

WASTE PLASTIC IN SOIL STABILITY AND IN ROAD CONSTRUCTION

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ABSTRACT

In this paper the study of some of plastic waste materials which we can reuse by certain processing and use in the stability of soil and in road construction. The new technique of soil stabilization can be effectively used to meet the challenges of society to reduce the problem of disposing the plastic as well as increases the density and California Bearing Ratio (CBR) of soil in an economical way and help in the construction of Embankment, Road and Building on low bearing capacity soil.

Waste Plastic can also be use as road material by blending it with bitumen to lay roads in India and compare with the environmental and economic conditions. Some of these materials are relatively cheaper and provide more strength as compared to traditional road materials. This project will come up with useful information and creating awareness amongst the learner in the industry regarding waste material. So that one can have a step towards further detailed information about these materials and thus be able to implement on field which will definitely improve the level of construction.

Keywords: California Bearing Ratio, Plastic, Soil And Stabilization Plastic Waste, Bitumen, Aggregates, Plastic Roads.

I. INTRODUCTION

Plastic is everywhere in today's lifestyle. It is 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, plastic has become the significant pollutant of Environment because of the Use and Throw mechanism .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. Utilizing this Plastic waste for a positive purpose assists in reducing its effect on environment. Plastic is waste hazard to the environment .Plastic waste can be reused productively in the construction of road and stability of soil for utilizing different purpose. Thus, using plastic as stabilizer and road construction material 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 and in the construction of road in rural area.

II. OBJECTIVE

- To increase the density and California Bearing Ratio (CBR) of soil using plastic as an admixture.
- To provide an alternative solution for the disposal of plastic waste.
- To provide an economical solution for soil stabilization and road construction using plastic waste.

➤ To increase the strength and performance of road by using plastic with bitumen mix.

METHODOLOGY

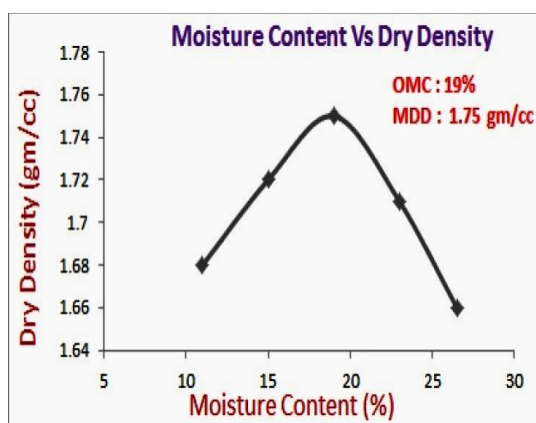
• PLASTIC IN SOIL STABILITY

The materials which are considered are soil and plastic with chemical composition of poly propylene. Tests are conducted to determine different properties of soil sample collected and results are tabulated and presented in Table 1.

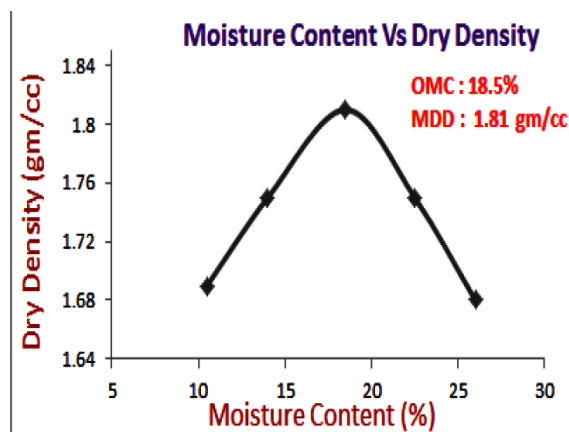
Table1. Properties of soil sample

S. No	Laboratory Test	Result
1	Swelling Index	65.3%
2	Specific Gravity	2.62
3	Sieve Analysis	
	Gravel	0%
	Coarse Sand	0%
	Medium Sand	0%
	Fine Sand	0%
	Silt and Clay	100%
4	Atterberg Limits	
	Liquid Limit, LL	68.5%
	Plastic Limit, PL	33.3%
	Plasticity Index, PI	35.2%
5	Unconfined Compression Test	
	Compressive Strength	90.8 kg/cm ²
6	Modified Proctor Test	
	Optimum Moisture Content, OMC	20.5%
	Maximum Dry Density, MDD	1.62 gm/cc
7	California Bearing Ratio Test, CBR	1.0%

