International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Experimental Study Of Clay Soil Stabilization Using Plastic Waste And Fly Ash

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ABSTRACT :

Waste items made of non-biodegradable plastics pose a serious environmental risk and require proper disposal techniques. The integration of these materials into different engineering applications, such as roads, runways, embankments, and filling sites, has been the focus of geotechnical efforts. The purpose of this experiment is to assess the effects of adding fly ash and non-biodegradable plastic debris on expansive soils. The goal is to use in-situ soil with additional plastic trash in road subgrades, as determined by CBR testing, to minimize the requirement for soil transportation from borrow pits. Tests of experimental CBR using different ratios of fly ash and plastic debris show improved soil characteristics. After being collected and dried, clay soil—which was selected for its low safe bearing capacity (SBC)—is tested using fly ash from Neyveli and plastic debris from the Chidambaram municipality.

Keywords: Non-Biodegradable Plastic Waste, Fly ash, Expansive soils, CBR testing, Road sub-grades, Economic benefits, Environmental benefits, Clay soil, Safe Bearing Capacity, Plastic waste disposal, Geotechnical engineering.

Introduction :

Sustainable disposal techniques are necessary due to the substantial environmental burden posed by non-biodegradable plastic trash on a global scale. As a result, in order to reduce environmental risks, the geotechnical community has looked for creative ways to incorporate these waste materials into other engineering applications. The purpose of this study is to assess the viability of incorporating fly ash and non-biodegradable plastic debris into expanding soils. Because of their significant swelling and shrinking qualities, expansive soils can cause damage to infrastructure and pose issues in development. This project aims to improve soil qualities, namely the California Bearing Ratio (CBR), which is important for road subgrades, by using plastic trash and fly ash as soil stabilizers. By eliminating the need to transfer soil, the use of locally available waste materials not only addresses environmental problems but also provides economic benefits.

Methodology :

- Collection and drying of clay soil samples
- Collection of Non-Biodegradable Plastic Waste from Chidambaram municipality and Fly ash from Neyveli
- Characterization of soil and waste materials
- Preparation of soil waste mixtures with varying percentages
- Conducting CBR tests on soil waste mixtures
- Analysis of CBR values to assess soil stabilization effectiveness
- Interpretation of results and conclusions regarding the impact of Plastic Waste and Fly ash on soil properties

Materials for Soil Stabilization:

Clay soil

A type of soil with fine particles, prone to swelling and shrinkage, causing instability in construction. Commonly used as subgrade material in road construction.

Jute Fiber:

Jute fiber is a natural, biodegradable material derived from the stems of the jute plant. It is classified based on its quality, color, and origin, with grades such as TD-5, TD-6, and B- Twill being commonly used. Jute fiber possesses excellent tensile strength, low extensibility, and biodegradability, making it suitable for various applications, including soil reinforcement, erosion control, and packaging. In this study, jute fiber is introduced as a reinforcing agent in soil stabilization. Its incorporation aims to enhance the mechanical properties of soil, such as cohesion and shear strength, while also promoting environmental sustainability through the utilization of natural, renewable resources.

Fly Ash

Fly ash is a byproduct of coal combustion in thermal power plants. It is predominantly composed of fine particles that are carried away by flue gases. Classified based on its chemical composition and particle size distribution, fly ash can be categorized as Class F or Class C, depending on its calcium oxide (CaO) and silicon dioxide (SiO_2) content. In this study, fly ash sourced from locations like Neyveli is utilized as a supplementary cementitious material. Its addition to soil aims to enhance properties such as compressibility and stability, offering a sustainable solution for soil improvement and waste utilization.

Experimental Programme :

FLY ASH CHARACTERIZATION

- Physical properties
- Chemical properties
- Engineering properties

PHYSICAL PROPERTIES

- *Specific gravity*
- *Sieve analysis*
- *Index properties*

(A) SPECIFIC GRAVITY

Coal ashes typically have a specific gravity of 2.0, though they can range widely (1.6 to 3.1). Ash fills typically provide low dry densities due to the coal ash's relatively lower specific gravity value when compared to soils.
According to the investigations, the specific gravity typically ranges from 1.46 to 2.66. Fly ash typically has a higher specific gravity than bottom and pond ash from the same area. In comparison to the uncrushed section of the same material, the crushed particles have a larger specific gravity.

Specific gravity = (W2 – W1)/ ((W2 – W1)-(W3 - W4)

= (1486 – 610) / ((1486 – 610) -(1998 - 1466))

= 2.35

S.NO	DESCRIPTION	TRIAL 1
1	Weight of pycnometer bottle (W1)g	610
2	Weight of the bottle + soil + fly-ash + plastic waste	1486
3	Weight of the bottle + soil + fly-ash + plastic waste	1998
4	Weight of the bottle + water (W4)g	1466
5	Specific gravity	2.34

Table 2: Specific gravity of Soil 64.5 + 25% fly ash + 0.5% plastic waste

Result:

Specific gravity = (W2 – W1)/ (W2 – W1)-(W3 - W4)

= (1482–610) / (1482–610) -(1986-1466))

= 2.42

S.NO	**DESCRIPTION**	**TRIAL 1**
1	Weight of pycnometer bottle (W1)g	610
2	Weight of the bottle + soil + fly-ash + plastic waste	1480
3	Weight of the bottle + soil + fly-ash + plastic waste	1970
4	Weight of the bottle + water (W4)g	1466
5	Specific gravity	2.45

Table 3: Specific gravity of Soil 69.3 + 30% fly ash + 0.7% plastic waste

Result:

Specific gravity = (W2 – W1)/ (W2 – W1)-(W3 - W4)

= (1480–610) / ((1480–610) -(1970-1466))

= 2.45

S.NO	DESCRIPTION	TRIAL 1
1	Weight of pycnometer bottle (W1)g	610
2	Weight of the bottle + soil + fly-ash + plastic waste	1484
3	Weight of the bottle + soil + fly-ash + plastic waste	1985
4	Weight of the bottle + water (W4)g	1466
5	Specific gravity	2.44

Table 4: Specific gravity of Soil 64.1 + 35% fly ash + 0.9% plastic waste

Result:

Specific gravity = (W2 – W1)/ (W2 – W1)-(W3 - W4)

= (1484–610) / ((1484–610) -(1985-1466))

=2.44

Table 5 shows the comparative study of the specific gravity values of soil sample along with various proportions

S.NO	DESCRIPTION	SPECIFIC GRAVITY
1.	Clay	2.35
2.	Clay + fly ash (25 %) + plastic waste (0.5 %)	2.42
3.	Clay + fly ash (30 %) + plastic waste (0.7 %)	2.45
4.	Clay + fly ash (35 %) + plastic waste (0.9 %)	2.43

