اللجنة الأكاديمية لقسم الهندسة المدنية

تقارير لاب الطرق

هيثم داوود

Name: هشم وليد حسين داود ID No: 1732491	Highway Engineering Lab	Exp.Title: Penetration of Bituminous Materials Softening Point of Bitumen Exp.No.01

Penetration of Bituminous Materials

1. Penetration of Bitumen Material is the distance in 0.1 mm that a standard needle vertically Penetrates a sample of bitumen under specific conditions of 25°C Temperature, 100g Sample weight & 5 sec for each reading.

2. The objective of the **Penetration of Bituminous Materials** test is to Calculate consistency and viscosity.

3. The apparatus required for penetration test is Pentrometer.

4. Bitumen with lower penetration values is used in hot regions.

5. Transfer the samples using the transfer dish and place them in a water bath having a controlled temperature. The standard temperature is 25°C.

٦. Answer with true (T) or false (F):

-If water comes in contact with the surface of the sample, discard the reading.(T)

- During cleaning of the needle, the sample must be kept out the water bath at the specified temperature.(T)

-Each reading should be at least 20 mm far from the previous one.(T)

Softening Point of Bitumen

Softening point (1) °C	Softening point (2) °C	Average , SP °C
50 °C	49.5 °C	49.75 °C

1. The softening point is the Temperature at which a disc of bitumen Softens enough to allow a standard ball resting on it to move downward a distance of 25 mm.

2. Bitumen with higher softening point is used in hot regions.

3 .If the difference between the two samples in the same test exceeds 1 °C, the test must be repeated.

4. Explain reheating and retesting the same sample increasing ; because the constituent materials to become stiffer it must volatize thus needs more heating

5. The apparatus required for **Softening point** test is ring and ball.

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Name : هيثم وليد حسين داود	Highway Engineering Lab	Exp.Title: Specific Gravity of Asphalt Cement& Viscosity of Asphalt Exp.No.03
ID No: 1732491		

Specific Gravity of Asphalt Cement

Mass of Pycnometer	A	34.25
Mass of Pycnometer Filled with Water	B	69.9
Mass of Pycnometer Partially Filled with Asphalt	C	56.7
Mass of Pycnometer Plus Asphalt Plus Water	D	70.5
Bitumen Specific Gravity ,GSb (C-A)/((B-A)-(D-C))		1.027

1. Specific gravity can be expressed as the ratio of the mass of the .material.....at a given temperature to the mass of an equal volume of.....water..... at the same temperature.

2. The method used for Specific gravity of asphalt test is....Pycnometer.....

3. Specific gravity of the asphalt cement changes when the asphalt cement ...temperature.....

Viscosity of Asphalt

Temperature (^{0}C)	Viscosity (cPs)			Average (cPs)	Asphalt specific gravity	Viscosity (cSt)
135	626	638.5	650	638.17	1.02	625.65
165	626	237.5	250	371.32		364.04

Hint :cSt=cPs/Gb

The mixing range viscosity is 170+-20 cst (150-190)
The compaction range viscosity is 280+-30 cst (250-310)

1.Measuring the viscosity of asphalt binder is used to ensure the binder is sufficient Viscous...for..mixing..&...Compaction applications.

2. Viscositytest method to determine viscosity of asphalt binder at high ...mixing.....

And ..Compaction..... temperatures.

3. The apparatus used to determine rotational viscometer is called...brook field viscometer

CIVIL ENGINEERING

California Bearing Ratio Test (CBR)

هيثم وليد حسين داود

Student name: Haitham Waleed Hassien Dawood

ID#: 1732491

Section: 2 (Wednesday)

Part A: CBR Test

Table 01: CBR Densities Data and Results

No.of Blows per Layer	12	26	56
Empty Mold Weight (Kg)	14.94	14.84	14.75
Weight of Mold +soil (Kg)	18.32	19.68	20.28
Water Content %	15		
Mold Volume ($cm^{3)}$	2305		
Bulk Densities ($g/cm^{3)}$	1.47	2.1	2.4
Dry Densities ($g/cm^{3)}$	1.28	1.83	2.09

