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INVESTIGATION ON SOIL STABILIZATION USING JUTE FIBRE AND GLASS POWDER

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Abstract - *Soil stabilization can be explained as the alteration of soil properties by chemical and physical means in order to enhance the engineering quality of soil. The main objective of soil stabilization is to increase the bearing capacity of soil, its resistance to weathering process and soil permeability. Stabilization techniques are necessary to ensure the good stability of soil. It saves a lot of time and money when compared to the method of cutting out and replacing the unstable soil. This project deals with the complete analysis of the improvement of soil properties and its stabilization using jute fibre and glass powder.*

Key Words: **Soil Stabilization, Clay Soil, Jute Fibre, Glass Powder, Compaction, Strength.**

1. INTRODUCTION

Soil is good and comfortable material for the construction purpose so it also very important to know about the properties and feasibilities of used soil before use in any kind of construction process. For any land-based structure, foundation is very important and has to be strong to support the entire structure.

In order for the foundation to be strong, the soil around it plays a very critical role. So, to work with soil, we need to have proper knowledge about their behaviour. The process of soil stabilization helps to achieve the required properties in a soil needed for the construction work. From the beginning of construction work, the necessity of enhancing soil properties has come to the light. Some types of soil have low bearing capacity and do not fulfil the engineering works. So to improve the engineering properties of soil and make it suitable for engineering works soil stabilization is needed.

Soil stabilization is the process which improves the engineering properties of soil and makes it stable. The main objective of soil stabilization is to improve the strength and stability of soil and mainly to lower the construction cost. The stability and bearing capacity of soil depends on the shear strength, which is directly proportional to the type and condition of soil. In some of the situation where two materials do not have the desired engineering properties, but when they mix together, they produce satisfactory material. The new stabilized material will be more stable and fulfill the desired conditions.

1.1 Objective

1. To improve the locally available soil using some eco-friendly and waste materials.
2. To determine the appropriate jute fibre and glass fibre content ratio to achieve the maximum gain in strength of soil.
3. To compare the original soil with that of remoulded soil to known the behavioural change.
4. To reduce compressibility and thereby settlements. To increase the load bearing capacity.

1.2 Scope

Soil stabilization is important industry practice, especially crucial for construction jobs. It is used for altering the soil properties like shear strength, prevention of shrinking & swelling due to moisture & other environmental stimulus. In order to have a strong foundation.

2. EXPERIMENTAL MATERIALS

2.1 Clay soil

Clayey soil are inorganic clays of medium to high compressibility and form a major soil group in India. The clayey soil is very hard when dry, but loses its strength completely when in wet condition. Changes in the moisture content of clay soil are generally accompanied by volume changes. On moisture uptake, there is generally a volume increase and moisture loss is accompanied by shrinkage. Expansive soils swell when given access to water and shrink when they dry out. Soils containing the clay mineral montmorillonite generally exhibit high swelling properties. The basic units of which the clay is made are silica (SiO_2) tetrahedral sheets and Aluminium (Al) or Magnesium (Mg) Oxide octahedral sheets.

Fig 2.1 Clay Soil

Fig 2.2 Jute Fibre

2.2 Jute Fibre

Jute is a long, soft, shiny vegetable fibre that can be spun into coarse, strong threads. It is produced from plants in the genus "Corchorus". The "Jute" is the name of the plant or fibre that is used to make burlap, hessian or gunny cloth. Jute is one of the most affordable natural fibres and is second only to cotton in amount produced and variety of uses of vegetable fibres. Jute fibres are composed primarily of the plant materials cellulose and lignin. The fibres are off-white to brown, and 1-4 metres (3-13 feet) long. Jute is also called "the golden fibre" for its colour and high cash value. The jute plant needs a plain alluvial soil and standing water. Jute fibre is 100% bio-degradable and recyclable and thus environmentally friendly. It is one of the most versatile natural fibres that has been used in raw materials for packaging, textiles, non-textile, construction, and agricultural sectors. The suitable climate for growing jute (warm and wet) is offered by the monsoon climate, during the monsoon season. Temperatures from 20℃ to 40℃ and relative humidity of 70% - 80% are favourable for successful cultivation. Jute requires 5-8 cm of rainfall weekly, and more during the sowing time. For this project, we have adopted the jute fibre as diameter of 2 mm and length of 20 mm.