Table 5:Comparative study of specific gravity values

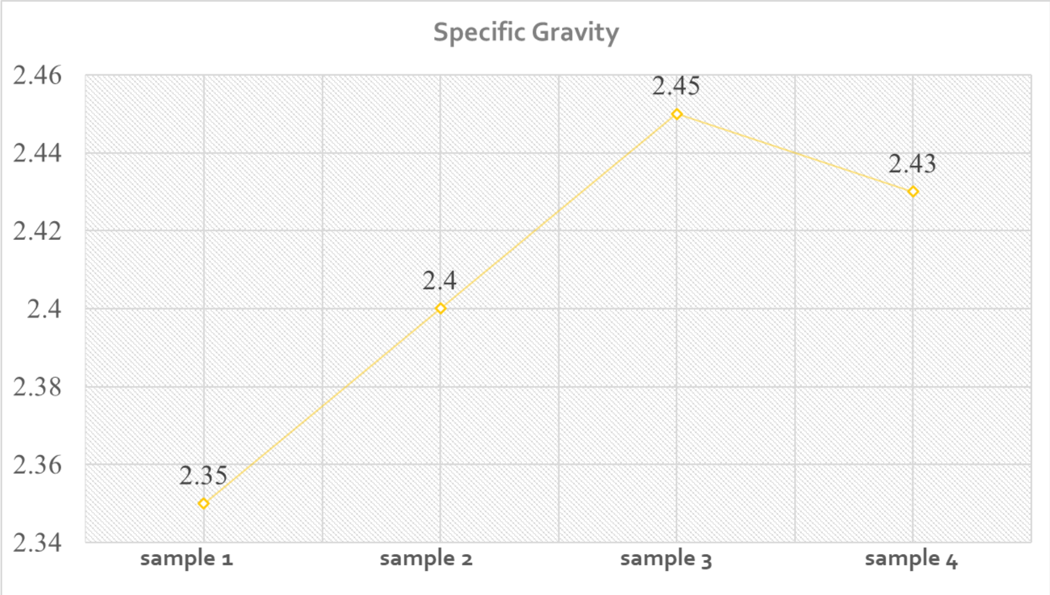


Fig 2: specific Gravity Graph

(B) FREE SWEEL TEST

The Free Swell Test is a geotechnical laboratory test used to evaluate the swelling potential of expansive soils. In this test, a soil sample is compacted into a cylindrical mold at a specified moisture content and allowed to swell freely while immersed in water. The increase in volume due to swelling is measured, typically expressed as a percentage of the initial volume. This test helps assess the potential for soil expansion and its implications for construction projects.

Fig 3: instrument of free swell index

Formula:

FSI= (B-B1/B1) X 100

= (22-14/14)X 100

=57.1%

S.NO	SOIL VOLUME IN WATER (Vw) ml	SOIL VOLUME IN KEROSENE (Vk) ml	FREE SWELL INDEX (Sd)%
1.	22	14	57.1

Result:

Table 6: free swell index

The Free Swell index value **57.1%** expansiveness range is high

4.2(C) SIEVE ANALYSIS

Sieve analysis is a fundamental method used in geotechnical engineering to determine the particle size distribution of soil or aggregate samples. In this test, the sample is passed through a series of sieves with progressively smaller openings, starting from coarse to fine. The amount of soil retained on each sieve is weighed, and a particle size distribution curve is plotted. This analysis provides valuable information about soil gradation, which influences its engineering properties such as permeability and stability.

Fig 4: sieve analysis

1) clay 96% and fly ash 4%

Sl. No.	IS Sieve Size	Weight Retained (g)	% Weight retained	Cumulative Percentage retained	Percentage Passing
1	4.75 mm	16	1.60	1.60	98.40
2	2.36 mm	28	2.80	4.40	95.60
3	1.18 mm	92	9.20	13.60	86.40
4	600 microns	368	36.80	50.40	49.60
5	300 microns	384	38.40	88.80	11.20
6	150 microns	94	9.40	98.20	1.80
7	75 microns	12	1.20	99.40	0.60
8	Silt	6	0.60	100.00	0.00

Table 7: sieve analysis

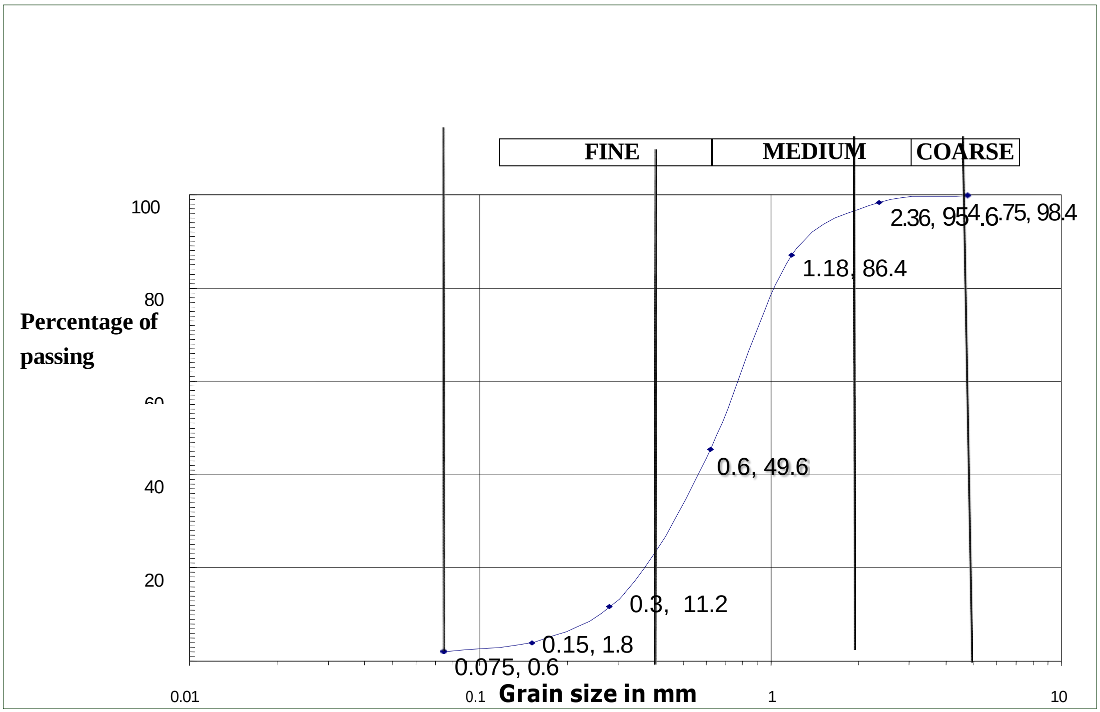


Fig 5: sieve analysis graph

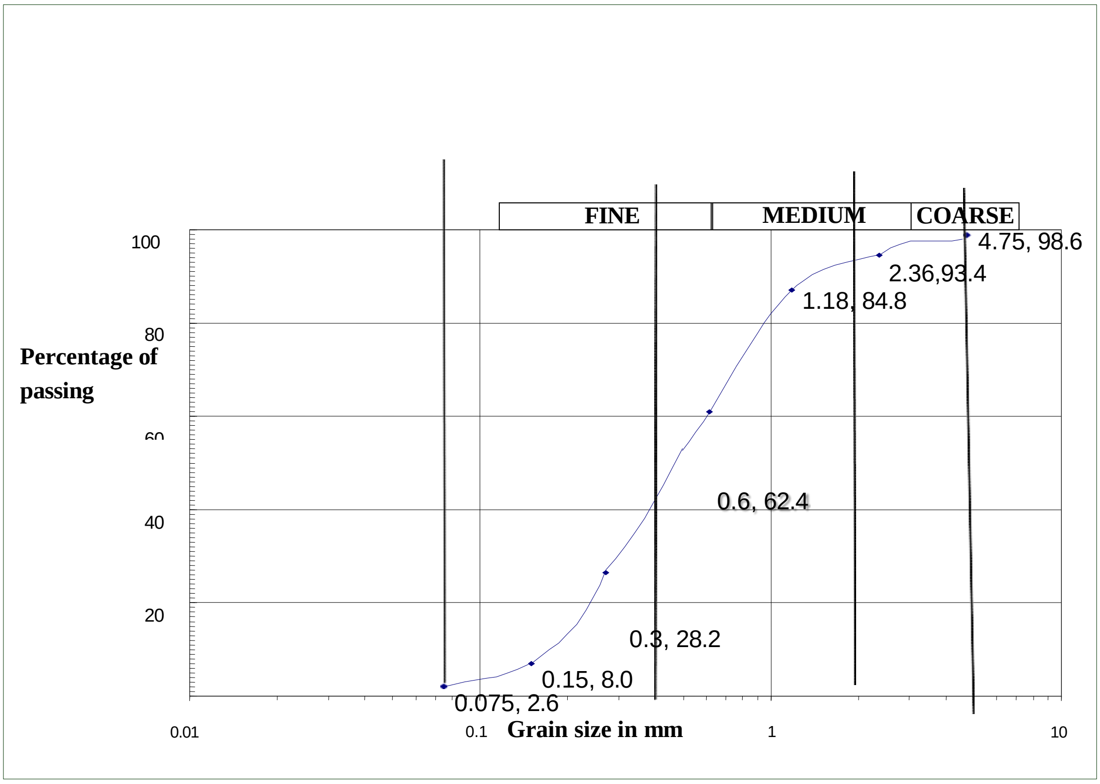
Result :

