula in Design Flexible Pavement ATJ 5/85 (Pindaan 2013)

$$ESAL_{Y1} = [ADT_{vc1} \times LEF_1 + ADT_{vc2} \times LEF_2 + \ldots + ADT_{vc9} \times LEF_9] \times 365 \times L \times T \quad \ldots(1)$$

where;

$ESAL_{Y1}$ = Number of ESALs for the Base Year (Design Lane)

ADT_{VC2}, etc = Average Daily Number of Vehicles in each Vehicle Class

LEF_2, etc = Load Equivalence Factors of applicable vehicle class

L = Lane Distribution Factor (refer to **Table 2.2**)

T = Terrain Factor (refer to **Table 2.3**)

$$\text{Design Traffic } ESAL_{DES} = ESAL_{Y1} \times \frac{[(1+r)^n - 1]}{r} \quad \ldots (3)$$

where;

$ESAL_{DES}$ = Design Traffic for the Design Lane in one Direction (determines the Traffic Category used as Basis for selecting a Pavement Structure from the Catalogue)

$ESAL_{Y1}$ = Number of ESALs for the Base Year (Equation 1 or 2)

r = Average Annual Traffic Growth Factor for Design Period

n = Number of Years in Design Period

$$\text{Design Traffic } ESAL_{DES} = ESAL_{Y1} \times TGF \quad \ldots (3a)$$

Design Input Value = Mean – (Normal Deviate x Standard Deviation)

Appendix 1 / *Lampiran 1*

Amendment 2.

Section 2.2 Determination of Design Traffic (Table 2.1, page 8) shall be read as follows:

Amendment 2 **TABLE 2.1: Axle Configuration and Load Equivalence Factors (LEF)**

Vehicle		Load Equivalence Factor (LEF)
Class Designation	**Class**	
Cars and Taxis	C	0
Rigid Vehicle (1+1) incl. Buses (2 Axle)	CV1	3.9
Rigid Vehicle (1+2) incl. Buses (3 Axle)	CV2	2.8
Rigid Vehicle (2+2) (4 Axle)	CV3	2.6
Articulated Vehicle (1+1+1) (3 Axle)	CV4	7.1
Articulated Vehicle (1+1+2) (4 Axle)	CV5	6.1
Articulated Vehicle (1+1+3) (5 Axle)	CV6	4.7
Articulated Vehicle (1+2+2) (5 Axle)	CV7	4.2
Articulated Vehicle (1+2+3) (6 Axle)	CV8	3.5
Articulated Vehicle (1+2+4) (7 Axle)	CV9	3.6
Motorcycles	MC	0

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**

TABLE 2.3: Terrain Factors

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

Appendix 1 / *Lampiran 1*

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)

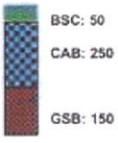
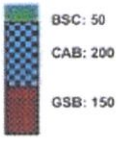
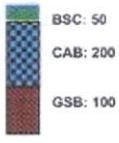
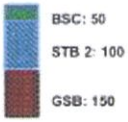
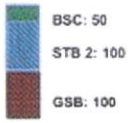
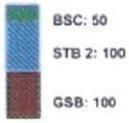
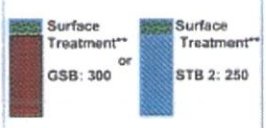
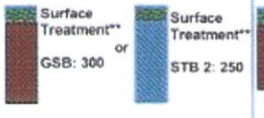
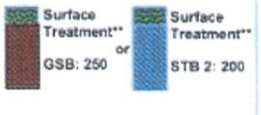
Traffic Category	Design Traffic (ESAL x 10^6)	Probability (Percentile) Applied to Properties of Sub-Grade Materials
▪ T 1	**≤ 1.0**	≥ 60%
▪ T 2	**1.1 to 2.0**	≥ 70%
▪ T 3	**2.1 to 10.0**	≥ 85%
▪ T 4	**10.1 to 30.0**	≥ 85%
▪ T 5	**> 30.0**	≥ 85%

