Improvements in Stabilization of Expansive Soil Using Quarry Dust and Recron 3s Fiber – A Review

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Abstract: One of the encountered issues on sites, in construction is the presence of highly cohesive soils, soils that are easily affected by the change of the water content. Active clay soils present a problematic challenge for civil and geotechnical engineers all over the world. Stabilization procedures are available in order to reduce or completely eliminate the swelling potential of expansive clays. The problematic soil is removed and replaced by a good quality material or treated using mechanical or chemical stabilization. The materials were used for preparing the samples are Expansive Soil, Quarry Dust and Recron 3S Fibre with different percentages. Soil stabilization is very necessary by the addition of additives in suitable dosages for road pavement foundation because it improves the engineering properties of soil to sustain load carrying capacity in terms of quality and quantity of performance. To overcome the same, many researchers have concentrated their studies on soil improvement techniques by developing new such materials, through the elaboration of composites. The main objective of this review is to study the effect of fibers in geotechnical applications. In this study a brief review is prepared on properties of material and some works carried out by various authors.

Index Terms **- Expansive soil, Quarry Dust, Recron 3S Fibre and Stabilization.**

I. INTRODUCTION

Site feasibility study for geotechnical projects is of far most beneficial before a project can take off. Site survey usually takes place before the design process begins in order to understand the characteristics of subsoil upon which the decision on location of the project can be made.

The following geotechnical design criteria have to be considered during site selection.

- Design load and function of the structure.
- Type of foundation to be used.
- Bearing capacity of subsoil.

In the past, the Bearing Capacity of subsoil played a major in decision making on site selection. Once the bearing capacity of the soil was poor, the following were options:

- Change the design to suit site condition.
- Remove and replace the in situ soil.
- Abandon the site.

Abandoned sites due to undesirable soil bearing capacities dramatically increased, and the outcome of this was the scarcity of land and increased demand for natural resources. Affected areas include those which were susceptible to liquefaction and those covered with soft clay and organic soils. Other areas were those in a landslide and contaminated land. However, in most geotechnical projects, it is not possible to obtain a construction Site that will meet the design requirements without ground modification. The current practice is to modify the engineering properties of the native problematic soils to meet the design specifications.

II. PROBLEM STATEMENT

The Accumulation of various waste materials is now becoming a major concern to the environmentalists. Earlier all the government policies had been planned to increase the development of industries but the environmental issues were not concerned. But now, the situation of environmental pollution has become alarming and it is the foremost task for environmentalist and government agency to think regarding the disposal of waste materials which are generated as the by-product during the operation of any industry. The generation, handling and disposal of solid wastes are now a great concern in every country. The wastes which are solid in nature and remain at the place of their disposal are called solid wastes.

They may be divided into four groups based on the source of their origination-

- Industrial Solid Wastes
  Industrial solid wastes are the wastes generated from various industrial processes. Example: Fly ash, Blast furnace slag, Red mud, Copper slag etc.
- Agricultural Solid Wastes
  Agricultural solid wastes are the waste generated from the processing of various agricultural products. Example: Rice husk, Bagasse, Ground nut shell etc.
- Domestic Solid Wastes
  Domestic solid wastes are the wastes generated from households or residential units. Example: Incinerator ash, waste trisects.
- Mineral Solid Wastes
  Mineral solid wastes are the wastes generated from various mining activities or the extraction of ores and minerals. Example: Quarry dust, Marble dust etc.

III. OBJECTIVES

Previous Researches had investigated the importance of using Quarry Dust and Recron 3S Fibers and shown considerable improvements in the geotechnical properties of Expansive Soil.

- To determine the properties of the expansive soil.
- To determine the properties of the quarry dust.
- To determine the properties of the Recron 3S Fibers.
- To know key issues of previous research works by various authors

IV. LITERATURE REVIEW

D S V Prasad et al (2017) - Studied the improvements in the geotechnical properties of Expansive Soil with the addition of Quarry Dust and Tile waste. At 10% of quarry dust and 20%

tile waste, liquid limit and plastic limit decreased and OMC, MDD and maximum CBR value obtained.

R. Thirumalai et al., (2017) - It represents the recent trends in stabilization of expansive soil using industrial waste (granite and Quarry dust, cement kiln dust, silica fume, rice husk ash) as stabilizers for decreasing the environment all hazards.

A. Dinesh et al., (2017) - Concluded that the soil stabilization by using various minerals like Quarry dust, sawdust, copper dust, and fly ash were most commonly used.

Siyyagalla Subbarayudu et al studied the Soil stabilization by using Recron -3s, flyash & lime. In this study, the stabilization of the soil by using RECRON-3S, FLYASH, LIME is done .In this study recron-3S as (1%,2%,) lime(2%,3%,4%) and fly ash at (10%,12%,15%,20%) are used. With different proportion of soil with additive materials California bearing ratio value will be more compare to conventional materials. And from that thickness of pavement can be minimized to the certain extent.