Gravel (4.75& above) = 1.6 %
Coarse soil (2 mm to 4.75 mm) = 12.00 %
Medium soil 0.425 mm to 2 mm) = 75.20 %
Fine soil (0.075 to 0.425 mm) = 10.60 %
Silt and clay(Less than 0.75) = 0.60 %

2) Clay 94% and Fly ash 6%

SI. No.	IS Sieve Size	Weight Retained (g)	% Weight retained	Cumulative Percentage retained	Percentage Passing
1	4.75 mm	14	1.40	1.40	98.60
2	2.36 mm	52	5.20	6.60	93.40
3	1.18 mm	86	8.60	15.20	84.80
4	600 microns	224	22.40	37.60	62.40
5	300 microns	342	34.20	71.80	28.20
6	150 microns	202	20.20	92.00	8.00
7	75 microns	54	5.40	97.40	2.60
8	Silt	26	2.60	100	0.00

Table 8: Sieve Analysis



Result :

Gravel (4.75& above) = 1.40 %
Coarse soil (2 mm to 4.75 mm) = 13.80%
Medium soil 0.425 mm to 2 mm) = 56.60 %
Fine soil (0.075 to 0.425 mm) = 25.60 %
Silt and clay(Less than 0.75) = 2.6 %

SI. No.	IS Sieve Size	Weight Retained (g)	% Weight retained	Cumulative Percentage retained	Percentage Passing
1	4.75 mm	4	0.40	0.40	99.60
2	2.36 mm	16	1.60	2.00	98.00
3	1.18 mm	108	10.80	12.80	87.20
4	600 microns	344	34.40	47.20	52.80
5	300 microns	248	24.80	72.00	28.00
6	150 microns	146	14.60	86.60	13.40
7	75 microns	86	8.60	95.20	4.80
8	Silt	48	4.80	100.00	0.00

Table 9: Sieve Analysis 39

Result :

Gravel (4.75& above) = 0.4 %
Coarse soil (2 mm to 4.75 mm) = 12.4 %
Medium soil 0.425 mm to 2 mm) = 69.2 %
Fine soil (0.075 to 0.425 mm) = 23.2 %
Silt and clay(Less than 0.75) = 4.8 %

4) Clay soil 90% and Fly ash 10%

SI. No.	IS Sieve Size	Weight retained (g)	% Weight retained	Cumulative Percentage retained	Percentage Passing
1	4.75 mm	12	1.20	1.20	98.80
2	2.36 mm	60	6.00	7.20	92.80
3	1.18 mm	168	16.80	24.00	76.00
4	600 microns	182	18.20	42.20	57.80
5	300 microns	154	15.40	57.60	42.40
6	150 microns	192	19.20	76.80	23.20
7	75 microns	180	18.00	94.80	5.20
8	Silt	52	5.20	100.00	0.00

Table 10: Sieve Analysis

Result :

Gravel (4.75& above) = 1.2 %
Coarse soil (2 mm to 4.75 mm) = 22.80 %
Medium soil 0.425 mm to 2 mm) = 33.60 %
Fine soil (0.075 to 0.425 mm) = 37.20 %
Silt and clay(Less than 0.75) = 5.20 %

LIQUID LIMIT TEST

The liquid limit test is a standard geotechnical procedure used to determine the moisture content at which a soil transitions from a plastic to a liquid state. In this test, a soil sample is gradually mixed with water until it reaches a specific consistency where it just begins to flow. This moisture content, expressed as a percentage, is known as the liquid limit. The test provides crucial information about the plasticity and behavior of soils, aiding in engineering design and construction.

3) Liquid limit Test for Clay Soil

Sl.No.	Water added in (%)	Water added in (ml)	No of blows
1	43	64	86
2	45	66	60
3	47	68	35
4	49	70	20
5	51	72	12

Table 11: Liquid limit Test for Clay Soil

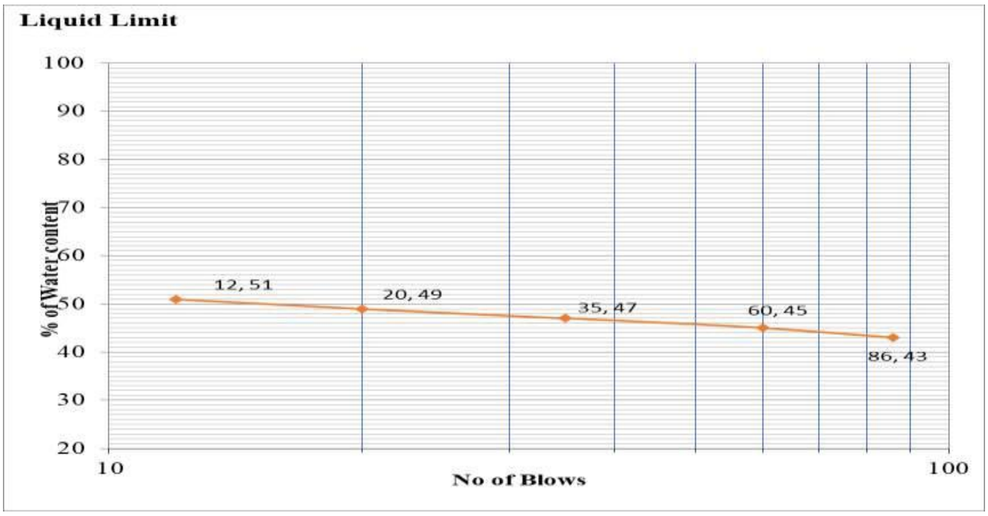


Fig 6: Liquid limit test graph

Flow index (If) = W1 – W2 / log (N1/N2)
= 50 – 45 / log (17/36)
=16.13

Result:

Liquid limit = 48% Flow index = 16.13

Liquid limit Test for 96 % Clay and 4 % Fly ash

SI.NO	WATER ADDED IN (%)	WATER ADDED IN (ml)
1	66	66
2	68	68
3	70	70
4	72	72
5	74	74

Table 12: Liquid limit Test for 96 % Clay and 4 % Fly ash

Fig 7: Liquid limit test graph

Sl.No.	Water added in (%)	Water added in (ml)	No of blows
1	60	60	58
2	62	62	36
3	64	64	21
4	66	66	19
5	68	68	17

