January – February 2020
ISSN: 0193-4120 Page No. 13250 - 13258

Stabilization of Expansive Soils by Using Plastic Powder

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Abstract

The physical properties of soil will be increased through soil stabilization, which incorporates rising the bearing capability, shear strength etc., this could be done by utilizing measured compaction or through adding applicable mixtures like lime, cement and waste materials like phosphoric, gypsum, ash etc., These additives value has been inflated in recent days that successively ends up in development of alternative reasonably soil additives like bamboo, plastics etc.,

These recent techniques of soil stabilization will be well wont to reach the confronts of the society, to attenuate the number of unproductive material and additionally to supply useful product from waste materials. one in all the most important issues of these days is that the usage of plastic product like polyethylene luggage, bottles etc., that is drastically increasing at AN frightening rate day by day. thus this disposal of plastic wastes while not inflicting any threat to setting has become a significant challenge. thanks to the animal product of excellent quality of soil for embankments the employment of plastic powder as a soil stabilizer has become an inexpensive application.

This project includes of the entire study on the attainable ways that to use waste plastic powder for soil stabilization. The examination was done by performing arts compaction check on soil. The comparison of check results showed that completely different percentages of plastic powder were the foremost effective in exasperating the ability of soil. By victimization unconfined compression check the most appropriate proportion of plastic powder in soil will be verified. The scale and content of waste plastic powder has noteworthy impact within the improvement of strength of the soil.

Keywords; *Expansive soil, plastic powder, stabilization, engineering properties, laboratory studies.*

INTRODUCTION

Instability of earth materials has forever been a questioning purpose for group, expansive soils being the foremost vital. at some point they're parched and hard and also the terribly next day they're soaked and weak. Bulged soil create fault for gently loaded structures, once combined below load and by creating volumetrical changes in conjunction with periodic variation in wet. As a result, the superstructures typically counter excessive settlement and differential movements, leading to injury to foundation systems, transportation structural components and beaux arts qualities. The structure becomes unbalanced or tumbles down in most of the cases. All the makes an attempt created to improvise the swelling soil have gone vainly because of the shortage of apt technology which ends up in giant changes and thence inflicting large economic losses. The present study has been concerned because of the higher than reasons. The aim was to enhance the capability price and conjointly cut back the expansiveness of the soil by adding additives.

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January – February 2020
ISSN: 0193-4120 Page No. 13250 - 13258

Plastics area unit thought of collectively of the foremost significant discovery that has extremely aided in various traits of life. As plastics area unit non-biodegradable materials that have given and a lot of issues to the users and conjointly destroyed the element of the atmosphere to the nice extent. There are a unit tough ways that wherever the employment of the plastic is being done it's not solely restricted to looking luggage, storages and selling however conjointly bottles and different varied things area unit made of plastic, that once thrown away creates several venturous. one in all the cost-efficient means that to improvise the performance of sub grade soils is to every which way strengthen the soil by mistreatment high density synthetic resin powder taken from waste plastic containers and plastic bottles.

MATERIALS

Stabilization of soil takes place the usage of stabilising materials in feeble soils to extend its geotechnical properties like softness, strength, permeableness and sturdiness. The stabilization method includes soils or soil minerals and stabilising agent or binders (cementitious materials).

SOIL

For achieving the necessary engineering properties, most of the stabilization experiments are being exhausted soft soils like silt, clayey humate or organic soils. As per dramatist (1993), the stabilisation of finely-grained granular materials is easier as they need massive expanse in scrutiny with their particle diameter. A clayey soil particle is flat and has elongated shapes thanks to that it's a bigger expanse compared to different soils. On the opposite hand, silt materials are troublesome to stabilise thanks to their high sensitivity even for a little amendment in wet (Sherwood, 1993). humate soils and organic soils have high consistence, high organic content and also are the water content is up to 2000%. The humate soil texture differs from muddy to fibrous and in more cases, the deposition is skin-deep, but in least cases, it will be somewhat several meters below the surface (Pousette, et al 1999; Cortellazzo and Cola, 1999; Åhnberg and Holm, 1999). Soils that are organic have high exchange capability; by that the association methodology can delay by holding the metal ions liberated throughout the association of metal salt and metal aluminates among the cement to satisfy the exchange capability. In such soils, the stabilization improves solely by adequate choice of binding materials and quantity of binding material adding (Hebib and Farrell, 1999; Lahtinen and Jyrävä, 1999, Åhnberg et al, 2003).

