Effect of fly ash and polypropylene fibre on geotechnical properties of clayey soil

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Abstract

Nowadays there is immense problem to harmless disposal of industrial wastes. Lots of waste resources are non-biodegradable so they make a environmental contaminated in the locality. Some studies show that in earlier period, manufacturing wastes can be used successfully in road construction. In the process of road making, the use of unwanted materials is based on some industrial, monetary and ecological criteria. Like India is a rising country and has a vast network of manufactories that are positioned in different parts of the country and may more are to establish in next few years. Industrial wastes are formed in huge amount from these industries in thousand tons. The disposal and pollution problems may be controlled by suitably utilizing the waste materials in construction sites. It is very crucial to test the materials properly and to build up a methodology and specifications, to increase the utilization of the industrial wastes for their successful use in road construction.

This paper describes the use of polypropylene and Fly Ash for soil stabilization. Modified proctor test, California bearing ratio test and unconfined compression strength test were carried out . The fraction of polypropylene is used in this paper is 0.00, 1.00, 1.50,2.00 along with fixed value of fly ash 30%. The different percentage were determined which showed considerable enhancement in the strength of treated soil. The maximum value of C.B.R. is at 2% Polypropylene and fly ash 30% . additional increase in ratio of Polypropylene the C.B.R. value increases. The maximum value of U.C.S. is also at 2% Polypropylene and fly ash 30%. Experiment results show Polypropylene and fly ash enhances the strength properties of soil along with use of economical materials and also solves the environment problem.

Keywords

Clayey Soil, Fly Ash, PP Fibre, Soil Stabilization.

INTRODUCTION

Soil is the uppermost unconsolidated material of the earth present naturally in the universe. It is formed by the decomposition of rocks under the influence of naturally occurring conditions such as wind, rain, snow, heat, etc. It is abundantly available and is the cheapest construction material. It is a complex material because of its highly variable composition and characteristics. The characteristics of soil change according to topography and its location. For safer construction the properties of soil should match with the design requirements of an engineering structure. Geotechnical engineer plays an important role in this work for checking whether the requirements of the structure are fulfilled by the soil or not. Construction of engineering structures on poor soil involves a great risk. These soils show settlements, low shear strength and high compressibility.

Very often the available soil is not suitable for construction purposes. Strength, permeability and stability on slopes are the main aspects of soil that we have to deal with. For studying the engineering behaviour of soil, we have to deal with the stability of underground structures, retaining structures, foundations, slopes, earth dams and pavement construction.

LITERATURE REVIEW

Tang et al (2008) carried out experimental program to investigate the effects of discrete short polypropylene (PP-) on the strength and mechanical behaviour of unflyashed and fly ashed clayey soil. The test results indicated that the inclusion of reinforced fly ash within unflyashed and fly ashed soil caused an increase in the unconfined compressive strength (UCS), shear strength and axial strain at failure, decreased the stiffness and the loss ofpost-peak strength, and changed the fly ashed soil's brittle behavior to a more ductile one.

Shukla et al (2003) used in study five types of soils ranging from low clay content to highclay content and stabilized them with bioenzyme. It was found that the improvement in engineering properties was little to high. The less improvement could be due to the low reactivity of soil with the bioenzymes.

Isaac et al (2003) had done experimental study on different types of soils from Kerala with terrazyme using as a stabilizer. With addition of different dosages of terrazyme, CBR tests were conducted on each soil sample under soaked conditions at different curing periods. They found that the terrazyme treated is very economical, effective and environment friendly technique for stabilization of clayey soils.

Shankar et al (2009) had done experimental study on lateritic soil collected from Dakshina Kannada and Udupi districts of Karnataka. The lateritic soil is blended for CBR and UCS. The soils were treated with terrazyme with varying dosages. The soils after treatment were again tested for CBR and UCS over different curing periods. By comparing the results terrazyme showed a marginal improvement.

Venkatasubramanian and Dhinakaran (2011) performed a series of tests on three different soils having different engineering properties. The tests were performed at different dosages of terrazyme. The values of liquid limit and plasticity index for these three types of soils were reported as 28 , 46 and 30% and 6 , 6 and 5% respectively. The increase in CBR value after four weeks was reported as 157 , 673 % and 152 to 200% in UCS.