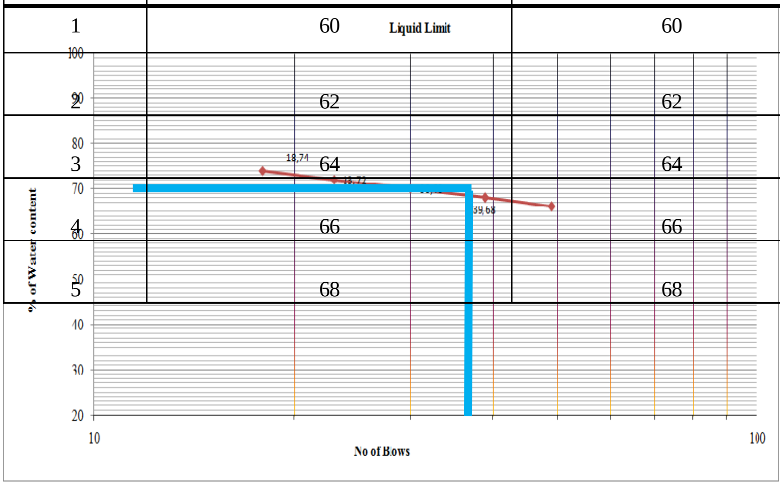


Table 13: Liquid limit Test for 94 % Clay and 6 % Fly ash

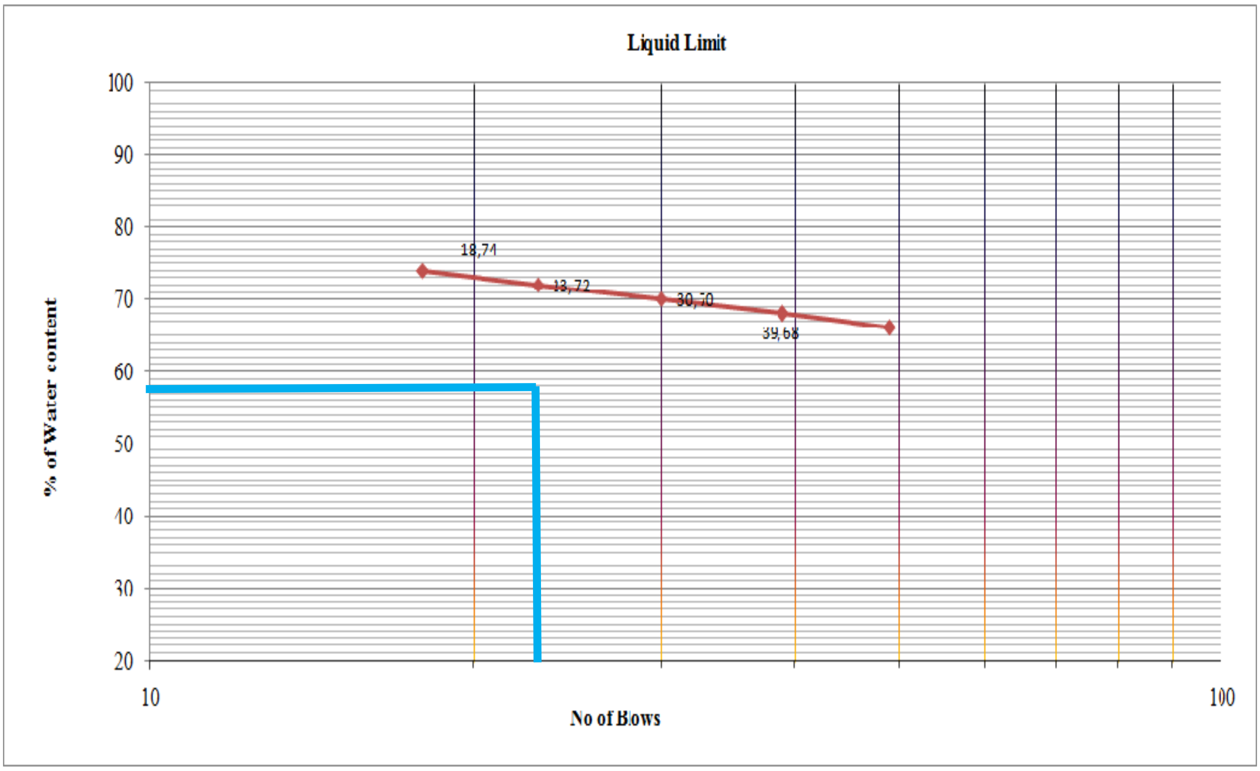


Fig 8: Liquid limit test graph

Flow index (If) = W1 – W2 / log (N1/N2)

= 70 – 65 / log (30/66)

= 8.06

Result:

Liquid limit = 71 % Flow index = 8.06

4) Liquid limit Test for 90 % Clay and 10 % Fly ash

Sl.No.	Water added in (%)	Water added in (ml)	No of blows
1	50	50	50
2	52	52	48
3	54	54	40
4	56	56	27
5	58	58	18
6	60	60	10

Table 14:. Liquid limit Test for 90 % Clay and 10 % Fly ash

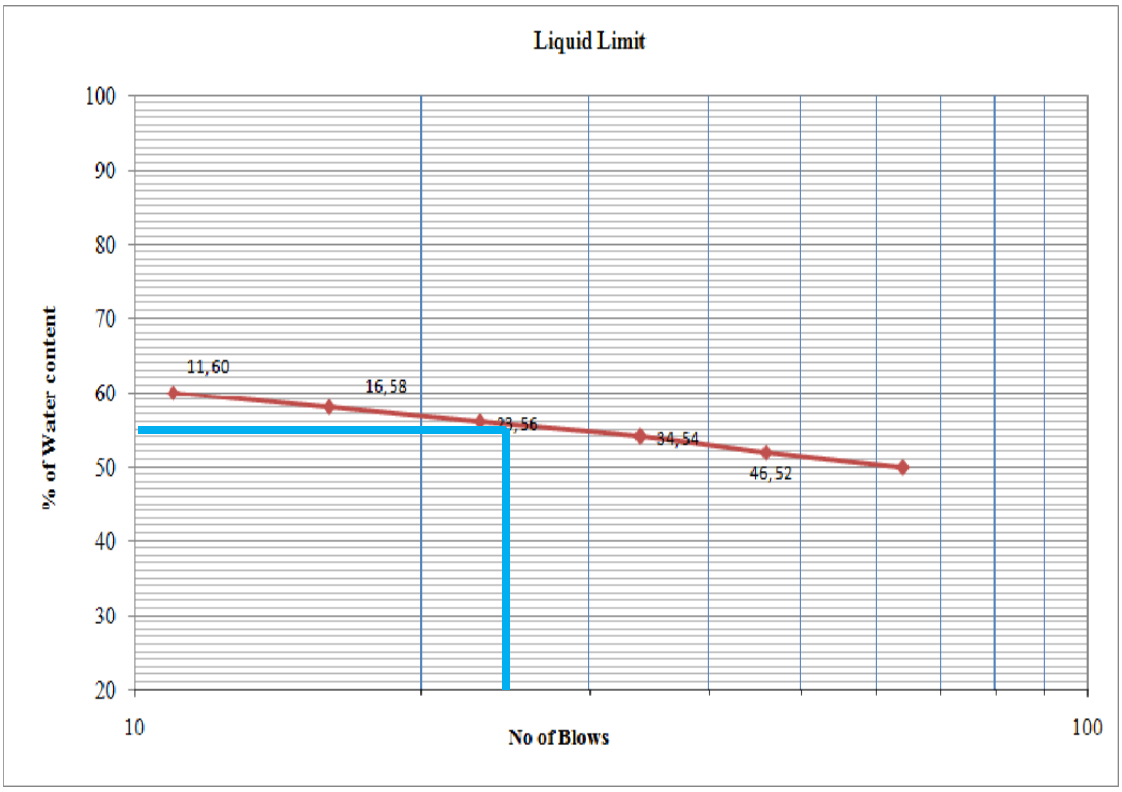


Fig 9: Liquid limit test

Flow index (If) = W1 – W2 / log (N1/N2)

= 55 – 50 / log (54/45)

= 17.03

Result:

Liquid limit = 55% Flow index = 17.03

Unconfined Compressive Strength test (UCC):

Fig 10. UCC machine

1) Unconfined Compressive Strength Test for clay soil

S.I No.	Deformation Dial Reading	Strain	Proving ring Reading in Div	Load in N	Corrected area in Sq.mm	Compressive Stress
1	0.50	0.007	1.5	4.02	1141.94	0.0035
2	1.00	0.015	3	8.04	1150.46	0.0070
3	1.50	0.022	4	10.72	1159.11	0.0092
4	2.00	0.029	5	13.4	1167.89	0.0115
5	2.50	0.037	5.5	14.74	1176.80	0.0125
6	3.00	0.044	6.5	17.42	1185.86	0.0147
7	3.50	0.051	7	18.76	1195.05	0.0157
8	4.00	0.059	7.5	20.1	1204.39	0.0167

Table 15: Unconfined Compressive Strength Test Clay Soil

Calculation:

(i) Strain, (E) = $\Delta L / L$ = 0.05 / 6.9 = 0.007
(ii) Corrected area, (A_c) = A_0 / (1-E) = 1133.54 / (1-0.007) = 1141.94 mm^2
(iii) Compressive stress, (Ϭ) = P / A_c = 4.02 / 1141.94 = 0.0035.

