

CHAPTER VI

CONCLUSION

6.1 Conclusion

Based on the research, it can be concluded that there is a strong relationship between CBR and DCP value for each fine aggregate replacement with GGBFS. From the four variants, it can be known that the best results are from the 30% aggregate replacement variant. From the five tests performed on each variant, at 30% aggregate replacement, four tests got the best results.

In this study, this approach is reliable for application in subbase evaluation and could enhance the credibility of the DCP as an accurate, portable, and yet inexpensive method of testing. As the determination of CBR by this method is time consuming and requires the use of costly equipment, another but the most accurate and indirect method is by using a dynamic cone penetrometer.

6.2 Suggestion

The further study need to be conducted to find the effect of fine aggregate replacement with GGBFS on CBR and DCP value of soaked condition that will help to evaluate the fine aggregate replacement with GGBFS on critical condition. Another test should be held to get the effects of curing time on the subbase mixture with fine aggregate replacement with GGBFS.

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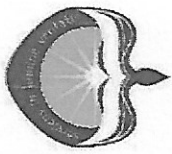
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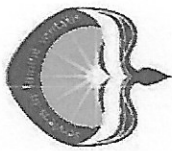
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SOIL MOISTURE CONTENT

Testing : Moisture Content of Soil

Date : 1st July 2019

	Tin Box Code	A	B
<i>Tin Box weight</i>	gram	9,82	10,58
<i>Tin Box + soil weight</i>	gram	49,82	50,58
<i>Tin Box + dried soil weight</i>	gram	48,28	49,01
Moisture weight	gram	$w_1 = w_2 - w_3$	1,54
Dried Soil weight	gram	$w_s = w_3 - w_1$	38,46
Moisture Content	%	$W = \frac{w_1}{w_s} \times 100\%$	4,00
Average Moisture Content	%	$W_{avg} = \frac{W_A + W_B}{2}$	4,04



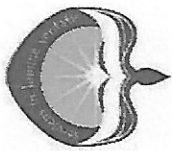
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FINE AGGREGATE MOISTURE CONTENT

Testing : Moisture Content of Fine Aggregate

Date : 1st July 2019

	Tin Box Code	A	B
<i>Tin Box weight</i>	gram	10,36	10,51
<i>Tin Box + soil weight</i>	gram	53,13	53,34
<i>Tin Box + dried soil weight</i>	gram	51,68	51,95
Moisture weight	gram	$w_1 = w_2 - w_3$	1,45
Dried Soil weight	gram	$w_s = w_3 - w_1$	41,32
Moisture Content	%	$W = \frac{w_1}{w_s} \times 100\%$	3,51
Average Moisture Content	%	$W_{avg} = \frac{w_A + w_B}{2}$	3,43



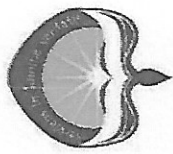
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COARSE AGGREGATE MOISTURE CONTENT

Testing : Moisture Content of Coarse Aggregate

Date : 1st July 2019

	Tin Box Code	A	B
<i>Tin Box weight</i>	gram	13,59	13,61
<i>Tin Box + soil weight</i>	gram	47,65	47,38
<i>Tin Box + dried soil weight</i>	gram	46,87	46,64
Moisture weight	gram	$w_1 = w_2 - w_3$	0,78
Dried Soil weight	gram	$w_s = w_3 - w_1$	33,28
Moisture Content	%	$W = \frac{w_1}{w_s} \times 100\%$	2,34
Average Moisture Content	%	$W_{avg} = \frac{w_1 + w_2}{2}$	2,29

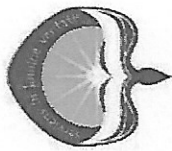


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SPECIFIC GRAVITY TEST OF SOIL

Testing : Specific Gravity of Soil
 Date : 2nd July 2019

	No. of Pycnometer	1	2
Pycnometer weight (w ₁)	gram	30,55	32,94
Pycnometer + Dry soil weight (w ₂)	gram	48,59	53,80
Pycnometer + Soil + Water (w ₃)	gram	92,94	96,27
Weight of Pycnometer + Water (w ₄)	gram	81,51	82,99
Temperature	°C	26	26
A = w ₂ -w ₁	gram	18,04	20,86
B = w ₃ -w ₄	gram	11,43	13,28
C = A-B	gram	6,61	7,58
Specific Gravity = A / C		2,729	2,752
Average Specific Gravity		2,741	
Specific Gravity on 27.5°C		2,741	
$G_{27,5} = G_{terata} \times \frac{\gamma_w(27,5^\circ C)}{\gamma_w(27,5^\circ C)}$		2,741	



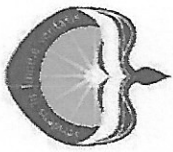
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GGBFS MOISTURE CONTENT

Testing : Moisture Content of Soil

Date : 1st July 2019

	Tin Box Code	A	B
<i>Tin Box weight</i>	gram	10,71	10,66
<i>Tin Box + soil weight</i>	gram	37,60	32,00
<i>Tin Box + dried soil weight</i>	gram	37,59	32,00
Moisture weight	gram	$W_w = W_2 - W_3$	0,01
Dried Soil weight	gram	$W_s = W_3 - W_1$	26,88
Moisture Content	%	$W = \frac{W_w}{W_s} \times 100\%$	0,04
Average Moisture Content	%	$W_{avg} = \frac{W_A + W_B}{2}$	0,02



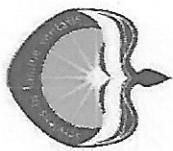
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SPECIFIC GRAVITY TEST OF FINE AGGREGATE

Testing
 Date

: Specific Gravity of Fine Aggregate
 : 2nd July 2019

No. of Pycnometer	1	2
Pycnometer weight (w ₁)	gram 30,59	30,71
Pycnometer + Dry soil weight (w ₂)	gram 67,15	67,68
Pycnometer + Soil + Water (w ₃)	gram 106,67	106,68
Weight of Pycnometer + Water (w ₄)	gram 81,60	81,24
Temperature	°C 26,2	26
A = w ₂ -w ₁	gram 36,56	37,27
B = w ₃ -w ₄	gram 25,07	25,44
C = A-B	gram 11,49	11,83
Specific Gravity = A / C	3,182	3,150
Average Specific Gravity	3,166	
Specific Gravity on 27.5°C	3,166	
$G_{27,5} = G_{terata} \times \frac{\gamma_w(20^\circ C)}{\gamma_w(27,5^\circ C)}$	3,166	

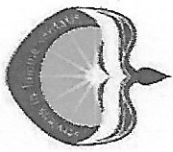


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SPECIFIC GRAVITY TEST OF GGBFS

Testing : Specific Gravity of GGBFS
 Date : 2nd July 2019

	No. of Pycnometer	1	2
Pycnometer weight (w ₁)	gram	31,28	31,77
Pycnometer + Dry soil weight (w ₂)	gram	42,06	40,23
Pycnometer + Soil + Water (w ₃)	gram	88,58	87,50
Weight of Pycnometer + Water (w ₄)	gram	81,54	81,94
Temperature	°C	26	26
A = w ₂ -w ₁	gram	10,78	8,46
B = w ₃ -w ₄	gram	7,04	5,56
C = A-B	gram	3,74	2,90
Specific Gravity = A / C		2,882	2,917
Average Specific Gravity		2,900	
Specific Gravity on 27.5°C		2,900	
$G_{27,5} = G_{terata} \times \frac{\rho_{(27,5^\circ C)}}{\rho_{(20^\circ C)}}$		2,900	

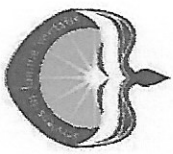


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SPECIFIC GRAVITY TEST OF COARSE AGGREGATE

Testing : Specific Gravity of Coarse Aggregate
Date : 3rd July 2019

Weight of Oven dried Coarse Aggregate (gram)	B_k	488,8
Weight of SSD Coarse Aggregate (gram)	B_j	491,2
Weight of Coarse aggregate submerged (gram)	B_a	306
Bulk Specific Gravity	$B_k / (B_j - B_a)$	2,639
SSD Specific Gravity	$B_j / (B_j - B_a)$	2,652
Apparent Specific Gravity	$B_k / (B_k - B_a)$	2,674



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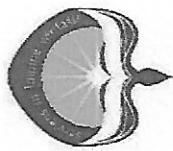
SHRINKAGE LIMIT TEST

Tested : Shrinkage Limit of Soil
 Date : 4th July 2019

A. Specific Gravity is known
 Based on Specific gravity test of soil, $G = 2,741$

	No. of Cup	1	2
Weight of Cup + Dry Soil	W_1	39,44	44,04
Weight of Shrinkage Cup	W_2	16,47	17,06
Weight of Dry Soil	$W_0 = W_2 - W_1$	22,97	26,98
Weight of Mercury Pressed by Dry Soil + Glass Cup	W_3	245,87	258,87
Weight of Glass Cup	W_4	48,29	48,29
Weight of Mercury	$W_5 = W_3 - W_4$	197,58	210,58
Volume of Dry Soil	$V_0 = W_4 / 13,6 \text{ cm}^3$	14,53	15,48
Shrinkage Limit of Soil	$SL = \left[\frac{V_0}{110} - \frac{1}{G} \right] \times 100\%$	26,76	20,91
Average Shrinkage Limit of Soil	$SL = (SL_1 + SL_2) / 2$	23,83	

Attachment 3.a

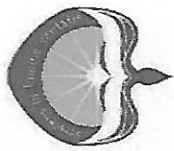


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LIQUID LIMIT TEST OF SOIL

Tested : Liquid Limit of Soil
 Date : 4th July 2019

Target of Blow	15-20	21-24	26-30	31-40
Number of Blow	16	23	27	33
Code of Cup	1	3	5	8
Weight of Empty Cup	13,61	13,46	13,61	13,60
Weight of Cup + Soil	16,11	15,62	16,04	16,72
Weight of Cup + Dry Soil	15,70	15,28	15,42	15,62
Weight of Water	0,41	0,34	0,36	0,48
Weight of Dry Soil	2,09	1,82	1,81	2,04
Moisture Content	19,62	18,68	19,89	16,67
Average Moisture Content	20,56			
Liquid Limit, LL	18,94%			
W_{10}	23,68%			
W_{100}	11,27%			
Flow Index, If	$W_{10} - W_{100} = 12,41\%$			

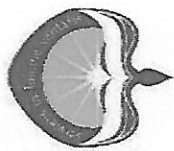


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PLASTICITY LIMIT TEST OF SOIL

Tested : Plasticity Limit of Soil
Date : 4th July 2019

Name of Cup	A	B
Weight of Empty Cup	22,16	23,32
Weight of Cup + Wet Soil	31,32	31,12
Weight of Cup + Dry Soil	30,31	30,21
Weight of Water	$W_w = W_1 - W_2$	0,91
Weight of Dry Soil	$W_s = W_2 - W_c$	6,89
Moisture Content	$W = \frac{W_w}{W_s} \times 100\%$	13,21
Plasticity Limit	%	12,80



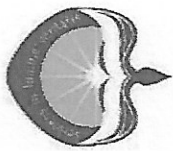
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GRAIN SIZE DISTRIBUTION TEST OF SOIL

Tested : Grain Size Distribution of Soil
Date : 4th July 2019

No. Sieve	Grain Size (mm)	Weight of Sieve (gram)	Weight of Sieve + Soil (gram)	Retained weight (gram)	Passed weight (gram)	Passing Percentage (%)
4	4,750	585,36	586,02	0,66	99,34	99,34
10	2,000	530,73	535,60	4,87	94,47	94,47
20	0,850	488,05	503,44	15,39	79,08	79,08
40	0,425	436,3	458,18	21,88	57,20	57,20
60	0,250	436,28	453,87	17,59	39,61	39,61
140	0,106	427,5	446,03	18,53	21,08	21,08
200	0,075	416,02	423,57	7,55	13,53	13,53
			Pan =	13,53		
			Total =	100,00		

