ENHANCING SOIL STRENGTH USING QUARRY DUST AND SISAL FIBRE – RESULT ANALYSIS

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Abstract : Engineering properties of expansive soil varies with the variation in moisture content and due to its swelling and shrinkage characteristics, it poses a serious threat to strength and stability of structure constructed over it. In the present scenario of catastrophic environmental degradation as a side effect of industrialization, urbanization and modern manufacturing processes, new innovative ideas of converting the waste into useful product in a way beneficial for use and recycling. This work deals with the use of quarry dust and sisal fibre for improvement in UCS and CBR values of clayey soil. Laboratory tests like Modified Compaction test, California Bearing Ratio (CBR) and Unconfined Compressive Strength (UCS) were conducted on plain soil, plain soil with different percentages of quarry dust (10%, 20%, 30% and 40%) and plain soil plus optimized QD (70:30 soil - QD) plus sisal fibre (0.5%, 1.0% and 1.5%) at two different lengths of 10 mm and 20 mm. The optimum combination recommended for clayey soil is 30% quarry dust with 1.5% sisal fibre of 20 mm length. The UCS as well as CBR value of clayey soil mixed with 30% quarry dust with1.5% sisal fibre of 20 mm length is increased by 665.31% and 115.51 % respectively. This shows that sisal fibre and quarry dust have the potential to improve the properties of clayey soil.

Index Terms : Soil Stabilization, Quarry Dust, Sisal Fibre, OMC and MDD, UCS, CBR.

1 Introduction

The stability of weak soil is one of the important factors during the construction of a structure. For better performance of structures built on such soils, the performance characteristics of such soils need to be improved. The poor engineering performance of soils has forced engineers to attempt to improve the engineering properties of weak soils. Most of the area in north India have soil with high swelling, shrinkage characteristics, extremely low CBR value and shear strength. Expansive soils are those which expands when water is added and shrinks when they dry out due to the presence of a mineral called montmorillonite. This continuous change in soil volume cause differential settlement of foundation and cracks in the structure and effects its appearance.

Objectives of Soil Stabilization

The main objectives of soil stabilization are :

1. To improve the strength, permeability control and durability of the soil.
2. To reduce the plasticity index of the soil.
3. To improve the CBR value of the soil.

4. To reduce the cost of construction by making best use of waste material and locally available material.
5. To reduce the need of landfill site for the dumping of poor material as well as construction waste.

2 Materials used in Research Work

There are calcium based materials which when comes in contact with water in the presence of pozzolanic materials forms cementious composite materials and also natural fibre was used eg : sisal fibre for reinforcement which further enhance the engineering properties of soil. Materials used in this work :

Clayey soil

Quarry dust

Sisal fibre.

3 METHODOLOGY

Initially we determined the basic engineering properties of natural collected soil. Then optimized the quantity of quarry dust in soil (soil-quarry dust ratio in 90:10, 80:20, 70:30 and 60:40) which gave best results of CBR and UCS tests at 30% mix. After optimizing the quarry dust quantity, sisal fibre was optimized (adding in length of 10mm and 20mm and varying percentages of 0.5%, 1% and 1.5%) on the basis of CBR and UCS test which gave best results at 1.5% for 20 mm length.

Table 3.1 Following Tests were conducted on various ssamples

S. No.	Name of the Test	Parameter
1	Determinations of the consistency limits of soil (IS: 2720: Part 5) 1985	Liquid Limit, Plastic Limit and Plasticity Index($I_{p)}$
2	Determinations of the OMC and MDD relationship by conducting Modified Proctor Compaction Test (IS: 2720: Part 8) 1983	MDD and OMC
3	Determinations of load- penetration curve by conducting CBR Test (IS: 2720: Part 16) 1987	CBR values
4	Determinations of Unconfined Compressive Strength by conducting Unconfined Compression Test (IS: 2720: Part 10) 1991	UCS values

4 RESULTS AND DISCUSSION

Through extensive laboratory experimental work an effort has been made to utilize the Quarry Dust with sisal Fibre for stabilization of clayey soil. Soil samples were tested to examine their physical properties like liquid limit, plastic limit and plasticity index. Modified proctor compaction test has been done to obtain the values of OMC and MDD. After examining the physical properties of clayey soil, the soil was mixed with different percentages of Quarry Dust and sisal Fibre and then UCS and CBR tests were conducted successfully. The main focus of the present investigation was to conduct systematic research work on the effect of Quarry Dust and sisal Fibre in stabilization of clayey soil, so that a new method of application can be evolved.