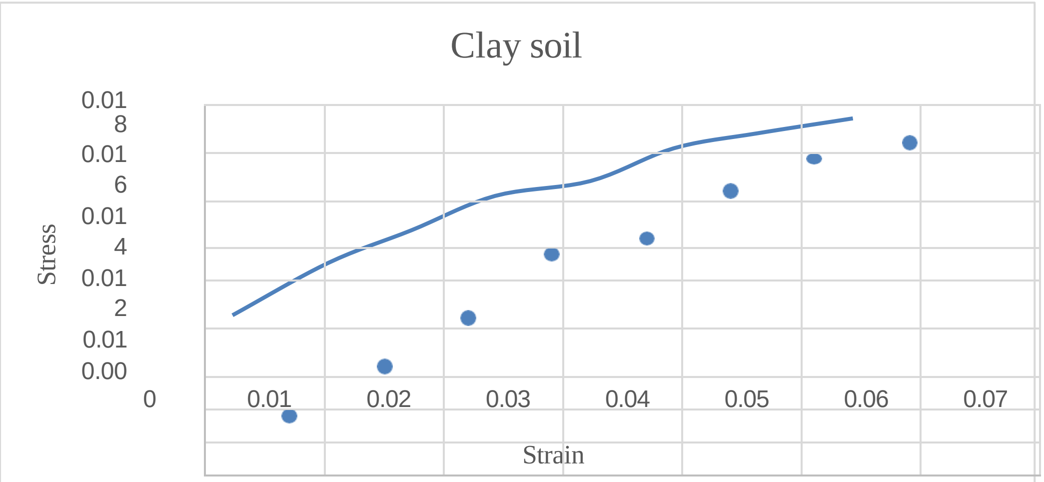
Deformation dia least count = 0.01 mm Volume = 78.25 sq.mm Proving ring constant 1 div = 943 div = 2.65 kN

Wet weight = 133 gm Height = 6.8 cm = 68 mm

Wet density = 1.69 g/cc

Diameter = 3.8 cm = 38 mm Dry weight = 120 gm

Area of specimen = 1133.54 sq.mm Dry density = 1.53 g/cc



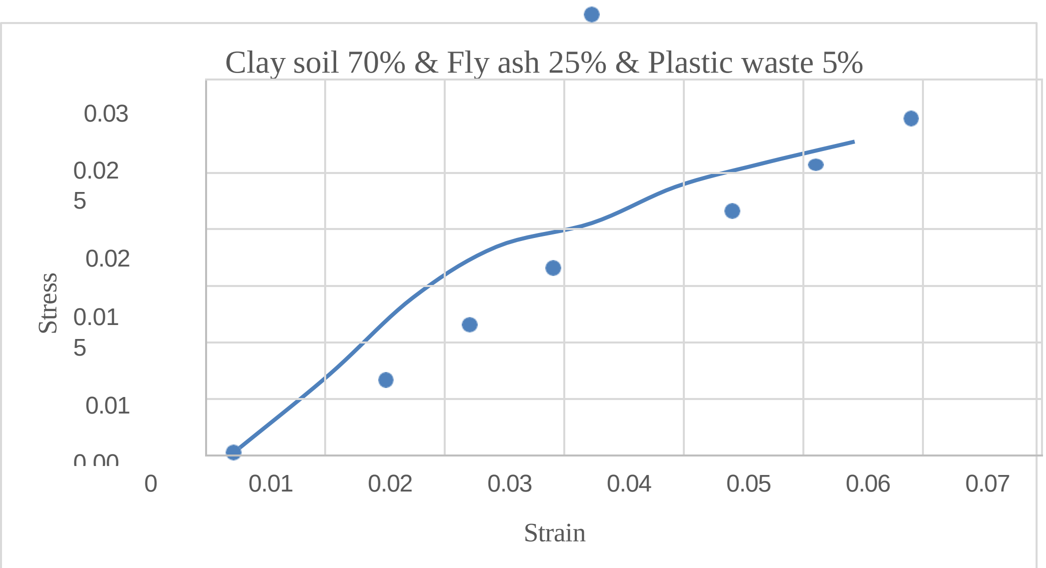
2) Clay Soil 70 % & Fly ash 25 % & Plastic waste 5%

S.L.No	Deformation dial reading		Strain	Proving ring reading Div	Load in N	Corrected area sq. mm	Compressive stress
	Div	m					
1	50	0.50	0.007	2	5.3	1141.94	0.0

2	100	1.00	0.015	3	7.95	1150.46	0.0069
3	150	1.50	0.022	6	15.9	1159.11	0.0137
4	200	2.00	0.029	8	21.2	1167.89	0.0182
5	250	2.50	0.037	9	23.85	1176.80	0.0203
6	300	3.00	0.044	10.5	27.825	1185.86	0.0235
7	350	3.50	0.051	11.5	30.475	1195.05	0.0255
8	400	4.00	0.059	12.5	33.125	1204.39	0.0275

Table 16: Clay Soil 70 % & Fly ash 25 % & Plastic waste 5%

Deformation dia least count = 0.01 mm Volume = 77.08 cm^3 Proving ring constant 1 div = 943 div = 2.65 kN Wet weight = 137 gm
Height = 6.9 cm = 69 mm Wet density = 1.77 g/cc
Diameter = 3.8 cm= 38 mm Dry weight = 122 gm Area of the Specimen = 1133.54 mm^2 Dry Density = 1.58 g/cc

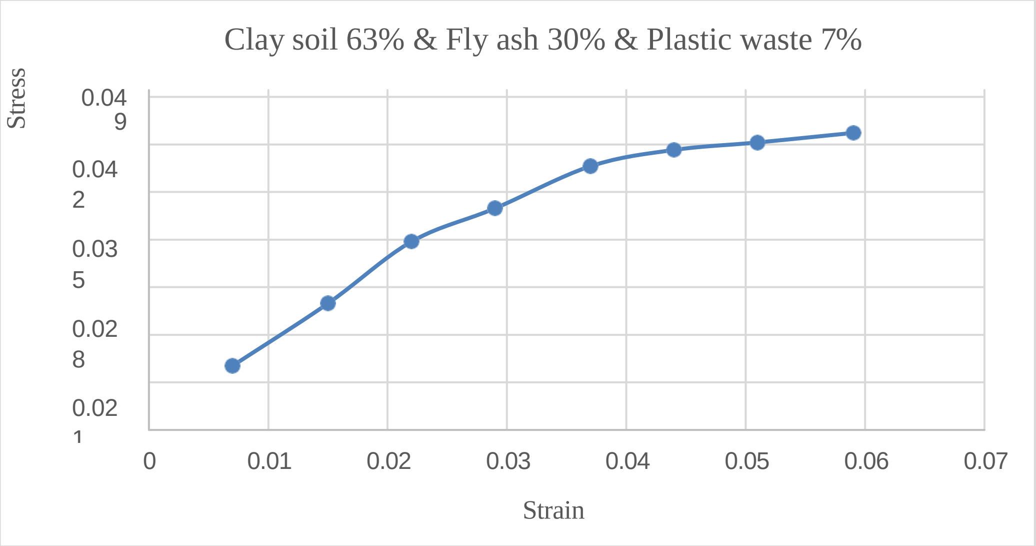


3) Clay soil 63% & Fly ash 30% & Plastic waste 7%

S.I No.	Deformation Dial Reading	Strain	Proving ring Reading in Div	Load in N	Corrected area in Sq. mm	Compressive Stress
1	0.50	0.007	4	10.72	1141.94	0.0094
2	1.00	0.015	8	21.44	1150.46	0.0186
3	1.50	0.022	12	32.16	1159.11	0.0277
4	2.00	0.029	16	42.88	1167.89	0.0326
5	2.50	0.037	21	56.28	1176.80	0.0388
6	3.00	0.044	25	67.20	1185.86	0.0412
7	3.50	0.051	32	85.26	1195.05	0.0423
8	4.00	0.059	44	17.92	1204.39	0.0437