Attachment 6.a



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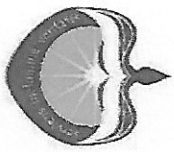
HYDROMETER TEST OF SOIL

Tested : Hydrometer Test of Soil
 Date : 4th July 2019

Hydrometer Type	152
Meniscus Correction (m)	1
Soil Specific Gravity (G)	2,741
Hydrometer Correction 152 (a)	0,980

Weight of Oven Dried	100 gram
K****	0,980
Reagent	Na ₂ SiO ₃
Amount of Reagent	2 tablespoons

Date	Hour	Time (Minutes)	Suspension Reading	Liquid Reading	Temperature (°C)	Meniscus Corrected Reading	Effective Depth	Constant	Grain Diameter (mm)	Corrected Reading	% Smaller
08-Jul-19	10:57	2	R ₁ = 6	R ₂ = 1	t °C = 26	R' = R +m = 7	L* = 15,2	K** = 0,01327	D = 0,0366	R = R ₁ - R ₂ = 5	p*** (%) = 6,64
08-Jul-19	11:00	5	5	1	26	6	15,3	0,01327	0,0232	4	5,31
08-Jul-19	11:25	30	4	2	26	5	15,5	0,01327	0,0095	2	2,65
08-Jul-19	11:55	60	2	1	26	3	15,8	0,01327	0,0068	1	1,33
08-Jul-19	15:05	250	1	1	26	2	16	0,01327	0,0034	0	0,00
09-Jul-19	10:55	1440	2	1	26	3	15,8	0,01327	0,0014	1	1,33



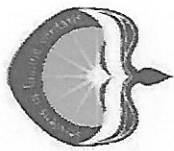
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GRAIN SIZE DISTRIBUTION TEST OF VARIANT I

Date : 5th September 2019

Sieve Number	Grain Size (mm)	Sieve Weight (gram)	Sieve + Retained Mixture Weight (gram)	Retained Mixture Weight (gram)	Passing Weight (gram)	Passing Percentage (%)
3"	75	543,4	543,4	0	5000	100
2"	50	550,1	550,1	0	5000	100
1 1/2"	37,5	491,9	1065,9	574	4426	88,52
1"	25	557,8	1142,8	585	3841	76,82
3/8"	9,5	456,1	1558,1	1102	2739	54,78
no. 4	4,75	585,5	840,5	255	2484	49,68
no.10	2	528,3	1303,3	775	1709	34,18
no. 40	0,425	437,2	1182,2	745	964	19,28
no. 200	0,075	415,2	1047,2	632	332	6,64
				Pan =	332	
				Total Weight =	5000	

Attachment 8.a



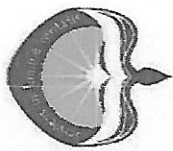
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GRAIN SIZE DISTRIBUTION TEST OF VARIANT 2

Date : 5th September 2019

Sieve Number	Grain Size (mm)	Sieve Weight (gram)	Sieve + Retained Mixture Weight (gram)	Retained Mixture Weight (gram)	Passing Weight (gram)	Passing Percentage (%)
3"	75	544,4	544,4	0	5000	100
2"	50	551,5	551,5	0	5000	100
1 1/2"	37,5	491,7	1079,7	588	4412	88,24
1"	25	557,3	1186,3	629	3783	75,66
3/8"	9,5	456,3	1538,3	1082	2701	54,02
no. 4	4,75	587,2	822,2	235	2466	49,32
no.10	2	530,1	1293,1	763	1703	34,06
no. 40	0,425	479,4	1180,4	701	1002	20,04
no. 200	0,075	416,7	1048,7	632	370	7,40
		Pan =		370		
		Total Weight =		5000		

Attachment 8.b



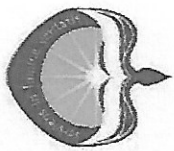
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GRAIN SIZE DISTRIBUTION TEST OF VARIANT 3

Date : 6th September 2019

Sieve Number	Grain Size (mm)	Sieve Weight (gram)	Sieve + Retained Mixture Weight (gram)	Retained Mixture Weight (gram)	Passing Weight (gram)	Passing Percentage (%)
3"	75	544,2	544,2	0	5000	100
2"	50	551,3	551,3	0	5000	100
1 1/2"	37,5	492,2	1116,2	624	4376	87,52
1"	25	558	1057	499	3877	77,54
3/8"	9,5	456	1599	1143	2734	54,68
no. 4	4,75	586,2	973,2	387	2347	46,94
no.10	2	529,1	1218,1	689	1685	33,16
no. 40	0,425	437,4	991,3	554	1104	22,08
no. 200	0,075	416,4	988,4	572	532	10,64
Total Weight =				Pan =	5000	
Total Weight =					5000	

Attachment 8.c



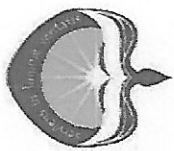
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GRAIN SIZE DISTRIBUTION TEST OF VARIANT 4

Date : 6th September 2019

Sieve Number	Grain Size (mm)	Sieve Weight (gram)	Sieve + Retained Mixture Weight (gram)	Retained Mixture Weight (gram)	Passing Weight (gram)	Passing Percentage (%)
3"	75	545,6	545,6	0	5000	100
2"	50	552,9	552,9	0	5000	100
1 1/2"	37,5	494,3	1088,3	594	4406	88,12
1"	25	560,3	1183,3	623	3783	75,66
3/8"	9,5	457	1523	1066	2717	54,34
no. 4	4,75	587,5	941,5	354	2363	47,26
no.10	2	529,8	1116,8	587	1776	35,52
no. 40	0,425	439,7	1068,7	629	1147	22,94
no. 200	0,075	415,4	937,4	522	625	12,50
Pan =				625		
Total Weight =				5000		

Attachment 8.d



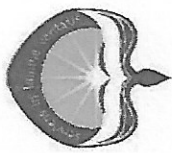
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COMPACTION TEST OF SOIL

Date : 14th - 16th August 2019

Moisture Content	%	6,25	11,19	13,38	14,08	14,65	20,86
Water Addition	ml	100	200	233	266	300	400
Weight of Cylinder + Compacted Soil	gram	3073	3204	3228	3256	3308	3228
Weight of Cylinder	gram	1595	1603	1593	1603	1603	1603
Diameter of Cylinder	cm	10,16	10,16	10,16	10,16	10,17	10,13
Height of Cylinder	cm	10,16	10,24	10,18	10,18	10,18	10,18
Compacted Soil Weight	gram	1478	1601	1635	1653	1705	1625
Density	gram/cm ³	1,794	1,928	1,981	2,003	2,062	1,981
Dry Density	gram/cm ³	1,689	1,734	1,747	1,756	1,798	1,639

Attachment 9.a



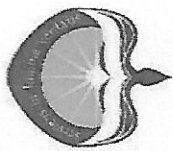
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COMPACTION TEST OF SAMPLE

Name of Sample : Subbase Mixture with 0% GGBFS
Date of Test : 28th August 2019

Moisture Content	%	4,73	6,01	7,21	8,64	9,42
Water Addition	ml	50	100	125	150	175
Weight of Cylinder + Compacted Soil	gram	3324	3387	3397	3477	3432
Weight of Cylinder	gram	1593	1602	1576	1603	1577
Diameter of Cylinder	cm	10,13	10,13	10,12	10,12	10,12
Height of Cylinder	cm	10,18	10,18	10,18	10,18	10,18
Compacted Soil Weight	gram	1731	1785	1821	1874	1855
Density	gram/cm ³	2,110	2,176	2,224	2,289	2,265
Dry Density	gram/cm ³	2,015	2,052	2,074	2,107	2,070

Attachment 9.b

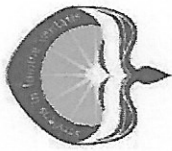


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COMPACTION TEST OF SAMPLE

Name of Sample : Subbase Mixture with 15% GGBFS
Date of Test : 28th August 2019

Moisture Content	%	5,42	6,95	7,37	7,82	8,53
Water Addition	ml	50	100	125	150	175
Weight of Cylinder + Compacted Soil	gram	3433	3492	3476	3522	3469
Weight of Cylinder	gram	1602	1604	1572	1603	1584
Diameter of Cylinder	cm	10,13	10,13	10,12	10,12	10,12
Height of Cylinder	cm	10,18	10,18	10,18	10,18	10,18
Compacted Soil Weight	gram	1831	1888	1904	1919	1885
Density	gram/cm ³	2,232	2,301	2,325	2,344	2,302
Dry Density	gram/cm ³	2,117	2,152	2,166	2,174	2,121

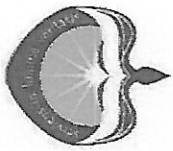


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COMPACTION TEST OF SAMPLE

Name of Sample : Subbase Mixture with 30% GGBFS
Date of Test : 29th August 2019

Moisture Content	%	5,74	7,14	7,49	8,13	10,04
Water Addition	ml	100	125	150	175	200
Weight of Cylinder + Compacted Soil	gram	3313	3410	3466	3469	3478
Weight of Cylinder	gram	1547	1539	1564	1581	1575
Diameter of Cylinder	cm	10,10	10,11	10,11	10,11	10,10
Height of Cylinder	cm	10,12	10,12	10,12	10,12	10,12
Compacted Soil Weight	gram	176	1871	1902	1888	1903
Density	gram/cm ³	2,178	2,303	2,341	2,324	2,347
Dry Density	gram/cm ³	2,060	2,150	2,178	2,149	2,133



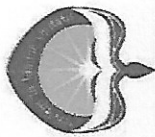
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COMPACTION TEST OF SAMPLE

Name of Sample : Subbase Mixture with 45% GGBFS
Date of Test : 29th August 2019

Moisture Content	%	4,77	7,31	8,07	8,61	10,16
Water Addition	ml	100	125	150	175	200
Weight of Cylinder + Compacted Soil	gram	3327	3432	3422	3422	3404
Weight of Cylinder	gram	1532	1534	1556	1577	1559
Diameter of Cylinder	cm	10,10	10,10	10,11	10,10	10,10
Height of Cylinder	cm	10,12	10,12	10,12	10,12	10,12
Compacted Soil Weight	gram	1795	1898	1866	1845	1845
Density	gram/cm ³	2,214	2,341	2,297	2,276	2,276
Dry Density	gram/cm ³	2,113	2,181	2,125	2,095	2,066

Attachment 9.e



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LOS ANGELES ABRASION TEST

Date : 28th August 2019

Sieve Number		Weight and Gradation of the Sample (gram)						
Passed (mm)	Retained (mm)	A	B	C	D	E	F	G
76,2	63,5					2500		
63,5	50,8					2500		
50,8	38,10					5000	5000	
38,10	25,40	1250				5000	5000	5000
25,40	19,05	1250						5000
19,05	12,70	1250	2500					5000
12,70	9,50	1250	2500					
9,50	6,35			2500				
6,35	4,75			2500				
4,75	2,36				5000			
Number of Steel Balls		12	11	8	6	12	12	12

Type of Gradation : B

Weight of Aggregate before test (A) : 5000 gram

Weight of Aggregate after test (retained on Sieve no. 12) (B) : 3800 gram

Abrasion of the Aggregate : $\frac{A-B}{A} \times 100\% = \frac{5000-3800}{5000} \times 100\% = 24\%$