Table 02: Mold Stress Data and CBR Results

Penetration (mm)	Mold 1 Load KN	Mold 2 Load KN	Mold 3 Load KN	Mold 1 Stress Mpa	Mold 2 Stress Mpa	Mold 3 Stress Mpa
0.0	0.00	0.00	0.00	0	0	0
0.5	0.27	0.88	1.43	0.14	0.45	0.74
1.0	0.43	1.36	1.83	0.22	0.7	0.95
1.5	0.55	1.68	2.11	0.28	0.87	1.09
2.0	0.66	1.88	2.33	0.34	0.97	1.2
2.5	0.82	2.02	2.50	0.42	1.04	1.29
3.0	0.85	2.23	2.64	0.44	1.15	1.36
3.5	0.94	2.33	2.83	0.49	1.2	1.46
4.0	1.02	2.44	2.96	0.53	1.26	1.53
4.5	1.09	2.53	3.10	0.56	1.31	1.6
5.0	1.16	2.63	3.20	0.6	1.36	1.65
5.5	1.22	2.73	3.33	0.63	1.41	1.72
6.0	1.29	2.75	3.43	0.67	1.42	1.77
6.5	1.34	2.79	3.51	0.69	1.44	1.81
7.0	1.40	2.82	3.59	0.72	1.46	1.86
7.5	1.45	2.86	3.66	0.75	1.48	1.89
						CBR

Mold 1	Mold 2	Mold 3
CBR%		
CBR%$_{2.5mm}$		
6.1	15.1	18.7
CBR%$_{5mm}$		
5.8	13.2	16
6.1	15.1	18.7

Hint:Piston area=1935mm^2

Objective:

To evaluate the strength of compacted Soil and design Pavement sample we have in field also to know relations:

as Load increase, CBR decrease, Penetration increase, Compaction effort increase and density increase.

Equipments & Apparatus:

- Piston $A = 1935\ mm^2$
- Molds 6 inch
- Soil
- Water
- Gauge
- Electric Compactor
- CBR marshal tester

1. Fill the Tables
1.1 Densities and stress to **two** decimal places.
1.2 CBR to **one** decimal places.

2. Sample of calculation.

$$\text{Bulk density} = \frac{W_{mold+soil} - W_{mold}}{\forall_{mold}} = \frac{(18.32 - 14.94) * 10^3}{2305} = 1.47\ g/cm^3$$

$$\text{Dry density} = \frac{\text{bulk density}}{1 + W\%} = \frac{1.47}{1 + 0.15} = 1.28\ g/cm^3$$

$$\text{Stress} = \frac{\text{Load}}{A_{Piston}} = \frac{0.27 * 10^3}{1935} = 0.14\ MPa$$

$$CBR_{2.5mm} = \frac{\text{Stress } T_{2.5mm}}{6.9\ MPa} * 100\% = \frac{0.42}{6.9} 100\% = 6.09\%$$

$$CBR_{5\ mm} = \frac{\text{Stress } T_{5mm}}{10.342\ MPa} * 100\% = \frac{0.59}{10.342} * 100\% = 5.71$$

3. Plot (no excel is allowed)

3.1 stress in piston vs. Penetration for three molds on the same graph.

3.2 CBR vs. Dry densities.

See next Page ↓

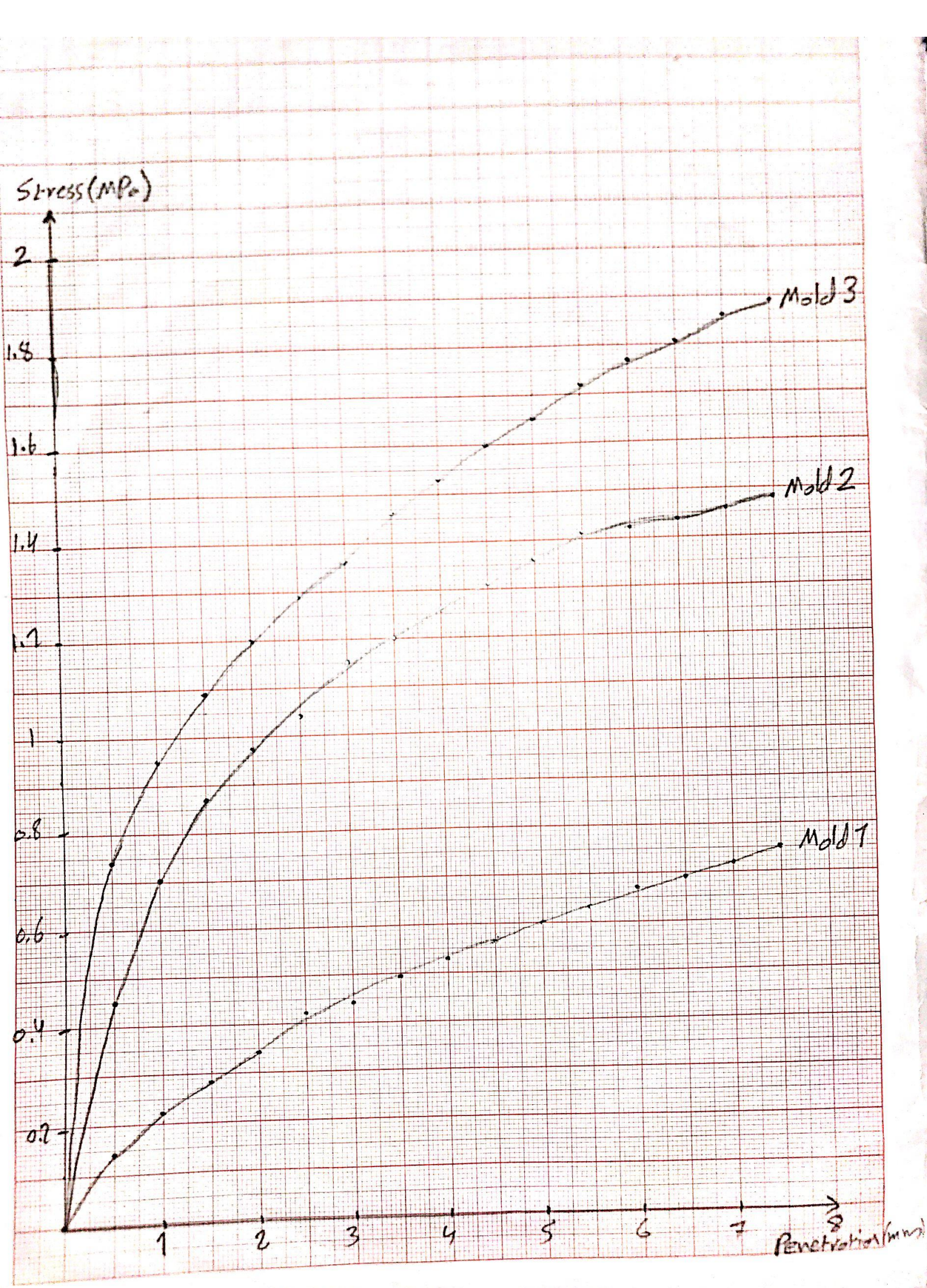
4.1 Discussion on the graph stress in piston vs. Penetration for three molds on the same graph.