Table 17: Clay soil 63% & Fly ash 30% & Plastic waste 7%

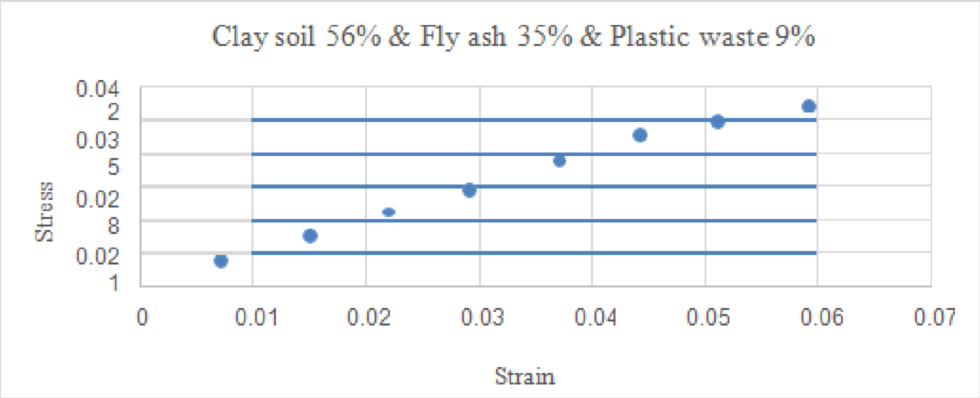
Deformation dia least count = 0.01 mm Volume = 78.21 cm^3 Proving ring constant 1 div = 943 div = 2.65 kN Wet weight = 118 gm Height = 6.9 cm = 69 mm Wet density = 1.52 g/cc
Diameter = 3.8 cm = 38 mm Dry weight = 107 gm Area of the Specimen = 1133.54 Sq.mm Dry Density = 1.37 g/cc



4) Clay soil 56% & Fly ash 35% & Plastic waste 9%

S.I No.	Deformation Dial Reading	Strain	Proving ring Reading in Div	Load in N	Corrected area in Sq mm	Compressive Stress
1	0.50	0.007	2	5.36	1141.94	0.0047
2	1.00	0.015	4.5	12.06	1150.46	0.0105
3	1.50	0.022	6.5	17.42	1159.11	0.0150
4	2.00	0.029	9	24.12	1167.89	0.0207
5	2.50	0.037	11.5	30.82	1176.80	0.0262
6	3.00	0.044	14	37.52	1185.86	0.0316
7	3.50	0.051	15.5	41.54	1195.05	0.0348
8	4.00	0.059	17	45.56	1204.39	0.0378

Deformation dia least count = 0.01 mm Volume = 78.25 cm^3 Proving ring constant 1 div = 943 div = 2.65 kN Wet weight = 133 gm Height = 6.8 cm = 68 mm Wet density =1.69 g/cc
Diameter = 3.8 cm = 38 mm Dry weight = 120 gm
Area of specimen = 1133.54 sq.mm Dry density = 1.53 g/cc



UCC Test for Jute fibre:

1) **Clay Soil 70 % & Fly ash 25 % & Jute fibre 5%**

S.L.No	Deformation dial reading		Strain	Proving ring reading Div	Load in N	Corrected area sq. mm	Compressive stress
	Div	m					
1	50	0.50	0.007	2	5.3	1141.94	0.0
2	100	1.00	0.015	3	7.95	1150.46	0.0068
3	150	1.50	0.022	5	13.25	1159.11	0.0114
4	200	2.00	0.029	6	15.9	1167.89	0.0136
5	250	2.50	0.037	8	21.2	1176.80	0.0180
6	300	3.00	0.044	9	23.85	1185.86	0.0201
7	350	3.50	0.051	10.5	27.83	1195.05	0.0232
8	400	4.00	0.059	11	29.15	1204.39	0.0240

Table 18: Clay Soil 70 % & Fly ash 25 % & Jute fibre 5%

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Deformation dia least count = 0.01 mm

Volume = 77.12 cm^3

Proving ring constant 1 div = 943 div = 2.65 kN

Wet weight = 126 gm Height = 6.8 cm = 6.8 mm

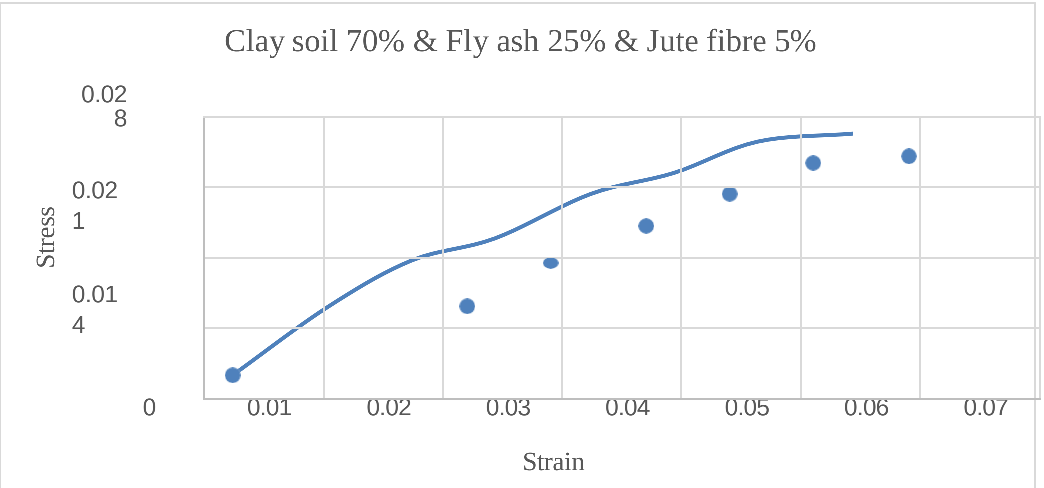
Wet density =1.54 g/cc

Diameter = 3.8 cm = 38 mm

Dry weight = 106 gm

Area of specimen = 1134.1 sq.mm

Dry density = 1.46 g/cc



2) Clay soil 63% & Fly ash 30% & Jute fibre 7%

S.I No.	Deformation Dial Reading	Strain	Proving ring Reading in Div	Load in N	Corrected area in Sq. mm	Compressive Stress
1	0.50	0.007	3	7.95	1141.94	0.0070
2	1.00	0.015	5	13.25	1150.46	0.0115
3	1.50	0.022	9	23.85	1159.11	0.0206
4	2.00	0.029	12	31.80	1167.89	0.0272
5	2.50	0.037	14	37.10	1176.80	0.0315
6	3.00	0.044	15	39.75	1185.86	0.0335
7	3.50	0.051	17	45.05	1195.05	0.0377
8	4.00	0.059	19	50.35	1204.39	0.0418

