IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X,
PP 46-54
www.iosrjournals.org

Improvement Of Clayey Soil By Using Egg Shell Powder And Quarry Dust

Geethu Saji[1], Nimisha Mathew[2]
[1](Department of Civil Engineering, SNGCE,Kadayiruppu, India)
[2](Department of Civil Engineering, SNGCE, Kadayiruppu, India)

Abstract: *Clayey soils with high content of clay particles are found very weak and they cannot be used as foundation layers or as a construction material. Different methods are adopted to stabilize these types of soils to suit the specifications of construction industry. Egg Shell Powder (ESP) and Quarry Dust (QD) were used to study the effect on the properties of clayey soil. Eggshell primarily contains calcium, magnesium carbonate and protein and the quantity of lime in eggshell is almost the same as in limestone on ton for ton basis. When quarry dust is added with expansive soil it is expected that it will make it more porous, less durable, reduce cohesion etc. The main objective of this paper is to determine the improvement in engineering properties of clayey soil under varying percentage of ESP and QD. An improvement in the strength properties of soil by addition of ESP and QD will help to find an application for waste materials to improve the properties of clayey soil and can be used as a better stabilizing agent.*

Keywords: *Soil Stabilization, Egg shell powder, Quarry dust, soil properties*

I. Introduction

Stabilization is the alteration of foundation soils to conform to desired characteristics or the improvement of a less stable soil in both strength and durability. Many soils are subject to differential expansion and shrinkage when they undergo changes in moisture content. Many soil also move and rut when subjected to moving wheel loads. It is therefore usually necessary to stabilize them to reduce the volume changes and strengthen them to the point where they can carry the imposed load, even when they are saturated. Stabilization is the alteration of foundation soils to conform to desired characteristics or the improvement of a less stable soil in both strength and durability. Eggshell Powder (ESP) has not being in use as a stabilizing material and it could be a good replacement for industrial lime, since its chemical composition is similar to that of lime. Chicken eggshell is a waste material from domestic sources such as poultries, hatcheries, homes and fast food centers. This amounts to environmental pollution. Eggshell waste falls within the category of waste food, they are materials from the preparation of foods and drinks, if subjected to adequate scrutiny, and they could be suitable for soil stabilization.In the present study, Egg Shell Powder (ESP) and Quarry Dust (QD) were used to study the effect on the properties of clayey soil. An improvement in the strength properties of soil by addition of ESP and QD will help to find an application for waste materials to improve the properties of clayey soil and can be used as a better stabilizing agent.

II. Objective

To study the Improvement on the Properties of Clayey Soil with the addition of wastes such as, Egg Shell Powder and Quarry Dust at varying percentages.

III. Methodology

The soil sample was collected from a site near Kalamassery. The sample was thoroughly oven dried, weighed and stored in sacks at room temperature.

The Egg Shell was collected from the nearby hotels and college ladies hostel. The Egg Shells, as per the requirements, was incinerated at 78^{o}C, for 6 hours and was finely powdered to a size finer than 150 µ and was sieved through 75µ, and used as one of the addictives.

Quarry dust, which was the second addictive and was collected from a crusher at Pareekanni, and was sieved through 75µ IS sieve, before use.

- Specific Gravity of Egg Shell powder used =1.31
- Specific Gravity of quarry dust used = 2.85
- Percentages of ESP used: 1,3,5,10,15,20,25,30
- Percentages of QD used: 10,20,30

In the present study, Egg Shell Powder (ESP) and Quarry Dust (QD) were used to study the effect on the properties of clayey soil. The tests conducted to study the effect of ESP and Quarry dust on soil properties were Atterberg's limit, standard proctor test, direct shear test, permeability test, and consolidation. First the influence of ESP on soil properties was found and from which the optimum percentage of ESP was selected. Then with optimum percentage of ESP the Quarry dust was added and the influence was found.