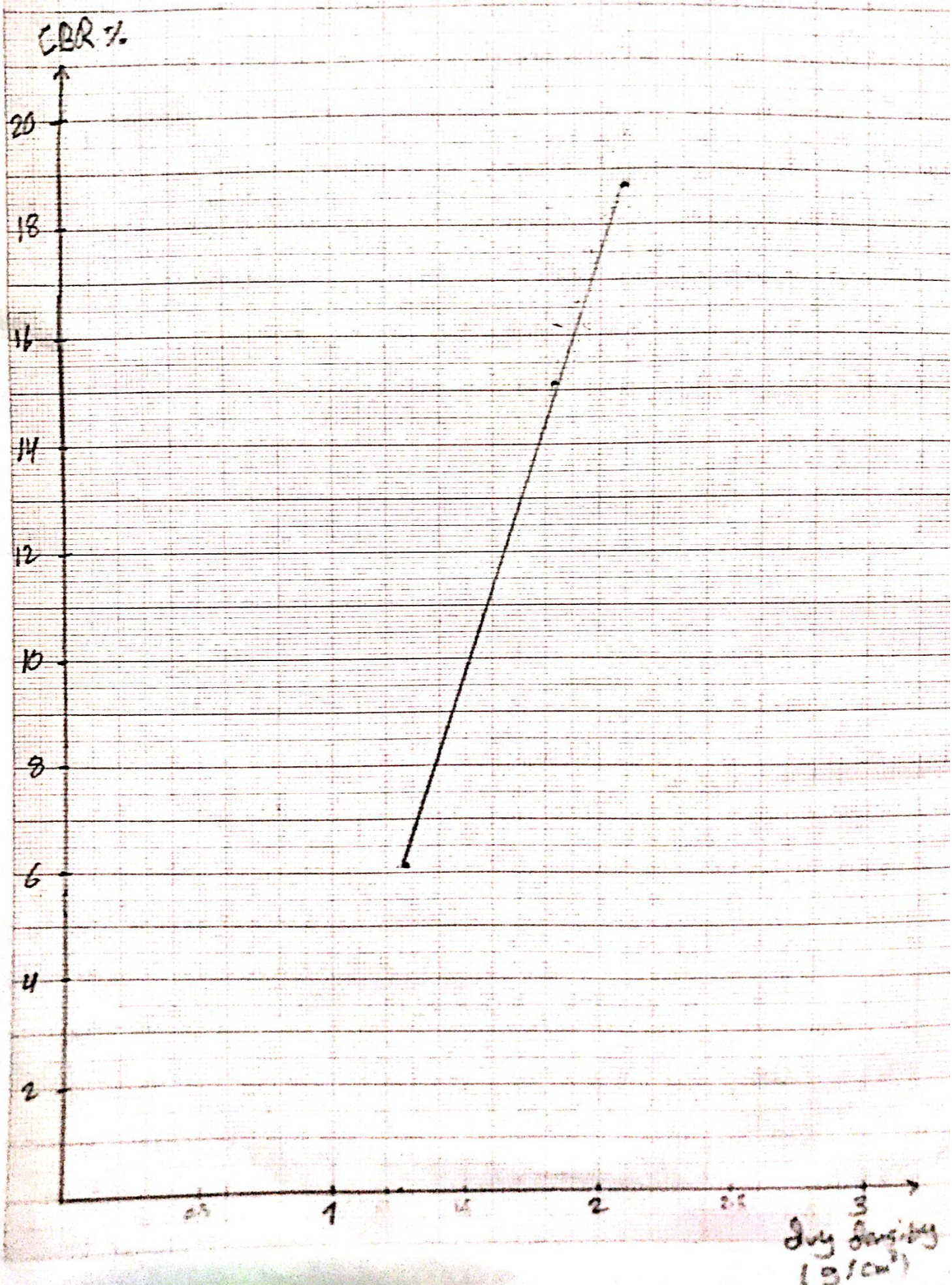
The relation between Penetration and stress is direct and not Linear, and the curves of the three molds are Sneth and Concaved up, so it don't need any corrections.