Table 19: Clay soil 63% & Fly ash 30% & Jute fibre 7%

Deformation dia least count = 0.01 mm

Proving ring constant 1 div = 943 div = 2.65 kN

= 126 gm Height = 6.8 cm = 6.8 mm

=1.54 g/cc

Diameter = 3.8 cm = 38 mm

Area of specimen = 1134.1 sq.mm

Volume

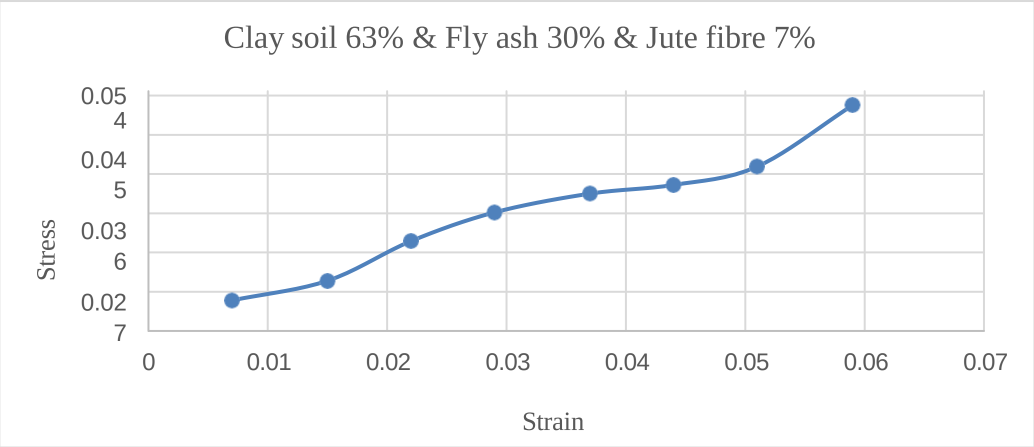
= 77.12 cm^3

Wet weight

Wet density

Dry weight = 106 gm

Dry density = 1.46 g/cc



3) Clay soil 56% & Fly ash 35% & Jute fibre 9%

S.I No.	Deformation Dial Reading	Strain	Proving ring Reading in Div	Load in N	Corrected area in Sq mm	Compressive Stress
1	0.50	0.007	2	5.30	1141.94	0.0046
2	1.00	0.015	3	7.95	1150.46	0.0069
3	1.50	0.022	5	13.25	1159.11	0.0114
4	2.00	0.029	7	18.55	1167.89	0.0159
5	2.50	0.037	10	26.50	1176.80	0.0225

6	3.00	0.044	12	31.80	1185.86	0.0268
7	3.50	0.051	13	34.45	1195.05	0.0288
8	4.00	0.059	15	39.75	1204.39	0.0330

Table 20: Clay soil 56% & Fly ash 35% & Jute fibre 9%

Deformation dia least count = 0.01 mm

Volume = 77.12 cm^3

Proving ring constant 1 div = 943 div = 2.65 kN

Wet weight = 126 gm

Height = 6.8 cm = 68 mm

Wet density = 1.59 g/cc

Diameter = 3.8 cm = 38 mm

Dry weight = 114 gm

Area of specimen = 1134.1 sq.mm

Dry density = 1.42 g/cc

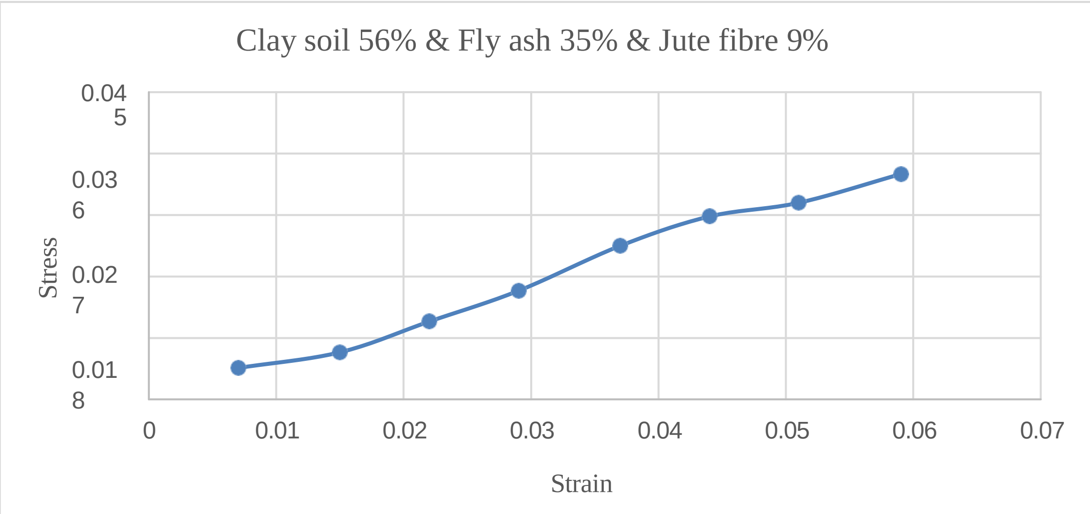


Table 21: Comparative study of the UCC values of the soil along with various proportions.

1) **Clay soil & Fly ash & Plastic waste:**

S.NO	DESCRIPTION	UCC
1.	Clay soil	0.0167 Kg/mm^2
2.	Clay soil 70% & Fly ash 25% & Plastic waste 5%	0.0275 Kg/mm^2
3.	Clay soil 63% & Fly ash 30% & Plastic waste 7%	0.0437 Kg/mm^2
4.	Clay soil 56% & Fly ash 35% & Plastic waste 9%	0.0378 Kg/mm^2

2) **Clay soil & Fly ash & Jute fibre:**

S.NO	DESCRIPTION	UCC
1.	Clay soil	0.0167 Kg/mm^2
2.	Clay soil 70% & Fly ash 25% & Jute fibre 5%	0.0240 Kg/mm^2
3.	Clay soil 63% & Fly ash 30% & Jute fibre 7%	0.0418 Kg/mm^2
4.	Clay soil 56% & Fly ash 35% & Jute fibre 9%	0.0330 Kg/mm^2

Result:

The above tables shows the comparative study of the UCC values of the soil along with varies proportions (clay soil + fly ash + plastic waste) better than the (clay soil + Fly ash + Jute fibre).

6.7. California bearing ratio (CBR)

Fig 11: California Bearing Ratio Test

Table 3 Standard Load Value at a Respective Deformation to obtain C.B.R. Value

Penetration, mm	Standard Load, kg	Unit Standard Load, Kg/Cm2
2.5	1370	70
5.0	2055	105
7.5	2630	134
10.0	3180	162
12.5	C3600	183

Table 22: CBR Test for clay soil sample

S.NO	UNSOAKED (%)			SOAKED (%)		
	DEFLECTION	LOAD	CBR (%)	DEFLECTION	LOAD	CBR (%)
1.	0.5	46.58		0.5	27.46	
2.	1	50.96		1	32.68	
3.	1.5	56.82		1.5	38.02	
4.	2	68.06		2	42.16	
5.	2.5	79.21	5.78	2.5	48.52	3.54
6.	3	81.86		3	50.46	
7.	4	92.04		4	56.78	
8.	5	102.02	4.96	5	67.31	3.27

For 2.5mm penetration

CBR = (load applied / standard load) x 100

= (79.21/1370) x 100

= 5.78

For 5mm penetration

CBR = (load applied / standard load) x 100

= (102.2/2055) x 100
= 4.96

Table 6.7.2 shows the values of various parameters noted down while performing the CBR test for the soil sample with 30% fly ash and 7% plastic waste.

1) **Table 23: CBR Test for soil (63%) +Fly ash (30%) + Plastic waste (7%)**

S.NO	UNSOAKED (%)			SOAKED (%)		
	DEFLECTION	LOAD	CBR (%)	DEFLECTION	LOAD	CBR (%)
1.	0.5	21.20		0.5	12.43	
2.	1	50.96		1	28.80	
3.	1.5	59.35		1.5	43.98	
4.	2	79.80		2	58.60	
5.	2.5	99.02	7.22	2.5	78.80	5.81
6.	3	105.01		3	88.1	
7.	4	120.98		4	98.7	
8.	5	129.56	6.30	5	105.6	5.13

For 2.5mm penetration

CBR = (load applied / standard load) x 100
= (99.02/1370) x 100
= 7.22

For 5mm penetration

CBR = (load applied / standard load) x 100
= (129.56/2055) x 100

= 6.30

Table 24. presents a comparison of the CBR values for the soil sample with different proportions. The CBR values were measured at 2.5mm and 5mm for both soaked and unsoaked samples. The most favourable CBR values were obtained with the addition of 30% fly ash and 7% plastic waste. For the unsoaked sample, the optimum CBR values were 7.22% and 6.30%, while for the soaked sample, they were 5.81% and 5.13%. The CBR value tends to increase as the surface becomes harder.

