Effect of Sewage Sludge on the Geotechnical Properties of Clayey Soil

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***Abstract*— Construction of structures on clayey soil is difficult due to its high compressibility and low shear strength. Such soils have low bearing capacity and high swelling and shrinking characteristics. Therefore some form of improvement in needed to avoid the settlement and stability problems. This paper aimed to study the strength and compaction characteristics of clayey soil by adding sewage sludge. Sewage sludge is a residual material resulting from waste water treatment. The percentage of sewage sludge used in this study was varied from 0% to 25% at an increment of 5% by dry weight of soil. The properties of soil added with sewage sludge was evaluated by using Standard Proctor Test and Unconfined Compressive Strength (UCS) Test. The addition of sewage sludge decreases the maximum dry density and increases the optimum moisture content of soil. The optimum UCS value is obtained at the addition of 15% of sewage sludge.**

Keywords—Clayey Soil; Sewage Sludge ; Standard Proctor Test; Unconfined Compressive Strength Test

I. INTRODUCTION

Soil is a most important and abundantly available material present in the earth. It is formed by the decomposition of rocks. soil can be used as cheapest construction material in construction fields. Clayey soil is problematic due to its expansive in nature. Therefore construction of structures on clayey soil creates many problems. Such soils need some form of improvement to avoid the settlement and stability problems. This paper aimed to study the effect of sewage sludge on the geotechnical properties of clayey soil. Sewage sludge is a semi-solid material that is produced as a by product of industrial or municipal waste water

II. LITERATURE REVIEW

Dr. M. Chittaranjan et. al. (2021), studied the effect of water treatment plant floods on the geotechnical properties of an expensive soil. The percentage of water treatment plant sludge used was varied from 0% to 15% at an increment of 3% by dry weight to soil. The test conducted are standard proctor, california bearing ratio test and unconfined compressive strength test. The addition of sewage sludge increases the optimum moisture conduct and reduces the maximum dry density. The optimum unconfined compressive strength value is obtained at the addition of 9% of alum sludge.

Mandlekar et. al. (2020), conducted an experimental investigation on natural soil stabilized with sewage sludge. The percentage of sewage sludge used in this study was varied from 0% to 30% at an increment of 5% by dry weight of soil. The test conducted are standard proctor test and California bearing ratio test. Addition of sewage sludge reduces the optimum moisture content up to 20% beyond it increases. And also increases the maximum dry density up to 20% beyond it decreases. The optimum CBR value is obtained at the addition of 20% of sewage sludge.

III. OBJECTIVES

The objective of the present study are:

- To study the compaction characteristics of clayey soil using sewage sludge
- To study the strength characteristics of clayey soil using sewage sludge

IV MATERIALS

A. Soil

The soil used in the present study was collected from Chowalloor, near Vilappilsala. The soil was classified as low plastic clay (CL). Is code test procedures are adopted to determine the properties of soil and the results are tabulated in table 1.

Figure 1 Clayey Soil

Table 1. Properties of soil

SL. No.	Properties	Value
1	Specific Gravity	2.64
2	Liquid Limit (%)	29.75
3	Plastic Limit (%)	18.89
4	Optimum Moisture Content (%)	16.22
5	Maximum Dry Density (kN/m^3)	15.7
6	Unconfined Compressive Strength value (kN/m^2)	28.25

B. *Sewage Sludge*

Sewage sludge is a residue of slurry derived from waste water treatment process. It was collected from muttathara sewage treatment plant. The specific gravity of sewage sludge was 1.71

Figure 2. Sewage Sludge

V METHODOLOGY

The soil was collected from the site. It was air dried and lumps were broken with wooden hammer. The properties of soil was determined by conducting various test such as liquid limit, plastic limit, specific gravity test, standard proctor test and unconfined compressive strength test. The soil was mixed with different percentages of sewage sludge (0%, 5%, 10%, 15%, 20% & 25%) to determine the variation in compaction and strength characteristics of clayey soil

VI RESULTS AND DISCUSSION

A. *Standard Proctor* Test

Table 2 shows the effect of sewage sludge on the compaction characteristics of clay soil. The OMC and MDD of natural soil were 16.22% and 15.7 kN/m^3 respectively. The addition of sewage sludge increases the OMC from 16.22% to 21.02% and also the addition of sewage sludge decreases the MDD from 15.7 kN/m^3 to 13.54 kN/m^3. Figure 3 and 4 shows the variation of OMC and MDD with percentage increase in sewage sludge.