Table 2.2 Properties of Jute Fibre

Property	**Range**
Fibre Length, mm	15 – 30
Fibre Diameter, mm	2 – 5
Specific Gravity	1.3
Colour	Yellowish brown

2.3 Glass Powder

Glass is an inert, amorphous, non-crystalline material which is typically brittle and optically transparent. Many silica based glasses that exist, ordinary glazing and container glass is formed from a specific type called soda-lime glass, composed of approximately 75% silicon dioxide (SiO_2), sodium oxide (Na_2O) from sodium carbonate (Na_2CO_3), calcium oxide (CaO), also called lime and several minor additives. Locally available waste glass has been collected and it is made into powdered form. Before adding the glass powder in the soil it has to be powdered to required size. In this study glass powder of particle size less the 90 micron was used. To improve the engineering properties of soil we are going for mixing of broken glass powder in the soil as we know that it has the various properties like it is a totally non-biodegradable material and it is also a totally inert material and can be useful to enhance the various road building elements strength and it also cannot get degraded in a very simple manner it has it's degradation phenomenon which is very much similar to the degradation of natural rocks.

Table 2.3 Properties of Glass Powder

Property	**Range**
Specific Gravity	2.6
Colour	White
Particle Size	< 90μ

Fig 2.3 Glass Powder

3. METHODOLOGY OF EXPERIMENT

3.1 Mixing Proportions

The percentage of jute fibre and glass powder by dry weight of soil was taken for the tests were done on clayey soil with 0% jute fibre and glass powder and also on clayey soil with different proportions of jute fibre and glass powder like 1%, 2%. In this project we have conducted various experiment to find the stabilization of the sub base using the jute fibre and glass powder the various test were conducted to find the stabilization of the sub base based on IS standards.

3.2 Tests to be conducted

1) Specific Gravity
2) Atterberg Limits
   a) Liquid Limit
   b) Plastic Limit
3) Standard Proctor Compaction
4) Unconfined Compression Strength

3.3 Standard Clay Soil Results

Table 3.3 Standard Clay Soil Properties

Soil Properties	Results
Specific Gravity	2.51
Liquid Limit (%)	35.5
Plastic Limit (%)	39.16
Optimum Moisture Content (%)	14.28
Maximum Dry Density (g/cm³)	2.15
Unconfined Compression Strength (kN/m²)	7.26

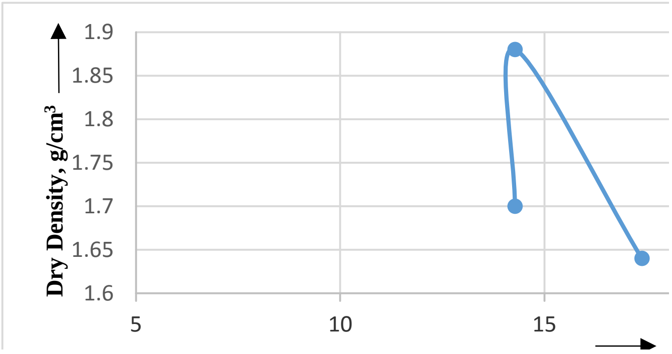

Fig 3.3 a) Proctor Compaction Graph

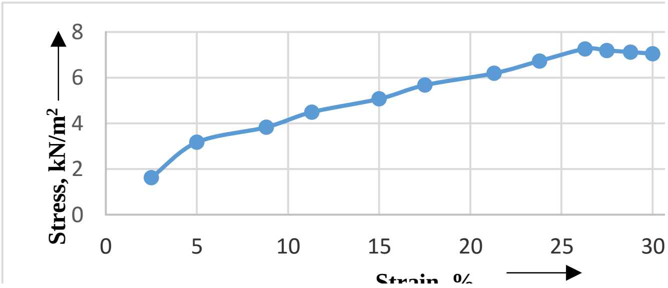

Fig 3.3 b) Unconfined Compression Graph

4. RESULTS AND DISCUSSION

4.1 Addition of Stabilizer and Testing

4.1.1 Atterberg Limits

Table 4.1.1 Atterberg Limits Results

Sl. No	Replacement Details	Liquid Limit (%)	Plastic Limit (%)
1	Clay Soil + 1% Jute Fibre	38	31.66
2	Clay Soil + 2% Jute Fibre	46	28.75
3	Clay Soil + 1% Glass Powder	43	33.8
4	Clay Soil + 2% Glass Powder	50	17.16