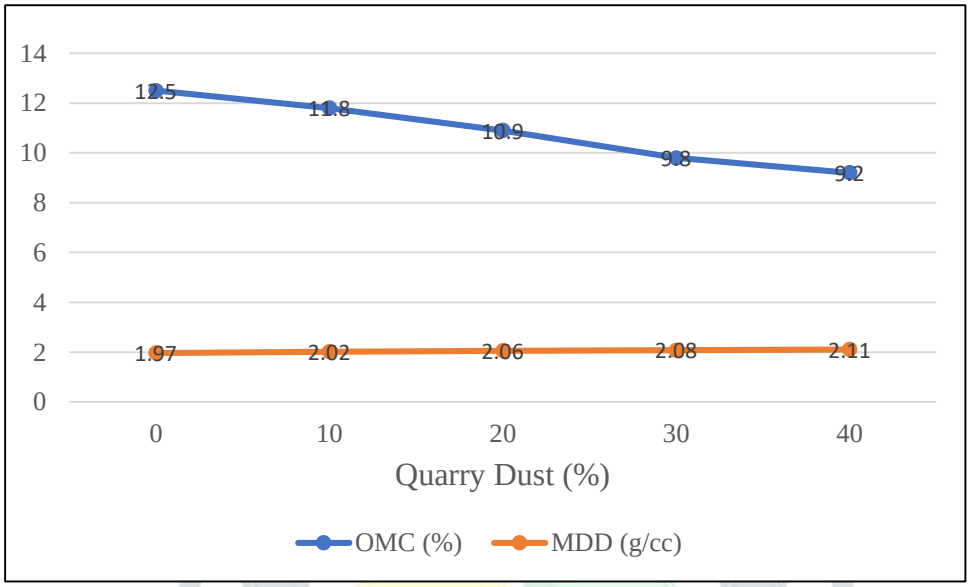

Fig 4.1 Effect of varying percentages of QD on MDD and OMC

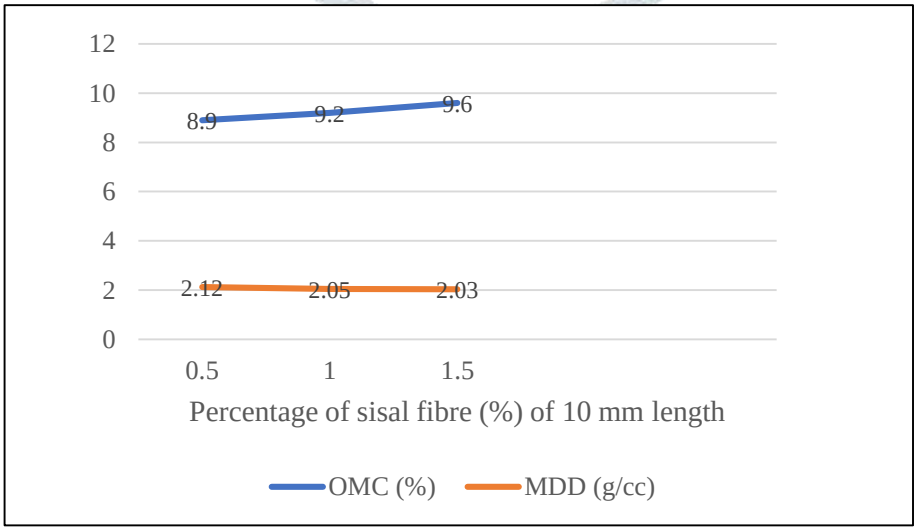

Fig 4.2 MDD and OMC values for 30 % QD + 10 mm fibre with varying percentage of sisal fibre.

