

Soil Stabilization by Using Waste Paper Sludge

Kalpana P. Patel¹, Champaneria Harshiv, Dadhaniya Priyal, Dhodiya Deep, Hunny Modi, Khatri Nishith²

Assistant Professor, Department of Civil Engineering, R.N.G.Patel Institute & Technology, Bardoli, Gujarat, India¹

B.E Students, Department of Civil Engineering, R.N.G.Patel Institute & Technology, Bardoli, Gujarat, India.²

ABSTRACT: The principle target of the soil stabilization is to build the bearing limit of the earth soil, its protection from enduring procedure and soil penetrability. The drawn out performance of any development project relies upon the sufficiency of the fundamental soils. The fundamental goal of this examination is to research the utilization of industrial waste materials in geotechnical applications and to assess the impacts of waste paper sludge on quality improvement of soft soil. This survey examines the impact of waste paper sludge on Black Cotton Soils. Waste paper sludge (WPS) is waste product from the Paper mill industries. The WPS can produce a cementitious material because WPS contains a large amount of CaO while it is Pozzolanic material. In this paper investigation, the different percentages of waste paper sludge i.e. 2%, 4%, and 6% were used to stabilize the black cotton soil. The soil was evaluated using physical and strength performance tested such as Specific gravity, Plasticity index, Compaction; free swell index, California Bearing Ratio (CBR) and unconfined compressive strength (UCS). We observed that at the optimum percentage of 6% WPS shows an improvement unconfined compressive strength from 0.227 kg/cm² to 0.4079 kg/cm². Furthermore California Bearing Ratio values improved from 17.08% to 4.53%. In general it was found that WPS is a suitable waste material for stabilizing of Black Cotton Soil.

KEYWORDS: Soil Stabilization, Compaction, California Bearing Ratio, Unconfined Compressive Strength, Waste Paper Sludge (WPS).

I. INTRODUCTION

In Civil Engineering Construction like Railway lines, Highway Network, Airport Runways etc are required on Soil Embankment for construction. There are various processes like chemical, mechanical, biological or combined method in order to improve soil properties such as compressibility, strength, permeability and durability. Industrialization and urbanization is a major area of every country which is growing up in each year. Industrialization is one of the areas of each country in which numbers of industries are increasing year by year. These industries manufacture many items and also produce thousands of tones waste material. Paper mill Industries is one of them which create waste material every year.

Urbanization is the required for the growth of country resulting developing the lives of its country people. Civil construction is also a part of urbanization. Sometimes site engineers face the problems in the field due to poor the strength of soil. Conventionally different materials like cement, lime and fiber etc are used to mix with soil for improving the strength of soil. These materials increase the cost of construction, results an uneconomical construction. In many industries waste materials are available which is not recycled yet for their utilizing purpose. Paper mill industries are one of them in which Waste Paper Sludge (WPS) is a waste materials dumped around the industry premise. This waste material also covers a large area to landfill. When this waste material dried in presence of sun light creates dust which leads to the air pollution in nearby areas which also affects human health.

II. MATERIALS

Sample of Soil: The sample of soil was collected from Vagra region of Bharuch district in Gujarat state of India. The soil sample was collected by disturbed sampling method after removing the top soil layer at 100 mm depth and transported to the laboratory.

The soil was air dried and sieved as per Indian Standard for the required laboratory test. The index and engineering properties of black cotton soil were determined as per IS codes.

Waste Paper Sludge (WPS): Waste Paper Sludge is a waste material for the paper industry and it is collected from the J.K. Paper Mill, Fort-Songadh of Tapi district in Gujarat state of India.



III. METHODS

Replacement of soil by WPS of 2%, 4% and 6% were chosen as research work. The laboratory testing been done in this study to determine the physical properties of Black Cotton Soil and WPS such as Free Swell Index, Particle size distribution, Specific Gravity, Atterberg limit, Compaction characteristics, California Bearing Ratio and Unconfined Compressive Strength. All the entire testing is based on IS 2720.

SPECIFIC GRAVITY: As per IS 2720 Part III- 1980 is needed in calculation of soil properties like void ratio, degree of saturation etc. were conducted on soil.

ATTERBERG’S LIMITS: As per IS 2720 Part IV-1985 liquid limit, plastic limit and shrinkage limit were conducted on soil for finding out Atterberg limits.

