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Paper Authors

B.V. Shiva Kumar[1*], M.Durga Prasad[2], P.Leela Krishna[3***]**

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STABILIZATION OF EXPANSIVE (BLACK COTTON) SOIL USING PLASTIC WASTE

B.V. Shiva Kumar[1*], M.Durga Prasad[2], P.Leela Krishna[3***]**
[1,2,3]Department of Civil Engineering,Welfare Engineering College, Visakhapatnam,530047,AP, India
* shivakumar.bandaru@gmail.com, **medisettydurgaprasad@gmail.com, ***p.leela9@gmail.com

ABSTRACT

Soil is the key element of this nature and all the basic needs of life such as food, house and cloths are fulfilled by the soil. Black Cotton soils with high potential for swelling and shrinking as a result of change in moisture content are one of the major soil deposits of India. Soil stabilization is the process which improves the physical properties of soil, such as shear strength, bearing capacity which can be done by use of controlled compaction or addition of suitable admixtures like cement, lime, sand, fly ash or by providing geo textiles, geo synthetics etc. The new technique of soil stabilization can be effectively used to meet the challenges of society, to reduce the quantities of waste, producing useful material from non-useful waste materials. Since the use of plastic in diversified forms such as chairs, bottles, polythene bags, etc., has been advancing speedily and its disposal has been a problem all the time regarding the environmental concern, using plastic as soil stabilizer would reduce the problem of disposing the plastic as well as increases the density and California Bearing Ratio (CBR) of soil in an economical way. This work serves as a means to the whole society by reducing the plastic waste and producing useful product from non-useful waste materials leading to the foundation of sustainable society. In the present study, an experimental program was conducted for stabilization of Black Cotton Soils with the utilization of Plastic waste as soil stabilizer. Different contents of plastic strips (% by weight varying from 0% to 1%) are added to the Black Cotton Soil and the optimum percentage of plastic strips in soil was found out by conducting California Bearing Ratio Test.

Keywords: Black cotton soil, California Bearing Ratio, Plastic Waste, soil stabilization

1. INTRODUCTION

Soil is defined as mineral particles produced by the physical or chemical disintegration of rocks. Soil is also a parent rock. Soil is a non-homogeneous, porous material. Based on origin it can be briefly classified as organic and inorganic. Organic soil is from decaying on plants excreta of animals and humans. Inorganic soil formed from physical and chemical disintegration.

BC soil is clayey soil seen grayish and black in colour. It contains montmorillonite clay mineral which contains very high expensive characteristics. BC soil possess low shrinkage limit and high optimum moisture content. BC soil is such a soil which has tendency to swell or shrink when it comes in contact to water.

Damages seen due to swelling soil can be as following:-

- Rigorous structural damage.
- Cracks develop to basement floor area.
- Condemnation of building.
- Damage to pipelines and sewer lines too.

In road construction main objective of stabilization is to increase stability of soil and to reduce its cost by the use of locally available materials. In developing countries like INDIA had great paralyze system to provide network of road system inadequate capital available to build it by conservative method only.

Hence it became necessary to move forward with suitable method of low capital construction.

Stabilization of course-grained soils with no fines can frequently be accomplished by use of waste material. For silt and clay soils the OMC strength is up to 4-8 percent which is below optimum for maximum density.

For granular soils OMC for maximum strength is 1-3 percent below optimum moisture for density. Thus it becomes critical to controlled moisture content during construction phase. Moisture content is basically measured using a nuclear density measurement instrument.

2. COMPONENTS OF STABILIZATION

2.1Black Cotton Soil In India

Almost 20% area is occupied by black cotton soil. These soil are predominant in states of Andhra Pradesh, Western Madhya Pradesh, Gujrat, Maharashtra, Northern Karnataka, Tamil Nadu and some parts of Southern Uttar Pradesh (Bundelkhand area). They are mostly clay soils and form deep cracks during dry season. They are popularly known as “Black Cotton Soils” because of their dark brown color and suitability for growing cotton. They are black due to compounds of iron and aluminum. These soils are deficient in nitrogen, phosphoric acid and organic matter but rich in calcium potash and magnesium.