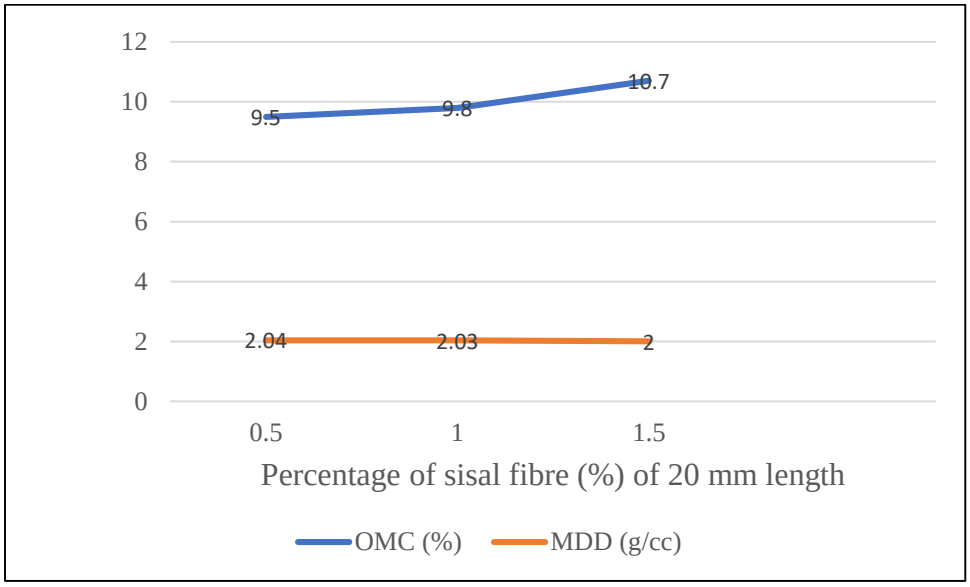

Fig 4.3 Effect of varying percentages of 20 mm long sisal fibre on MDD and OMC

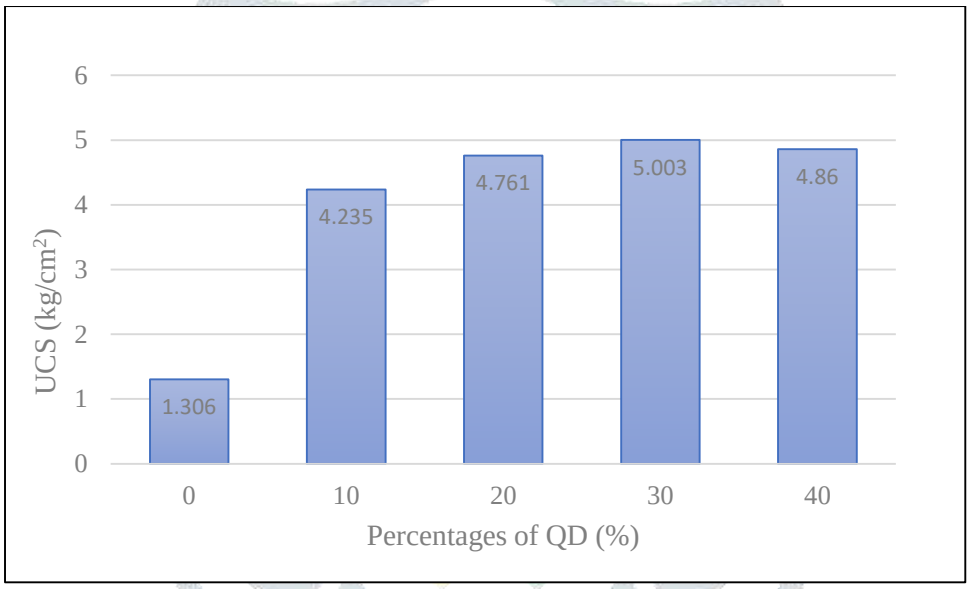

Fig 4.4 Effect of varying percentages of QD on UCS

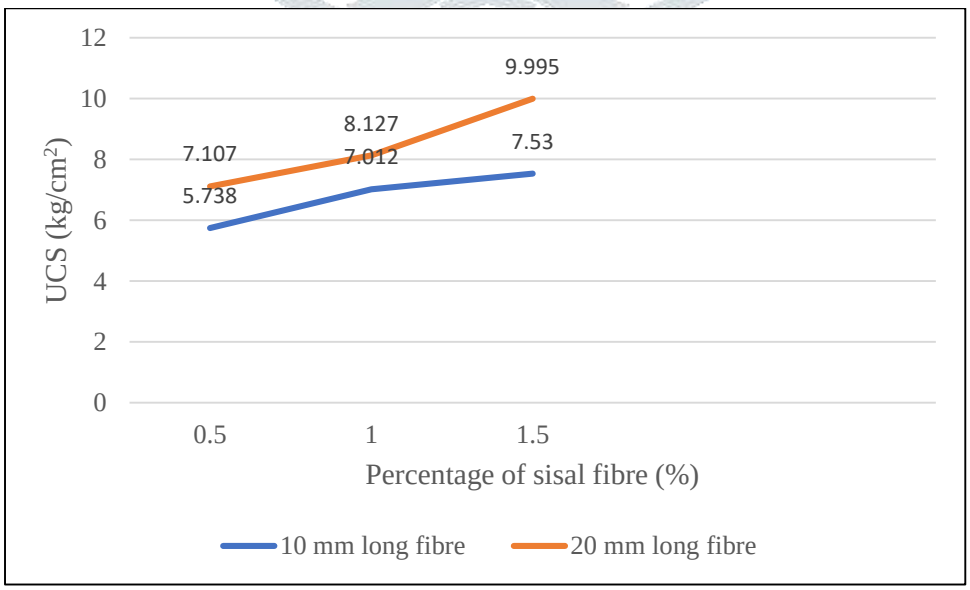

Fig 4.5 Effect of varying percentages and length of sisal fibre on UCS

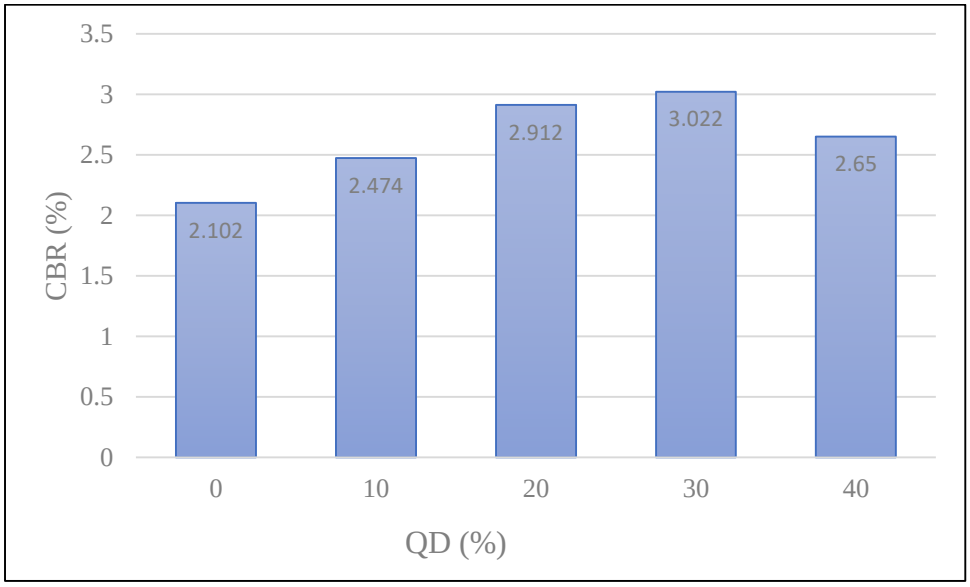

Fig 4.6 Effect of varying percentages of QD on CBR

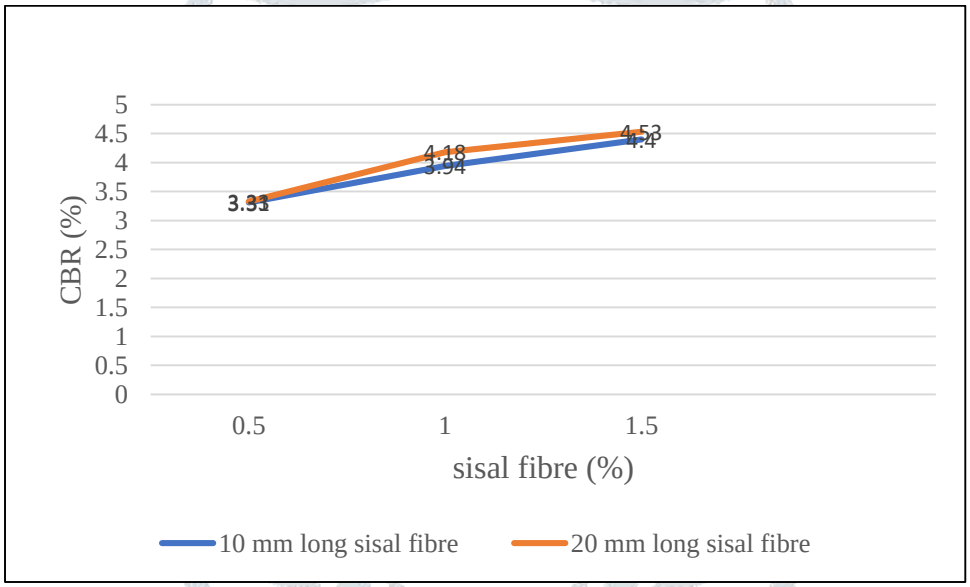

Fig 4.7 Effect of varying percentages and length of sisal fibre on CBR

5 CONCLUSIONS

- OMC and MDD values obtained for plain soil are 12.5 % and 1.97 g/cc respectively.
- With the addition of quarry dust in the soil MDD value increases considerably reaching maximum value of 2.11 g/cc for 60:40 soil- QD sample whereas OMC decreases and reaches a minimum value of 9.2 % for the same sample.