Table 24: CBR Values

S.NO	DESCRIPTION	UNSOAKED		SOAKED	
		2.5 mm	5 mm	2.5 mm	5 mm
1.	Clay	5.78	4.96	3.54	3.27
2.	Clay soil (70%) + Fly ash (25%) + Plastic waste (5%)	6.89	5.99	5.12	4.85
3.	Clay soil (63%) + Fly ash (30%) + Plastic waste (7%)	7.22	6.30	5.81	5.13

4.	Clay soil (56%) + Fly ash (35%) + Plastic waste (9%)	6.50	5.89	4.61	4.72

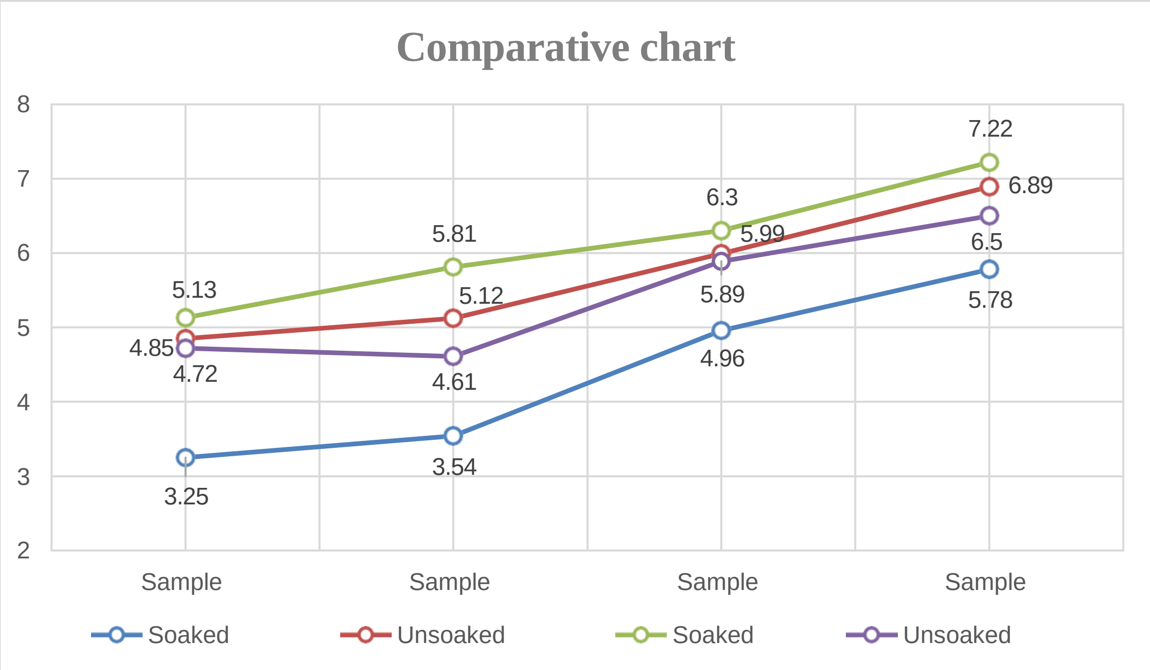


Fig 12: Comparative Graph of CBR

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CBR Test for Jute Fibre:

1) Table 25: CBR Test for clay soil 70% & Fly ash 25% & Jute fibre 5%

S.NO	UNSOAKED (%)			SOAKED (%)		
	DEFLECTION	**LOAD**	**CBR (%)**	**DEFLECTION**	**LOAD**	**CBR (%)**
1.	0.5	40.26		0.5	23.48	
2.	1	43.96		1	27.56	
3.	1.5	48.53		1.5	31.64	
4.	2	52.06		2	37.86	
5.	2.5	61.28	4.47	2.5	42.24	3.08
6.	3	68.86		3	46.76	
7.	4	75.09		4	49.64	
8.	5	87.02	4.23	5	53.46	2.60

For 2.5mm penetration

CBR = (load applied / standard load) x 100

= (61.28/1370) x 100

= 4.47

For 5mm penetration

CBR = (load applied / standard load) x 100
= (87.02/2055) x 100
= 4.23

2) **Table 26: CBR Test for soil (63%) +Fly ash (30%) + Jute Fibre (7%)**

S.NO	UNSOAKED (%)			SOAKED (%)		
	DEFLECTION	LOAD	CBR (%)	DEFLECTION	LOAD	CBR (%)
1.	0.5	18.26		0.5	10.41	
2.	1	36.94		1	24.78	
3.	1.5	44.37		1.5	32.46	
4.	2	51.26		2	49.78	
5.	2.5	78.54	5.73	2.5	57.62	4.21
6.	3	85.62		3	64.98	
7.	4	94.86		4	76.14	
8.	5	108.48	5.28	5	85.86	4.18

For 2.5mm penetration

CBR = (load applied / standard load) x 100
= (78.54/1370) x 100
= 5.73

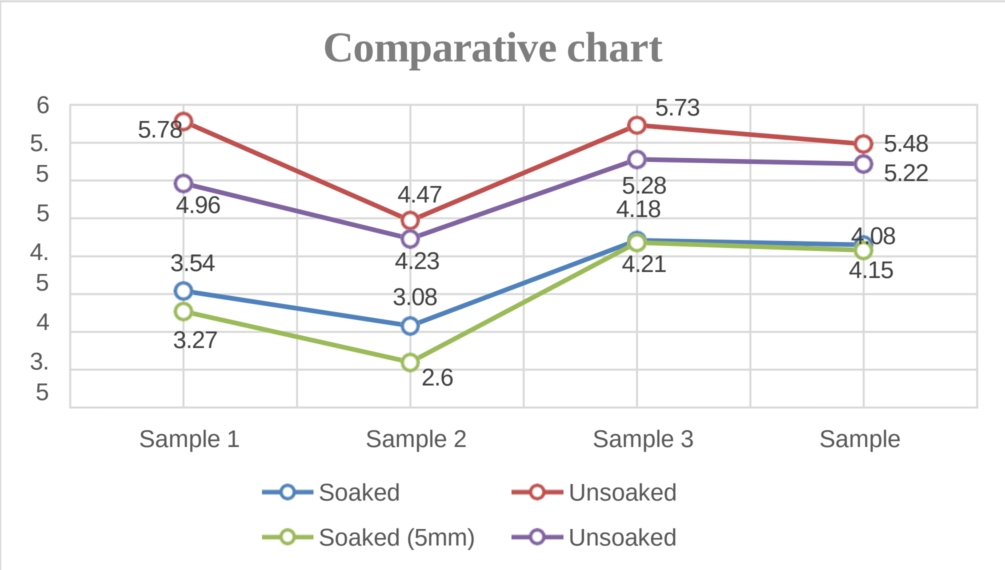
For 5mm penetration

CBR = (load applied / standard load) x 100
= (108.48/2055) x 100
= 5.28

Table 27: CBR Values

S.NO	DESCRIPTION	UNSOAKED		SOAKED	
		2.5 mm	5 mm	2.5 mm	5 mm
1.	Clay	5.78	4.96	3.54	3.27
2.	Clay soil (70%) + Fly ash (25%) + Jute fibre (5%)	4.47	4.23	3.08	2.60
3.	Clay soil (63%) + Fly ash (30%) + Jute fibre (7%)	5.73	5.28	4.21	4.18

4.	Clay soil (56%) + Fly ash (35%) + Jute fibre (9%)	5.48	5.22	4.15	4.08



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Result:

The above tables shows the comparative study of the CBR values of the soil along with varies proportions (clay soil + fly ash + plastic waste) better than the (clay soil + Fly ash + Jute fibre).

Conclusion :

The suitability of fly ash for use in ash alloys, soil conditioners, mine fills, roads and embankments, cement, and other uses is evaluated.
This waste material can be transformed into useful wealth and used as a new building material for a variety of projects, including backfilling behind retaining walls, building embankments for roads and trains, filling in low-lying areas, and building embankments for canals and lakes.
Since fly ash is provided free of charge at the power plant, the only expenses associated with it are those related to transportation, laying, and rolling. Therefore, the economy realized while using fly ash as a fill material is directly correlated with the cost of fly ash transportation. Construction costs can be significantly reduced if the lead distance is shorter.

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