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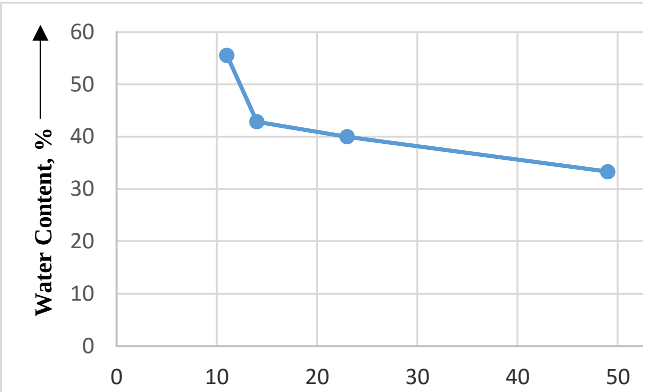

Fig 4.1.1 a) Liquid Limit graph for 1% Jute Fibre

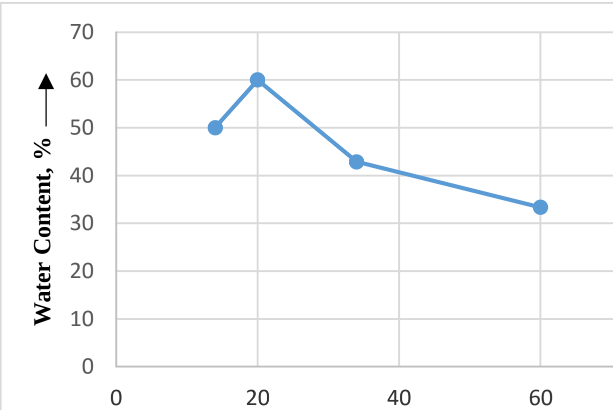

Fig 4.1.1 b) Liquid Limit graph for 2% Jute Fibre

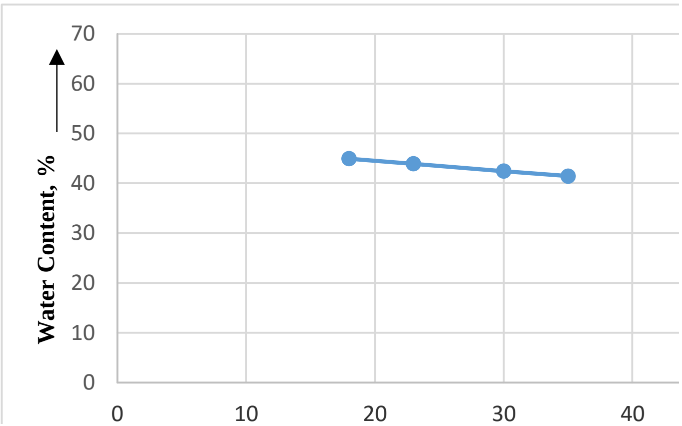

Fig 4.1.1 c) Liquid Limit graph for 1% Glass Powder

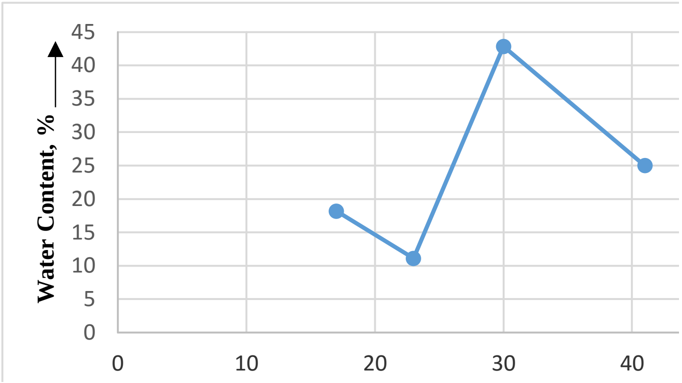

Fig 4.1.1 d) Liquid Limit graph for 2% Glass Powder

4.1.2 Proctor Compaction

Table 4.1.2 Proctor Compaction Results

Sl. No	Replacement Details	OMC (%)	MDD (g/cm^3)
1	Clay Soil + 1% Jute Fibre	18.18	2.49
2	Clay Soil + 2% Jute Fibre	14.25	1.76
3	Clay Soil + 1% Glass Powder	13.04	1.87
4	Clay Soil + 2% Glass Powder	16.67	1.72