4.2 comment on the graph CBR vs. Dry densities.

The relation between CBR% and dry density is direct and Linear; because number of blows increases Compaction of Samples thus the dry density, so CBR increases.

In our experiment, $CBR_{2.5_m} > CBR_{5mm}$, so the curve doesn't need any correction.


Stress (MPa)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
Mold 3
Mold 2
Mold 1
1
2
3
4
5
6
7
8
Penetration (mm)


CBR %
20
18
16
14
12
10
8
6
4
2
1
2
3
Dry density (g/cm³)

Name : حکیم ولی حسن داود ID No: 1732491	Highway Engineering Lab	Exp.Title: Specific gravity of coarse and fine aggregate Exp.No.05

Specific gravity of coarse and fine aggregate

Data	Aggregate Type					
	I	II	III	IV	V	VI
A	472	482	495	1095	996	1096
B	1666	1359	1395	1101	1012	1100
C	1950	1627	1664	695	654	698
D	500	500	500			

Specific Gravity of Coarse and Fine

Find bulk specific gravity for aggregate type (VI)

$$G_{sb} = \frac{A}{B-C} = \frac{1096}{1100-698} = 2.73$$

Find APPARENT specific gravity for aggregate type (V)

$$G_{sa} = \frac{A}{A-C} = \frac{996}{996-654} = 2.91$$

Find APPARENT specific gravity for aggregate type (III)

$$G_{sa} = \frac{A}{B+A-C} = \frac{495}{1395+495-1664} = 2.19$$

Find absorption for aggregate type(VI)

$$\text{absorption} = \frac{B-A}{A} \times 100\% = \frac{1100-1096}{1096} \times 100\% = 0.365\%$$

Find bulk specific gravity for aggregate type (II)

$$G_{sb} = \frac{A}{B+D-C} = \frac{482}{1359+500-1627} = 2.08$$

What is the apparent specific gravity?

Net Volume of agg without voids.

Specific Gravity and Absorption for Aggregate Blends

Aggregate Type	Absorption %	Specific Gravity	Percentage of blend %	Absorption of the blend%	Specific Gravity of the blend
I	5.93	2.72	60	4.34	2.81
II	3.73	2.8	10		
IV	1.01	2.97	30		

CIVIL ENGINEERING

Highway Laboratory

Experiment title:

Aggregate Blending to meet Specifications

Student's Name: Haitham Waleed Hussien Dawoud | هيثم وليد حسين داود

Student's ID. No.: 1732491

Sec#: 2 Day: 14/4/2021

1. Sieve Analysis Data and Results

Hint: all calculations to two decimal places

Table 01: Sieve Analysis for Aggregate A, Cumulative Percent Passing For Aggregates B and C.