PLASTIC POWDER

To obtain appropriate engineering characteristics, most of stabilization experiments have to be compelled to be performed in soft soils (silt, clayey humate or organic soils) so as. in line with playwright (1993), finely-grained granular materials with square shape very easier to stabilize because of their massive area compared to their particle diameter. A clay soil particle is flat and has elongated shapes because of that it's a bigger area compared to different soils. On the opposite hand, silt materials square measure tough to stabilise because of their high sensitivity even for a little modification in wetness (Sherwood, 1993). humate soils and organic soils have high porousness, high organic content and also are the water content is up to regarding 2000%. The humate soil texture differs from muddy to fibrous and in most cases, the deposition is of little depth, but in least cases, it will be diverse meters below the surface (Pousette, et al 1999; Cortellazzo and Cola, 1999; Åhnberg and Holm, 1999). Organic soils have high exchange capability; it'll delay the association technique by holding the Ca ions liberated throughout the association of Ca salt and Ca aluminates at intervals the cement to satisfy the exchange capability. In such soils, the stabilization improves solely by adequate choice of binding material and quantity of binding material adding (Hebib and Farrell, 1999; Lahtinen and Jyrävä, 1999, Åhnberg et al, 2003).

Published by: The Mattingley Publishing Co., Inc.

January – February 2020
ISSN: 0193-4120 Page No. 13250 - 13258

Different Types of Plastic Wastes and their origin.

Waste Plastic	Sources
Low density polyethylene	Carry bags, sacks, milk packets, bin lining, cosmetic and detergent bottles
High density polyethylene (HDPE)	carry bags, bottle covers, house-hold articles
Polyethylene terephthalate (PET)	potable water bottles etc.,
Polypropylene (PP)	Bottle covers, detergent wrappers, biscuit packets.
Polystyrene (PS)	Clear egg packs, bottle covers, food tray, egg containers and disposal cups.
Poly Vinyl Chloride (PVC)	Mineral water bottles, cards, toys,pipes, electrical fittings.

STABILIZATION METHODOLOGY

The following study is a trial created to check the consequence of the plastic powder on the characteristic properties of the soil. The blending of soil and plastic powder has been drained the laboratory. The vital properties thought of during this report square measure Compaction, Plasticity, Differential Free Swell Index and strength characteristics of Expansive soil. These tests are performed on varied soil-fly ash mixtures of variable proportions. the subsequent properties of expansive soil square measure determined through laboratory like Grain Size Analysis, Atterberg Limits, Liquid Limit, Plastic Limit, Plasticity Index, Free Swell Index (FSI), Compaction Characteristics (Standard Proctor Test), relative density and Unconfined Compression check.

Tests made on Expansive Soil:

Grain Size Distribution:

The fraction of different sizes of particles in an exceedingly given parched sample is found by a particle size distribution analysis or mechanical analysis. The mechanical analysis is supposed for the segregation of soil into completely different size fractions. The mechanical distribution analysis is conducted in 2 states like deposit analysis and wet mechanical analysis

It is here concerned with the sieve analysis which is meant for coarse-grained soils only, arranged the cleaned sieves of size 4.75 mm, 2.36 mm, 1.18 mm, 600 microns, 300 microns, 150 microns and 75 microns, in the order of decreasing aperture size, after ensuring that all of them are cleaned. The receiver is placed at the bottom.

The Coefficient of Uniformity (Cu) and Coefficient of Curvature (Cc) can be found by following formulae:

- Co-efficient of Uniformity = Cu = D_{60}/D_{10}
- Co-efficient of Curvature, Cc = $(D_{30})^2/(D_{10}*D_{60})$

Liquid Limit: The Liquid Limit (WL) is typically made public as a result of the water content at that the behaviour of a clayey soil changes its state from plastic to liquid. Actually, clayey soil incorporates a very little shear strength at the Liquid Limit and hence the hardiness of the soil reduces as water content increases; the modification from plastic to liquid behaviour happens over a spread of water contents. The importance of the Liquid Limit take a glance at is to classify soils. whole completely different soils have varied liquid limits. to examine the plasticity Index, one ought to use the Plastic Limit Specific Gravity of Clayey Soil (IS: 4031-1968): Specific gravity is the ratio of the weight of an equal volume of distilled water at that temperature both weight taken in air.