P. Rajendra Kumar et al., (2017) - The main objective of this study is to investigate the effect of fibers in geotechnical applications and to evaluate the strength of unsaturated soil by carrying out compaction test and CBR tests on soil sample. The fibers are cut in length of 6mm and 12 mm and mix randomly in varying percentages (0.50%, 1.0%, 2.0%, and 4.0%) by dry weight of soil and compacted to maximum dry density at optimum moisture content. The test results indicate a reduction in the maximum dry density and optimum moisture content of soil due to the addition of Recron fiber. It also indicates an improvement in the CBR value.

P.V.Koteswara Rao et al., (2012) - An attempt is made to study the influence of polymer fibers on the properties of locally available Black cotton soil with and without admixture modification. This study revealed that the fiber reinforcement improves the soil properties in terms of improved stress-strain patterns and progressive failure in place of quick post peak failure of plain samples. The unconfined compressive strength of Clay soil is increased by 7 times with admixture stabilization and 9 times for admixture with fiber modification with respect to plain samples. The shear strength parameters of clay soil are also significantly increased upon admixture stabilization and admixture with fiber treatment. The CBR value also increased significantly even for soaked CBR tests. By addition of CKD the Liquid limit of the mixture is decreased 23 %, whereas plastic limit is increased by 41%. Plasticity Index of the mix is decreased by 57%. Based on the thorough Recron-3S Fibers the combination to study was determined as 5% increment of Quarry dust from 10% i.e., 10%, 15%, 20% and 25% and for Recron-3S-Fibers with 0.5% increment i.e., 0.5%, 1%, 1.5% and 2%.study and understanding of various reviews with combination of Expansive soil with Quarry dust.

Muhammad Nawazish Husain et al., (2015) - The objective of the present paper is to check the usefulness of Recron 3S Fibre in improving soil subgrade strength of local silty soil of Kurukshetra. For this purpose a series of experiments were conducted which include Modified Proctor Compaction, California Bearing Ratio (CBR) and Unconfined Compressive Strength (UCS) tests. A total of four samples of soil - fibre mixture were made with fibre content as 0.15%, 0.30%, 0.45% and 0.60% of dry weight of soil. Other tests for index and physical properties like Atterberg's limits, Specific gravity and sieve analysis of parent soil were also carried out. Experimental results revealed that addition of Recron 3S fibre increases the CBR and UCS value of the silty soil. From the results it is also observed that benefit is more appreciable at lower percentage of Recron 3S fibre i.e. 0.15% as compared to higher percentage.

P. Sowmya ratna et al., (2016) - The properties of the black cotton soils can be altered in many ways viz. mechanical, thermal and chemical means. Therefore soil stabilization techniques are necessary to ensure the good stability of soil so that it can successfully sustain the load of the superstructure especially in case of soil which is highly active; also it saves a lot of time. In the present work, an attempt has been made to study the compaction and CBR characteristics tests of black cotton soil mixing with different percentages of lime and Recron-3s Fibre with a view to determine the optimum percentage. Test results shows that stabilizing clayey soils with lime and imparting Recron 3s fibers enhance the strength.

V. METHODS OF STABILIZATION

The two general stabilization methods are mechanical and additive. The effectiveness of stabilization depends on the ability to obtain uniformity in blending the various materials. Mixing in a stationary or traveling plant is preferred. However, other means of mixing (such as scarifies, plows, disks, graders, and rotary mixers) have been satisfactory. The soil-stabilization method is determined by the amount of stabilizing required and the conditions encountered on the project. An accurate soil description and classification are essential for selecting the correct materials and procedure.

- Mechanical Stabilization Mechanical stabilization is accomplished by mixing or blending two or more gradations of material to obtain a mixture meeting the required specifications. The blending of these materials may take place at the construction site, at a central plant, or at a borrow area. The blended material is then spread and compacted to the required densities by conventional means. If, after blending these materials, the mixture does not meet the specifications, then stabilization with an additive may be necessary.
- Additive Stabilization Additive refers to a manufactured commercial product that, when added to the soil in the proper quantities, will improve the quality of the soil layer. The two types of additive stabilization discussed mainly in this chapter are chemical and bituminous. Chemical stabilization is achieved by the addition of proper percentages of Portland cement, lime, lime-cement-fly ash (LCF), or combinations of these materials to the soil. Bituminous stabilization is achieved by the addition of proper percentages of bituminous material to the soil. Selecting and determining the percentage of additives depend on the soil classification and the degree of improvement in the soil quality desired. Smaller amounts of additives are usually required to alter soil properties (such as gradation, workability, and plasticity) than to improve the strength and durability sufficiently to permit a thickness-reduction design. After the additive has been mixed with the soil, spreading and compacting are achieved by conventional means.

