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Soil Improvement Using Molasses

Prof. S. V. Bankar, Prof. A. A. Ingole, Prof. R. B. Ghogare
Department of Civil Engineering, SBPCOE Indapur, Maharashtra, India

ABSTRACT
Nowadays, rapid and continuous development characterizes every aspect of the construction industry. Roads, in particular, play a crucial role in the advancement of our nation. While numerous methods and technologies exist for soil stabilization, the utilization of molasses, bagasse, and fly ash stands out as cost-effective and readily available materials. Although these raw materials may pose environmental challenges, their proper incorporation into soil stabilization renders construction practices more eco-friendly. This method of stabilization holds promise for the future, especially considering the potentially harmful effects of rapid industrialization. By employing bagasse, fly ash, and molasses, soil stabilization can be achieved in a safe and environmentally sustainable manner.
Keywords: molasses, soil, plasticity index.

I. INTRODUCTION

Road plays a very important role in the development of the country. In the case of a developing country development of roads is considered as the development of the country. Road pavements, today, are one of the most important infrastructures for a developing country like India. Any damage to the same causes a lot of inconvenience to the traffic, physical harm to the commuters, and many such problems that are not unavoidable. In days to come, the axle loads and traffic intensity are likely to exceed the capabilities of soil used in the construction of road pavements, if the use of the soil is assumed inevitable then certain modifications will be essential in the future to bring its capabilities to meet the demand of increasing axle loads and traffic intensity. One such modification is the improvement in the strength of soil by using molasses. The molasses is available in enough quantity in Maharashtra state as there is much sugarcane produced. The sugarcane factory produces 10 tons of sugar and 4 tons of molasses after processing 100 tons of sugar cane. The molasses is used as binding material in the stabilization of soil. [1]

II. MATERIALS

A. Soil
The locally available soil is used at Dhangwadi, Tal. Bhor, Dist. Pune. The percentages of molasses vary in soil samples.

B. Molasses

It is a by-product of the sugarcane industry. The molasses syrup left from the final crystallization stage is called molasses. The molasses used is from Rajgad Sarkari sakhar karkhana Bhor.

TABLE I PROPERTIES OF SOIL. [2]

Sr. no	Property	Result
1	Specific gravity	2.59
2	**Particle size analysis**	
3	Gravel content% (20 to4.75mm.)	18.23
4	Sand content % (4.75 to 0.075mm)	64.86
5	Silt and clay content % (below 0.075mm.)	16.91
6	**Atterberg's Limits: %**	
7	Liquid limit	32.16
8	Plastic limit	22.56
9	Plasticity index	12.87
10	Maximum dry density (gm./cm3)	1.48
11	Optimum Moisture Content (%)	21.42

TABLE III PHYSICAL PROPERTIES [2]

Sr. no	Physical properties	Molasses
1	Color	Dark brown
2	Specific gravity	1.2
3	Viscosity (cp at 200C)	1450
4	PH	4.2
5	Litters/tone	714
6	Appearance	Syrupy Liquid
7	Gallons/tone	157

III.SAMPLE PREPARATION AND TESTING RESULTS

A. Procedure

To improve the properties of soil in subgrade and subbase using industrial wastes various laboratory tests are carried out. In the present experimentation work the soil is improved by adding industrial waste in different percentages. The effect of the Addition of industrial waste on the strength behaviour of the soil is studied by varying percentages of industrial waste by weight of the sample.[1]

B. Planning for Laboratory tests

Locally available soil which was proposed to be used in the road at subgrade or sub-base was modified by mixing molasses in different proportions. The mix of locally available soil and molasses is designated as SM. Table 3: Details of Soil Mix and the Symbols Used For Them.[2]

TABLE IIIII

Symbols	Proportion Local Soil: Molasses
SM0	100:0%
SM1	95: 5%
SM2	94.5: 5.5%
SM3	94 : 6.0%
SM4	93.5: 6.5%
SM5	92.5 : 7.5%

The laboratory test conducted on locally available soil and molasses mixes in decided proportion. The different tests conducted are

- Grain size analysis
- Specific gravity
- Consistency limits
- Standard Proctor test

C. Consistency Limits

Consistency means the relative ease with which the soil can be deformed and this term is mostly used for fine-grained material. Atterberg's limits are divided in four parts

- Liquid state
- Plastic state
- Semi-solid state
- Solid state.