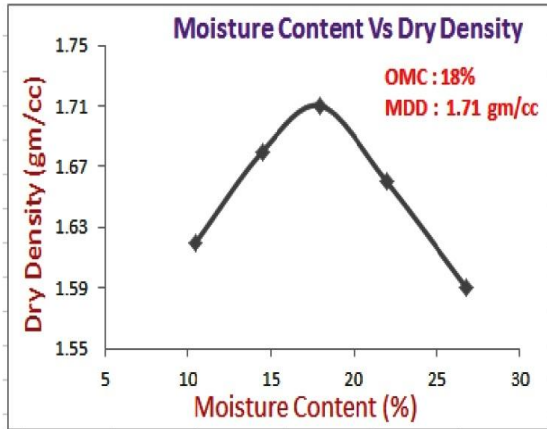
The plastic which was collected from used plastic chairs are collected and are made into different strips. Plastic strips with a density about 0.42 gm/cc are added to the Black Cotton Soil in percentages of 2, 4, 6 and 8 and the modified proctor test has been conducted on the sample and graphs obtained are shown below in Figures 1 to 4.



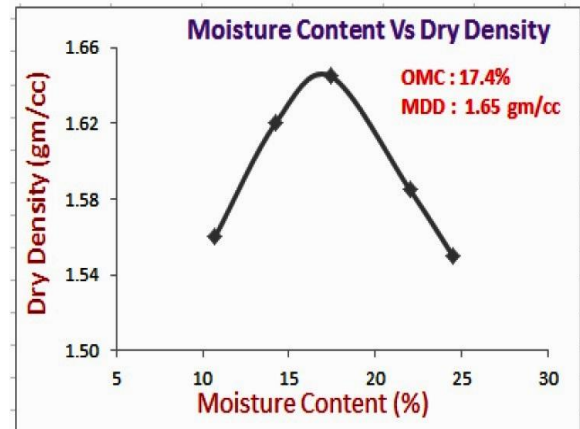
1. Soil with 2% plastic



2. Soil with 4% plastic

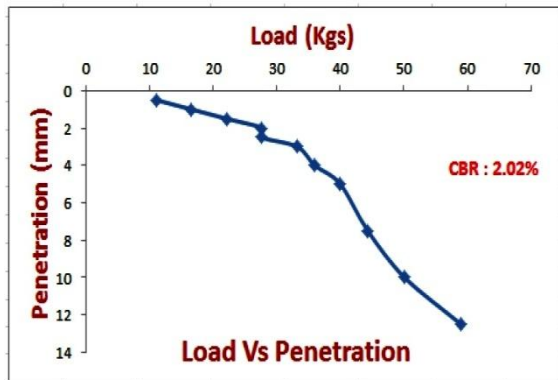


3. Soil with 6% plastic

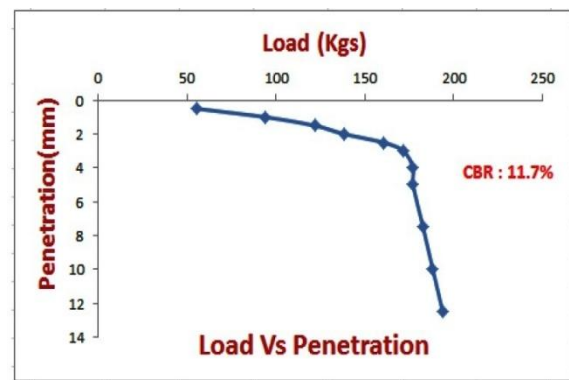


4. Soil with 8% plastic

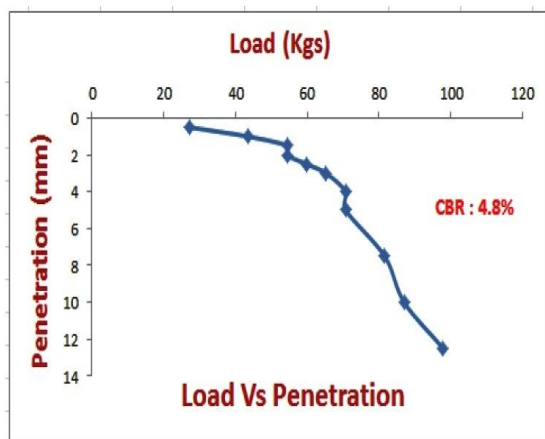
Similarly, California Bearing Ratio (CBR) Test was conducted to obtain the CBR Value on the samples with plastic strips in various percentages of 2, 4, 6 and 8 and the results obtained are presented as load Vs penetration graphs below in Figures 5 to 8. California Bearing Ratio, $CBR = (Load / Standard Load) * 100$



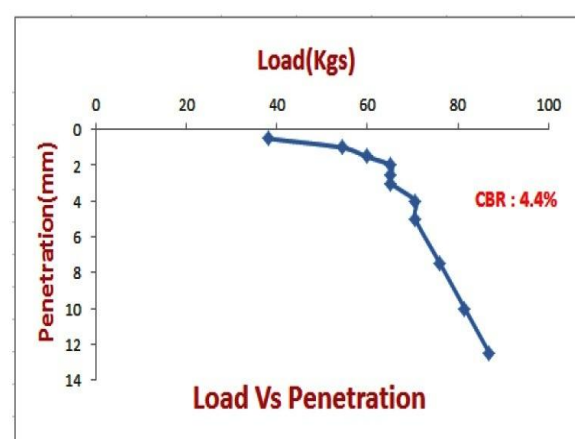
5. Soil with 2% plastic



6. Soil with 4% plastic



7. Soil with 6% plastic



8. Soil with 8% plastic

- PLASTIC IN ROAD CONSTRUCTION

BASIC PROCESS

1. Segregation

Plastic waste collected from various sources must be separated from other waste. Maximum thickness is 60microns.



2. Cleaning Process

Plastic wastes get cleaned and dried.



3. Shredding process

Will be shredded or cut into small piece. The different types of plastic wastes are mixed together.

4. Collection process

The plastic waste retaining in 2.36 mm is collected.

CO-PROCESSING OF PLASTIC WASTE MANAGEMENT