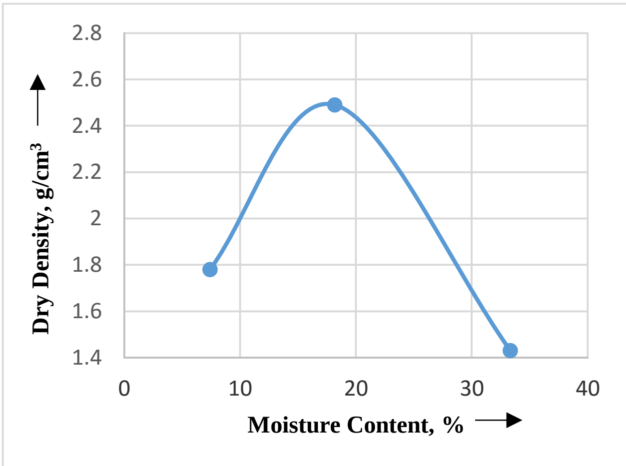

Fig 4.1.2 a) Compaction Curve for 1% Jute Fibre

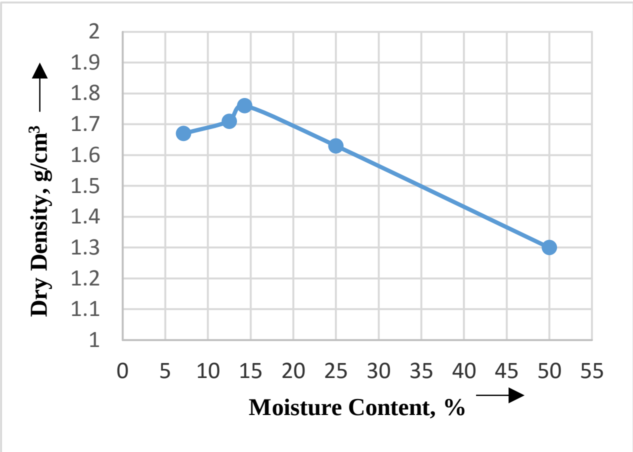

Fig 4.1.2 b) Compaction Curve for 2% Jute Fibre

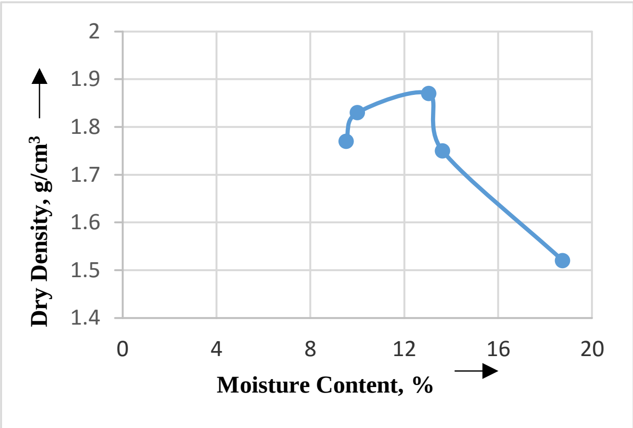

Fig 4.1.2 c) Compaction Curve for 1% Glass Powder

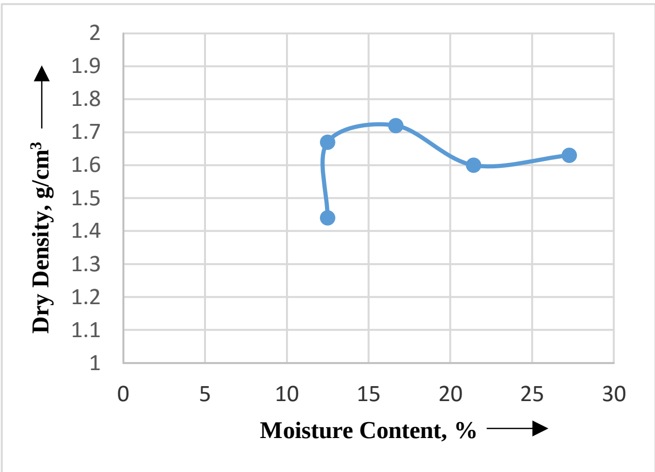

Fig 4.1.2 d) Compaction Curve for 2% Glass Powder

4.1.3 Unconfined Compression Strength

Table 4.1.3 Unconfined Compression Results

Sl. No	Replacement Details	Unconfined Compression Strength (kN/m²)
1	Clay Soil + 1 % Jute Fibre	26.67
2	Clay Soil + 2% Jute Fibre	154.17
3	Clay Soil + 1% Glass Powder	20.78
4	Clay Soil + 2% Glass Powder	71.53