The effect of Molasses addition in varying proportions with local soil has been studied and the difference in Consistency limits for various mixes are shown in Table 5 and Fig.1. It is observed that as the percentage of molasses increases the liquid limit of soil mix is increased.

TABLE IVII EFFECT OF MOLASSES ADDITION ON ATTERBERG'S LIMIT FOR SM0 TO SM6 [2]

Sr.No.	Properties	Soil + Molasses Mix					
		SM0	SM1	SM2	SM3	SM4	SM5
	Proportion Soil: Molasses	100: 0	95:5%	94.5:5.5%	94:6.0%	93.5:6.5%	92.5:7.5%
	Atterberg's limits: (%)						
1	Liquid Limit	32.78	34.16	35.06	38.02	47.12	SM0
	Plastic Limit	21.56	24.09	25.22	28.93	38.79	41.23
	Plasticity index	11.22	10.7	9.84	9.09	8.33	7.93

The table no 4 shows changes in consistency limits due to addition of molasses in various percentages. Variations of consistency limits indicate changes in properties of soil.

D. Compaction Behavior for Soil + Molasses

The Standard Proctor's test for soil with molasses mixes is performed and presented in Table 6. Different curves for molasses percentage and max. Dry density for various combinations is presented in Fig.1. Similarly, the effect of the addition of molasses with soil for OMC is presented in Fig.2

TABLE VV EFFECT OF MOLASSES ADDITION ON MAXIMUM DRY DENSITY FOR SOIL [2]

Sr.No.	Properties	Soil + Molasses Mix					
		SM0	SM1	SM2	SM3	SM4	SM5
	ProportionSoil: Molasses	100: 0	95:5%	94.5:5.5%	94:6.0%	93.5:6.5%	92.5:7.5%
1	Maximum Dry Density(gm./cm3)	2.06	2.74	2.7	2.78	2.83	2.6

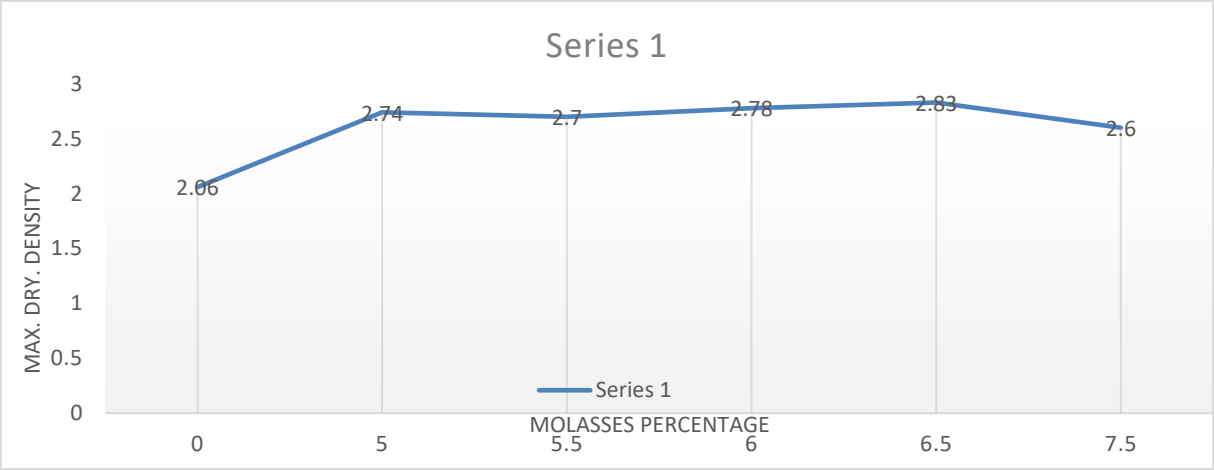

Figure1:Different Curves for Molasses Percentage and Max. Dry Density [1]