Plastic Limit Test: In this test that water content of soil is estimated at which soil changes its state from plastic to semi-solid state. Due to the plasticity of the soil in its plastic state it can moulded into numerous shapes. Whereas the soil becomes brittle

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January – February 2020
ISSN: 0193-4120 Page No. 13250 - 13258

in its semi solid state. When pressure is applied the soil simply crumples.

Free Swell Index: To estimate the Free Swell Index of soil as per IS: 2720(Part XL) – 1977. Free Swell Index is the increase in volume of soil when it is immersed in water without any external limitation.

Take representative oven dried soil sample of 10 grams passing through 425-micron sieve. Put the soil sample in graduated glass cylinders of 100ml capacity and fill up the cylinder with 100 ml distilled water. Separate the trapped air in the cylinder by gentle shaking and stirring with a glass rod. Allow the samples to settle in the cylinder. The soil sample will take less than 24 hours to attain equilibrium state without any change in the volume of the soils. The final volume of the soils in each of the cylinders is recorded.

Free swelling index, FSI = $((f_v-i_v)/i_v)*100$

f_v =final value after 24 hours

i_v =initial value and

FSI=Free swelling index

Standard Proctor's Test: Proctor's test is used to understand the compaction features of various soils when subjected to small change in water content. Compaction of soil is the best possible water content at which a given soil type becomes very dense and achieve its maximum parched density by elimination of air vacuums.

Unconfined Compression Strength: The unconfined compressive strength (UCS) is that the most axial compressive stress that a right-cylindrical sample of fabric will tolerate below free conditions—the confining stress is zero. The first purpose of the Unconfined Compression strength take a look at is to swiftly verify a live of the unconfined compressive strength of rocks or fine-grained soils that possess adequate cohesion to allow testing within the unconfined state.

RESULTS AND DISCUSSIONS

Specific Gravity of Clayey Soil (IS: 4031-1968):

As per IS 4031, it is the ratio of the weight of an equal volume of distilled water at that temperature both weight taken in air.

Specific Gravity, G = $(W_2-W_1) / ((W_4-W_1)-(W_3-W_2))$

=(81-28)/((79-28)-(111-81))

= 2.528.

The specific gravity of soil is above 2.5 so the taken soil is clayey with low permeability.

Grain Size Distribution:

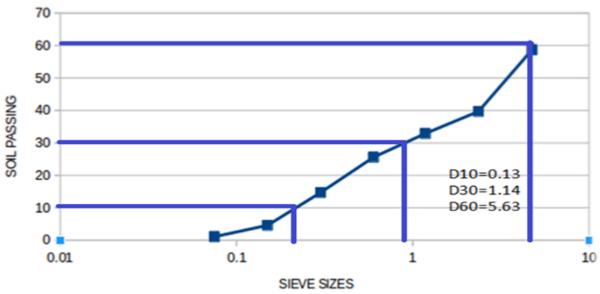
The value of Coefficient of Uniformity (Cu) and Coefficient of Curvature(Cc)are determined by following formulae:

Co-efficient of Uniformity, Cu = D_{60}/D_{10}

Co-efficient of Curvature, Cc= $(D_{30})^2/(D_{10}*D_{60})$

Wet Sieve Analysis

S.NO	IS sieve no.	Sieve sizes (mm)	Soil retained (g)	% wt. retained	Cumulative % wt retained	% passing through
1.	4.75	4.75	413	41.3	41.3	58.7
2.	2.36	2.36	190	19.0	60.3	39.7
3.	1.18	1.18	68	6.8	67.1	32.9
4.	600microns	0.600	73	7.3	74.4	25.6
5.	300microns	0.300	109	10.9	85.3	14.7
6.	150microns	0.150	101	10.1	95.4	4.6
7.	75microns	0.075	35	3.5	98.9	1.1
8.	pan	-	11	1.1	100	-



Grain Size Distribution

Co-efficient of Uniformity, Cu = D_{60}/D_{10} = 0.11

Co-efficient of Curvature, Cc = $(D_{30})^2/(D_{60}*D_{10})$

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TEST Engineering & Management

January – February 2020
ISSN: 0193-4120 Page No. 13250 - 13258

= 1.55

Taken soil sample exists C-H grade (clay with high compressive property).

Free Swelling Index: Free swelling index is the increase in volume of soil when it is immersed in water without any extrinsic limitation.