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CBR TEST OF SOIL

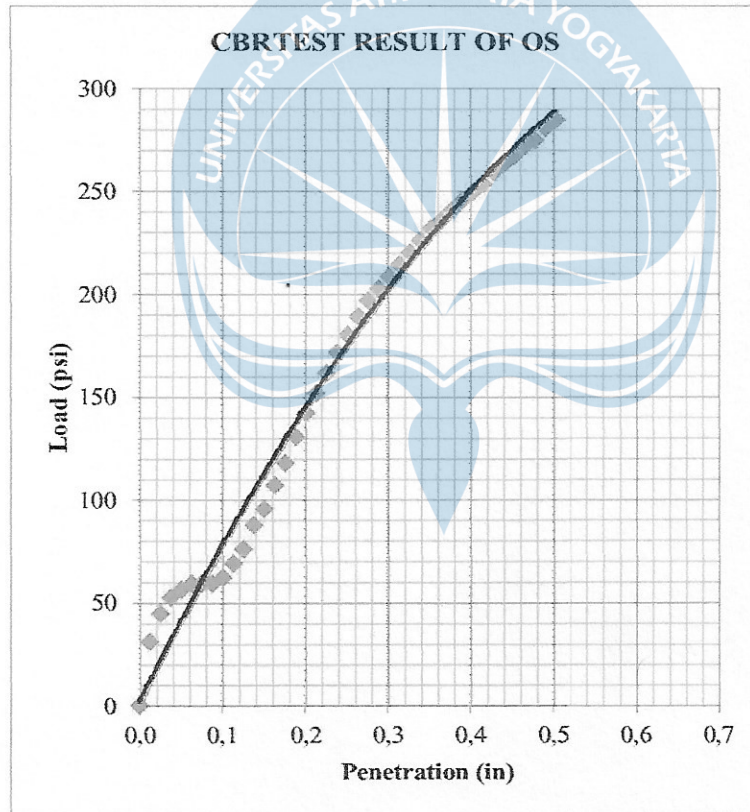
Sample Code = OS-A
 Sample was made on = 21 July 2019
 Sample was tested on = 22 July 2019

Penetration		Load		Pressure
Dial Reading	ΔL	Dial Reading	P	σ
	(in)		(lbs.)	(psi)
0	0	0	0	0
32	0,013	16	93,521	31,174
64	0,025	23	134,436	44,812
96	0,038	27	157,816	52,605
128	0,050	29	169,506	56,502
160	0,063	30,5	178,273	59,424
192	0,076	30,5	178,273	59,424
224	0,088	30,5	178,273	59,424
256	0,101	32	187,041	62,347
288	0,113	35,5	207,499	69,166
320	0,126	39	227,956	75,985
352	0,139	45	263,026	87,675
384	0,151	49	286,407	95,469
416	0,164	55	321,477	107,159
448	0,176	60,5	353,624	117,875
480	0,189	67	391,617	130,539
512	0,202	73	426,687	142,229
544	0,214	78	455,912	151,971
576	0,227	83	485,138	161,713
608	0,239	88	514,363	171,454
640	0,252	92,5	540,665	180,222
672	0,265	97	566,968	188,989
704	0,277	101	590,348	196,783
736	0,290	104	607,883	202,628
768	0,302	107	625,418	208,473
800	0,315	110	642,953	214,318
832	0,328	113	660,489	220,163
864	0,340	116	678,024	226,008
896	0,353	119	695,559	231,853
928	0,365	121	707,249	235,750
960	0,378	123,5	721,861	240,620
992	0,391	126	736,474	245,491



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Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	Σ (psi)
1024	0,403	128	748,164	249,388
1056	0,416	130	759,854	253,285
1088	0,428	133	777,389	259,130
1120	0,441	135	789,079	263,026
1152	0,454	137	800,769	266,923
1184	0,466	139,5	815,382	271,794
1216	0,479	141	824,149	274,716
1248	0,491	144	841,685	280,562
1280	0,504	146	853,375	284,458



CBR VALUE			
Penetration (in)	Load (psi)	Standard Load (psi)	CBR (%)
0,1	187,041	1000	18,70
0,2	426,687	1500	28,45

Attachment 11.a



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CBR TEST OF SUBBASE MIXTURE

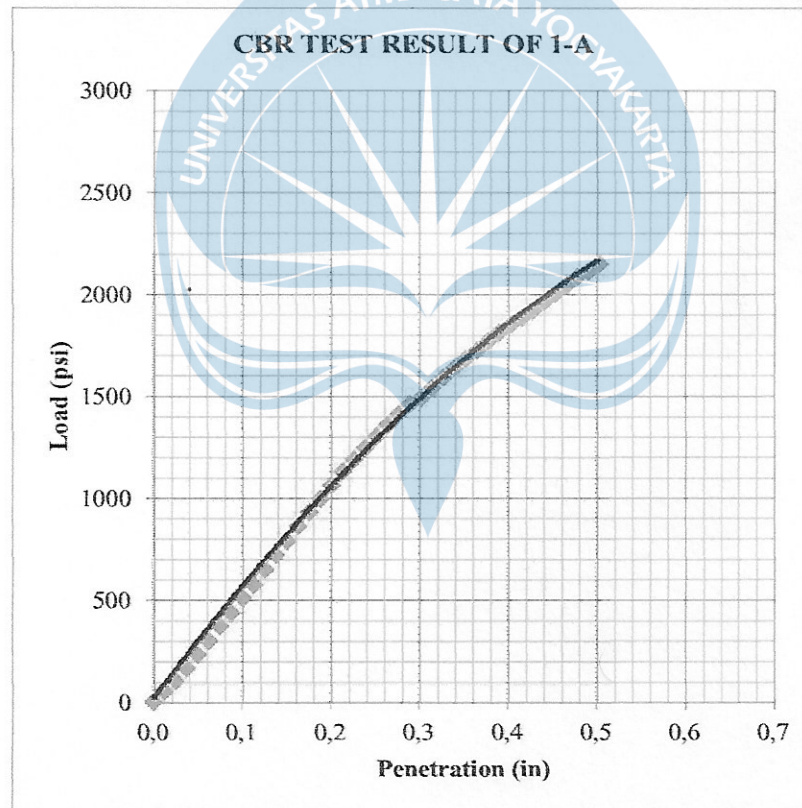
Sample Code = I-A
 Sample was made on = 9 September 2019
 Sample was tested on = 11 September 2019

Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	σ (psi)
0	0	0	0	0
32	0,013	26	151,971	50,657
64	0,025	54	315,632	105,211
96	0,038	85	496,828	165,609
128	0,050	119	695,559	231,853
160	0,063	154	900,135	300,045
192	0,076	191	1116,401	372,134
224	0,088	224	1309,287	436,429
256	0,101	261	1525,553	508,518
288	0,113	295	1724,284	574,761
320	0,126	332	1940,550	646,850
352	0,139	370	2162,662	720,887
384	0,151	405	2367,238	789,079
416	0,164	442	2583,504	861,168
448	0,176	478	2793,925	931,308
480	0,189	511	2986,811	995,604
512	0,202	545	3185,542	1061,847
544	0,214	580	3390,118	1130,039
576	0,227	610	3565,469	1188,490
608	0,239	640	3740,820	1246,940
640	0,252	669	3910,326	1303,442
672	0,265	697	4073,987	1357,996
704	0,277	724	4231,803	1410,601
736	0,290	750	4383,773	1461,258
768	0,302	765	4471,449	1490,483
800	0,315	790	4617,575	1539,192
832	0,328	816	4769,546	1589,849
864	0,340	840	4909,826	1636,609
896	0,353	863	5044,262	1681,421
928	0,365	885	5172,853	1724,284
960	0,378	908	5307,288	1769,096
992	0,391	930	5435,879	1811,960



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Penetration		Load		Pressure
Dial Reading	ΔL	Dial Reading	P	σ
	(in)		(lbs.)	(psi)
1024	0,403	949	5546,935	1848,978
1056	0,416	966	5646,300	1882,100
1088	0,428	985	5757,356	1919,119
1120	0,441	1007	5885,947	1961,982
1152	0,454	1027	6002,847	2000,949
1184	0,466	1048	6125,593	2041,864
1216	0,479	1070	6254,184	2084,728
1248	0,491	1083	6330,169	2110,056
1280	0,504	1103	6447,070	2149,023



CBR VALUE			
Penetration	Load	Standard Load	CBR
(in)	(psi)	(psi)	(%)
0,1	508,518	1000	50,85
0,2	1061,847	1500	70,79

Attachment 11.b



CBR TEST OF SUBBASE MIXTURE

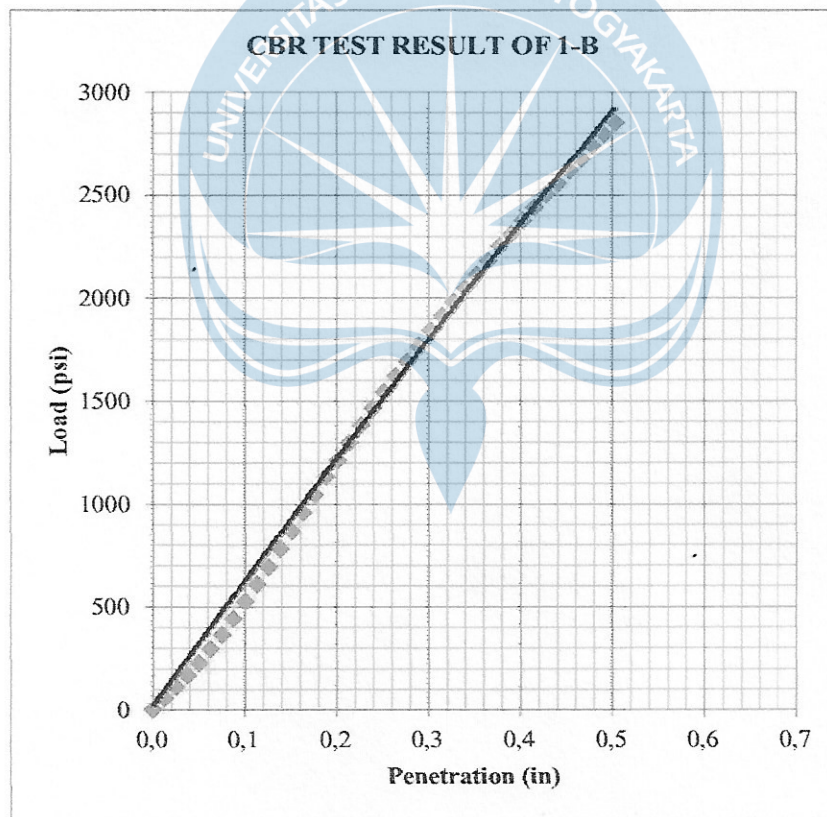
Sample Code = 1-B
 Sample was made on = 9 September 2019
 Sample was tested on = 11 September 2019

Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	σ (psi)
0	0	0	0	0
32	0,013	28	163,661	54,554
64	0,025	56	327,322	109,107
96	0,038	85	496,828	165,609
128	0,050	116	678,024	226,008
160	0,063	151	882,600	294,200
192	0,076	186	1087,176	362,392
224	0,088	226	1320,977	440,326
256	0,101	269	1572,313	524,104
288	0,113	312	1823,650	607,883
320	0,126	355	2074,986	691,662
352	0,139	400	2338,013	779,338
384	0,151	445	2601,039	867,013
416	0,164	490	2864,065	954,688
448	0,176	536	3132,937	1044,312
480	0,189	581	3395,963	1131,988
512	0,202	621	3629,764	1209,921
544	0,214	665	3886,946	1295,649
576	0,227	709	4144,127	1381,376
608	0,239	751	4389,619	1463,206
640	0,252	791	4623,420	1541,140
672	0,265	831	4857,221	1619,074
704	0,277	867	5067,642	1689,214
736	0,290	906	5295,598	1765,199
768	0,302	945	5523,555	1841,185
800	0,315	981	5733,976	1911,325
832	0,328	1016	5938,552	1979,517
864	0,340	1051	6143,128	2047,709
896	0,353	1084	6336,014	2112,005
928	0,365	1119	6540,590	2180,197
960	0,378	1156	6756,856	2252,285
992	0,391	1186	6932,207	2310,736



