Stabilization of Weak Soil With Sewage Sludge And Gypsum

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Abstract- *soil stabilization is a technique to refine and improve the engineering properties of the soil. For any construction project such as buildings, roads or an airfield. The base soil act as the foundation. This study focuses on improving the strength of soil by adding gypsum and sewage sludge. Gypsum and sewage sludge is added in different percentage to the weak soil. In this study, gypsum and sewage sludge is added together and separately to the soil and found out the difference in their strength. The strength of soil is determined by compaction test and unconfined compressive strength test(ucs).*

Keywords- compaction test, gypsum, sewage sludge, stabilization, ucs test

I. INTRODUCTION

Weak soils are incapable of supporting the loads of super structures due to its poor bearing capacity. A stable foundation is necessary for the stability and long life of the structure. Weak soil creates trouble for engineers. So soil stabilization is veryimportant to solve this problem. Different type of soil stabilization methods are chemical, physical, biological, mechanical, or combined technique. That improves the strength and bearing capacity of soil.

Gypsum is type of soil stabilization agent. This material is easily available rather than other conventional materials. It extracted by minerals and used as a fertilizer. Gypsum is used as stabilization material to increase the strength of soil.

We all know thatone of the major challenges in our present society is protection of environment. Sewage sludge is a waste material produced from waste water treatment plant. All over the world the waste water treatment plant has resulted in the production of large quantities of sewage sludge. The disposal of sewage sludge in landfills or open areas is not an environmental friendly solution. In order to solve this problem a sewage sludge used as a soil stabilization material.

II. LITERATURE REVIEW

BussaReethu, et al., (2020) studied the strength of soil mixed with different percentage of gypsum. They got the best results with the addition of 6% gypsum to the soil. Specific gravity of the soil has no much variation after stabilization but the liquid limit and plastic limit have advisable result on the addition of gypsum.

M.A. Karim, et al., (2021) studied the potential use of sewage sludge ash and fly ash used to improve the shear strength of soft soil. Based on the UCS values, both the soil mixtures with 7.5% SSA-50%FA and 10%SSA-40%FA contents seemed to better in terms of providing strengths for a curing period of 28 days. Both materials reduce the waste disposal pressure and provide a potential sustainable construction material for engineering applications.

Mohd Amin Shafii, et al., (2018) determined that the cohesion strength increases as sewage sludge ash increases upto 8% and decrease beyond 16%. The optimum value at which the strength peaked is 8%. Therefore SSA is an effective soil stabilizer to improve soft soil properties.

ShakirZahoor Mir, et al., (2022) found that addition of gypsum resulted in the increase of optimum moisture content and a decline in compressibility value in terms of MDD parameters. The increase of UCS when compared with untreated soil is 61.89%. the percentage increment in CBR value when compared to virgin soil is 45.04%.

III. MATERIALS AND METHODOLOGY

3.1 MATERIALS USED

3.1.1 Gypsum

Gypsum is a sulphate mineral with chemical formula $CaSO_4.2H_2O$. It has the ability to bind soil stability of soil. It has a neutral pH hence does not affects the natural pH of the soil.

Fig 3.1: Gypsum powder

3.1.2 Sewage sludge

Sewage sludge is a waste material resulting water treatment plant. Sewage sludge collected from water treatment plant Aruvikkara. It contains organic matters and nutrients . These contents helps to improve the strength of soil.

Fig 3.2:Sewage sludge

3.2 METHODOLOGY

This project follows the steps given below:

- Collection of materials and study of the properties of the natural soil.
- Determination of soil strength by the addition of gypsum and sewage sludge.

3.2.1 Properties of natural soil

Table 1: Properties of natural soil

SL. NO	PROPERTY	VALUE
1	Water content	27%
2	Liquid limit	38%
3	Plastic limit	25%
4	Specific gravity	2.41
5	UCS	0.187Kg/cm^2
6	OMC	18%
7	Maximum dry density	1.744g/cc

3.2.2 Tests for the soil

Compaction Test

Test used to find the optimum moisture content (OMC) and maximum dry density (MDD). OMC is the moisture content at which the dry density is maximum. Dry density is the ratio of the mass of solid to the total volume of the soil.