Mass of soil = 10 g

Initial value, i_v =10ml

Final value, f_v= 16ml

Free Swelling Index, FSI = $((f_v-i_v)/i_v))*100$

= ((16-10)/10)*100

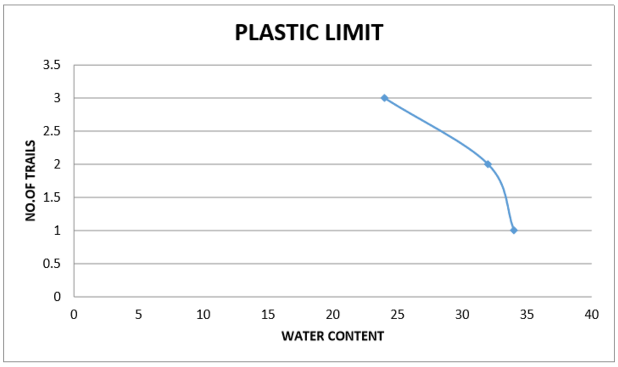
FSI = 60%

As the Free Swell Index of the Sample is > 50 %. It is highly expansive soil.

Plastic Limit: In this test that water content of soil is originated at which soil changes its state from plastic to Semi-solid state.

Plastic Limit

s.no	Particulars	1	2	3
1	Container no	1	2	3
2	Wt of container	35	27	25
3	Wt of container+wet	50	47	45
4	Wt of container+dry soil	44.5	40	38
5	Water content	12%	17%	18.4%
6	Water added(for 3mm of thread)	34%	32%	24%



Plastic Limit

Plastic Limit of Clayey Soil = 29.6%

Liquid Limit: The liquid limit is the moisture content at which the solid has less or no shear strength and when it just begins to flow. Wt of soil = 120g

Liquid Limit

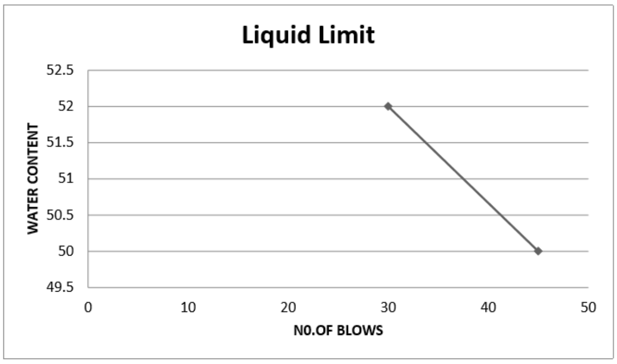
Particulars	Trail 1	Trail 2	Trail 3
Water content (%)	52	53	54
Amount of water (ml)	62.4	63.6	64.8
No. of blows	30	25	27

Water content

$= ((W_w-W_d)/W_d)*100$

= ((50-34)/34)*100

= 47.05%



Liquid Limit

Liquid limit=53%

The liquid limit of the soil is more than 30% .So the taken soil is highly expansive soil

Standard Proctor Test:

Volume of mould = 1000cc

Standard Proctor Test

S.NO.	Particulars	Trail1	Trail2	Trail3	Trail4
1.	Water content added	18%	20%	22%	24%
2.	Amount of water add(ml)	540	600	660	720
3.	Wt of empty mould w_1(g)	2011.6	2011.6	2011.6	2011.6
4.	Wt of mould+compact soil w_2	3788.0	3884.0	3945.0	3930.0
5.	Wt of compacted soil (w_2-w_1)	1755.0	1871.0	1932.0	1917.0
6.	Wet density w_d =w/v	1.755	1.871	1.932	1.917
7.	Dry density=w_d/(1+w)	1.576	1.680	1.735	1.721

Mass of container+wet soil, W_w= 41.2g

Mass of container+dry soil, W_d = 37g

Water content = ((W_w -W_d) /W_d)*100

= ((41.2-37)/37)*100

W =11.35%

Optimum Moisture Content = 22%;

Maximum Dry Density = 1.735g/cc.

Tests conducted on Soil with Plastic Powder:

Specific Gravity of Plastic Powder (IS: 4031-1968)

Specific gravity is the ratio of the Mass of an equal volume of distilled water at that temperature both Mass taken in air. The range of specific gravity of plastic powder is (0.5-1.3).

- Mass of empty bottle, W_1= 29g
- Mass of bottle + plastic powder, W_2 = 48g
- Mass of bottle + powder + water, W_3 = 75.8g
- Mass of bottle +water, W_4 = 79.3g

Specific Gravity of Plastic Powder,

= W_2-W_1)/ ((W_4-W_1)-(W_3-W_2))

= (48-29)/((79.3-29)-(75.8-48))

= 0.85

The average range of specific gravity of plastic powder should be (0.5-1.3).