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Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	Σ (psi)
1024	0,403	1219	7125,093	2375,031
1056	0,416	1252	7317,979	2439,326
1088	0,428	1284	7505,020	2501,673
1120	0,441	1311	7662,836	2554,279
1152	0,454	1343	7849,877	2616,626
1184	0,466	1373	8025,228	2675,076
1216	0,479	1405	8212,269	2737,423
1248	0,491	1433	8375,930	2791,977
1280	0,504	1463	8551,281	2850,427



CBR VALUE			
Penetration (in)	Load (psi)	Standard Load (psi)	CBR (%)
0,1	524,1045	1000	52,41
0,2	1209,921	1500	80,66



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CBR TEST OF SUBBASE MIXTURE

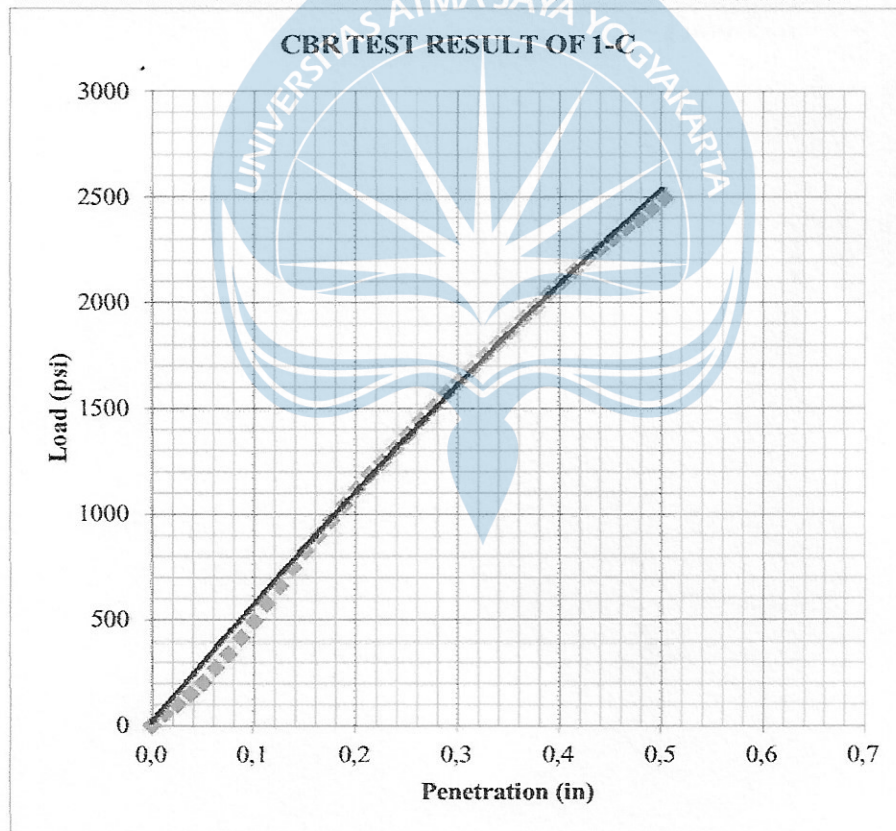
Sample Code = 1-C
 Sample was made on = 9 September 2019
 Sample was tested on = 11 September 2019

Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	σ (psi)
0	0	0	0	0
32	0,013	29	169,506	56,502
64	0,025	51	298,097	99,366
96	0,038	76	444,222	148,074
128	0,050	103	602,038	200,679
160	0,063	139	812,459	270,820
192	0,076	172	1005,345	335,115
224	0,088	212	1239,147	413,049
256	0,101	252	1472,948	490,983
288	0,113	294	1718,439	572,813
320	0,126	337	1969,776	656,592
352	0,139	382	2232,802	744,267
384	0,151	422	2466,603	822,201
416	0,164	459	2682,869	894,290
448	0,176	497	2904,981	968,327
480	0,189	534	3121,247	1040,416
512	0,202	572	3343,358	1114,453
544	0,214	608	3553,779	1184,593
576	0,227	638	3729,130	1243,043
608	0,239	671	3922,016	1307,339
640	0,252	704	4114,902	1371,634
672	0,265	739	4319,478	1439,826
704	0,277	771	4506,519	1502,173
736	0,290	804	4699,405	1566,468
768	0,302	834	4874,756	1624,919
800	0,315	863	5044,262	1681,421
832	0,328	896	5237,148	1745,716
864	0,340	926	5412,499	1804,166
896	0,353	955	5582,005	1860,668
928	0,365	987	5769,046	1923,015
960	0,378	1015	5932,707	1977,569
992	0,391	1046	6113,903	2037,968



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Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	σ (psi)
1024	0,403	1076	6289,254	2096,418
1056	0,416	1103	6447,070	2149,023
1088	0,428	1133	6622,420	2207,473
1120	0,441	1156	6756,856	2252,285
1152	0,454	1181	6902,982	2300,994
1184	0,466	1207	7054,953	2351,651
1216	0,479	1228	7177,698	2392,566
1248	0,491	1253	7323,824	2441,275
1280	0,504	1279	7475,795	2491,932



CBR VALUE			
Penetration (in)	Load (psi)	Standard Load (psi)	CBR (%)
0,1	490,983	1000	49,10
0,2	1114,453	1500	74,30



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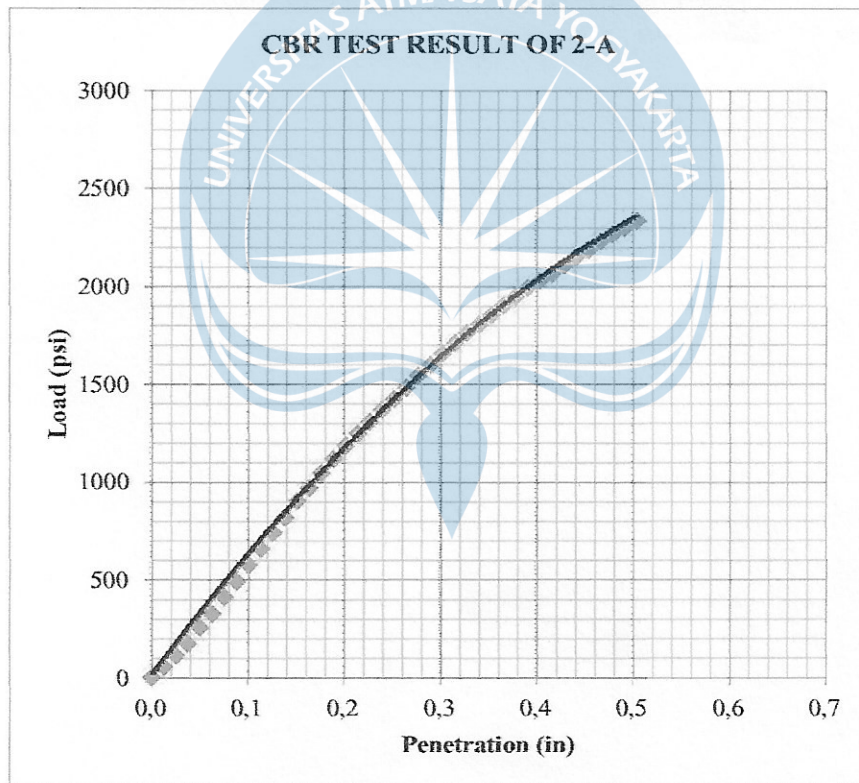
CBR TEST OF SUBBASE MIXTURE

Sample Code = 2-A
 Sample was made on = 10 September 2019
 Sample was tested on = 12 September 2019

Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	σ (psi)
0	0	0	0	0
32	0,013	28	163,661	54,554
64	0,025	57	333,167	111,056
96	0,038	88	514,363	171,454
128	0,050	130	759,854	253,285
160	0,063	167	976,120	325,373
192	0,076	211	1233,302	411,101
224	0,088	251	1467,103	489,034
256	0,101	295	1724,284	574,761
288	0,113	337	1969,776	656,592
320	0,126	379	2215,267	738,422
352	0,139	419	2449,068	816,356
384	0,151	463	2706,250	902,083
416	0,164	498	2910,826	970,275
448	0,176	537	3138,782	1046,261
480	0,189	573	3349,203	1116,401
512	0,202	608	3553,779	1184,593
544	0,214	640	3740,820	1246,940
576	0,227	671	3922,016	1307,339
608	0,239	702	4103,212	1367,737
640	0,252	730	4266,873	1422,291
672	0,265	760	4442,224	1480,741
704	0,277	791	4623,420	1541,140
736	0,290	819	4787,081	1595,694
768	0,302	849	4962,432	1654,144
800	0,315	876	5120,247	1706,749
832	0,328	903	5278,063	1759,354
864	0,340	925	5406,654	1802,218
896	0,353	950	5552,780	1850,927
928	0,365	976	5704,751	1901,584
960	0,378	999	5839,186	1946,395
992	0,391	1022	5973,622	1991,207



Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs)	σ (psi)
1024	0,403	1041	6084,678	2028,226
1056	0,416	1059	6189,888	2063,296
1088	0,428	1081	6318,479	2106,160
1120	0,441	1103	6447,070	2149,023
1152	0,454	1122	6558,125	2186,042
1184	0,466	1144	6686,716	2228,905
1216	0,479	1163	6797,771	2265,924
1248	0,491	1179	6891,292	2297,097
1280	0,504	1198	7002,348	2334,116



CBR VALUE			
Penetration (in)	Load (psi)	Standard Load (psi)	CBR (%)
0,1	574,761	1000	57,48
0,2	1184,593	1500	78,97



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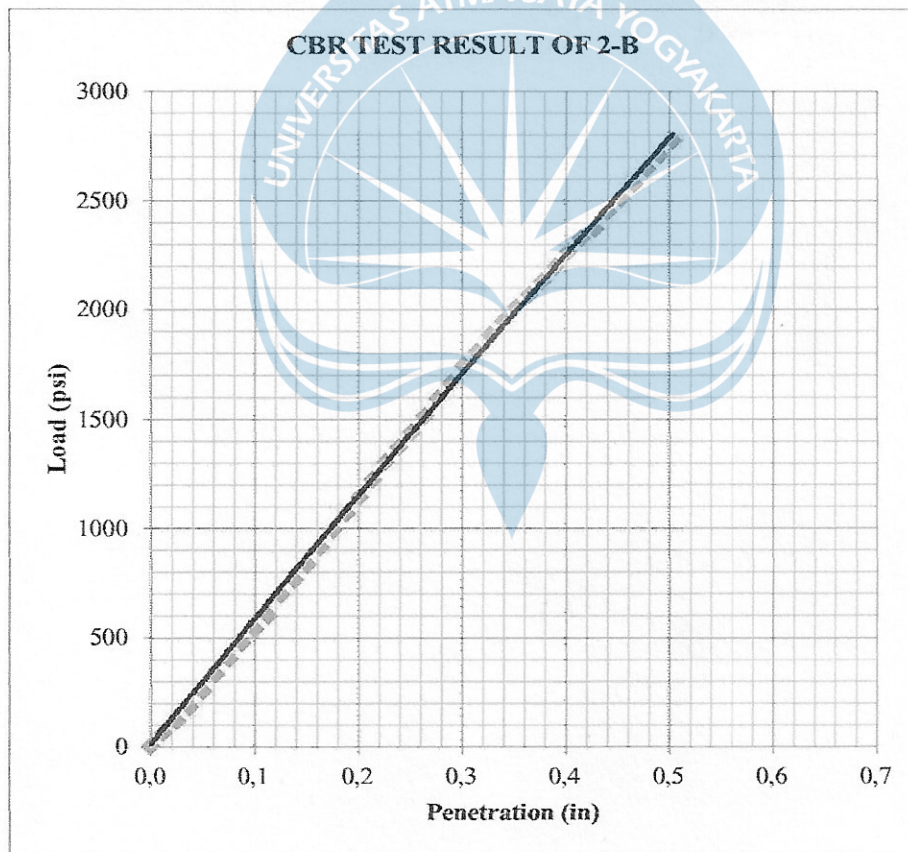
CBR TEST OF SUBBASE MIXTURE