2.2 Characteristics of Black cotton soil

Black cotton soil are generally reddish brown to black in color. They occur 0.50m to 10 m deep possessing high compressibility. Common characteristics are listed in table-1 below-

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S.No	Property	Value
1	Dry density (γd)	1300- 1800 Kg/m³
2	Liquid Limit (L.L.)	40 - 120%
3	Plastic Limit (P.L.)	20 - 60%
4	Activity	0.8- 18%
5	Specific Gravity(G)	2.60 - 2.75
6	Proctor Density	1350- 1600 Kg/m³
7	OMC (Max dry density)	20- 35%
8	Free Swell Index	40- 180%
9	Swelling pressure	50- 800 KN/m²
10	C.B.R. (soaked)	1.2- 4.0
11	Compression Index	0.2- 0.5
12	Fines(<75μ)	70- 100%
13	2 μ Fraction	20 - 60%
14	Soil Classification	CH or MH

2.3 Chemical composition of Black cotton soil

S.No.	Property	Value
1	pH value	>7(Alkaline)
2	Organic Content	0.4 – 204%
3	CaCO3	1-15%
4	SiO2	50- 55%
5	SiO2 , Al2O3	3- 5%
6	Montmorrilonite Mineral	30- 50%

Chemical compositions of black cotton soil are listed in table-2 below

Black cotton soil consists of clay minerals like Montmorrilonite, Illite and Kaolinite, chemicals like iron oxide and calcium carbonate (in the form of kankars), and organic matter like humus. Montmorrilonite is the predominant mineral of Black cotton soils. The swelling and shrinkage behavior of black cotton soil originate mainly from this mineral are hydrous silicates of aluminum and magnesium .They are made of sheets of silica (tetrahedral) and alumina (octahedral) stacked on above the other forming sheet like of flaky particle. Montmorrilonite has a three sheeted structure with expanding lattices. The structure carries negative charge, due to isomorphic substitution of some aluminum ions by magnesium ions and minerals becomes chemically

Figure: Structure of Montomorrilonite Mineral

2.4 Plastic Wastes

The increase rate of urbanization, development and population has lead to increasing plastic waste.
Municipal solid waste is increased due to increase in population and development.
Generally, plastic waste has two types:

1. Municipal plastic waste
2. Industrial plastic waste

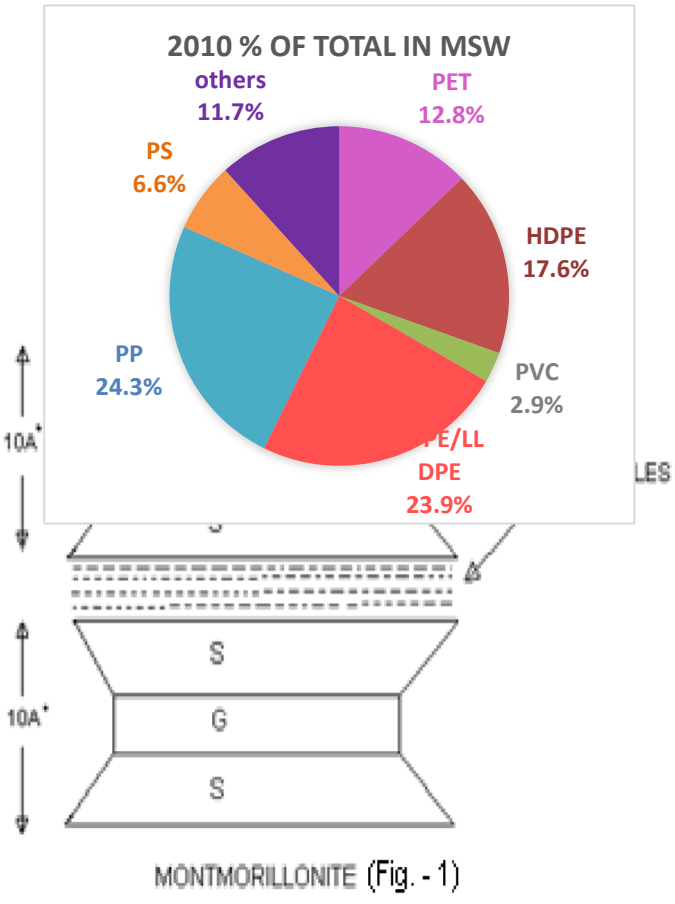

Fig: Plastic Waste % in MSW

Plastic bags have caused a lot of problems in recent times, as they are present in large quantities and due to their improper disposal which causes the degradation of the environment.
Even though they are very cheap and easy to produce in large quantities, they have become a major threat to the environment.

Also, recently it has been specified that the minimum thickness of plastic bags should be kept 40 micron instead of previously specified 20 micron, as the thickness of the bag determines the strength of the bag to break into smaller pieces.
If the bag is thin the probability of breakdown is higher and cause deterioration of the soil.
Flora and fauna are greatly deteriorated along with the land and water. It is the main cause of clogs in the sewage system and environment disruption.

3.METHODS OF SOIL STABILIZATION

There are different materials in utilization for the stabilization of black cotton soils. Depending on the internal factor which describes the bonding between the soil and the stabilizer utilized, the methods are broadly classified into two types. They are

Mechanical Stabilization:
It is based on the principle of friction i.e., when the admixtures are added to soil and compacted the strength is enhanced due to the friction between the soil and the material added. Examples for the materials which increase the strength by this principle are sand, plastic, geo textiles etc.

Chemical Stabilization:
It is based on the chemical reaction between the material added and the minerals in soil. Plastics are considered as one of the important invention which has remarkably assisted in different aspects of life whether it might be in scientific field or others. The use of plastic has been enormously increasing these days. But now, plastic has become the significant pollutant of Environment because of the Use and Throw mechanism and everyone should think about this in the present scenario. The use of plastic has to be limited by now otherwise there would be harshly circumstance that human and environment has to face in near future. Since Plastic is a non-decomposable material, the necessity for recycling or reusing it, is also increasing thereby reducing its wastage. Utilizing this Plastic waste for a positive purpose assists in reducing its effect on environment also.

Stabilization was coined as to make anything in a stable condition which itself is a challenging task. Various researches are going on for incorporating the waste to the soil and stabilizing it so that it can be utilized for different purposes. Thus, using plastic as stabilizer will help in two ways, in addressing the problem of disposing the plastic waste and also using the most available black cotton soils wherever possible.

The present study deals with the stabilization of Black cotton soils near our college(WISTM) in Mogalipuram village,Pendurthy, Visakhapatnam by utilizing plastic strips produced from used plastic bottles and disposal glasses. The proper proportion in soil helps in controlling the compaction factor and also makes it very useful. This study indicates that Plastic wastes can be utilized for stabilization of soil which is concluded from different tests performed on soil in various percentages of plastic content.
Some of the above methods are listed below:-

- Soil stabilization by cement
- Soil stabilization by grouting
- Soil stabilization by bitumen
- Soil stabilization by chemicals
- Soil stabilization by lime
- Soil stabilization by geotextiles
- Electrical stabilization
- Soil stabilization by plastic waste

Our project deals with the last one (Soil stabilization by plastic waste) on expansive(black cotton) soils. The objective and tests performed are briefly dealt in the following project work.

4. EXPERIMENTAL WORK

4.0 Methodology and Sample Collection

A word plastic is a material of consists huge range of synthetic organic. It's a very huge issue to whole word as it degrades very slowly to earth.

Plastic pollution is gathering of plastic a product that is dangerous to human habitats, animal, plants, etc. Manufactured of plastic is increasing due to low range, easy to produced, imperviousness to water, etc.
Since 60-65 years its production is increasing to first stage in pollution
There are 3 major form of plastic namely:-

- Micro-plastic
- Mega-plastic
- Macro-plastic

Utilization of plastic waste bottle in geotechnical constriction may reduce the problems faced for its disposal as their properties are mostly related to natural material. In this topic we had mention about how we are using waste bottles.