Singh Baleshwar (2011) performed compaction test and UCS test on clayey-silt. He showed the effects of using low calcium fly ash and ordinary portlandfly ash in improving the strength of a clayey silt soil. He determined that with increment of fly ash in soil, MDD decreases and OMC increases. When only fly ash is added, the soil mixes are to be used for constructing road embankments and subgrade layer of pavements. When 1% fly ash is added to the soil-fly ash mixes, these are be used even for sub-base of low-volume roads

Manjunath K.R. et al. (2013) studied the effect of propylene fibre on compaction and strength characteristics of black cotton soil treated with lime. They reported that for a particular fibre percentage, the MDD of stabilized soil increases and OMC decreases. The maximum dry density and OMC of propylene fibre reinforced soil increased with 3% lime. 3% of lime content and 0.75% propylene fibre were considered as optimum percentage for black cotton soil to increase the California bearing ratio value.

Savitha A.L. et al. (2013) conducted compaction tests and UCS tests on Black Cotton soil using coarse and fine fly ash. They varied the percentage of fly ash from 5% to 25% with increase of 5% at a time. Curing was done for 1, 7, 14, 28 days. They reported that the strength obtained by fine fly ash was 25% more than that of coarse fly ash. On increasing water content upto 30%, the dry density decreases and if water content is increased further the dry density decreases gradually. The MDD was 1.35 g/cc for 5% fly ash mixed with 95% soil and lowest density was 0.6g/cc for 30% fly ash mixed with 70% soil.

Agrawal M.L. et al. (2013) performed compaction tests and CBR test on black cotton soil. They varied the percentage of fly ash from 10% to 50% with increase of 10% at a time. They investigated that the MDD increases with increment in fly ash up to 20% and with more addition it decreases. The increase in CBR value and dry density is maximum for 30% fly ash mixture with black cotton soil. On increasing percentage of fly ash, there is decrease in the the liquid limit of black cotton soil, resulting in reduced swelling of soil.

Peng et al (2011) examined three types of soild and conducted unconfined compression tests on them. The three soils are fined grained soil, silty loam and the coarse grained soil. These three types of soils are treated with quicklime and permazyme. The sample were placed for the curing period of 60 days in two different conditions: (1) sealed container and (2) air dried. Permazyme found more effective in air dried conditions than quicklime. But on the other hand in sealed conditions, the quicklime found to be more effective than permazyme as water was not evaporated and hydration was promoted.

Nadgouda K.A. and HegdeRA (2010) had concluded in their study that the optimum lime content varies within 3.5% to 4.5% for the stabilization of clayey soil. The study shows that the optimum moisture content and the potential for swelling upon contact with water is reduced on treatment with lime.

D.A. Sweeney et al (2012) had examined the effect of lime on highly plastic clay having properties as liquid limit 86.0%, plastic limit 27.2% and plasticity index 58.8%. The study shows that an increasing in aging period does not have a signifivant effect the plasticity index. Aging produces lower density for specimens prepared using a constant compaction effort. The aging have no significant effect on swell of treated specimens and with increased compaction.

MATERIALS AND METHODS

SOIL

Source of soil

The soil used in this study was obtained from sri sai institute,bungal in district pathankot. As per IS classification of soil, the soil used is low compressibility clayey soil. The soil properties are given in the table as under:

Properties of soil used in the study

S. No.	Properties of soil	Value
1	Specific gravity	2.68
2	Liquid Limit (%)	29
3	Plastic Limit (%)	24
4	Plastic Index (%)	5
5	Classification of soil(According to ISC)	ML (clay of Low Compressibility)
6	Maximum Dry Density (kN/m^3)	17.2
7	Optimum Moisture Content (%)	14
8	CBR (soaked)	2.67
9	Unconfined compressive strength (kN/m^3)	178.6

FLY ASH

Source of Fly ash

Fly ash used in this research work was collected from Guru Gobind Singh Super Thermal Plant, Rupnagar. The fly ash was dried in oven and then it was sieved for the removal of foreign particles.. Properties and composition of fly ash as obtained from the thermal plant shown in table no. 3.2 and 3.3

Engineering Properties of Fly ash
(Source: Guru Gobind Singh Thermal Plant, Rupnagar)

1	Colour	Whitish Grey
2	Specific Gravity	2.2
3	Liquid limit	45

Chemical Composition of Fly Ash

S. No	Name of constituent	Percentage
1	Silica (SiO_2)	2.26
2	Alumina (Al_2O_3)	23.72
3	Iron Oxide (Fe_2O_3)	7.93
4	Calcium Oxide (CaO)	63.93
5	Magnesium oxide (MgO)	1.22
6	Potassium oxide (K_2O)	1.00

Laboratory tests
The following tests were performed for the present study:

1. Pycnometer test
2. Liquid Limit test
3. Plastic Limit test
4. Standard Proctor test
5. California bearing ratio test
6. Unconfined compressive strength test

POLYPROPYLENE FIBRE

Source of polypropylene fibre
The pp fibre used in this study was obtained from Jindaram Exports, Sirsa. PP is a natural fibre having greater tensile strength and can be used as an effective reinforcing material in soil stabilization. The properties and composition of pp fibre are discussed in table.