Sample Code = 2-B
 Sample was made on = 10 September 2019
 Sample was tested on = 12 September 2019

Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	Σ (psi)
0	0	0	0	0
32	0,013	32	187,041	62,347
64	0,025	60	350,702	116,901
96	0,038	93	543,588	181,196
128	0,050	130	759,854	253,285
160	0,063	170	993,655	331,218
192	0,076	206	1204,076	401,359
224	0,088	243	1420,343	473,448
256	0,101	276	1613,229	537,743
288	0,113	307	1794,425	598,142
320	0,126	356	2080,831	693,610
352	0,139	391	2285,407	761,802
384	0,151	427	2495,828	831,943
416	0,164	467	2729,630	909,877
448	0,176	508	2969,276	989,759
480	0,189	547	3197,232	1065,744
512	0,202	586	3425,188	1141,729
544	0,214	627	3664,835	1221,612
576	0,227	669	3910,326	1303,442
608	0,239	703	4109,057	1369,686
640	0,252	738	4313,633	1437,878
672	0,265	777	4541,589	1513,863
704	0,277	817	4775,391	1591,797
736	0,290	854	4991,657	1663,886
768	0,302	894	5225,458	1741,819
800	0,315	926	5412,499	1804,166
832	0,328	966	5646,300	1882,100
864	0,340	998	5833,341	1944,447
896	0,353	1032	6032,072	2010,691
928	0,365	1062	6207,423	2069,141
960	0,378	1093	6388,619	2129,540
992	0,391	1128	6593,195	2197,732



Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	σ (psi)
1024	0,403	1163	6797,771	2265,924
1056	0,416	1194	6978,967	2326,322
1088	0,428	1216	7107,558	2369,186
1120	0,441	1256	7341,359	2447,120
1152	0,454	1287	7522,555	2507,518
1184	0,466	1322	7727,131	2575,710
1216	0,479	1357	7931,708	2643,903
1248	0,491	1388	8112,903	2704,301
1280	0,504	1423	8317,480	2772,493



CBR VALUE			
Penetration (in)	Load (psi)	Standard Load (psi)	CBR (%)
0,1	537,7429	1000	53,77
0,2	1141,729	1500	76,12



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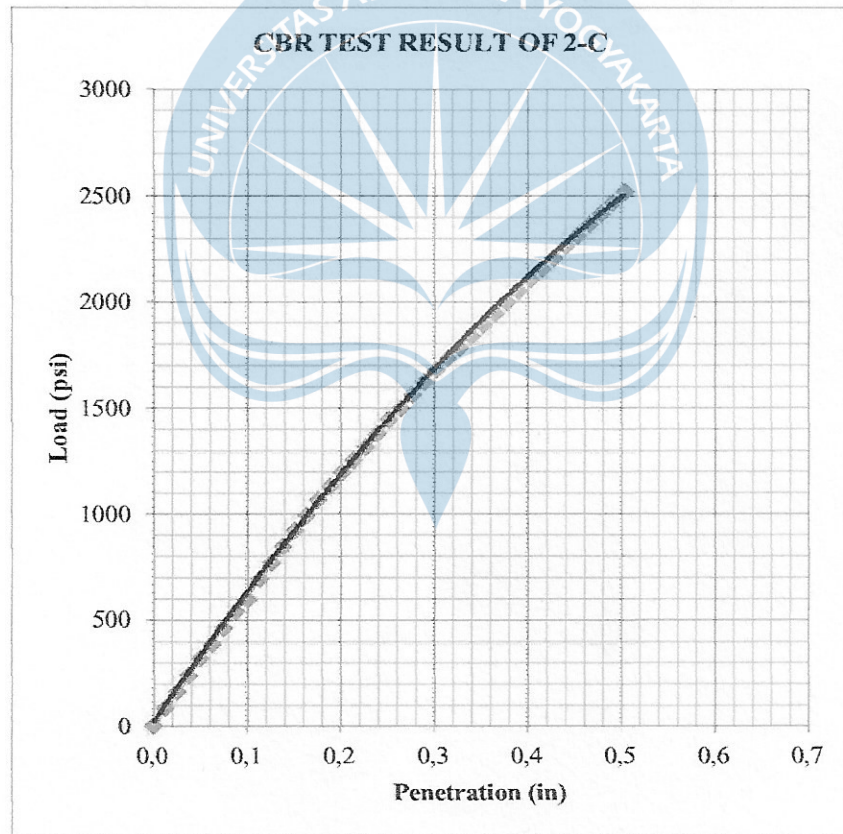
CBR TEST OF SUBBASE MIXTURE

Sample Code = 2-C
 Sample was made on = 10 September 2019
 Sample was tested on = 12 September 2019

Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs)	Σ (psi)
0	0	0	0	0
32	0,013	43	251,336	83,779
64	0,025	83	485,138	161,713
96	0,038	122	713,094	237,698
128	0,050	163	952,740	317,580
160	0,063	198	1157,316	385,772
192	0,076	237	1385,272	461,757
224	0,088	276	1613,229	537,743
256	0,101	306	1788,580	596,193
288	0,113	355	2074,986	691,662
320	0,126	394	2302,942	767,647
352	0,139	433	2530,899	843,633
384	0,151	473	2764,700	921,567
416	0,164	508	2969,276	989,759
448	0,176	547	3197,232	1065,744
480	0,189	579	3384,273	1128,091
512	0,202	613	3583,004	1194,335
544	0,214	643	3758,355	1252,785
576	0,227	675	3945,396	1315,132
608	0,239	708	4138,282	1379,427
640	0,252	741	4331,168	1443,723
672	0,265	769	4494,829	1498,276
704	0,277	801	4681,870	1560,623
736	0,290	832	4863,066	1621,022
768	0,302	861	5032,572	1677,524
800	0,315	888	5190,388	1730,129
832	0,328	914	5342,359	1780,786
864	0,340	942	5506,020	1835,340
896	0,353	969	5663,835	1887,945
928	0,365	996	5821,651	1940,550
960	0,378	1024	5985,312	1995,104
992	0,391	1052	6148,973	2049,658



Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs)	Σ (psi)
1024	0,403	1079	6306,789	2102,263
1056	0,416	1105	6458,760	2152,920
1088	0,428	1132	6616,575	2205,525
1120	0,441	1161	6786,081	2262,027
1152	0,454	1186	6932,207	2310,736
1184	0,466	1213	7090,023	2363,341
1216	0,479	1239	7241,994	2413,998
1248	0,491	1266	7399,810	2466,603
1280	0,504	1292	7551,780	2517,260



CBR VALUE			
Penetration (in)	Load (psi)	Standard Load (psi)	CBR (%)
0,1	596,1932	1000	59,62
0,2	1194,335	1500	79,62



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CBR TEST OF SUBBASE MIXTURE

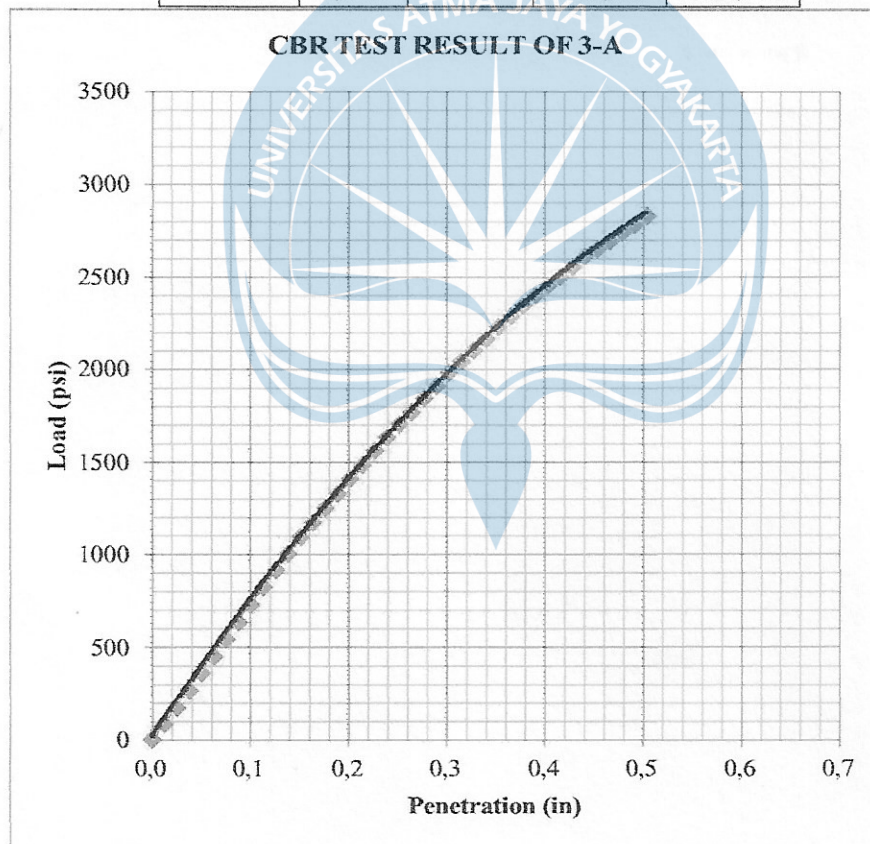
Sample Code = 3-A
 Sample was made on = 11 September 2019
 Sample was tested on = 13 September 2019

Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	σ (psi)
0	0	0	0	0
32	0,013	43	251,336	83,779
64	0,025	88	514,363	171,454
96	0,038	135	789,079	263,026
128	0,050	184	1075,486	358,495
160	0,063	229	1338,512	446,171
192	0,076	278	1624,919	541,640
224	0,088	324	1893,790	631,263
256	0,101	373	2180,197	726,732
288	0,113	422	2466,603	822,201
320	0,126	469	2741,320	913,773
352	0,139	514	3004,346	1001,449
384	0,151	561	3279,063	1093,021
416	0,164	601	3512,864	1170,955
448	0,176	641	3746,665	1248,888
480	0,189	681	3980,466	1326,822
512	0,202	723	4225,958	1408,653
544	0,214	761	4448,069	1482,690
576	0,227	801	4681,870	1560,623
608	0,239	838	4898,136	1632,712
640	0,252	874	5108,557	1702,852
672	0,265	908	5307,288	1769,096
704	0,277	946	5529,400	1843,133
736	0,290	979	5722,286	1907,429
768	0,302	1016	5938,552	1979,517
800	0,315	1048	6125,593	2041,864
832	0,328	1079	6306,789	2102,263
864	0,340	1110	6487,985	2162,662
896	0,353	1143	6680,871	2226,957
928	0,365	1173	6856,222	2285,407
960	0,378	1202	7025,728	2341,909
992	0,391	1231	7195,234	2398,411



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Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	Σ (psi)
1024	0,403	1259	7358,894	2452,965
1056	0,416	1282	7493,330	2497,777
1088	0,428	1311	7662,836	2554,279
1120	0,441	1339	7826,497	2608,832
1152	0,454	1360	7949,243	2649,748
1184	0,466	1381	8071,988	2690,663
1216	0,479	1406	8218,114	2739,371
1248	0,491	1427	8340,860	2780,287
1280	0,504	1452	8486,985	2828,995



CBR VALUE			
Penetration (in)	Load (psi)	Standard Load (psi)	CBR (%)
0,1	726,7	1000	72,67
0,2	1408,653	1500	93,91