Free Swelling Index: To make certain of the Free Swell Index of soil as per IS: 2720(Part XL) – 1977. Free swell or differential free swell, also termed as Free Swell Index, is the elevation in volume of soil when immersed in water without any exterior limitation.

Free Swelling Index = ((fv-iv)/iv)*100

Mass of Soil = 10 g

Free swelling index

% of plastic powder added	4%	6%	8%	10%
Initial value in beaker with both powder and soil (i_v)	13	14	15	16
Final value in beaker after 24 hrs(f_v)	17	18	19	21
FSI=((f_v-i_v)/i_v)*100 %	30.0	28.5	26.6	31.2

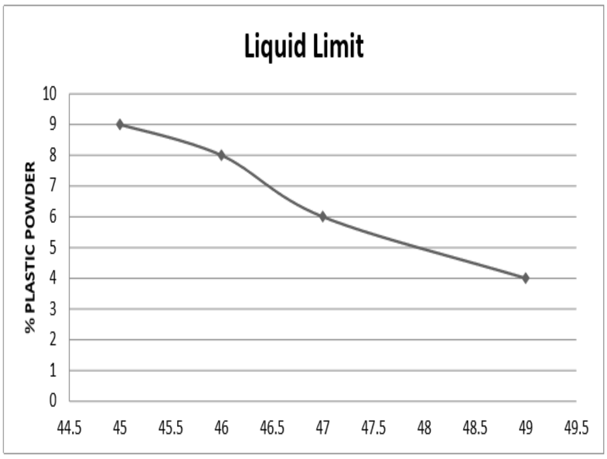
Free Swelling Index is minimum at the ranges of 8 to10% of Plastic Powder.

Liquid Limit (IS: 2720 PART-5): The liquid limit of the treated soil varies between 53.2% to 59.5% (IS 2720 Part 5 1985).The liquid limit of the soil decrease with increase in lime content up to 8% after it goes on increasing with enlargement in lime content. Thus the optimum lime content is between 8% to 10% for maximal effect on liquid limit.

Liquid Limit

% of plastic powder	0%	4%	6%	8%	9%	10%
Water added (%)	53	49	47	46	45	46
Water added (ml)	63	58.8	56.4	55.2	54	55.2
No. of blows	24	25	25	25	25	25

Wt of Soil = 120g



Liquid Limit

Mass of the container = 9g

Mass of the container + wet soil, W_w = 48g

Mass of the container + dry soil ,W_d = 37g

Water content = ((W_w-W_d) /W_d)*100

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January – February 2020
ISSN: 0193-4120 Page No. 13250 - 13258

= ((48-37)/37)*100

= 30%

Liquid Limit is maximum at 9% of Plastic Powder with 45% of water content. The Liquid Limit is 30%.

Standard Proctor Test (IS 2720 part-7):

For determining the bond between the water content and dry density of soils using light compaction.

Standard Proctor Test

2% of Powder

Water added	22%	24%	26%	28%
Bulk density	1.952	1.979	1.961	1.942
Dry density	1.774	1.799	1.782	1.765

3% of Powder

Water added	18%	20%	22%	24%
Bulk density	1.962	1.981	1.987	1.963
Dry density	1.767	1.784	1.806	1.768

4% of Powder

Water added	16%	18%	20%	22%
Bulk density	1.965	1.985	1.993	1.978
Dry density	1.819	1.837	1.845	1.831

5% of Powder

Water added	15%	16%	18%	20%
Bulk density	1.964	1.992	2.051	1.988
Dry density	1.835	1.861	1.916	1.857

6% of Powder

Water added	18%	20%	22%	23%
Bulk density	1.932	1.953	1.972	1.961
Dry density	1.788	1.808	1.825	1.815

The combination of OMC and MMD for different percentages of Plastic Powder

% of Plastic Powder	2%	3%	4%	5%	6%
OMC	26%	22%	20%	18%	22%
Bulk Density	1.961	1.987	1.993	2.051	1.972
Dry Density	1.782	1.806	1.845	1.916	1.825

For the addition of 0-5%plastic, MDD increased by 20% and OMC reduced by 10% compare to individual soil

Unconfined Compression Test:

Length of the specimen = 7.5 cm = 75 mm. Diameter of the specimen = 3.8 cm.