Unconfined Compressive Strength Test (UCS)

It is the load per unit area at which the cylindrical specimen of a cohesive soil fails in compression.

$$Qu = P/A$$

P- axial load at failure, A- corrected area

IV. RESULTS

4.1 Compaction Test

Table 2: compaction test result for gypsum treated soil

Sample added by gypsum (%)	OMC(%)	MDD(g/cc)
0	18	1.744
2	21	1.778
4	24	2.285
6	21	1.728

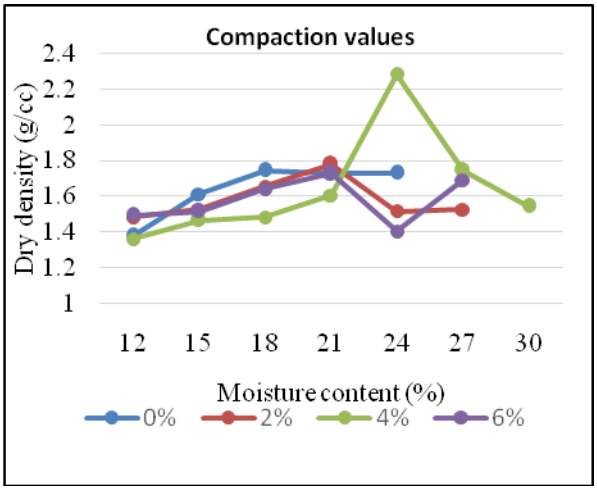

Fig 4.1: Compaction values of gypsum treated soil

Table 3: Compaction test result for sewage sludge treated soil

Sample added by sewage sludge (%)	OMC (%)	MDD (g/cc)
0	18	1.744
2	18	1.793
4	21	1.712
6	21	1.732

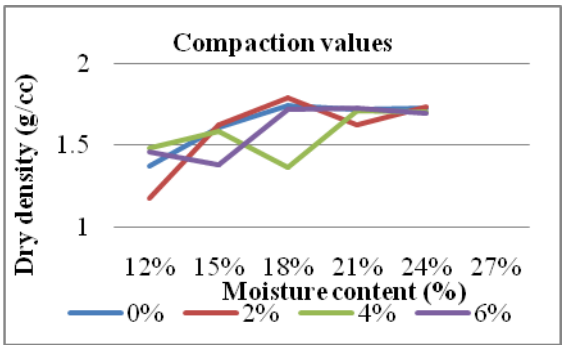

Fig 4.2: Compaction values of sewage treated soil

Table 4: Compaction test result for gypsum and sewage sludge treated soil

Sample added by gypsum and sewage sludge (%)	OMC (%)	MDD (g/cc)
0	18	1.744
2	18	1.661
4	18	1.698
6	21	1.771
8	18	1.736
10	18	1.679

