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# Evaluation and Analysis of Stabilization of Clayey Soil with Some Additives

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***ABSTRACT***
*Building on weak or soft soils presents challenges such as differential settlements, low strength, and significant compressibility. As a consequence of their inherent weakness, clayey soils are unable to adequately sustain pavement, which in turn reduces the quality of the pavement's performance and shortens its lifespan. The load-bearing capacity of soil may be increased by a number of methods, including soil stabilisation, reinforcement, etc. Stabilization of soil is a common method in construction engineering that has allowed for the efficient use of industrial wastes as a stabiliser, and it is one of the modification techniques used to enhance soil's geotechnical qualities. Because of its accessibility and versatility, this method is gaining in popularity. Stabilization is a way to make inexpensive roadways by recycling existing materials. This paper reports the results of a research that tested the efficacy of Fly ash, Terrasil, and Recron 3-S Fibre in enhancing the quality of clayey soil. By adjusting the ratio of admixture to unmodified soil, the optimal level of stability may be achieved. Admixtures like fly ash, Terrasil, and Recron 3-S Fibre are used for this purpose. Atterberg's limit, Compaction, CBR, and UCS tests were performed on both modified and unmodified clayey soil for this comparative research. In this study, we used index properties tests to set the percentages of FA and RF in the stabilised TL at 20% and 1.5%, respectively, while we altered the percentage of Terrsail (i.e. 0.6%, 1.2%, and 1.8%).*
***Keywords:*** *Clayey soil, soil stabilisation, Fly ash, Terrasil, CBR, UCS.*

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## I. Introduction

Construction of buildings, dams, bridges, etc., all have a high failure rate owing to faulty soil below them. The earth must be solid and sturdy to support a building's base. For civil engineers and geotechnical engineers, expansive soils provide a number of challenges. Expansive soils like black cotton soil swell when water is added and shrink when the water is taken away. The clay mineral montmorillonite found in black cotton soil is to blame for the soil's extreme shrinking and swelling. Many issues arise when buildings in touch with or made from swelling soils experience variations in volume.

A lot of India's surface has that dark colour because of the prevalence of cotton. Basalt deposits leave behind black cotton soils. These soils have a high clay content and range in colour from grey to black. Deepening the foundation, compacting the soil, replacing the soil under the foundation, and stabilising the soil are all methods used to increase the earth's bearing capacity and hence the building's stability. The process of stabilising soil involves either glueing the soil particles together or water proofing the particles, or a combination of the two, with the goal of enhancing the soil's strength and resistance to softening by water. By incorporating stabilising agents (binder materials) into poor soils, geotechnical qualities including compressibility, strength, permeability, and durability may be enhanced.

Increased need for infrastructure, raw resources, and fuel has given rise to a new approach to soil stabilisation in recent years. As more information becomes available and more efficient tools become available, this technique is quickly gaining in popularity as a viable option for enhancing soil quality at a reasonable cost. Subgrade stabilisation often involves replacing weaker materials (like soft soil) with harder ones (like crushed rock). Highway authorities have been compelled to examine other methods for building highways over soft subgrade due to the high expense of replacement. The subgrade and base layers are the basis of the pavement, and their performance is crucial to the pavement's overall quality. Layers of the subgrade and base should have sufficient shear strength, stiffness modulus, moisture resistance, stability, and durability.

Roads are especially vulnerable to water damage in countries like India, which have frequent monsoons. A road's soil foundation is weakened when water is allowed to enter it during wet seasons. Poor shear strength and significant swelling and shrinkage need some method of treating the soil. Most often, techniques for stabilising and reinforcing soil are used to enhance the mechanical behaviour of soil, which in turn increases the dependability of building.

In both rich and developing nations, the road infrastructure plays a crucial role in the economy by providing fast, inexpensive, and convenient transportation. Pavement is a key part of any road system, since it provides a stable base upon which vehicles may travel safely and efficiently. When it comes to creating a solid, long-lasting pavement, the subgrade is a crucial component.