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CBR TEST OF SUBBASE MIXTURE

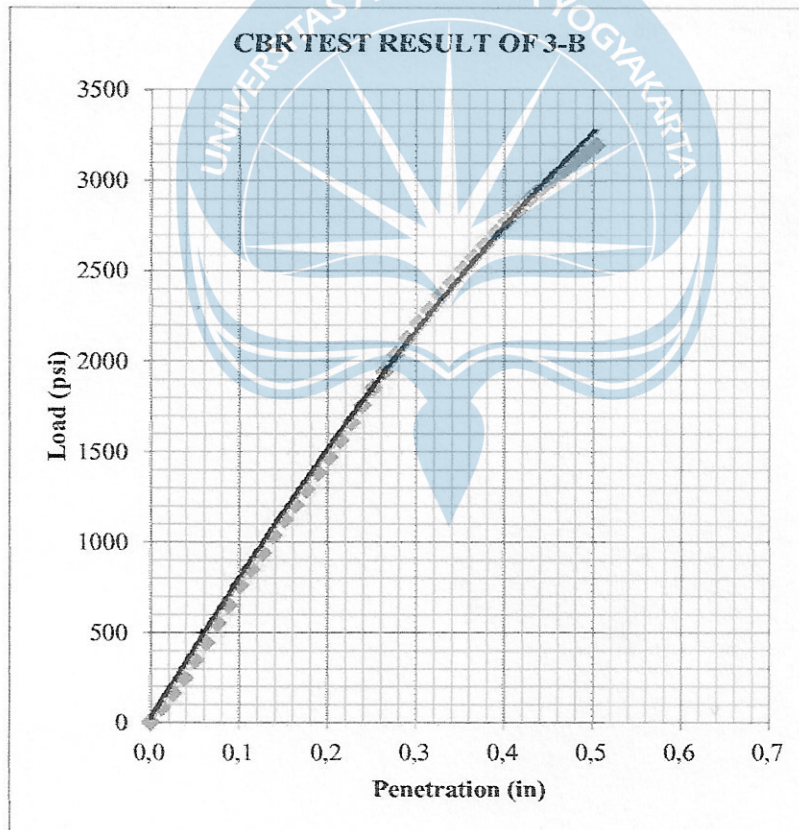
Sample Code = 3-B
 Sample was made on = 11 September 2019
 Sample was tested on = 13 September 2019

Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	σ (psi)
0	0	0	0	0
32	0,013	42	245,491	81,830
64	0,025	83	485,138	161,713
96	0,038	126	736,474	245,491
128	0,050	177	1034,571	344,857
160	0,063	228	1332,667	444,222
192	0,076	283	1654,144	551,381
224	0,088	334	1952,240	650,747
256	0,101	390	2279,562	759,854
288	0,113	435	2542,589	847,530
320	0,126	481	2811,460	937,153
352	0,139	531	3103,712	1034,571
384	0,151	576	3366,738	1122,246
416	0,164	618	3612,229	1204,076
448	0,176	662	3869,411	1289,804
480	0,189	709	4144,127	1381,376
512	0,202	754	4407,154	1469,051
544	0,214	802	4687,715	1562,572
576	0,227	853	4985,812	1661,937
608	0,239	901	5266,373	1755,458
640	0,252	951	5558,625	1852,875
672	0,265	997	5827,496	1942,499
704	0,277	1043	6096,368	2032,123
736	0,290	1089	6365,239	2121,746
768	0,302	1134	6628,266	2209,422
800	0,315	1171	6844,532	2281,511
832	0,328	1213	7090,023	2363,341
864	0,340	1249	7300,444	2433,481
896	0,353	1288	7528,400	2509,467
928	0,365	1322	7727,131	2575,710
960	0,378	1357	7931,708	2643,903
992	0,391	1391	8130,439	2710,146



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Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	Σ (psi)
1024	0,403	1425	8329,170	2776,390
1056	0,416	1456	8510,366	2836,789
1088	0,428	1488	8697,407	2899,136
1120	0,441	1517	8866,913	2955,638
1152	0,454	1543	9018,883	3006,294
1184	0,466	1568	9165,009	3055,003
1216	0,479	1592	9305,290	3101,763
1248	0,491	1615	9439,726	3146,575
1280	0,504	1639	9580,006	3193,335



CBR VALUE			
Penetration (in)	Load (psi)	Standard Load (psi)	CBR (%)
0,1	759,8541	1000	75,99
0,2	1469,051	1500	97,94



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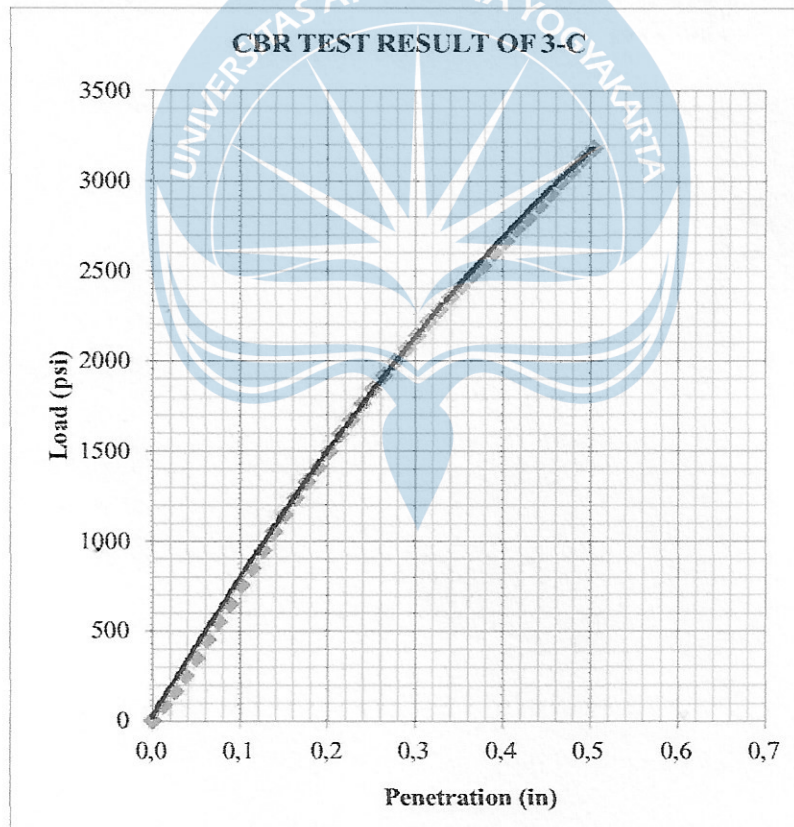
CBR TEST OF SUBBASE MIXTURE

Sample Code = 3-C
 Sample was made on = 11 September 2019
 Sample was tested on = 13 September 2019

Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	Σ (psi)
0	0	0	0	0
32	0,013	44	257,181	85,727
64	0,025	84	490,983	163,661
96	0,038	128	748,164	249,388
128	0,050	179	1046,261	348,754
160	0,063	231	1350,202	450,067
192	0,076	283	1654,144	551,381
224	0,088	332	1940,550	646,850
256	0,101	386	2256,182	752,061
288	0,113	435	2542,589	847,530
320	0,126	486	2840,685	946,895
352	0,139	540	3156,317	1052,106
384	0,151	588	3436,878	1145,626
416	0,164	636	3717,440	1239,147
448	0,176	681	3980,466	1326,822
480	0,189	722	4220,113	1406,704
512	0,202	768	4488,984	1496,328
544	0,214	818	4781,236	1593,745
576	0,227	858	5015,037	1671,679
608	0,239	904	5283,908	1761,303
640	0,252	945	5523,555	1841,185
672	0,265	984	5751,511	1917,170
704	0,277	1023	5979,467	1993,156
736	0,290	1059	6189,888	2063,296
768	0,302	1097	6411,999	2137,333
800	0,315	1136	6639,956	2213,319
832	0,328	1171	6844,532	2281,511
864	0,340	1207	7054,953	2351,651
896	0,353	1238	7236,149	2412,050
928	0,365	1270	7423,190	2474,397
960	0,378	1297	7581,006	2527,002
992	0,391	1334	7797,272	2599,091



Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	Σ (psi)
1024	0,403	1367	7990,158	2663,386
1056	0,416	1403	8200,579	2733,526
1088	0,428	1432	8370,085	2790,028
1120	0,441	1468	8580,506	2860,169
1152	0,454	1502	8779,237	2926,412
1184	0,466	1537	8983,813	2994,604
1216	0,479	1568	9165,009	3055,003
1248	0,491	1602	9363,740	3121,247
1280	0,504	1632	9539,091	3179,697



CBR VALUE			
Penetration (in)	Load (psi)	Standard Load (psi)	CBR (%)
0,1	752,061	1000	75,21
0,2	1496,328	1500	99,76



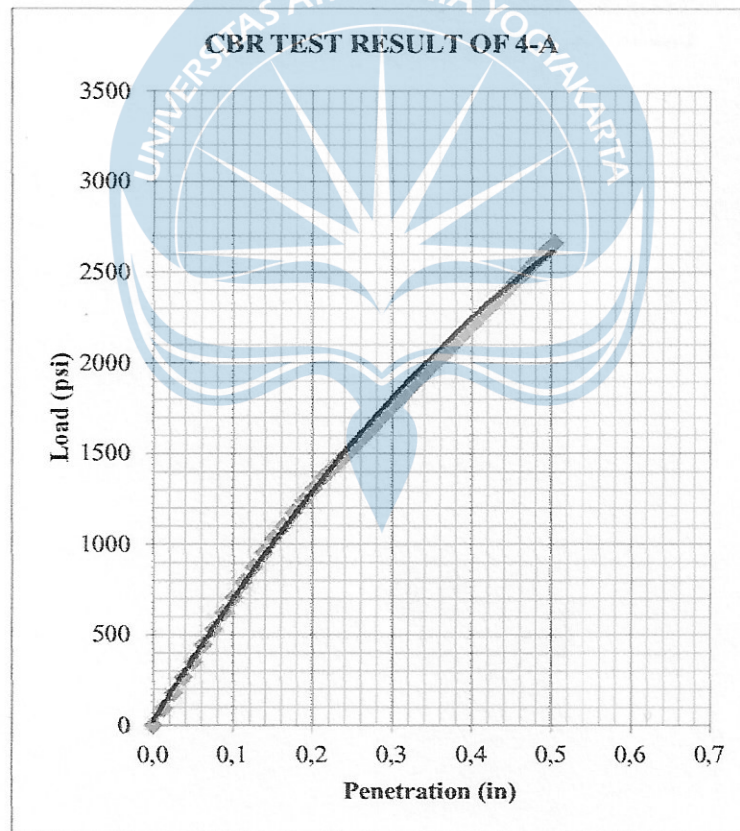
CBR TEST OF SUBBASE MIXTURE

Sample Code = 4-A
 Sample was made on = 12 September 2019
 Sample was tested on = 14 September 2019

Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	σ (psi)
0	0	0	0	0
32	0,013	47	274,716	91,572
64	0,025	92	537,743	179,248
96	0,038	136	794,924	264,975
128	0,050	179	1046,261	348,754
160	0,063	228	1332,667	444,222
192	0,076	272	1589,849	529,950
224	0,088	318	1858,720	619,573
256	0,101	362	2115,901	705,300
288	0,113	405	2367,238	789,079
320	0,126	448	2618,574	872,858
352	0,139	488	2852,375	950,792
384	0,151	529	3092,022	1030,674
416	0,164	564	3296,598	1098,866
448	0,176	602	3518,709	1172,903
480	0,189	635	3711,595	1237,198
512	0,202	670	3916,171	1305,390
544	0,214	704	4114,902	1371,634
576	0,227	731	4272,718	1424,239
608	0,239	760	4442,224	1480,741
640	0,252	790	4617,575	1539,192
672	0,265	819	4787,081	1595,694
704	0,277	848	4956,587	1652,196
736	0,290	878	5131,938	1710,646
768	0,302	908	5307,288	1769,096
800	0,315	936	5470,949	1823,650
832	0,328	965	5640,455	1880,152
864	0,340	994	5809,961	1936,654
896	0,353	1022	5973,622	1991,207
928	0,365	1049	6131,438	2043,813
960	0,378	1079	6306,789	2102,263
992	0,391	1109	6482,140	2160,713



Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	σ (psi)
1024	0,403	1138	6651,646	2217,215
1056	0,416	1168	6826,997	2275,666
1088	0,428	1196	6990,657	2330,219
1120	0,441	1224	7154,318	2384,773
1152	0,454	1253	7323,824	2441,275
1184	0,466	1280	7481,640	2493,880
1216	0,479	1310	7656,991	2552,330
1248	0,491	1338	7820,652	2606,884
1280	0,504	1366	7984,313	2661,438



CBR VALUE			
Penetration (in)	Load (psi)	Standard Load (psi)	CBR (%)
0,1	705,3004	1000	70,53
0,2	1305,39	1500	87,03



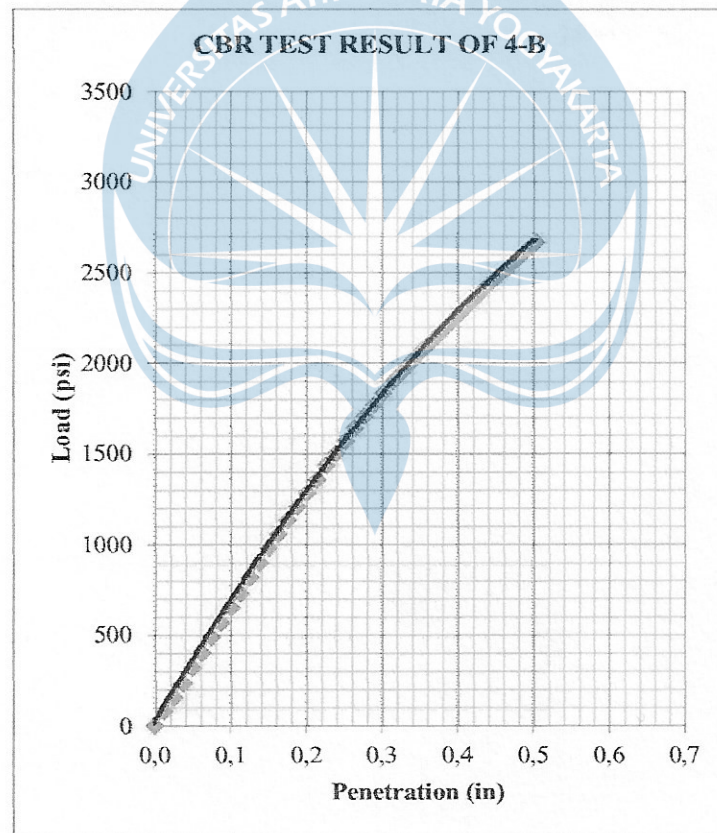
CBR TEST OF SUBBASE MIXTURE

Sample Code = 4-B
 Sample was made on = 12 September 2019
 Sample was tested on = 14 September 2019

Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	σ (psi)
0	0	0	0	0
32	0,013	41	239,646	79,882
64	0,025	80	467,603	155,868
96	0,038	120	701,404	233,801
128	0,050	164	958,585	319,528
160	0,063	206	1204,076	401,359
192	0,076	250	1461,258	487,086
224	0,088	291	1700,904	566,968
256	0,101	335	1958,085	652,695
288	0,113	374	2186,042	728,681
320	0,126	420	2454,913	818,304
352	0,139	461	2694,559	898,186
384	0,151	503	2940,051	980,017
416	0,164	542	3168,007	1056,002
448	0,176	582	3401,808	1133,936
480	0,189	620	3623,919	1207,973
512	0,202	659	3851,876	1283,959
544	0,214	695	4062,297	1354,099
576	0,227	737	4307,788	1435,929
608	0,239	770	4500,674	1500,225
640	0,252	806	4711,095	1570,365
672	0,265	842	4921,516	1640,505
704	0,277	876	5120,247	1706,749
736	0,290	908	5307,288	1769,096
768	0,302	942	5506,020	1835,340
800	0,315	974	5693,061	1897,687
832	0,328	1002	5856,721	1952,240
864	0,340	1030	6020,382	2006,794
896	0,353	1059	6189,888	2063,296
928	0,365	1084	6336,014	2112,005
960	0,378	1112	6499,675	2166,558
992	0,391	1139	6657,491	2219,164



Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	σ (psi)
1024	0,403	1166	6815,307	2271,769
1056	0,416	1194	6978,967	2326,322
1088	0,428	1220	7130,938	2376,979
1120	0,441	1247	7288,754	2429,585
1152	0,454	1271	7429,035	2476,345
1184	0,466	1295	7569,316	2523,105
1216	0,479	1320	7715,441	2571,814
1248	0,491	1345	7861,567	2620,522
1280	0,504	1368	7996,003	2665,334



CBR VALUE			
Penetration (in)	Load (psi)	Standard Load (psi)	CBR (%)
0,1	652,6952	1000	65,27
0,2	1283,959	1500	85,60



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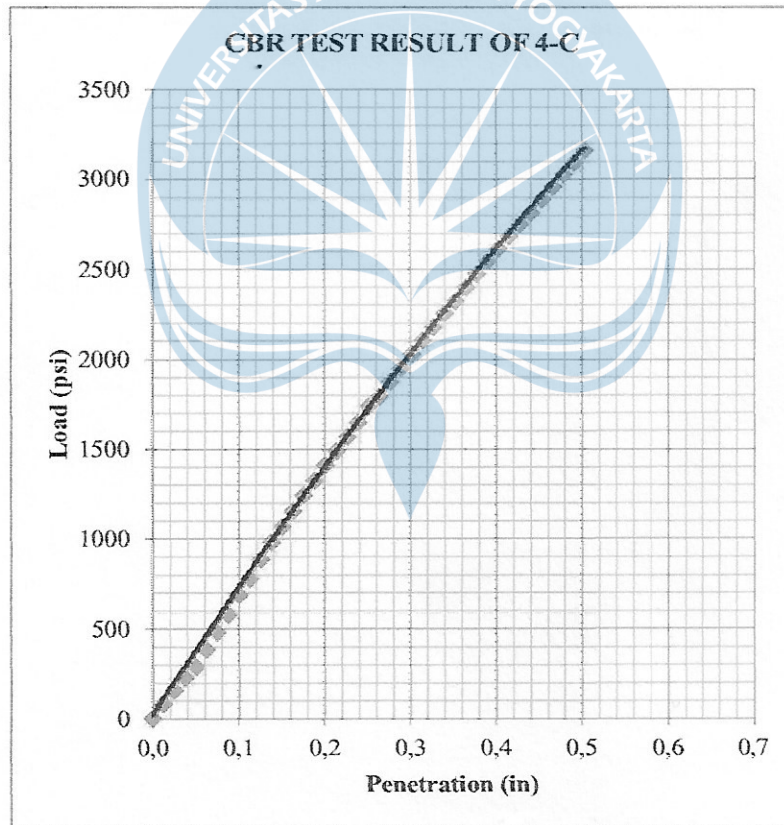
CBR TEST OF SUBBASE MIXTURE

Sample Code = 4-C
 Sample was made on = 12 September 2019
 Sample was tested on = 14 September 2019

Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	Σ (psi)
0	0	0	0	0
32	0,013	42	245,491	81,830
64	0,025	80	467,603	155,868
96	0,038	116	678,024	226,008
128	0,050	148	865,065	288,355
160	0,063	196	1145,626	381,875
192	0,076	246	1437,878	479,293
224	0,088	296	1730,129	576,710
256	0,101	351	2051,606	683,869
288	0,113	398	2326,322	775,441
320	0,126	454	2653,644	884,548
352	0,139	502	2934,206	978,069
384	0,151	546	3191,387	1063,796
416	0,164	591	3454,414	1151,471
448	0,176	636	3717,440	1239,147
480	0,189	678	3962,931	1320,977
512	0,202	723	4225,958	1408,653
544	0,214	763	4459,759	1486,586
576	0,227	804	4699,405	1566,468
608	0,239	844	4933,206	1644,402
640	0,252	891	5207,923	1735,974
672	0,265	918	5365,739	1788,580
704	0,277	961	5617,075	1872,358
736	0,290	999	5839,186	1946,395
768	0,302	1040	6078,833	2026,278
800	0,315	1078	6300,944	2100,315
832	0,328	1116	6523,055	2174,352
864	0,340	1156	6756,856	2252,285
896	0,353	1191	6961,432	2320,477
928	0,365	1230	7189,389	2396,463
960	0,378	1268	7411,500	2470,500
992	0,391	1304	7621,921	2540,640



Penetration		Load		Pressure
Dial Reading	ΔL (in)	Dial Reading	P (lbs.)	Σ (psi)
1024	0,403	1341	7838,187	2612,729
1056	0,416	1376	8042,763	2680,921
1088	0,428	1410	8241,494	2747,165
1120	0,441	1443	8434,380	2811,460
1152	0,454	1481	8656,491	2885,497
1184	0,466	1517	8866,913	2955,638
1216	0,479	1552	9071,489	3023,830
1248	0,491	1586	9270,220	3090,073
1280	0,504	1621	9474,796	3158,265



CBR VALUE			
Penetration (in)	Load (psi)	Standard Load (psi)	CBR (%)
0,1	683,8687	1000	68,39
0,2	1408,653	1500	93,91



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DCP TEST OF SUBBASE MIXTURE

Sample Code = DCP 0% GGBFS
 Sample was made on = 9 September 2019
 Sample was tested on = 9 September 2019

No. of Blows	DCP 1 Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)	No. of Blows	DCP 2 Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)
0	24.3	0	0	0	23.1	0	0
1	25.5	12	12	1	23.7	6	6
2	26	5	17	2	24.2	5	11
3	27.9	19	36	3	25	8	19
4	28.2	3	39	4	26.4	14	33
5	28.7	5	44	5	27.9	15	48
6	29.1	4	48	6	28.3	4	52
7	30.3	12	60	7	28.8	5	57
8	31.3	10	70	8	29.3	5	62
9	32.1	8	78	9	31	17	79
10	33.8	17	95	10	31.6	6	85
11	34.3	5	100	11	32.5	9	94
12	35.9	16	116	12	33.1	6	100
13	36.4	5	121	13	34.1	10	110
14	37	6	127	14	35.2	11	121
15	37.5	5	132	15	36	8	129
16	38.1	6	138	16	37.6	16	145
17	38.7	6	144	17	38.4	8	153
18	39.3	6	150	18	39	6	159
19	39.7	4	154	19	39.7	7	166
20	40.2	5	159	20	40.1	4	170
21	40.9	7	166	21	40.9	8	178
22	41.6	7	173	22	41.6	7	185
23	42.3	7	180	23	42.3	7	192
24	43	7	187	24	43	7	199
25	44.7	17	204	25	43.7	7	206



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No. of Blows	DCP 1 Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)	No. of Blows	DCP 2 Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)
26	45.4	7	211	26	44.3	6	212
27	46.3	9	220	27	44.8	5	217
28	48.3	20	240	28	45.3	5	222
29	48.7	4	244	29	45.8	5	227
30	49.3	6	250	30	46.2	4	231
31	50.1	8	258	31	47.9	17	248
32	51.5	14	272	32	48.5	6	254
33	52.5	10	282	33	50.4	19	273
34	53.4	9	291	34	51.5	11	284
35	54	6	297	35	52.3	8	292
36	54.7	7	304	36	53.6	13	305
37	55.4	7	311	37	55.2	16	321
38	56.3	9	320	38	56	8	329
39	57	7	327	39	56.9	9	338
40	57.7	7	334	40	57.7	8	346

Attachment 12.a



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DCP TEST OF SUBBASE MIXTURE

Sample Code = DCP 15% GGBFS
 Sample was made on = 10 September 2019
 Sample was tested on = 12 September 2019