1. Plastic Waste Management

a) Conventional Technology

- Recycling
- Incineration
- Land filling

b) New Technology

- Plasma Pyrolysis Technology
- Liquid Fuel
- Polymer Blended Bitumen Roads
- Co-processing in Cement Kiln

2. POLYMER BLENDED BITUMEN ROAD

The process of road laying using waste plastics is designed and the technique is being implemented successfully for the construction of flexible roads at various places in India.

- a. Striping and pothole formation: Bitumen film is often stripped off the aggregate.
- b. Leaching: polymer will not leach out of the bitumen layer.
- c. Effect of Bleeding: Waste polymer –bitumen blend shows higher softening temperature.
- d. Effect of fly ash: It is also observed that the fly ash does not leach from this mixture.



2.1 Polymer blended bitumen road

III. FIELD TRIALS

1. Dry process



3.1 Hot bitumen is added



3.2 Shredded plastic waste is added

2. Wet process

- 1) Waste plastics by direct mixing with hot bitumen at 160°C.
- 2) Mechanical stirrer is needed.
- 3) Addition of stabilizers and proper cooling.
- 4) Since the wet process require a lot of investment and bigger plants.
- 5) Not commonly used..

IV. CHARACTERIZATION OF WASTE PLASTICS

Binding property: Plastic is a good Binder.

Table 2: Showing compressive & Bending strength

% of plastic coating over aggregate	Compressive strength (MPa)	Bending strength (MPa)
10%	250	325
20%	270	335
30%	290	350
40%	320	390

V. HOW MUCH PLASTIC? HOW MANY ROADS?

Each 5-member family's use of 5 gm plastic bags a week, all- India = 52,000 tons a year.