Appendix 1 / *Lampiran 1*

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**

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.*

Appendix 1 / *Lampiran 1*

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

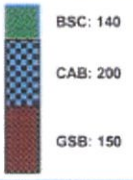
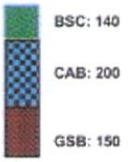
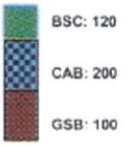
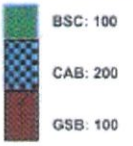
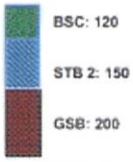
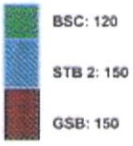
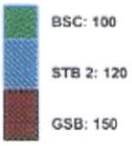
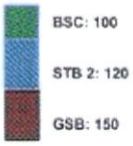
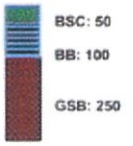
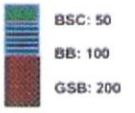
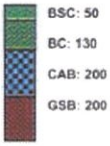
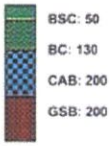
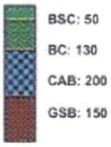
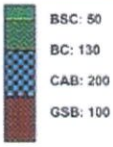
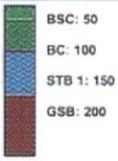
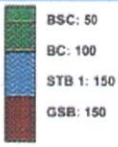
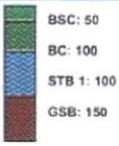
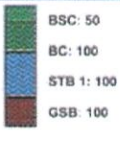
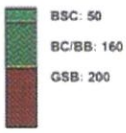
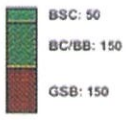
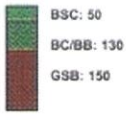
Pavement Type	Sub-Grade Category			
	SG 1: CBR 5 to 12	SG 2: CBR 12.1 to 20	SG 3: CBR 20.1 to 30	SG 4: CBR > 30
Conventional Flexible: Granular Base				
Deep Strength: Stabilised Base				
Full Depth: Asphalt Concrete Base				