Sieve No.	Sieve opening mm	Sieve opening ^0.45	Retained Kg			Retained %			Cumulative Retained %			Cumulative Passing %		
			A	B	C	A	B	C	A	B	C	A	B	C
1"	25	4.26	0.00	0.00	0.00	0	0	0.00	0	0	0.00	100	100	100.00
3/4"	19	3.76	0.53	0.00	0.00	14	0	0.00	14	0	0.00	86	100	100.00
1/2"	12.5	3.12	0.99	0.23	0.00	26.68	6.10	0.00	40.68	6.10	0.00	59.32	93.9	100.00
3/8"	9.5	2.75	0.34	0.26	0.00	9.16	6.89	0.00	49.84	12.99	0.00	50.16	87.01	100.00
#4	4.75	2.02	0.59	0.29	0.00	15.90	7.69	0.00	65.74	20.68	0.00	34.26	79.32	100.00
#8	2.38	1.48	0.19	1.29	0.01	5.12	34.21	0.63	70.86	54.89	0.63	29.14	45.11	99.37
#20	1.19	1.08	0.19	0.38	0.39	5.12	10.08	24.79	75.98	64.97	25.43	24.02	35.03	74.57
#50	0.3	0.58	0.22	0.54	0.12	5.93	14.32	7.67	81.91	79.29	33.10	18.09	20.71	66.90
#100	0.15	0.43	0.22	0.24	0.01	5.93	6.37	0.44	87.84	85.66	33.54	12.16	14.34	66.46
#200	0.075	0.31	0.22	0.30	0.51	5.93	7.96	32.59	93.77	93.62	66.14	6.23	6.38	33.86
pan			0.22	0.24	0.53	5.93	6.37	33.86	100	100	100.00	0	0	0.00
			Sum											
			3.71	3.77	1.58									

2. Aggregate Blending Results

2.1 For three Aggregate Blend:

- Two trials are required for the three aggregates blend, one with the initial guess from critical sieves, the other with the final percentages used.
- Your remarks should include "ok", reject or "improve".
- The final trial should be all of "ok" remark.

Table 02: Aggregate Blending For Three Aggregate Calculations

Aggregate	Percent used	1''	3/4''	1/2''	3/8''	#4	#8	#16	#50	#100	#200
A	Original	100	86	59.32	50.16	34.26	29.14	24.04	18.09	12.16	6.23
B	Original	100	100	93.9	87.01	79.32	45.11	35.03	20.71	14.34	6.83
C	Original	100.00	100.00	100.00	100.00	100.00	99.37	74.57	66.9	66.46	33.86
Specification	Upper	100	100	80	70	55	43	30	20	15	8
	Lower	100	85	68	52	35	23	14	5	5	1
	Median	100	92.5	74	61	45	33	22	12.5	10	4.5
Aggregate	Initial guess%	First Trial									
A	53.6	53.6	46.1	31.8	26.89	18.36	15.62	12.89	9.7	6.52	3.34
B	12.28	12.28	12.28	11.53	10.68	9.74	5.54	4.3	2.54	1.76	0.84
C	34.12	34.12	34.12	34.12	34.12	34.12	33.91	25.44	22.83	22.68	11.55
Blend		100	92.5	77.45	71.69	62.22	55.06	42.63	35.07	30.95	15.73
Remark		Ok	Ok	Ok	Improve	Reject	Reject	Reject	Reject	Reject	Reject
Aggregate	Final guess%	Final Trail									
A	75	75	64.5	44.49	37.62	25.7	21.86	18.03	13.57	9.12	4.67
B	24	24	24	22.54	20.88	19.04	10.83	8.41	4.97	3.44	1.64
C	1	1	1	1	1	1	0.99	0.75	0.67	0.66	0.34
Blend		100	89.5	68.03	59.5	45.73	33.68	27.18	19.21	13.23	6.65
Remark		Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok

3. Sample of Calculations:

3.1 No Sample of calculations is needed for sieve analysis, only fill the table.

3.2 Put a detailed sample of calculations of the way finding the initial guess of aggregate percentages. **Mention your critical sieve**.

Critical sieve of A ¾ “ Critical sieve of B #4

For a:

100 – ¾ “ median = 100 - 92 .5 = 7.5

100 – 86 = 14 so a = (7.5/14) * 100% = 53.6%

For b:

100 - 61 = 39

100 - 50.16 = 49.84

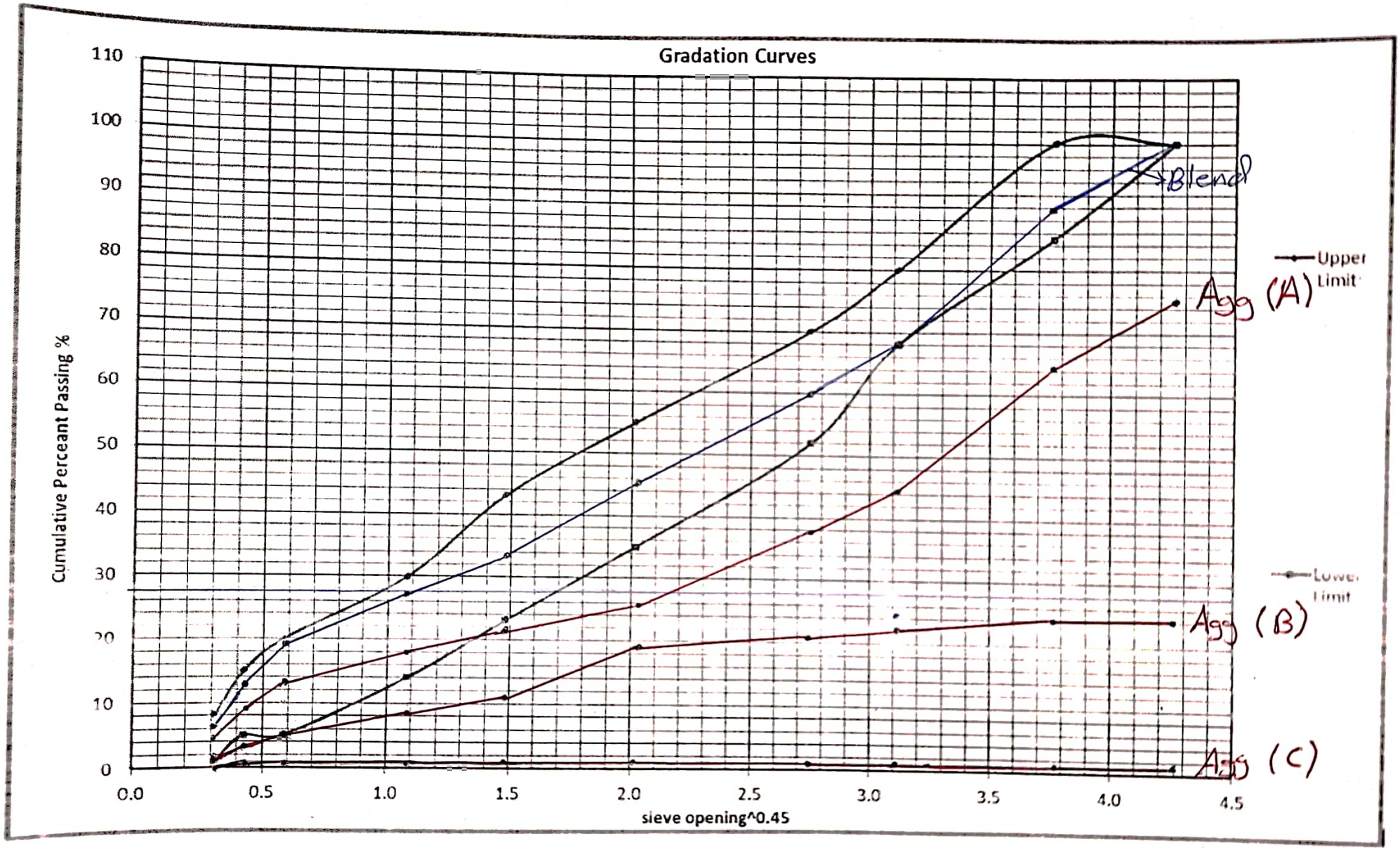
39 - (0.536*49.84) = 12.28 %

For c:

100 – 53.6 – 12.28 = 34.12%

1732491

هشام علي حسين حامد



CIVIL ENGINEERING

Highway Laboratory

Experiment title:

Marshall Mix Design

Student's Name: Haitham Waleed Hussien Dawood هيثم وليد حسين داود

Student's ID. No.: 1732491

Sec#: 2 Day: Wednesday

1. Abbreviations and Equations

LIST OF ABBREVIATIONS	
G_{se}	Effective specific gravity of aggregate coated with asphalt
$G_{mm\ exp}$	Theoretical maximum specific gravity
G_b	Specific gravity of the asphalt binder
Gsb	Bulk specific gravity of aggregate
Gmb	Bulk specific gravity of the compacted specimen
$G_{mm,cal}$	Theoretical maximum specific gravity of asphalt concrete
AV% or (VTM)	Percent of air voids in the compacted bitumen paving mixture
VMA%	Voids in mineral aggregate (AV + volume of effective asphalt)
VFA%	Voids filled with asphalt
P_s	Percent weight of aggregate
P_b	Percent weight of the asphalt cement

LIST OF EQUATIONS	
Gmb	$A/(B-C)$
Gmm_{cal}	$G_{mm} = \frac{100}{\left(\frac{P_s}{G_{se}} + \frac{P_b}{G_b}\right)}$
AV%	$[1 - \frac{Gmb}{Gmm}] * 100$
VMA	$[1 - \frac{Gmb(1-Pb)}{Gsb}] * 100$
VFA	$[\frac{VMA - AV}{VMA}] * 100$

Note: Gmm and Gse should be to two decimal places

2. Theoretical Maximum Specific Gravity Gmm.

Calculated from loose sample at optimum asphalt content

A: Wt. of sample (g)	D: Wt. of Pycnometer filled with water (g)	E: Wt. of Pycnometer filled with sample and water (g)	Gmm: Maximum Theoretical Specific Gravity
1154	7655	8319	$G_{mm} = \frac{A}{D+A-E} = \frac{1154}{7655+1154-8319} = 2.355$

3. Effective Specific Gravity for Aggregate

Calculated at optimum asphalt content. assume $P_b = 6.5\ \%$

$Gse = \frac{Pmm - Pb}{\frac{Pmm}{Gmmexp} - \frac{Pb}{Gb}}$	$= \frac{100 - 6.5}{\frac{100}{2.36} - \frac{6.5}{1.03}} = 2.586$

4. Marshall Table

Note: Calculate Gmb to three decimal places. AV, VMA and VFA to two decimal places.