A compacted layer of local soil or stabilised soil from borrow pits immediately below the pavement crust provides a stable base for the pavement construction. This layer is known as the subgrade. To make the most of the subgrade layer's strength and reduce the need for a thicker pavement, it must be consistently and thoroughly compacted. Because of the dynamic transient stresses produced by automobile traffic, subgrade layers are crucial to the structural integrity of the pavement structure. Transmission of these traffic loads must be planned such that, even under harsh climatic and traffic loading circumstances, the resulting deformation of the subgrade remains within elastic limitations and the shear forces created remain below safe limits.

Less CBR value soils need greater pavement thickness of design traffic on highways, which leads to expensive pavement composition. Several methods for subgrade stabilisation have been developed as a means of dealing with this soil-related issue.

Soils and/or soil minerals, as well as stabilising agents or binders, are components of stabilisation technology (Cementitious materials)

The commonly used stabilizing agents are:

- Cement
- Lime
- Fly Ash

## II. MATERIALS

**2.1 RECRON 3-S FIBRE:** Since it is inexpensive, hydrophobic, chemically inert, and resistant to reactivity with soil moisture, Recron-3S is by far the most used synthetic fibre. Use of Recron-3S as a reinforcing material improves soil performance in terms of strength, and also makes the soil more adaptable, simple to work with, and impermeable. Sizes of 6 mm, 12 mm, and 24 mm for Recron-3s are also on hand. The fibre employed in this research has a length of 12 mm, and it was made by Reliance Industries.

**2.2 TERRASIL:** The chemical known as Terrasil is being developed as a potential new substance for soil stabilisation. Terrasil is made by Zydex Industries Ltd. in Gujarat, and it was developed using nanotechnology. In this context, "organo-silane compound" refers to a chemical that combines with soil particles to turn them from hydrophilic polar into hydrophobic nonpolar. This renders the soil water-resistant and allows for improved interlocking of soil particles through compaction.

**2.3FLY ASH**

Coal dust is produced in thermal power plants during the combustion process. The fly ash powder was first suspended in the flue gas and then separated using electrostatic precipitators. Ash from thermal power plants often falls into one of three categories: fly ash, bottom ash, or pond ash. In a power plant, bottom ash may be found in the boilers, whereas fly ash is collected using electrostatic precipitators. Pond ash is a slurry made from a combination of fly ash and bottom ash. The production of metals such as aluminium, copper, and steel also results in massive amounts of fly ash.

Compared to lime and Portland cement, fly ash has a finer particle size. The resulting silt particles are between 10 and 100 microns in size. Fly ash's fineness is a crucial factor in determining its pozzolanic reactivity. They resemble bubbles of varying sizes when seen under a microscope.

## III. Experimental Programe.

### 3.1 SOIL

**Source of soil**

Soil for this research was collected from the hamlet of Russu, located in the region of Badgam, not far from the town of Magam. The soil utilised has a low compressibility and is clayey, as defined by the IS soil classification system. The following is a table containing information on the soil:

**Table no.1 Properties of soil used in the study**

| S.NO. | PROPERTIES | RESULTS |
|---|---|---|
| 1. | Liquid Limit | 36 % |
| 2. | Plastic Limit | 21.5 % |
| 3. | Plasticity Index | 14.5 % |
| 4. | Optimum Moisture Content | 14.4 % |

| | | |
|---|---|---|
| 5. | Maximum Dry Density | 18.5 kN/m³ |
| 6. | Specific Gravity | 2.56 |
| 7. | C.B.R | 3.8 % |
| | U.C.S | 96.52 kN/m² |
| 8. | Indian Soil Classification | CI |

### 3.4.2 RECRON 3-S FIBRE:

**Table 2. Properties of Recron-3s-fibre**

| **Properties** | **Description** |
|---|---|
| Colour | White |
| Length | 12mm |
| Unit length | $0.91g/cm^3$ |
| Tensile strength | $4000\text{-}6000kg/cm^2$ |
| Water Absorption | 85.22% |
| Acid resistance | Excellent |
| Alkali resistance | Good |