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				

Appendix 1 / *Lampiran 1*

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

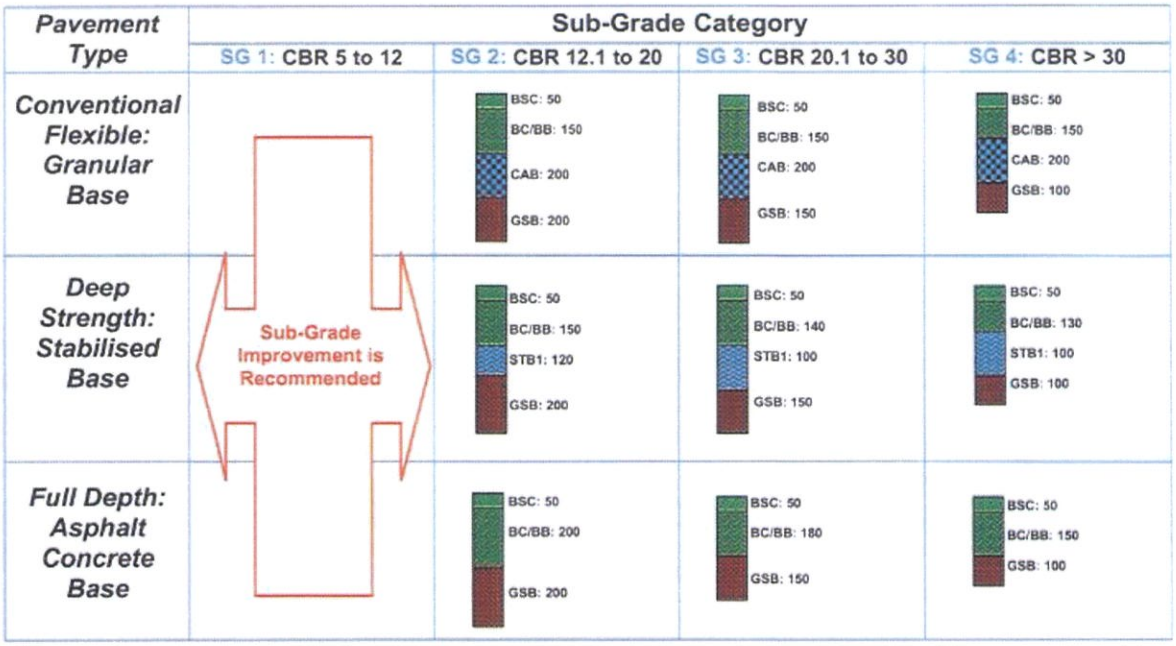
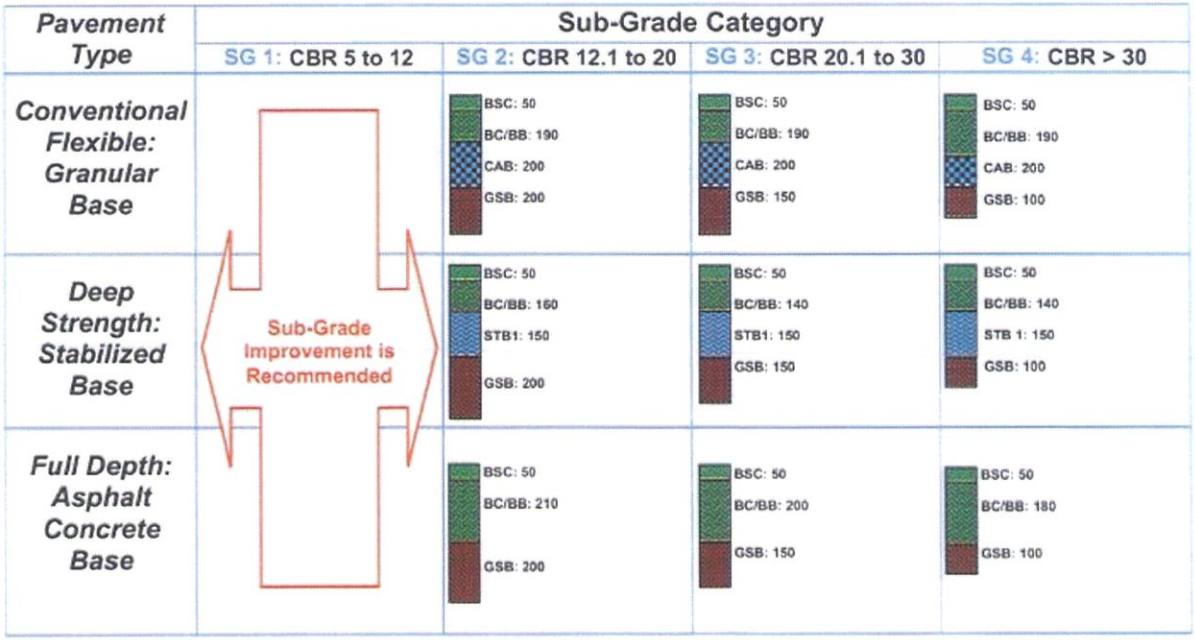
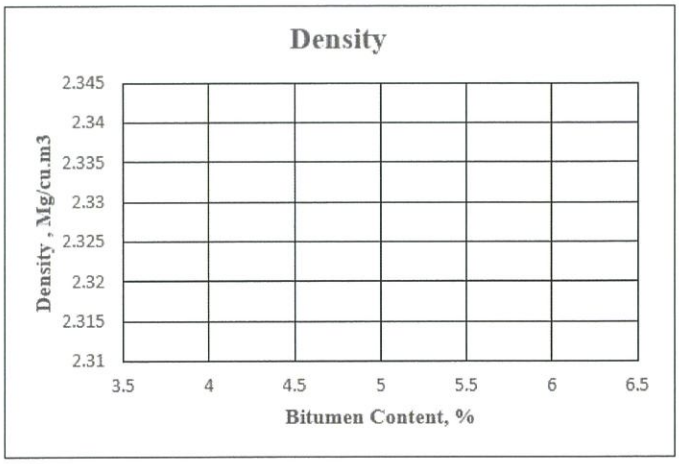
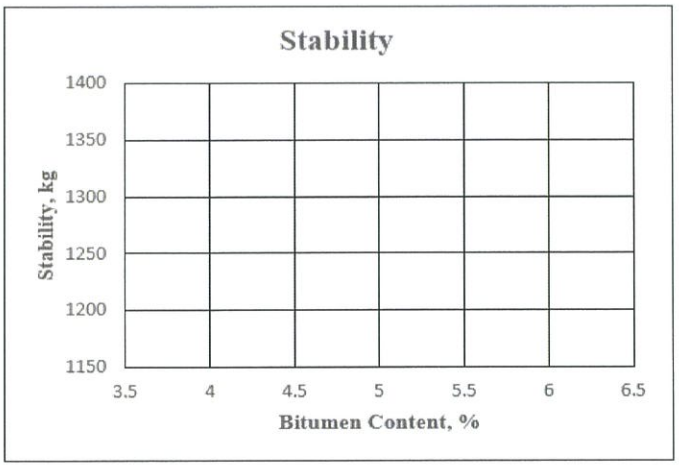