We had cut bottles of plain surface whose dimension is almost length 2mm and width 1.5mm.

Plastic bags are made from thin, flexible, plastic film, nonwoven fabric or plastic textile. Plastic bags made with a different type of plastic films .polyethylene (LDPE, LLDPE, etc.) Is the most common .the plastic properties are clear, though, solvent resistant, barrier to gas and moisture soften at 80°.

We were use PET (polyethelyne terephthalate) type of code 1plastic. The plastic strips we were used for stabilization is made from polythene shopping bags of 40micron thick. The size of strip is 3cm×1cm (aspect ratio=3).

The Geotechnical characteristics of BC soil samples were studied by conducting experiments like sieve analysis, liquid limit, plastic limit, free swell index, compaction, unconfined compression, CBR.

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The soil sample for experiment work is taken near Visakhapatnam.

Table 4.1: Tests and complying standards

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S.No	Test methods	Complying standards	parameters
1.	Sieve analysis	IS:2720(part-4)-1985	Particle size
2.	Specific gravity	IS:2720(part-3)-1980	Specific gravity
3.	Liquid limit	IS:2720(part-5)-1985	Water content
4.	Plastic limit	IS:2720(part-4)-1985	Water content
5.	Free swell index	IS:2720(part-40)-1970	Swell index
6.	Compaction	IS:2720(part-29)-1975	OMD and MMD
7.	Unconfined compression	IS:2720(part-10)-1991	U C strength
8.	CBR test	IS:2720(part-16)-1987	CBR

SIEVE ANALYSIS

To determine the grain size distribution of the soils

Sieve analysis is a test that is done in order to clarify a soil for engineering purpose. We must be known about the distribution of size of grains in the soil mass taken. This method of sieve analysis is applicable for soils that are mostly granular with some or no fines .it does not provide information as to shape of particle.

S. No	IS Sieve	Size of Opening	Mass of soil retained	Percentage retained	Cumulative % retained	% finer
1.	2mm	2mm	12	12	12	88
2.	1mm	1mm	140	14	26	74
3.	600 µ	0.6mm	94	9.4	35.4	64.6
4.	425 µ	0.425mm	90	9.0	44.4	55.6
5.	300 µ	0.3mm	102	10.2	54.6	45.4
6.	150 µ	0.15mm	330	33	57.6	12.4
7.	75 µ	0.075mm	114	11.4	99.0	1
8.	Pan	-	10	1	100	0

RESULTS AND DISCUSSION

The results of the following tests are shown in the table as follows –

S.No	Laboratory Test	Result
1	Swelling Index	50%
2	Specific Gravity	2.63
3	Sieve Analysis	
	Gravel	0%
	Coarse Sand	0%
	Medium Sand	0%
	Fine Sand	0%
	Silt and Clay	100%
4	Atterberg Limits	
	Liquid Limit, LL	54%
	Plastic Limit, PL	25%
	Plasticity Index, PI	29
5	Unconfined Compression Test	
	Compressive Strength	94.98 kg/cm^2
6	Modified Proctor Test	
	Optimum Moisture Content,OMC	21.6%
	Maximum Dry Density, MDD	1.879 gm/cc
7	California Bearing Ratio Test, CBR	2.37%

From the properties of the BC soil obtained after several tests is classified as following-

- The sieve analysis test shows that the soil is of uniformly graded soil.
- The atterberg limits shows that, from IS plasticity chart, the soil is above A-line and WL=54%. So it is classified as Clay of High Plasticity (CH).
- From the modified compaction test of the BC soil, the M.D.D. is found out to be 1.879gm/cc and the OMC is found out to be 21.65% respectively.
- From the California bearing ratio (CBR) test, the CBR value is found out to be 2.37%.