### 3.2 TERRASIL:

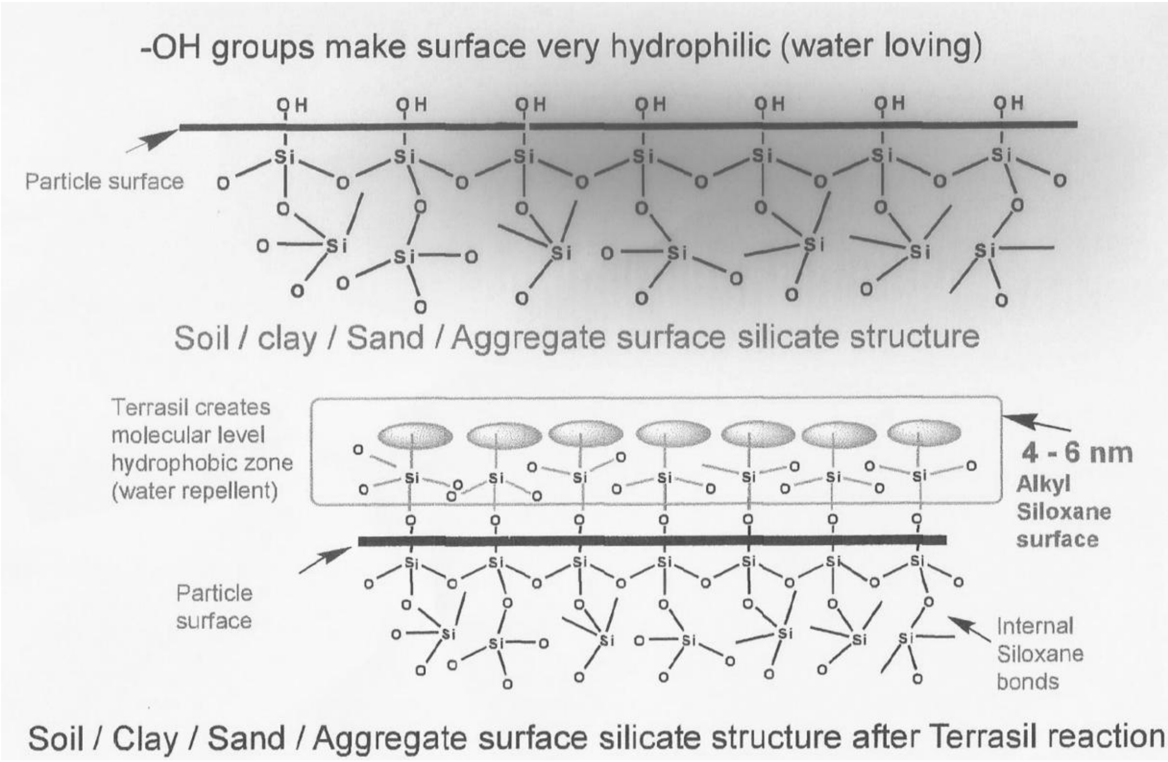



**Fig. 1**

### 3.3 FLY ASH

**Table 3 Classification of fly ash**

(Source: Ferguson, 1999)

| **S. No** | **Compound** | **Class F Fly ash** | **Class C Fly ash** |
|---|---|---|---|
| 1. | Silica($Sio_2$) | 54.8 | 39.8 |
| 2. | Alumina ($Al_2O_3$) | 25.9 | 16.9 |
| 3. | Calcium oxide (CaO) | 8.6 | 24.2 |
| 4. | Iron oxide ($Fe_2O_3$) | 6.9 | 5.8 |
| 5. | Magnesium oxide (MgO) | 1.9 | 4.7 |

| | | | |
|---|---|---|---|
| 6. | Sulphur (S) | 0.5 | 3.2 |

### 3.4 Processing of materials

Lumps of earth were crushed with a wooden hammer after being taken from the location. It was then air dried and sieved with a 2.36 mm IS sieve. Then we made sure everything was well combined, and we put it away in plastic containers. Each test required a certain amount of dirt, which was removed from the bags and dried in an oven. A amount of Fly Ash was extracted and well blended with the ground. After the soil and Terrasil mixture had cured, the necessary quantity of Recron 3-S fibre was applied. Due diligence was performed to ensure a homogeneous soil-Recron 3-S fibre-Fly Ash-Terrasil blend.