STANDARD PROCTOR TEST: The standard proctor test is used to determine optimum moisture content and maximum dry density of soil in the laboratory. In this method the soil filled into the mould in three layers and each layer compacted by 25 number of blow from a 2.6 kg hammer weight with fall of 310 mm. The process is repeated for different soil sample to determine optimum moisture content and maximum dry density. The plot between dry density and water content is drawn on graph to find out optimum moisture content and maximum dry density. ‘Standard Proctor Test’ is conducted as per IS: 2720 Part VII-1980 to perform experiment.

UNCONFINED COMPRESSIVE STRENGTH: An Unconfined compression test is a special case of triaxial test in which no confined pressure is given to soil. Unconfined compressive strength test is simpler and quicker test to perform in the laboratory. The compressive load required to fail the UCS sample is called Unconfined Compressive Strength of soil. ‘Unconfined Compressive Strength Test is conducted as per IS: 2720 Part X-1991 to perform experiment.

CALIFORNIA BEARING RATIO: The CBR test is conducted for evaluating the suitability of the sub-grade and the materials used in sub-grade and sub-base of flexible pavements. ‘California Bearing Ratio Test’ is conducted as per IS: 2720 Part XVI-1987 to perform this experiment.

FREE SWELL INDEX: As per IS 2720 Part XL-1977 to find free swell of soil to determine the swelling potential of the soil.

IV. EXPERIMENTS

GEO-TECHNICAL PROPERTIES OF SOIL:

A series of laboratory test performed to determine the basic properties of soil. The geotechnical parameters of soil are presented in Table-1.

Table -1: Geo-Technical Properties of Soil

Sr.No.	Geo-Technical Properties of Soil	
	Parameter	Result
1.	Specific Gravity	2.40
2.	Atterberg’s limit	
	Liquid Limit (%)	59.26
	Plastic Limit (%)	30.98
	Plastic Index (%)	28.28
	Shrinkage Limit	20.18
	Shrinkage Ratio Volumetric	1.69
	Shrinkage (%)	56.08
3.	Standard Proctor Test	
	Maximum Dry Density	1.552
	Optimum Moisture Content	18.6
4.	Unconfined Compressive Strength(Kg/cm2)	0.227
5.	California Bearing Ratio (%)	15.69
6.	Free Swell Index (%)	50

STANDARD PROCTOR TEST:

Standard proctor tests were conducted on 2 %, 4 % and 6 % Waste Paper Sludge (WPS) mixed to the soil. Optimum moisture content increased and maximum dry density decreased of soil with addition of Waste Paper Sludge (WPS) up to 6 %. The relationship graph between dry density and water content plot as shown in Fig.1 and 2 for different percentage of Waste Paper Sludge (WPS) mixed to soil.



UNCONFINED COMPRESSIVE STRENGTH:

Unconfined compressive strength test is the special case of triaxial test when no confining pressure given to the soil sample. For unconfined strength of soil with different percentage of Waste Paper Sludge (WPS) was tested as shown in fig. 4. From test results, it was found that 6% is optimum percentage of Waste Paper Sludge (WPS) for maximum strength of soil.

CALIFORNIA BEARING RATIO:

California Bearing Ratio is expressed in percentage of force per unit area required to penetrate a soil mass with a circular plunger of 50 mm diameter at the rate of 1.25 mm/min to that required for corresponding penetration in a standard material. The ratio is usually determined for penetration of 2.5 and 5 mm. Where the ratio at 5 mm is consistently higher than that at 2.5 mm and the ratio at 5 mm is used. The relationship graph between loading and penetration plot as shown in figs. 3 for different percentage of Waste Paper Sludge (WPS) mixed to soil.

FREE SWELL INDEX:

To determine the swelling characteristics of the expansive soil, differential free swell test is carried out. This test helps to find out swelling potential of the soil. The test is performed as per IS: 2720 (Part-40) – 1977.

V. RESULT AND DISCUSSION

In this, the results of natural black cotton soil is compared with the soil mixed with WPS. Table below shows variation of different parameters of soil like liquid limit, plastic limit, optimum moisture content, maximum dry density, CBR, UCS and free swell index.