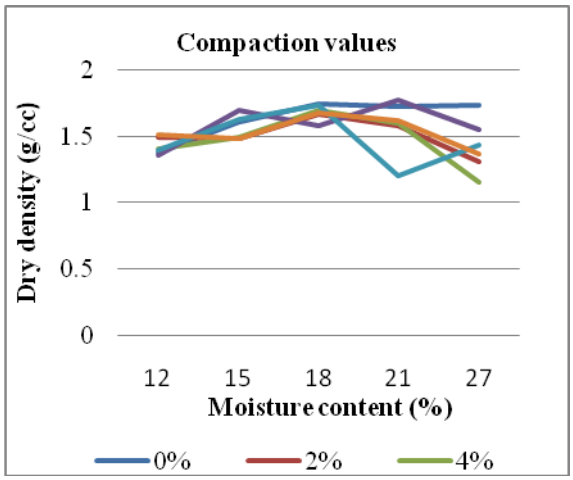

Fig 4.3: Compaction values of soil treated with gypsum and sewage sludge

4.2 Unconfined Compressive Strength Test

Table 5: UCS test result for gypsum treated soil

Sample added by gypsum (%)	UCS (kg/cm^2)
0	0.1870
2	0.3026
4	0.6484
6	0.3890

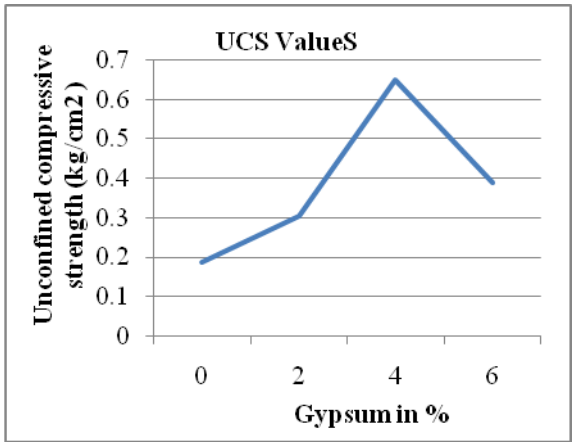

Fig 4.4: UCS values of gypsum treated soil

Table 6: UCS test result for sewage sludge treated soil

Sample added by sewage sludge (%)	UCS (kg/cm^2)
0	0.1870
2	0.3747
4	0.4179
6	0.2882

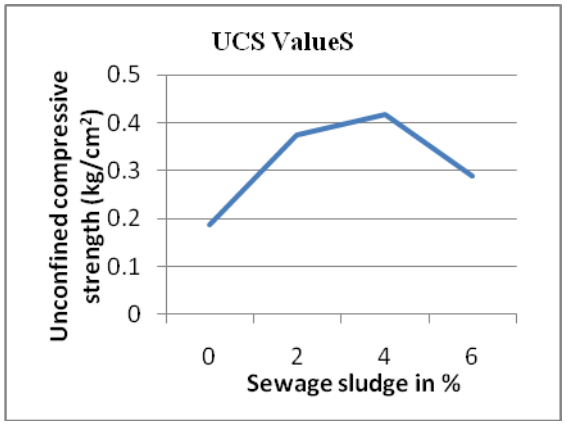

Fig 4.5: UCS values of sewage sludge treated soil

Table 7: UCS test result for gypsum and sewage sludge treated soil

Sample added by gypsum and sewage sludge (%)	UCS (kg/cm^2)
0	0.1870
2	0.288
4	0.303
6	0.331
8	0.504
10	0.158

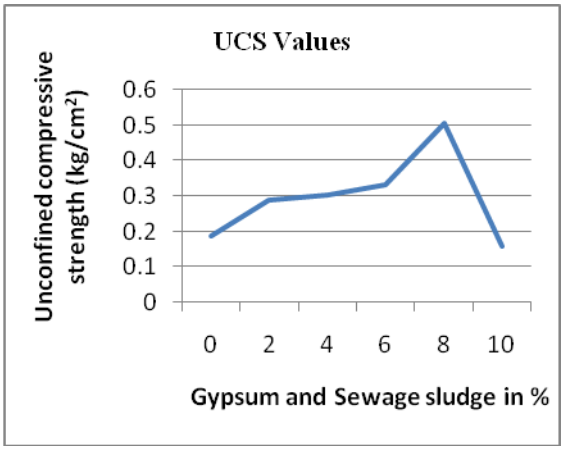

Fig 4.6: UCS values of soil treated with gypsum and sewage sludge

V. CONCLUSION

1. Addition of gypsum and sewage sludge increases the strength of the soil.
2. The UCS and MDD valued peaked at the addition of 4% gypsum to the soil. The UCS is increased by 246.7%.
3. MDD is obtained at the addition of 2% and UCS is found to be maximum at the addition of 4% sewage sludge to the soil. The UCS is increased by 123.47%.
4. The MDD is found at 6% and the UCS value peaked at 8% when the gypsum and sewage sludge is added together to the soil. The UCS is increased by 169.52%.
5. The use of gypsum gives better strength and use of sewage sludge will be a sustainable move. Use of these together creates a balance between strength and sustainability.

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