- On the other hand, with the addition of sisal fibre of either length and with increasing percentages MDD decreases which attains minimum value of 2.00 g/cc for 70:30 soil-QD + 20 mm (1.5%) sample and OMC increases which attains maximum value of 10.7 % for the same sample.
- UCS value for the plain soil is 1.306 kg/cm^2.
- The percentage increase in the value of UCS when samples were prepared with 10%, 20%, 30% and 40% quarry dust is found to be 224.27%, 264.54%, 283.08% and 272.13% respectively. The increases in UCS is maximum for 30% quarry dust content i.e. 283.08%.

- Laboratory tests conducted on sample of 70% soil, 30% QD plus 10 mm, 20 mm sisal fibre with 0.5%, 1.0% and 1.5% shows that maximum value of UCS is obtained at 20 mm long 1.5% sisal fibre content which is equal to 9.995 kg/cm^2. The percentage increase as compare to plain soil is 665.31 %.
- The optimum quantity of quarry dust and sisal fibre for UCS is 30% QD and 20 mm long with 1.5% sisal fibre.
- Thus, it can be concluded that soil mixed with 30% quarry dust and 20 mm long with 1.5% sisal content can bear large loads which further improves the economy and scope of engineering work.
- The soaked CBR value of the plain soil is 2.102 %.
- The soaked CBR value with 30% quarry dust is 3.022 %, percentage increase in CBR value as compare to plain soil is 43.77 %.
- Laboratory tests conducted on sample of 70% soil, 30% QD plus 10 mm, 20 mm sisal fibre with 0.5%, 1.0% and 1.5% shows that maximum value of CBR is obtained at 20 mm long 1.5% sisal fibre content which is equal to 4.53 %. The percentage increase as compare to plain soil is 115.51%.
- The optimum quantity of quarry dust and sisal fibre for CBR is 30% QD and 20 mm long with 1.5% sisal fibre.
- Thus, soil mixed with the optimum quantity of QD and sisal fibre can help in reducing the pavement thickness considerably and ultimately improves economy of the work.

6 REFERENCES

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