TABLE V EFFECT OF MOLASSES ADDITION ON OPTIMUM MOISTURE CONTENT FOR SOIL. [2]

Sr.No.	Properties	Soil + Molasses Mix					
		SM0	SM1	SM2	SM3	SM4	SM5
	ProportionSoil: Molasses	100: 0	95:5%	94.5:5.5%	94:6.0%	935:6.5%	92.5:7.5%
2	Optimum Moisture Content (%)	6.2	9.1	12	14.4	17.36	25.72

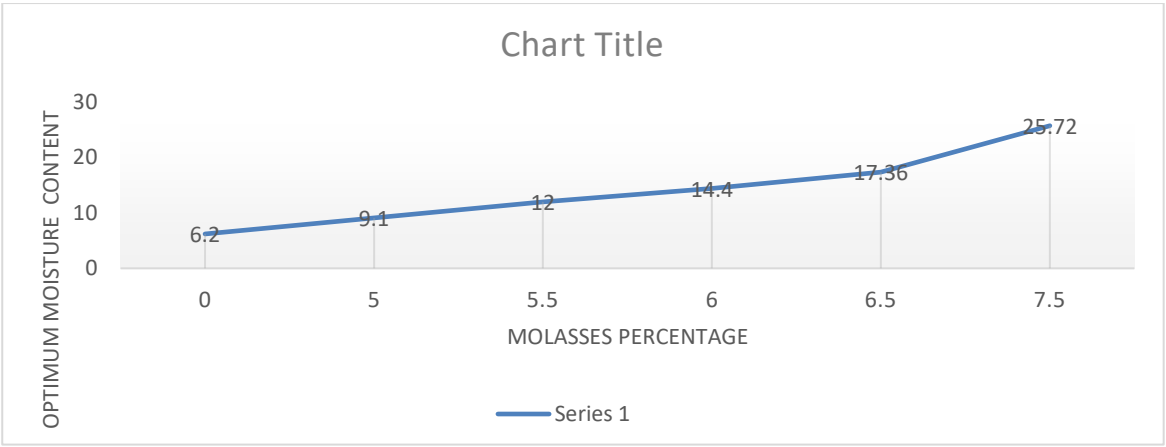

Figure2:Different Curves for Molasses Percentage and Optimum Moisture Content. OMC [1]

TABLE VI EFFECT OF MOLASSES ADDITION ON OPTIMUM MOISTURE CONTENT FOR SOIL. [2]