### 3.5 Mixing Proportions

A consistent combination of soil, Recron 3-S fibre, fly ash, and Terrasil must be created. Ten, twenty, and thirty percent Fly Ash, six percent Terrasil, twelve percent Recron 3-S fibre, and two percent Recron 3-S fibre were utilised in the experiment, respectively.

## IV. RESULTS OUT OF EXPERIMENTS.

The section displays the outcomes of all laboratory experiments. Standard Proctor Test, California Bearing Ratio (CBR), and Unconfined Compression Test were the three most prominent investigations (UCS).

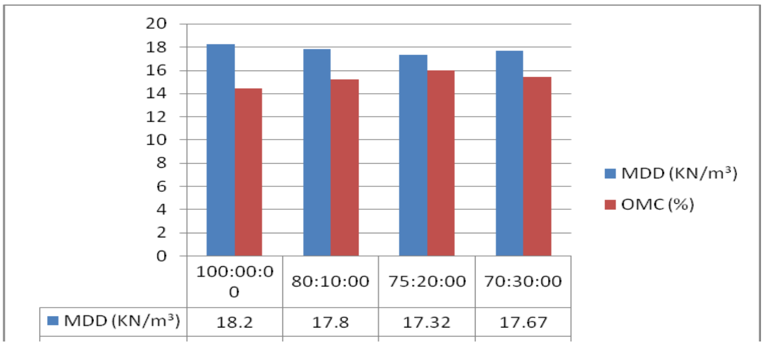
### 4.1 STANDARD PROCTOR TEST

### 4.2 Untreated Soil and Fly Ash Mix

**Table 4: Results of OMC and MDD for untreated soil and FA mix**

| SOIL:FA | MDD (KN/m³) | OMC (%) |
|---|---|---|
| 100:0 | 18.20 | 14.40 |
| 80:10 | 17.80 | 15.21 |
| 75:20 | 17.32 | 15.94 |
| 70:30 | 17.67 | 15.42 |

**Fig no. 2Variations b/w MDD and OMC of FA & soil with different proportions**




**CLAYEY SOIL AND RECRON 3-S FIBRE MIXES**

**Table no. 5: Results of OMC and MDD for mix proportions of Soil and Recron 3-S Fibre**

| SOIL:RF | MDD (kN/m³) | OMC (%) |
|---|---|---|
| 100:0:0 | 18.20 | 14.4 |
| 99.0:1.0 | 18.92 | 13.8 |
| 98.5:1.5 | 19.3 | 13.50 |
| 98.0:2.0 | 19.5 | 12.90 |
| | | |

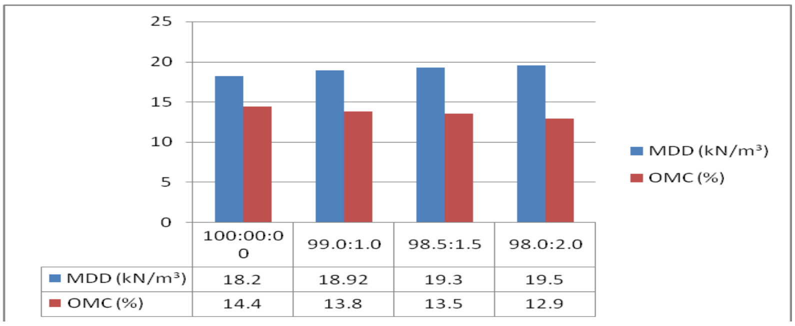



**Fig. 3 Variations b/w MDD and OMC of Recron 3-S Fibre & soil with different proportions**

**CLAYEY SOIL AND TERRASIL MIXES**

**Table no. 6: Results of OMC and MDD for mix proportions of Soil and Terrasil m**

| SOIL:TL | MDD (kN/m³) | OMC (%) |
|---|---|---|
| 100:0:0 | 18.20 | 14.4 |
| 99.4:0.6 | 18.50 | 14.1 |
| 98.8:1.2 | 18.80 | 13.8 |
| 98.2:1.8 | 19.10 | 13.2 |