Area of the specimen = 11.341cm^2

Clayey Soil @ 95% and Plastic Powder @ 5%

Table 4.2.5.5 Unconfined Compression test with 5% of Powder

Divisions (n)	Deformation in 'mm'(0.01*n)	Proving ring readings(h)	Load in 'kg' (0.2076*h)	Strain %	Corrected area in 'cm^2'	Stress in 'kg/cm^2'
0	0	0	0.000	0.000	11.341	0.000
25	0.25	7	1.453	0.003	11.375	0.127
50	0.5	14	2.906	0.006	11.409	0.254
75	0.75	16	3.321	0.010	11.455	0.289
100	1	18	3.736	0.013	11.490	0.325
125	1.25	22.5	4.671	0.016	11.520	0.405
150	1.5	25	5.190	0.020	11.572	0.448
175	1.75	28	5.812	0.023	11.607	0.500
200	2	29.5	6.124	0.026	11.643	0.525
250	2.5	31	6.435	0.033	11.728	0.548
300	3	33.5	6.954	0.040	11.813	0.588
400	4	36	7.473	0.053	11.975	0.624
500	5	41.5	8.615	0.066	12.140	0.709
600	6	43.5	9.030	0.080	12.327	0.754
700	7	48	9.964	0.093	12.503	0.796
800	8	51	10.587	0.106	12.685	0.834
900	9	54	11.210	0.120	12.887	0.869
1000	10	59	12.248	0.133	13.080	0.936
1100	11	64	13.286	0.146	13.279	1.000
1200	12	60	12.456	0.160	13.501	0.922

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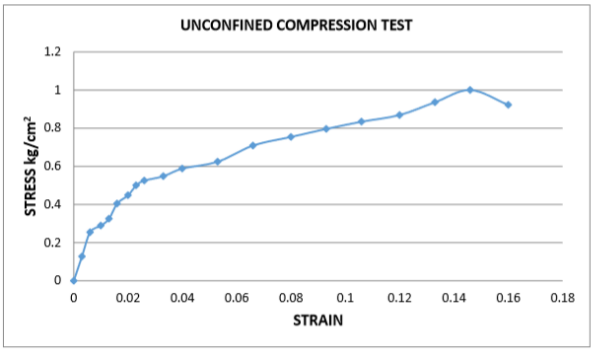
January – February 2020
ISSN: 0193-4120 Page No. 13250 - 13258



Graph 4.2.5.5 Unconfined Compression test with 5% of Powder

Unconfined Compression Strength = 1.000 kg/cm^2

DISCUSSIONS:

The specific gravity of soil is obtained 2.528 and the specific gravity of plastic powder is 0.85.

The soil is characterised clayey with highly compressive based on the grain size distribution. Free Swelling Index of Soil is 60% and Free Swelling Index of Soil with Plastic Powder is 26.6% (optimum) at 8% of Plastic Powder.

The liquid limit of a clayiest soil is 53% and the liquid limit of soil with plastic powder is 45% (optimum) at 9% of plastic powder.

The best water content and maximum dry density of soil is 22% and 1.735g/cc respectively. The water content and dry density is 18% and 1.916 g/cc respectively is optimum at 5% of plastic powder.

The unconfined compressive strength of soil is 0.687 kg/cm2 and the unconfined strength of taken soil in addition to plastic powder at 5% has increased to 1.0 kg/cm2.

CONCLUSIONS

The following assumptions were drawn after carrying out the research work in detail:

• The addition of plastic powder decreases the physical property options of expansive soil. The liquid limit decrease and plastic limit will increase with arise in powder content. physical property index reduces by twenty second with the addition of 0-10% plastic powder. Shrinkage limit goes on increasing frequently with an excellent rate with increase in plastic content.

• The addition of plastic powder to expansive soil decreases the free swell index. For the expansive soil used each free swells were reduced by twenty fifth from 0-9% plastic powder. At higher share of plastic powder rate of reduction in free swell and swelling pressure slowly reduced.

• OMC decreases and MDD increases. Therefore, addition of plastic powder is equivalent to increased compactive effort. For the addition of 0-5% plastic, MDD increased by 20% and OMC reduced by 10%. For higher percentage of plastic powder more than 5% variation in MDD and OMC is not appreciable.

• The unconfined compression strength of soil is increases at 5% of plastic powder. Beyond 5% of plastic powder the strength of soil is decreases.

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