Gb	1.03

Gsb	2.62

ρw	1000 kg/m³

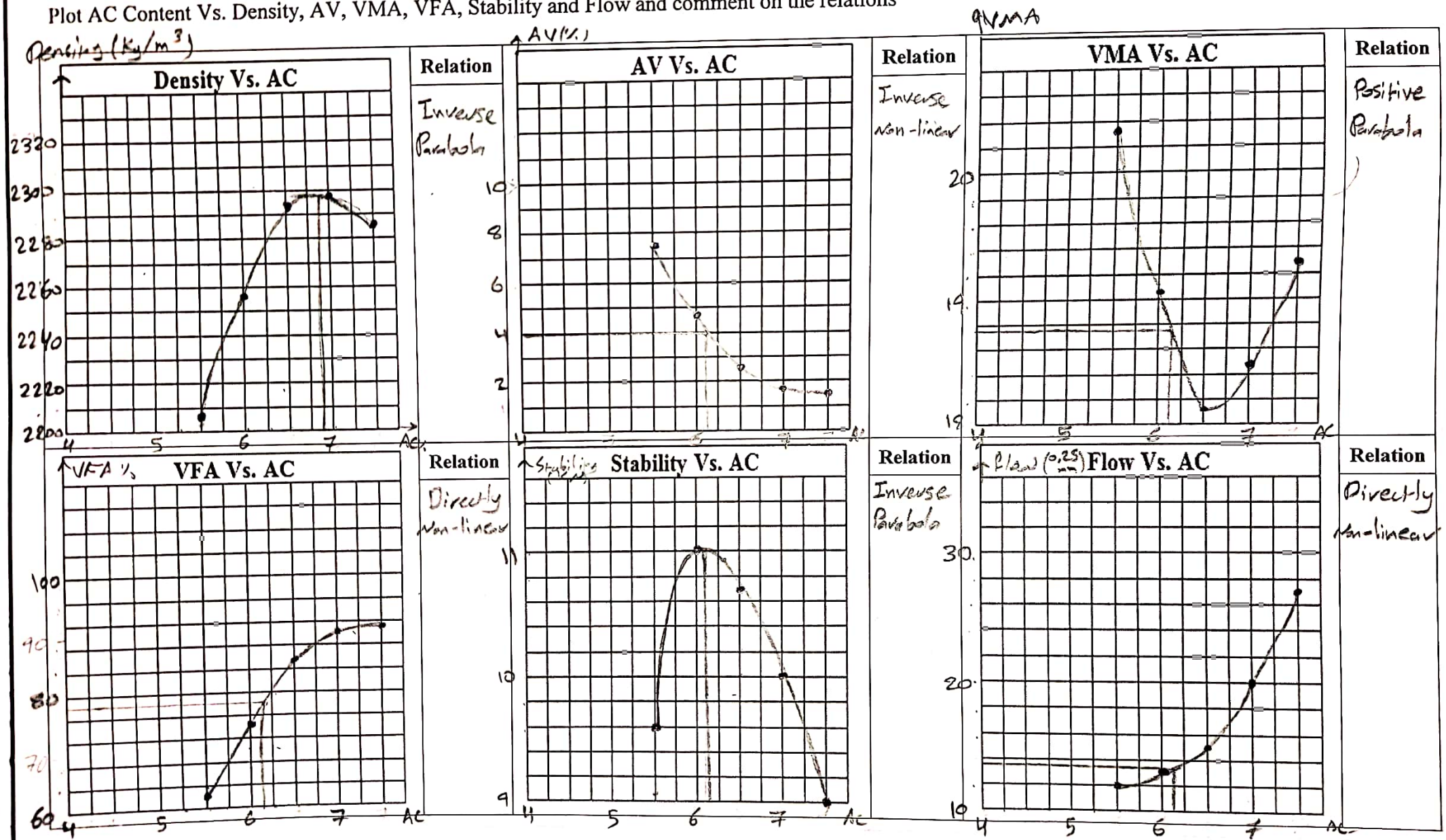
AC %	Wt in air (g)	Wt SSD (g)	Wt in water (g)	Gmb	Mix Density (Kg/m³)	$Gmm_{,cal}$	AV %	VMA %	VFA %	Stability (KN)	Flow (0.25mm)
5.5	1235.4	1262.5	702.9	2.208	2208	2.388	7.538	20.36	62.976	9.6	12
6.0	1243.1	1271.8	720.7	2.256	2256	2.371	4.85	19.06	74.554	11	13
6.5	1248.1	1261.4	717.3	2.244	2244	2.355	2.59	18.134	85.717	10.7	15
7.0	1255.5	1267.8	721.3	2.247	2297	2.334	1.796	18,465	90.273	10	20
7.5	1259.6	1272.5	721.4	2.286	2286	2.323	1.543	19.292	91.743	9	27