No. of Blows	DCP 1 Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)	No. of Blows	DCP 2 Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)
0	19	0	0	0	20	0	0
1	20.5	15	15	1	21.6	16	16
2	21.3	8	23	2	22.1	5	21
3	21.5	2	25	3	22.7	6	27
4	22.9	14	39	4	23.1	4	31
5	23.5	6	45	5	23.7	6	37
6	23.8	3	48	6	24.5	8	45
7	24.2	4	52	7	25.2	7	52
8	24.9	7	59	8	26	8	60
9	25.6	7	66	9	26.7	7	67
10	26	4	70	10	27.4	7	74
11	27	10	80	11	29	16	90
12	27.6	6	86	12	30.6	16	106
13	28.8	12	98	13	31.5	9	115
14	29.8	10	108	14	32.4	9	124
15	30.4	6	114	15	33.4	10	134
16	31.2	8	122	16	34.6	12	146
17	32	8	130	17	35.2	6	152
18	32.9	9	139	18	36.8	16	168
19	33.7	8	147	19	37.4	6	174
20	34.1	4	151	20	38.5	11	185
21	35	9	160	21	39.5	10	195
22	36.1	11	171	22	39.8	3	198
23	37.3	12	183	23	40	2	200
24	37.9	6	189	24	40.4	4	204
25	38.4	5	194	25	40.7	3	207



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No. of Blows	DCP Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)	No. of Blows	DCP Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)
26	39.1	7	201	26	41.2	5	212
27	40.4	13	214	27	41.9	7	219
28	40.9	5	219	28	42.4	5	224
29	41.6	7	226	29	42.8	4	228
30	42.8	12	238	30	43.1	3	231
31	43.3	5	243	31	43.6	5	236
32	44.5	12	255	32	44	4	240
33	45	5	260	33	44.5	5	245
34	45.9	9	269	34	45.7	12	257
35	46.7	8	277	35	46.6	9	266
36	47.2	5	282	36	47	4	270
37	47.9	7	289	37	47.4	4	274
38	48.5	6	295	38	48	6	280
39	49.7	12	307	39	49.3	13	293
40	50.2	5	312	40	49.6	3	296
41	50.5	3	315	41	50.4	8	304
42	50.8	3	318	42	50.9	5	309
43	51.2	4	322	43	51.2	3	312
44	51.5	3	325	44	51.8	6	318
45	51.7	2	327	45	52.3	5	323

Attachment 12.b



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DCP TEST OF SUBBASE MIXTURE

Sample Code = DCP 30% GGBFS
 Sample was made on = 11 September 2019
 Sample was tested on = 13 September 2019

No. of Blows	DCP 1 Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)	No. of Blows	DCP 2 Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)
0	19	0	0	0	21.3	0	0
1	19.5	5	5	1	22.4	11	11
2	20.1	6	11	2	23	6	17
3	21	9	20	3	23.5	5	22
4	21.9	9	29	4	24.2	7	29
5	22.4	5	34	5	24.7	5	34
6	22.8	4	38	6	25.1	4	38
7	23	2	40	7	25.8	7	45
8	23.4	4	44	8	26.3	5	50
9	23.9	5	49	9	26.8	5	55
10	24.5	6	55	10	27	2	57
11	25	5	60	11	28.2	12	69
12	25.2	2	62	12	28.7	5	74
13	25.7	5	67	13	30.3	16	90
14	26.9	12	79	14	31.9	16	106
15	27	1	80	15	32.7	8	114
16	27.7	7	87	16	33.6	9	123
17	28.4	7	94	17	34	4	127
18	29.2	8	102	18	34.6	6	133
19	30	8	110	19	35.2	6	139
20	31	10	120	20	35.8	6	145
21	32	10	130	21	37	12	157
22	32.5	5	135	22	37.4	4	161
23	33.2	7	142	23	37.9	5	166
24	33.8	6	148	24	38.2	3	169
25	34.5	7	155	25	38.4	2	171



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No. of Blows	DCP Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)	No. of Blows	DCP Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)
26	35	5	160	26	38.6	2	173
27	35.4	4	164	27	39.1	5	178
28	35.9	5	169	28	39.2	1	179
29	36.4	5	174	29	39.4	2	181
30	36.7	3	177	30	39.8	4	185
31	37.1	4	181	31	40.1	3	188
32	37.6	5	186	32	40.3	2	190
33	38	4	190	33	40.8	5	195
34	38.4	4	194	34	41.1	3	198
35	38.7	3	197	35	41.2	1	199
36	39.1	4	201	36	41.5	3	202
37	39.5	4	205	37	41.9	4	206
38	39.8	3	208	38	42.3	4	210
39	40.1	3	211	39	42.7	4	214
40	40.4	3	214	40	42.9	2	216
41	40.8	4	218	41	43.5	6	222
42	41.2	4	222	42	43.8	3	225
43	41.9	7	229	43	44.3	5	230
44	42.4	5	234	44	45.4	11	241
45	43	6	240	45	45.6	2	243
46	43.5	5	245	46	45.9	3	246
47	43.8	3	248	47	46.1	2	248
48	44.4	6	254	48	46.4	3	251
49	44.6	2	256	49	46.8	4	255
50	44.7	1	257	50	47.5	7	262

Attachment 12.c



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DCP TEST OF SUBBASE MIXTURE

Sample Code = DCP 45% GGBFS
 Sample was made on = 12 September 2019
 Sample was tested on = 14 September 2019

No. of Blows	DCP 1 Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)	No. of Blows	DCP 2 Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)
0	18	0	0	0	19	0	0
1	19.2	12	12	1	19.5	5	5
2	20	8	20	2	20.4	9	14
3	21.5	15	35	3	21.5	11	25
4	22	5	40	4	22	5	30
5	22.2	2	42	5	22.6	6	36
6	22.9	7	49	6	23.2	6	42
7	23.5	6	55	7	23.7	5	47
8	23.8	3	58	8	24.4	7	54
9	24.1	3	61	9	25.7	13	67
10	24.5	4	65	10	26.2	5	72
11	25.2	7	72	11	26.8	6	78
12	26.1	9	81	12	27.5	7	85
13	26.3	2	83	13	28	5	90
14	26.7	4	87	14	29.7	17	107
15	27.7	10	97	15	30.8	11	118
16	28.3	6	103	16	31.3	5	123
17	28.8	5	108	17	32	7	130
18	29.6	8	116	18	32.8	8	138
19	30.6	10	126	19	33.8	10	148
20	31.5	9	135	20	34.5	7	155
21	32.2	7	142	21	35.3	8	163
22	33.5	13	155	22	35.9	6	169
23	34	5	160	23	36.5	6	175
24	34.5	5	165	24	37.4	9	184
25	35	5	170	25	38.1	7	191



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No. of Blows	DCP Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)	No. of Blows	DCP Scale Reading (cm)	Penetration/ Blow (mm)	Cumulative Penetration (mm)
26	35.7	7	177	26	38.9	8	199
27	36.5	8	185	27	39.4	5	204
28	36.9	4	189	28	39.8	4	208
29	37.3	4	193	29	40.5	7	215
30	37.7	4	197	30	41.6	11	226
31	38.2	5	202	31	42	4	230
32	38.5	3	205	32	42.9	9	239
33	38.9	4	209	33	43.5	6	245
34	39.5	6	215	34	43.9	4	249
35	40.7	12	227	35	44.2	3	252
36	41.3	6	233	36	44.8	6	258
37	42	7	240	37	45.9	11	269
38	43.8	18	258	38	46	1	270
39	44.5	7	265	39	46.1	1	271
40	45.1	6	271	40	46.2	1	272
41	46.2	11	282	41	46.3	1	273
42	47.1	9	291	42	46.6	3	276
43	47.3	2	293	43	46.9	3	279
44	47.5	2	295	44	47	1	280
45	47.6	1	296	45	47.3	3	283

Attachment 12.d



Excel Summary Output of 0% Aggregate Replacement

<i>Regression Statistics</i>	
Multiple R	0.879205
R Square	0.773001
Adjusted R Square	0.716251
Standard Error	0.122605
Observations	6

<i>ANOVA</i>					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	0.204755013	0.204755	13.6212	0.021006
Residual	4	0.06012832	0.015032		
Total	5	0.26488333			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	11.9246	0.923389785	12.91394	0.000207	9.360862	14.48834	9.360862	14.48834
X Variable 1	-0.04522	0.012252919	-3.69069	0.021006	-0.07924	0.0112	-0.07924	0.0112

Attachment 13.a



Excel Summary Output of 15% Aggregate Replacement

<i>Regression Statistics</i>	
Multiple R	0.87827
R Square	0.771359
Adjusted R Square	0.714198
Standard Error	0.155364
Observations	6

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	0.32573	0.3257	13.494	0.021325
Residual	4	0.09655	0.0241		
Total	5	0.42228			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	19.5174	3.28786	5.9361	0.0040	10.38883	28.645	10.388	28.645
X Variable 1	-0.15439	0.04202	3.6735	0.0213	-0.27109	-0.0377	0.2710	-0.0377

Attachment 13.b



Excel Summary Output of 30% Aggregate Replacement

<i>Regression Statistics</i>	
Multiple R	0.882668
R Square	0.779102
Adjusted R Square	0.723878
Standard Error	0.199581
Observations	6

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	0.561954	0.561954	14.10793	0.019843
Residual	4	0.159333	0.039833		
Total	5	0.721287			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	17.64814	3.241076	5.445148	0.005524	8.649468	26.64668	8.649468	26.64668
X Variable 1	-0.1252	0.033333	-3.75605	0.019843	-0.21775	0.03265	-0.21775	0.03265



Excel Summary Output of 45% Aggregate Replacement

<i>Regression Statistics</i>	
Multiple R	0.874285
R Square	0.764374
Adjusted R Square	0.705467
Standard Error	0.179813
Observations	6

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	0.41955	0.41955	12.976	0.022713
Residual	4	0.12933	0.03233		
Total	5	0.54888			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	13.27815	1.799407	7.379179	0.001798	8.282191	18.2741	8.282191	18.2741
X Variable 1	-0.0729	0.020236	-3.60223	0.022713	-0.12908	0.01671	-0.12908	0.01671

**LABORATORIUM KIMIA ANALITIK**

JURUSAN KIMIA FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
UNIVERSITAS GADJAH MADA

HASIL ANALISIS

No. : 7030/HA-KA/06/19
Pengirim : **ALEXIUS CHANDRA KURNIAWAN**
Alamat : Jl. Jl. Kusumanegara No. 43 DI Yogyakarta
Jenis Sampel : Padatan
Jumlah : 1 sampel
Penentuan : Kadar CaO, Al₂O₃ dan SiO₂
Tgl. Analisis : 31 Mei 2019

NO	KODE SAMPEL	PARA METER	HASIL PENGUKURAN (%)			METODE
			I	II	III	
1.	GGBFS	Al ₂ O ₃	19,3769	19,6426	19,1113	Atomic Absorption Spect.
2.		SiO ₂	49,3003	46,4164	47,8583	"
3.		CaO	29,6989	30,1763	30,4149	"

RESEARCH FIGURES



Figure A.1 GGBFS Sample



Figure A.2 Coarse Aggregate Sample

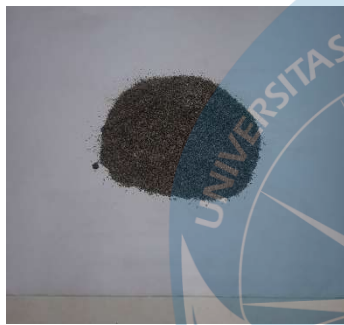


Figure A.3 Fine Aggregate Sample



Figure A.4 Soil Sample



Figure A.5 Compaction Test



Figure A.6 Hydrometer Test



Figure A.7 Gradation Test



Figure A.8 Los Angeles Abrasion Test



Figure A.9 CBR Preparation



Figure A.10 CBR Test



Figure A.11 CBR Result Sample



Figure A.12 DCP Preparation



Figure A.13 DCP Test



Figure A.14 DCP Results Sample