Properties of PP Fibre
(Source: Jindaram Exports, Sirsa)

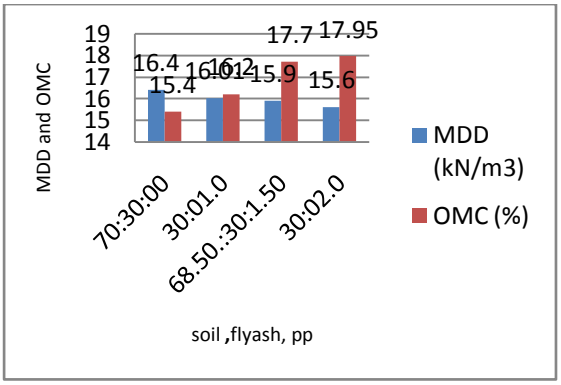
S. No	Property	Value
1	Colour	White
2	Specific Gravity (Kg/m^3)	910
3	Water Absorption (%)	110
4	Length of fibre (mm)	12
5	Diameter of pp fibre (mm)	0.034
4	Tensile Strength(MPa)	350
5	Modulus of elasticity (GPa)	3500

EXPERIMENTAL PROGRAMME

The experimental programme for this study includes the processing of materials and their mix proportion to be used for finding various engineering properties of soil- fly ash- pp fibre mix. The procedure for conducting tests i.e. standard proctor test, California bearing ratio test, unconfined bearing ratio is discussed in this chapter. All the tests were conducted according to IS code.

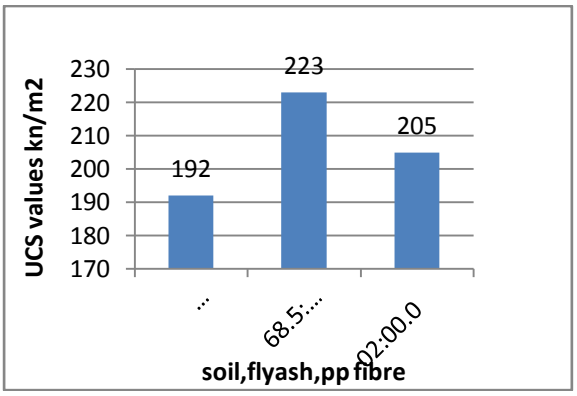
STANDARD PROCTOR TEST

Proportion Soil : Fly ash : pp fibre	MDD (kN/m^3)	OMC (%)
70:30:00	16.4	15.4
69 : 30 :1.00	16.01	16.2
68.50:30 :1.5	15.9	17.7
68 : 30 : 2.00	15.6	17.95



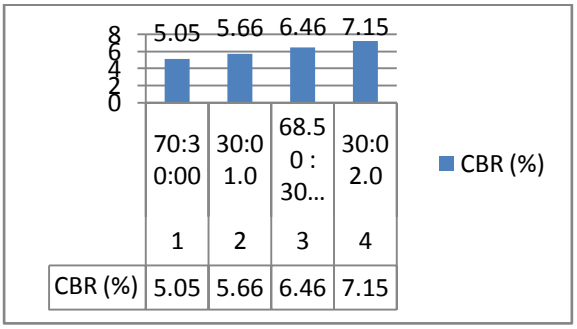
UNCONFINED COMPRESSIVE STRENGTH TEST

(Soil : Fly ash : PP Fibre)	UCS (kN/m^2)
69: 30 : 1.00	192
68.5 : 30 : 1.5	**223**
69.25 : 30 : 2.00	205



CALIFORNIA BEARING RATIO TEST (SOAKED)

Proportion Soil : Fly ash : pp	CBR (%)
70 : 30 : 00	5.05
69 : 30 : 1.00	5.66
68.50: 30 : 1.50	6.46
68 : 30 : 2	7.55



CONCLUSIONS

The conclusions drawn from the experimental investigation are as under:

- When percentage fly ash increases in soil there is increase in O.M.C. and decrease in M.D.D.
- With the increase in quantity of pp fibre the value of O.M.C. increases and M.D.D. decreases.
- The optimum value of fly ash to be used for further work was 30%.
- The best ratio obtained was 68% soil: 30% fly ash: 2% pp fibre.
- Soaked CBR value increases from 5.05% for virgin soil to 7.15% for the best ratio of the mix.
- Unconfined compressive strength of soil-fly ash mixtures increase with increase in pp fibre up to 2% by weight.

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