Table 2 Variation of OMC and MDD with percentage increase in sewage sludge

Materials	MDD (kN/m^3)	OMC (%)
Soil	15.7	16.22
Soil + 5% Sewage Sludge	15.12	17.28
Soil + 10% Sewage Sludge	14.42	18.32
Soil+ 15% Sewage Sludge	13.93	19.54
Soil + 20% Sewage Sludge	13.64	20.87
Soil + 25% Sewage Sludge	13.54	21.02

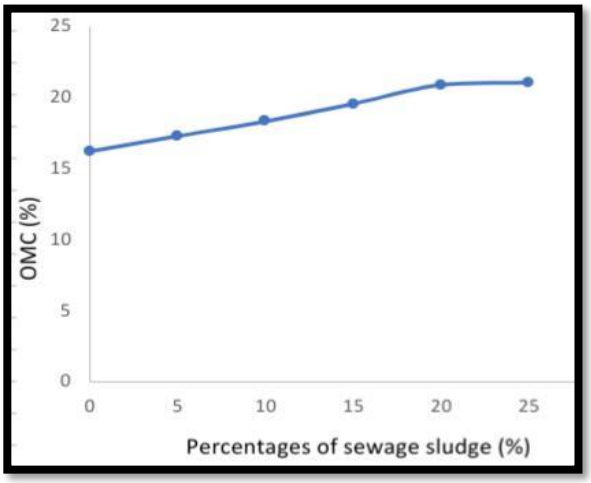

Figure 3 Variation of OMC with percentage increase in sewage sludge

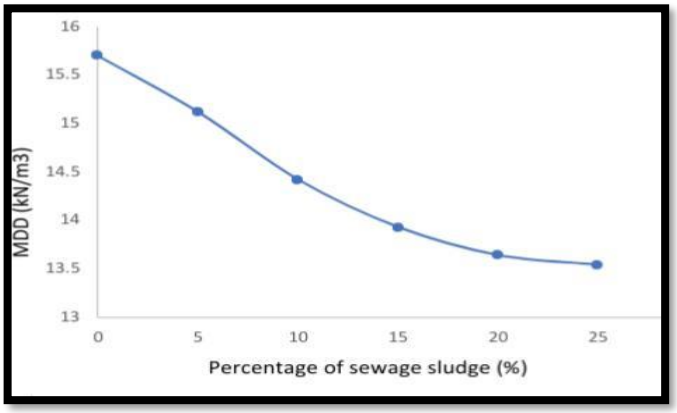

Figure 4 Variation of MDD with percentage increase in sewage sludge

B. *Unconfined Compressive Strength* Test

Table 3 shows the variation of sewage sludge on the strength characteristics of clayey soil. The UCS value of natural soil was found to be 28.25 kN/m^2. The addition of sewage sludge increases the UCS value up to 15% of content beyond it decreases.

Table 3 Variation of UCS value with percentage increase in sewage sludge

Materials	UCS value (kN/m^2)
Soil	28.25
Soil + 5% Sewage Sludge	29.9
Soil + 10% Sewage Sludge	36.09
Soil+ 15% Sewage Sludge	45.96
Soil + 20% Sewage Sludge	43.23
Soil + 25% Sewage Sludge	41.44

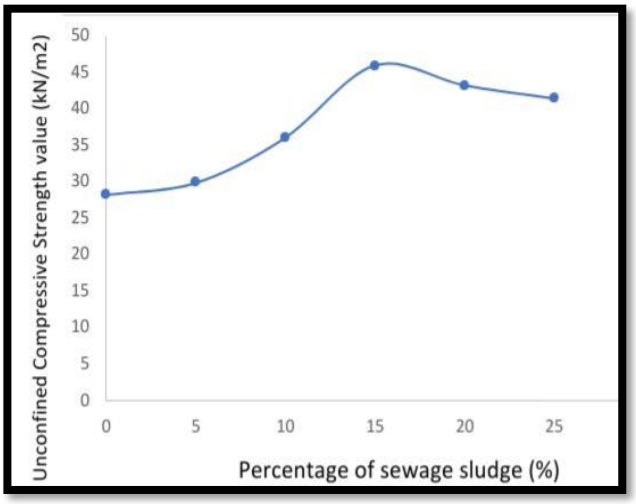

Figure 5 Variation of UCS value with percentage increase in sewage sludge

Vll CONCLUSION

The following conclusions are obtained from the present study:

- Addition of sewage sludge decreases the MDD and increases the OMC.
- The UCS value increases with increase in percentage of sewage sludge upto 15% of sewage sludge beyond it decreases.
- The percentage increase in UCS value is 62.69%.

VIII REFERENCES

- **Dr. M. Chittaranjan, K. Muniswamy, V. Mahesh & V. R. Sai Devayani** (2021), " Effect of water treatment plant sludge on the geotechnical properties of an expansive soil", *International Journal of Engineering, Reasearch and Application*, vol.11, issue 6, pp 11-15
- **P. K. Singhai, Sumi Shrivastava and Veena Mandlekar,** " An experimental investigation of natural soil stabilized with sewage sludge for flexible pavement", *International Journal of Advance Research, Ideas and Innovations in* Technology, Vol.6, issue 2, ISSN : 2454-132X