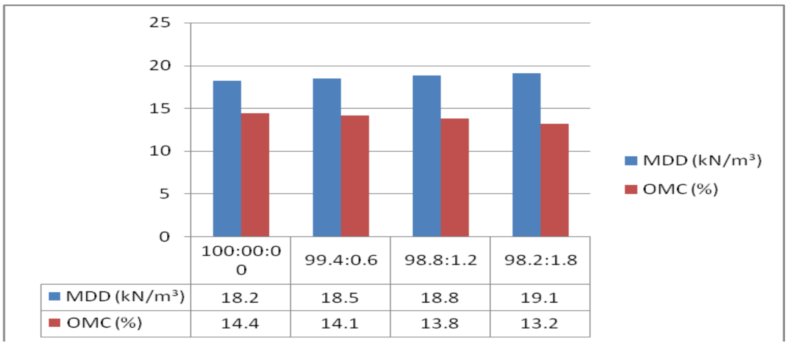



**Fig. 4 Variations b/w MDD and OMC of Recron 3-S Fibre & soil with different proportions**

**4 CLAYEY SOIL- FLY ASH, RECRON 3-S FIBRE AND TERRASIL MIXES**

**Table no. 7: Results of OMC and MDD for mix proportions of FA, Recron 3-S Fibre and Terrasil**

| SOIL:FA:RF:TL | MDD (kN/m³) | OMC (%) |
|---|---|---|
| 100:0:0:0 | 18.20 | 14.40 |
| 77.9:20:1.5:0.6 | 18.62 | 15.60 |
| 77.3:20:1.5:1.2 | 18.94 | 15.27 |
| 76.7:20:1.5:1.8 | 19.31 | 14.21 |

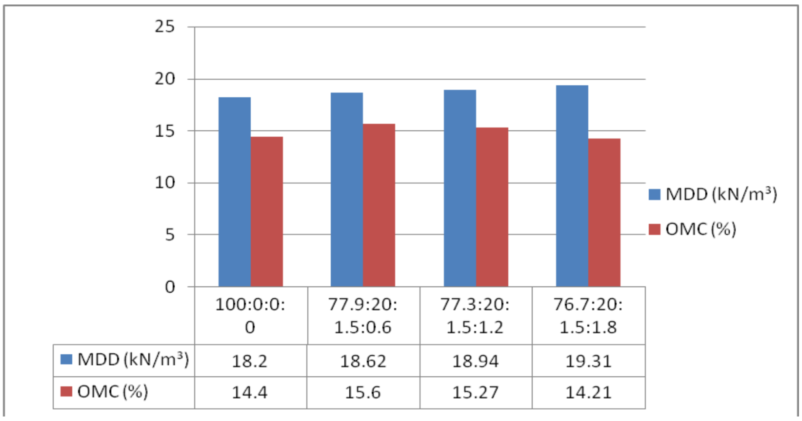



**Fig.5 variations b/w MDD and OMC of FA,Recron 3-S Fibre &Terrasil with different proportions**

## V. Conclusions

The results of the trials lead to the following hypotheses:

1. The primary takeaway from this research is that Fly Ash is an industrial byproduct that may be utilised as stabilisers to clay soil, so resolving the long-standing issue of where to dispose of such materials.
2. Adding 20% Fly Ash to soil yields the highest C.B.R., hence this is the amount that was employed in this study.
3. Adding more Terrasil to a predetermined amount of Fly Ash and Recron 3-S Fibre raises the CBR. When compared to untreated soil, it grew by a factor of 1.36.
4. To stabilise soil, the ideal percentages of Fly Ash, Terrasil, and Recron 3-S Fibre are 20%, 1.8%, and 1.5%, respectively, based on the soil's weight.
5. With a constant amount of Fly Ash, adding more Terrasil and Recron 3-S Fibre results in a higher unconfined compressive strength. As compared to the untreated soil, the unconfined compressive strength value increases by 1.77 times.

The addition of Terrasil, Fly Ash, and Recron 3-S Fibre stabiliser to soil mixes increases their longevity, decreases their cost, and increases their efficiency as a soil amendment. If those two things can be found conveniently close to the building site, then construction may begin.