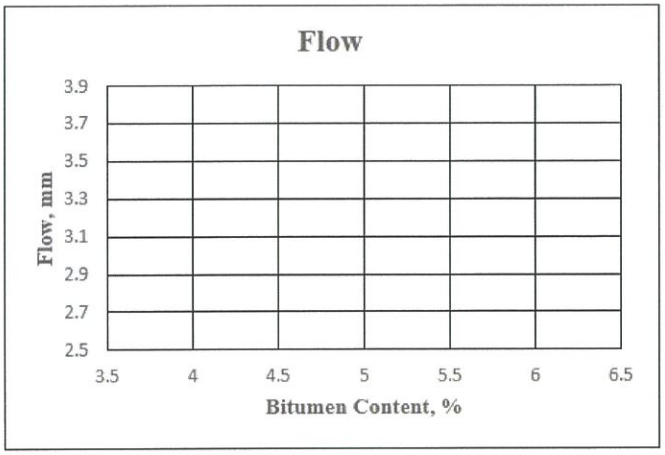
FIGURE 3.5: Pavement Structures for Traffic Category T 5: > 30.0 million ESALs (80 kN)

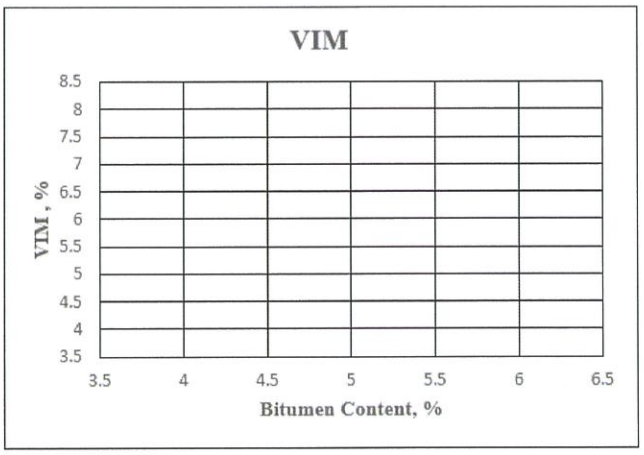


Appendix 2 / *Lampiran 2*









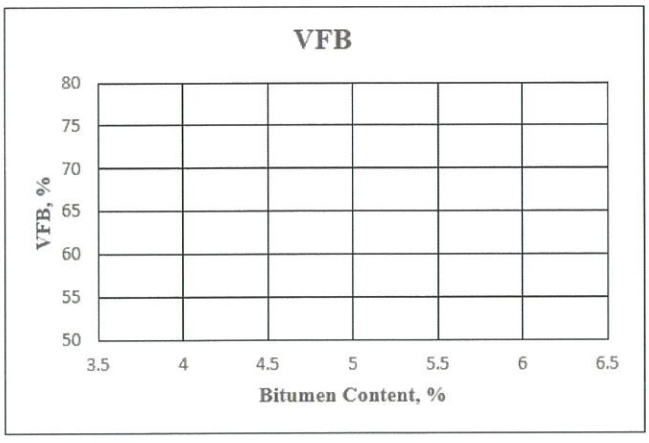


TABLE 4.3.5: TEST AND ANALYSIS PARAMETERS

Parameter	Wearing Course	Binder Course
Stability, S	> 8000 N	> 8000 N
Flow, F	2.0 - 4.0 mm	2.0 - 4.0 mm
Stiffness, S/F	> 2000 N/mm	> 2000 N/mm
Air voids in mix (VIM)	3.0 - 5.0%	3.0 - 7.0%
Voids in aggregate filled with bitumen (VFB)	70 - 80%	65 - 75%

Candidates are required to detach this sheet and attach it together with the answer script

Calon diminta untuk ceraikan helaian ini dan kepilkan bersama skrip jawapan