VI. MATERIALS USED

6.1 Expansive Soil

The Expansive soil used for the study was collected from near Enikepadu, Vijayawada, Krishna District in India from open excavation at 2.0 m depth below the ground surface. Before Testing, the soil was air dried and then allowed to pass through4.75 mm sieve. Soil passing through 425 microns sieve was used for consistency tests. The properties of the Expansive soil used are summarized in Table

Table 1: Properties of Expansive Soil

S.NO	PROPERTY	VALUE
1	Grain Size Distribution Sand (%) Clay (%)	 6 94
2	Atterberg's limits Liquid Limit (%) Plastic Limit (%) Plasticity Index (%)	 84 36 48
3	Compaction properties Optimum Moisture Content (O.M.C), (%) Maximum Dry Density (M.D.D), (g/cc)	 28.43 1.472
4	Specific Gravity (G)	2.54
5	IS Classification	CH
6	Differential Free Swell (%)	130

6.2 Quarry Dust

Aggregate crusher units produce large quantities of quarry dust, a waste product, produced during crushing of Gravel and rock. Disposal of these large quantities of quarry dust produces serious problem in environment and health hazard. There is requirement to utilize these waste materials. Quarry dust can be used in very large quantity, reducing the total cost of construction in addition to providing a solution to an environmental problem. Quarry dust for this study was collected from Vijayawada, Krishna District of Andhra Pradesh, India. The index and Engineering properties of the soil were determined as per IS codes.

Table 2: Properties of Quarry dust

SI. NO	Property	Value
1	Grain Size Distribution Coefficient of Uniformity (Cu) Coefficient of Curvature (Cc)	 17.65 2.92
2	Compaction Optimum Moisture Content (OMC)% Maximum Dry Density (MDD) KN/m3	 12.5 1.63
3	Specific Gravity (G)	2.46

6.3 Recron-3s Fiber

Recron-3sfiber used in this study is the most commonly used synthetic material fiber due to its low cost and hydrophobic and chemically inert nature which does not allow the absorption or reaction with soil moisture or leachate and it is a polypropylene fiber which is a stabilizer to improve CBR and UCS values. The Properties of Recron 3S- fibers are Color = White, Specific gravity = 1.334, Cut length = 12mm, Equivalent diameter (um) = 32-55, Water absorption (%) = 85.22, Tensile strength (MPa) = 600, Acid resistance = Excellent, Melting Point (°C) = >250 and Alkali resistance is Good.

Table 3: Chemical Composition of Recron 3S fiber

Chemical Identify	Concentration
Polymer (Polyethylene terephthalate)	>94.0%
Additives (Titanium dioxide, optical brighteners)	<0.5%
Spin finish	<0.5%
Hazardous ingredient	None

6.3.1 Properties of Recron 3S Fibers

A) Physical Properties

- Color: Available in white / white.
- Smell: Odorless
- Appearance/Form: chopped staple fibers
- Cross-section: Triangle
- Relative Density: 1.3-1.4 g/
- Length: Available in 6, 12 and 18 mm cut length.
- Diameter: The diameter of Recron 3S fiber varies from 30-40 microns

B) Chemical Properties

- Solubility: Recron 3S fibers are insoluble in common solvents.
- Water Solubility: Insoluble in Water
- It has no oxidizing properties.
- Fibers Recron 3S fibers degrade when contacted with strong oxidizing agents.
- Toxicity: Very low.
- Recron 3S fiber is non-biodegradable.

C) Thermal Properties

- Melting point/range: 240-260 °C
- Softening point: 220 °C

D) Mechanical Properties

- Elongation: >100 %
- Recron 3S fibers are non-capillary and non-hygroscopic, giving good moisture resistance.
- Tensile strength: 4000-6000 kg/cm^2

Utilization of Recron-3S as a reinforcing material is to increment the in sundry applications like cement predicated precast products, filtration fabrics etc. It withal provides resistance to impact, abrasion and greatly ameliorates the quality of construction during substratum, retaining wall design etc. Recron-3S fibre is the most widely used includes laboratory testing of soil reinforcement. Currently Recron-3S fibre is utilized to enhance the soil strength properties, to decrease the shrinkage properties and to surmount chemical and biological degradation.

VII. CONCLUSION

On the basis of various studies done by authors, Following conclusions are drawn:

- Strength of soil can be increased to the certain extent by using additive materials in soil. Especially Recron 3s, when mixed with soil gives a wonderful result.
- Fiber absorbs everything and keeps the road surface intact and many problems can be solved like potholes, cracking & failure of pavement.
- Both the length and content of coir have important role in developing the strength properties of stabilized soil. But the strength properties are mostly affected by coir content than by size of coir fiber.
- Quarry dust and Recron 3s fiber is also available and cheap material. If Quarry dust and Recron 3s fiber is used for soil stabilization it will reduce the environmental hazard caused by waste. It will be the one of cheapest method for ground improvement.

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