## VI. Future Reach

1. The work in this research is done on clayey soil. Substituting a different kind of soil for clayey soil is possible.
2. Standard proctor exam, C.B.R. test, and U.C.S. test are used in this investigation. The direct shear test, triaxial test, durability test, and permeability test are only some of the other tests that may be employed in the development stage.
3. While the U.C.S. test only requires a week of curing time, the actual time needed to complete the task may be longer.
4. Recron 3-S Fibre may be utilised with a wide variety of binder materials, not only Fly Ash and Terrasil. Even though Recron 3-S Fibre is a kind of fibre, other fibres may be used instead.
5. Improved outcomes may be achieved by using varying ratios of Fly Ash, Terrasil, and Recron 3-S Fibre.

## Refrences


[1]. Poonam Tripathi (2020), *"Evaluation and Analysis of soil stabilization of some non conventional Additives*". International Journal of Engineering Research and Technology (IJERT), ISSN 2278-0181.

[2]. T Raghavendra (2018), *"Stabilization of black cotton soil using Terrsil and Zycobond".* 2018 IJCRT | National Conference Proceeding NTSET Feb 2018 | ISSN: 2320-2882 National Conference On Trends In Science, Engineering & Technology by Matrusri Engineering College & IJCRT.

[3]. V. Padmavathi (2019), *"Stabiliation of soil using Terrasil, Zycobond and Cement as admixtures".*https://www.researchgate.net/publication/328570647.

[4]. Ansu Thomas and RK Tripathi (2016), *"Soil Stabilisation Using Terrasil".* Indexed in scopuscompendex and GeobaseElseveir. International Journal of Earth Sciences and Engineering. June 2016, P.P. 1049-1052.

[5]. Athulya P.V (2015), *"Stabilisation of subgrade soil using additives".* International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, Published by www.ijert.org, NCRACE-2015 Conference Proceedings.

[6]. Alaa M. Rashad, (2015), "*Potential use of Phosphogypsum in alkali-activated fly ash under the effects of elevated temperatures and thermal shock cycles*".Journal of Cleaner Production.

[7]. Bhattacharyya JK, Shekdar AV, Gaikwad SA, (2004), "*Recyclability of some major industrial solid wastes*", Journal of Indian Association for Environmental Management, 31, pp.71–75

[8]. Cyr M, Aubert JE, Husson B, Clastres P, (2004), "*Recycling Waste in Cement Based Materials: A Studying Methodology"* In: RILEM Proceedings of the Conference on the Use of Recycled Materials in Building and Structures, Barcelona, Spain, pp. 306-315

[9]. DivyaKrishnan.K ,V.Janani , P.T.Ravichandran , R.Annadurai , Manisha Gunturi,(2014). "*Soil Stabilisation Using Phosphogypsum and Flyash".***International Journal of Engineering Trends and Technology (IJETT).**

[10]. Faisal I Shalabi, Ibrahim M Asi (2017). *"Effect of by product steel slag on the engineering properties of clayey soil".* Journal of King Saud University – Engineering Sciences (2017) 29, 394–399, Elsevier.

[11]. Hanan Tayibi, Mohamed Choura, Fransico J. Alguacil, (2009), "*Environmental impact and management of Phosphogypsum*". Journal of Environmental Management.

[12]. NuFAyatDegirmenci, (2007), " *The using of waste Phosphogypsum and natural gypsum in adobe stabilization*". Construction and Building Materials

[13]. SudongHua, Kejin Wang, Xiao Yao, Wen Xu, Yuxin He, (2016), "*Effects of fibers on mechanical properties and freeze-thaw resistance of Phosphogypsum-slag based cementitious materials*". Construction and Building Materials.

[14]. Shubham more, ApekshaLokhande (2018) "*Stabiliation of black cotton soil by using steel slag".IJIRSET,Volume 7, Issue 5.*

[15]. Yun Huang, ZongShou, (2010), " *Lin Investigation on Phosphogypsum–steel slag–granulated blast-furnace slag–limestone cement*". Construction and Building Materials.

[16]. Pallavi, Pradeep Tiwari, Dr P D Poorey(2016) *"Stabilization of Black Cotton Soil using Fly Ash and Recron 3-S Fibre".* IRJET Volume: 03 Issue: 11 | Nov -2016

[17]. Indian Standard Code IS 2720-16, IS 2720-10.