CBR can be said as the indirect measure of the strength as soil deformed was shear in nature. From the results, it is evident that waste plastic increases the CBR value. There is a major increase in CBR value when the soil is incorporated with Plastic strips and compared to that of soil with no plastic. The results are tabulated and presented below in the

Sample Description	MDD (gm/cc)	OMC (%)	CBR (%)
BC Soil	1.879	21.6	2.37
BC Soil with 0.25% plastic	1.940	17.7	4.62
BC Soil with 0.5% plastic	1.959	17.2	8.42
BC Soil with 0.75% plastic	1.993	16.9	13.19
BC Soil with 1% plastic	1.890	16.0	9.52

The modified compaction test and CBR test is performed on the samples with varying percentages of Plastic strips i.e., 0.25%, 0.5%, 0.75% and 1%. In this regard, the CBR value has been increasing up to 0.75% plastic content and thereon it started to decrease. From this, it can be inferred that, 0.75% plastic content is the OPTIMUM CONTENT of utilization of waste plastic in the soil.

CONCLUSION:

The project is focused on the performance of plastic fiber as black cotton soil stabilization material. The study suggests that if the plastic fibers are properly mixed and applied then it can be used as a great soil stabilization technique on the basis of the results obtained.

It was observed that the M.D.D. was increased slightly from 1.879gm/cc to 1.993gm/cc at 0.75% plastic content and thereon decreased to 1.89gm/cc at 1% plastic content respectively. Hence, we can say that 0.75% plastic content is the optimum content of plastic waste in the soil. It was observed that there was a decrease in O.M.C. from 21.6% to 16%upto an addition of 1% plastic content respectively.

In the present study, the improved CBR value of the soil is due to the addition of plastic strips. Plastic can be utilized as one of the material that can be used as a soil stabilizing agent but the proper proportion of plastic must be there, which helps in increasing the CBR of the soil.

It can be concluded that CBR percentage goes on increasing up to 0.75% plastic content in the soil and thereon it decreases with increase in plastic content. Hence, we can say that 0.75% plastic content is the optimum content of plastic waste in the soil.

Utilization of plastic products in various forms is enormously increasing day by day. This has an adverse effect in nature and it is not possible to restrict its uses. In this regard, the disposal of the plastic wastes without causing any ecological hazards has become a real challenge to the present society. Thus, using plastic as a soil stabilizer is an economical and gainful usage because there is lack of good quality soil for various constructions.

This work serves as a means to the whole society by reducing the plastic waste and producing useful product from non-useful waste materials leading to the foundation of sustainable society.

REFERENCES:

1. Arora, K. R (2004). Soil Mechanics and Foundation Engineering, Standard Publishers and Distributors.
2. K. Shyaam Chamberlin, assistant professor, Dept. of Civil Engineering, KL University, Vijayawada, AP India. “Stabilization of soil by using plastic wastes”.
3. PragyanBhattaria, A.V.A. Bharatkumar, k.santosh, T.C.manikanta&k.Tejawini. Engineering behavior of soil reinforced with plastic strips.
4. Kalumba D., chebetF.C.University of cape Town, south Africa. Utilization of polyethylene shopping bags waste for soil improvement in sandy soils.
5. Rajkumar Nagle, Geotechnical Engineering M.E.student, Dept. of civil Engineering, Jabalpur Engineering College, Jabalpur, India. Comparative study of CBR of soil, reinforced with natural waste plastic material.
6. IS: 2720(part-16)-1987 methods of test for soil part-16, laboratory determination of CBR.
7. IS: 2720(part-v)-1985 Methods of test for soil part-5, determination of liquid and plastic limit.
8. IS: 2720(part-XXIX)-1975 methods of test for soil part-29, determination of dry density of the soils.
9. IS: 2720(part-IV)-1985 methods of test for soil part-40, determination of free swell index of soil.
10. IS 2720(III/SEC-I): 1980 Methods of Test for Soils. Determination of specific gravity.
11. IS 2720(X):1991 Methods of Test for Soils. Determination of unconfined compression test.
12. IS 2720(IV):1985 Methods of Test for Soils. Determination of grain size analysis.