Sr. No.	Properties	Soil + Molasses Mix					
		SM0	SM1	SM2	SM3	SM4	SM5
	Proportion Soil: Molasses	100: 0	95:5%	94.5:5.5%	94:6.0%	935:6.5%	92.5:7.5%
1.	Maximum Dry Density (gm./cm3)	2.06	2.74	2.7	2.78	2.83	2.6
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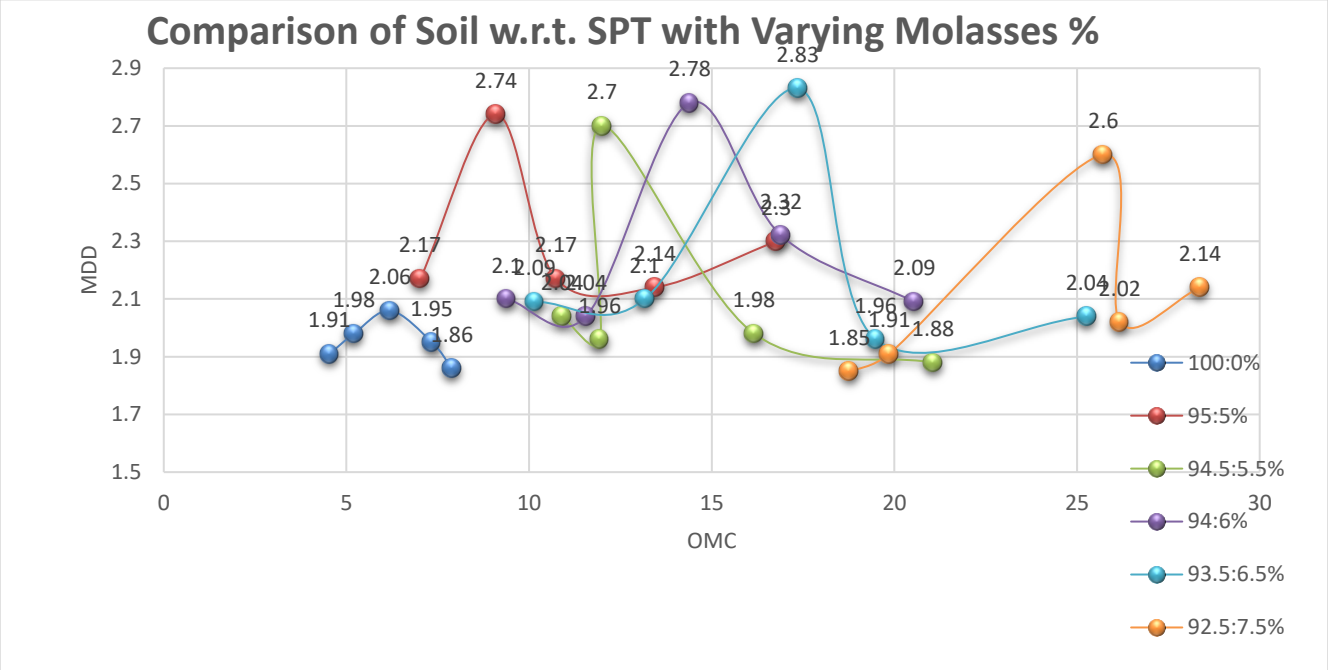

Figure3:Effect of Molasses Addition on Dry Density (MDD) and Moisture Content (OMC). [2]

E. Economy in Using Molasses

Industrial wastes are used for constructing different layers of road pavements. Utilization of industrial waste for stabilization of subgrade depends on the interaction between industrial wastes and embankment soil. If the type of soil available in the area is found to beflexible to pozzolanic action industrial wastes are added. This characteristic improves the engineering qualities of the soil like density, and decreases the Plasticity index of soil. The main feature of molasses utilization in road Construction is the remarkable cost savings aspect Industrial wastes is important in the formulation of pavement specifications. With this economy can be achieved and utilization of industrial wastes in bulk quantities for road construction. Many Civil Engineering Companies are involved in the construction of roads using an innovative technology called a bio-enzymatic, Terrazyme (molasses) soil stabilizer. Sugar waste molasses is a liquid.

IV. CONCLUSION

The use of industrial by-products like molasses in soil stabilization for locally available material near road construction shows sincere results in experimentation. The density of soil increases as the percentage of molasses increases up to some limits. We obtain the max density of soil at 6.5% of molasses percentage. The plasticity index of soil decreases as the percentage of molasses increases. As we know ρ= m/v the results of

experimentation indicate that the density of the locally available soil increases with an increase in molasses percentage. The mass of soil solids is constant the volume of soil reduces to attain the required strength of sub-base or base coarse.The volume of soil reduced means the quantity of material required for the construction of the same quality of sub-base or base course is also reduced. Molasses gives the saving in quantity of material with economical and superior results. Industrial by-products are reused in construction and it helps to solve the problem of disposal of industrial by-products.

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