5. Sample of Calculation @ the first AC%

Gmb	$Gmm_{,cal}$	AV %	VMA %	VFA %
$G_{mb} = \frac{A}{B-C}$ $= \frac{1235.4}{1262.5-702.9}$ $= 2.208$	$G_{mm,cal} = \frac{100}{\left(\frac{P_s}{G_{se}} + \frac{P_b}{G_b}\right)}$ $= \frac{100}{\left(\frac{94.5}{2.586} + \frac{5.5}{1.03}\right)} = 2.388$	$AV = \left[1 - \frac{G_{mb}}{G_{mm,cal}}\right] \times 100\%$ $= \left[1 - \frac{2.208}{2.388}\right] \times 100\%$ $= 7.538\%$	$VMA = \left[1 - \frac{G_{mb}(1-P_b)}{G_{sb}}\right] \times 100\%$ $= \left[1 - \frac{2.208(1-0.055)}{2.62}\right] \times 100\%$ $= 20.36\%$	$VFA = \left[\frac{VMA - AV}{VMA}\right] \times 100\%$ $= \left[\frac{20.36 - 7.538}{20.36}\right] \times 100\%$ $= 62.976\%$

6. Plots and Comments

Plot AC Content Vs. Density, AV, VMA, VFA, Stability and Flow and comment on the relations



7. Finding Optimum AC Content

Show your values clearly on the graphs

7.1 Determine the optimum asphalt content from curves, which yield the maximum density, maximum stability and 4% AV.

Hint:
Nominal Maximum Particle Size=3/8 in
Compare to Medium Traffic.

AC% at			Average of AC%
Max Density	Max Stability	4% AV	
6.875	6.125	6.125	6.375

	Value (Using the curves, at avg. of AC %)	The specification (Using table 9.13, 9.14)	Accepted or not
AV	4	3 – 5	Accepted ✓
VMA	18.75	15	Accepted ✓
VFA	78	65 – 78	Accepted ✓
Stability	11	5.34	Accepted ✓
Flow	10.36	8 – 16	Accepted ✓

TABLE 9.13 Asphalt Institute Criteria for Marshall Mix Design (The Asphalt Institute, 1995)

	Traffic Level					
	Light		Medium		Heavy	
Compaction (blows)	35		50		75	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Stability, kN	3.34	—	5.34	—	8.01	—
Flow, 0.25 mm	8	18	8	16	8	14
Air Voids, %	3	5	3	5	3	5
VMA, %	Use the criteria in Table 9.14					
VFA, %	70	80	65	78	65	75

TABLE 9.14 Minimum Percent Voids in Mineral Aggregate (VMA) (The Asphalt Institute, 1995)

Nominal Maximum Particle Size[1]	Minimum VMA, Percent Design Air Voids[2] 3.0	4.0	5.0
2.36 mm (No. 8)	19.0	20.0	21.0
4.75 mm (No. 4)	16.0	17.0	18.0
9.5 mm (3/8 in.)	14.0	15.0	16.0
12.5 mm (1/2 in.)	13.0	14.0	15.0
19.0 mm (3/4 in.)	12.0	13.0	14.0
25.0 mm (1.0 in.)	11.0	12.0	13.0

Name: Haitham Dawoud هيثم وليد حسين داود ID#: 1732491	Highway Engineering Lab	Exp.9 Skid Resistance & Asphalt Extraction

Skid resistance

BPN 1	BPN2	BPN3	BPN4	Average
55	54	48	51	52

1. Skid resistance is a measure of the resistance of the pavement surface to **sliding or skidding** of vehicle.

2. The test apparatus for skid resistance is **British Pendulum Tester**

3. This test is made with (wet or dry) **wet** surface.

Asphalt Extraction

W_1: Weight of test sample (g)	3000
W_2: Weight of ignited sample (g)	2830
AC%: Bitumen content from sample weight (AC%) = $(W_1-W_2)/W_1$	**5.67%**

4. The test method used is called **National Center for Asphalt Technology (NCAT) Method**.

5. The aggregate is burned at which temperature **538°C.**

6. One advantage of the test is **more accurate and used to find aggregate gradation.**