% WPS	0	2	4	6
LL (%)	59.26	65.01	64.96	71.37
PL (%)	30.98	27.87	34.74	32.64
OMC (%)	18.6	26.01	24.63	22.7
MDD (gm/cc)	1.552	1.444	1.415	1.379
CBR (%)	15.69	4.40	3.45	4.53
UCS (kg/cm ²)	0.227	0.184	0.256	0.408
FSI (%)	50.00	36.36	28.57	20.00

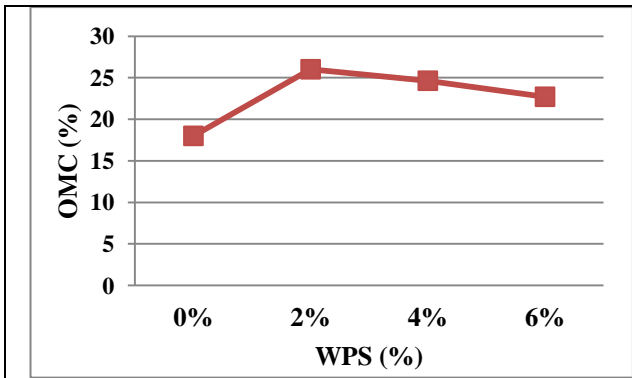


Fig.1: Variation of OMC with increasing % of WPS

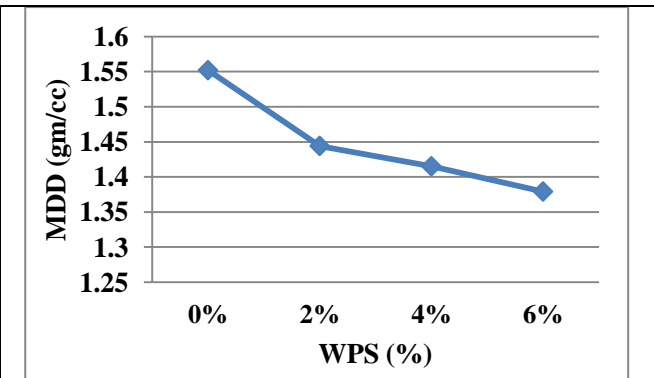


Fig.2: Variation of MDD with increasing % of WPS

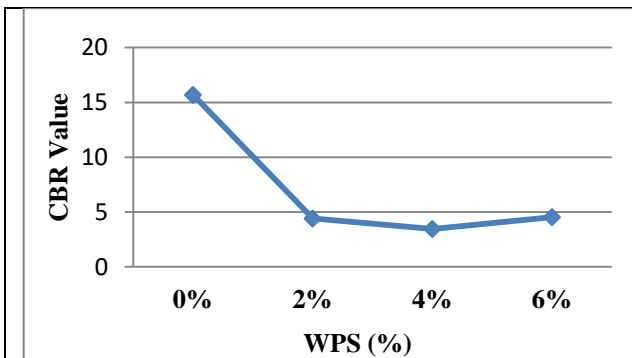


Fig.3: Variation of CBR value with increasing % of WPS

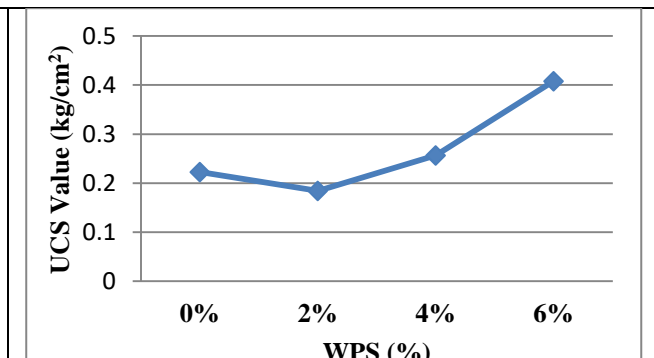


Fig.4: Variation of UCS value with increasing % of WPS

VI. CONCLUSION

- When soil is treated with WPS an increase in Optimum moisture content and decrease in maximum dry density is observed. It was found that the ratio of decrease in density and increase in percentage of additive WPS.
- The maximum strength reached by blocked at optimum percentage of WPS 6% this may be due to better pozzolanic reaction between soil and WPS along with the additives.
- The addition of 6% WPS increase CBR value of black cotton soil.
- The swelling of soil decrease on gradually addition of WPS.
- This WPS can be used as additive without adding any other additives for stabilization. The use of WPS as additives contributes good alternate additive for cement and lime. It will reduce the construction cost and solve disposal problems and tends to be eco-friendly stabilization.

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