Assume 50% of this is available for roads. **1.5 tons plastic goes into average 1 km road.**

So resurfacing just 35,000 km of roads a year will absorb all this littered waste. This is just 3.5 % of India's 1 million km surfaced roads. (1.1 million km more roads are un-surfaced).

VI. RESULT AND DISSCUSSION

1. PLASTIC IN SOIL STABILITY

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 Table 2.

CBR test is performed on the samples with varying percentages of Plastic strips i.e., 2%, 4%, 6% and 8%. In this regard, the CBR value has been increasing up to 4% plastic content and thereon it started to decrease. From this, it can be inferred that, 4% plastic content is the OPTIMUM CONTENT of utilization of waste plastic in the soil.

Table 3: Test Results of Soil Sample Incorporated with Plastic Strips.

Sample Description	MDD (gm/cc)	OMC (%)	CBR (%)
Soil	1.62	20.5	1.00
Soil with 2% plastic	1.75	19.0	2.02
Soil with 4% plastic	1.81	18.5	11.70
Soil with 6% plastic	1.71	18.0	4.80
Soil with 8% plastic	1.65	17.4	4.40

Where,

MDD is maximum dry density

OMC is optimum moisture content

CBR is California bearing ratio

2. PLASTIC IN ROAD CONSTRUCTION

- The durability of the roads laid out with shredded plastic waste is much more compared with roads with asphalt with the ordinary mix.
- While a normal 'highway quality' road lasts four to five years it is claimed that plastic-bitumen roads can last up to 10 years.
- Rainwater will not seep through because of the plastic in the tar.
- The cost of plastic road construction may be slightly higher compared to the conventional method.
- The maintenance cost is low as compared to conventional method.
- Its initial cost is slightly more as compared to conventional method.

VII. CONCLUSION

1. In the study of soil stability plastic, the improved CBR value of the soil is due to the addition of plastic strips. Plastic can be utilized as one of the materials 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 4% plastic content in the soil and then it decreases with increase in plastic content. Hence, we can say that 4% 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, using plastic as a soil stabilizer is an economical and gainful usage because there is lack of good quality soil for various constructions.
2. In the study of plastic in road construction, Plastic will increase the melting point of the bitumen and help in better road construction. This innovative technology not only strengthened the road construction but also increased the road life. Plastic roads would be a boon for India's hot & extremely humid climate, where temperature frequently crosses 50°C.

REFERENCES

- [1]. Pragyani Bhattarai, Bharat Kumar, Engineering behavior of soil reinforced with plastic strips, International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSIEIRD) ISSN 2249-6866 Vol. 3, Issue 2, Jun 2013, 83-88.
- [2]. Consoli, N. C., Montardo, J. P., Prietto, P. D. M., and Pasa, G. S., Engineering behavior of sand reinforced with plastic waste, Journal of Geotechnical and Geo environmental Engineering, Vol. 128 No. 6, 2002, pp, 462-472.
- [3]. Madhavi Vedula, PawanNath G and Prof. B. P. Chandrashekar , NRRDA, New Delhi Critical review of innovative rural road construction techniques and their impacts.
- [4]. K.V. Madurwar, P.P. Dahale, Comparative Study of Black Cotton Soil Stabilization with RBI Grade 81 and Sodium Silicate, International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, Issue 2, February 2013.
- [5]. Anas ashraf, arya sunil, Soil stabilization using raw plastic bottles, Journal of Engineering and Development, Vol. 17, No.4, October 2013, ISSN 1813- 7822.
- [6]. Vasudevan .R, utilization of waste plastics for flexible pavement, Indian High Ways (Indian Road Congress), Vol.34, No.7. (July 2006).
- [7]. S.S.Verma,(2008),Roads from plastic waste, The Indian Concrete Journal ,pp.43-47
- [8]. Kajal , N K S Pundhir , Sangita and A Chandra(2007), Use of waste plastics and copper slag for low cost bituminous roads, Journal Of Scientific and Industrial Research,Vol.66.pp.938 994.
- [9]. Sri Ram Institute for Industrial Research, Plastics Processing and Environmental Aspects, New Delhi – 7.