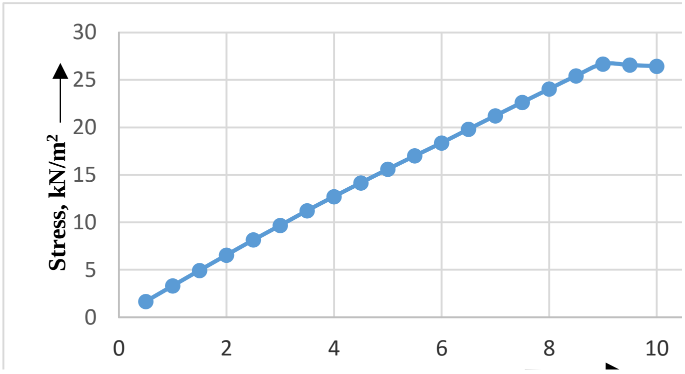

Fig 4.1.3 a) Stress-Strain Curve for 1% Jute Fibre

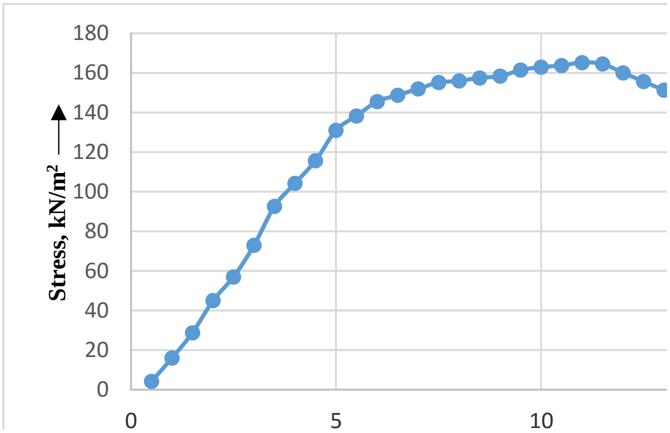

Fig 4.1.3 b) Stress-Strain Curve for 2% Jute Fibre

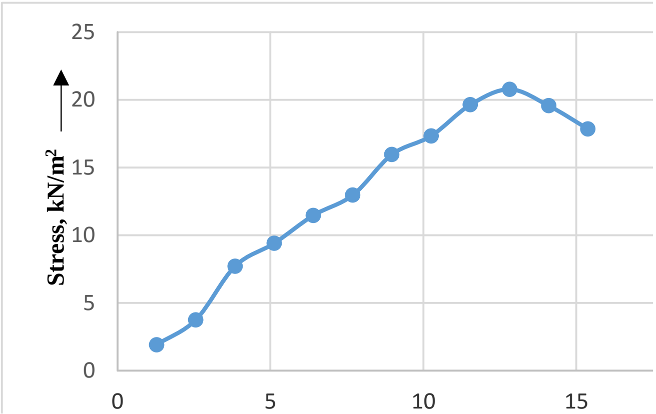

Fig 4.1.3 c) Stress-Strain Curve for 1% Glass Powder

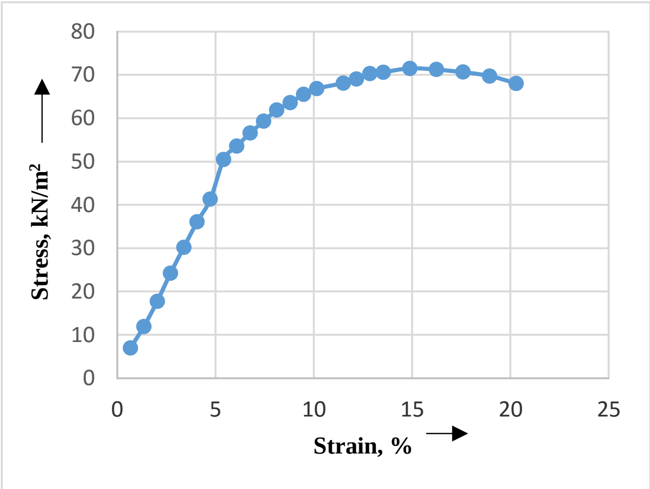

Fig 4.1.3 d) Stress-Strain Curve for 2% Glass Powder

5. CONCLUSION

In the present study the behaviour and properties of the clay soil is determined. The use of modern soil stabilization techniques has significantly helped in ground improvements. Soil stabilization using jute fibre and glass powder can be effectively used to meet the challenges of society. The admixtures as jute fibre and glass powder were added in varying percentages of 1%, 2% respectively. From this project soil stabilization using 2% jute fibre can significantly enhances the properties of the soil used in construction of road and infrastructure. Results include a better and long-lasting road and structures with increased loading capacity. The unconfined compression test and also the dry density and optimum moisture content was obtained in standard proctor compaction test are given below,

- Optimum water content during performing proctor compaction test of clay soil is 14.25 % at 1.76 g/cm^3 dry density.
- Maximum strength attained in the mix of 2% jute fibre is 154.17 kN/m^2.

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