IV. Results And Discussions

The general properties of the soil were determined and shown in table 1

TABLE 1: General Soil Properties

PROPERTIES	RESULT
Water Content (%)	28.3%
Specific Gravity of Soil	2.78
Permeability (cm/s)	7.1×10^{-5}cm /s
Liquid Limit (%)	52%
Plastic Limit (%)	30.67%
Plasticity Index	21.33%
Optimum Moisture Content	26%
Maximum Dry Density	1.51g/cc

TABLE 2:Grain size analysis

PROPERTIES	RESULT
Effective size, D_{10}	12µ
Uniformity coefficient, C_U	5.83
Coefficient of curvature,C_c	0.744
Percentage gravel	0
Percentage sand	13
Percentage silt and clay	87
Percentage clay	4

4.1 Influence of Egg Shell Powder on soil properties

4.1.1 Atterberg's limits

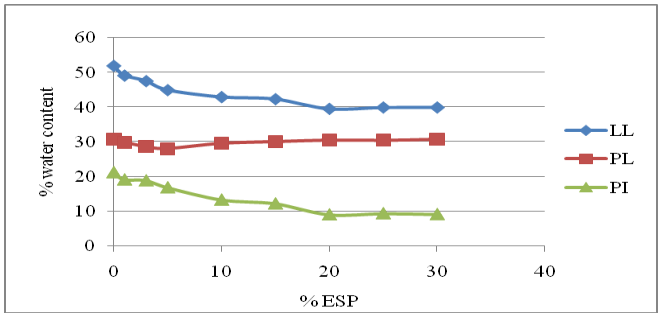

Fig. 1: Variation of Atterberg's limits with ESP

The plasticity index of the clay was 21.33% with a liquid limit of 52.0% and plastic limit of 30.67%, indicating that that the clay is of high plasticity. Figure 1 shows that, up to 20% of ESP is added, there is a considerable decrease in Atterberg,s Limits, and after that the value seems to be almost constant. So egg shell powder - soil mix gives optimum at about 20% for plasticity index.

4.1.2 Standard proctor test

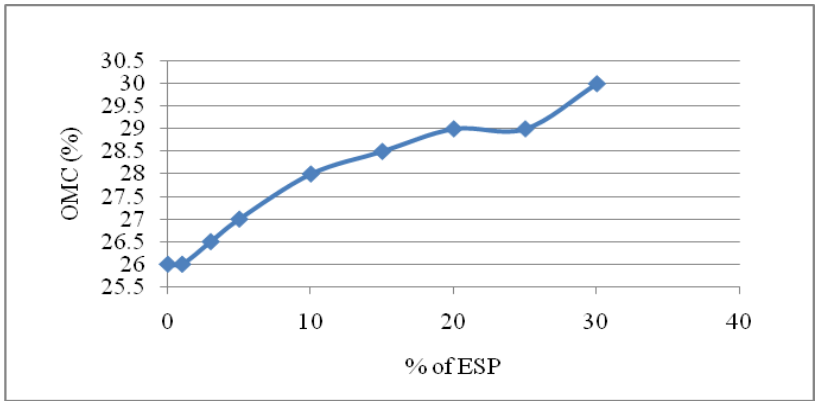

Fig. 2: Variation of OMC with ESP

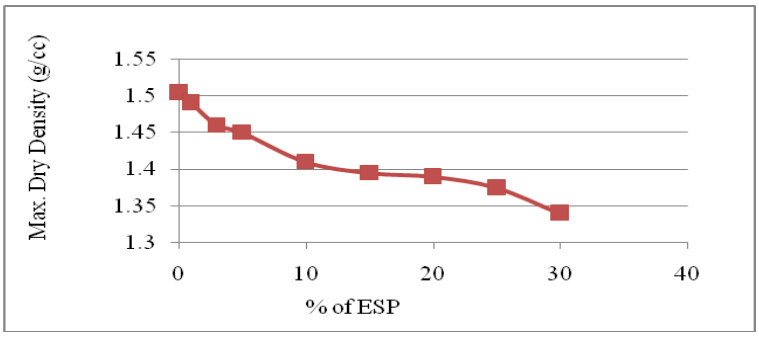

Fig. 3: Variation of maximum dry density with ESP

It can be inferred from figure 2 that there is increase in OMC with increase ESP. The increase is due to the addition of ESP, which decreases the quantity of free silt and clay fraction and coarser materials with larger surface areas were formed (these processes need water to take place). This implies also that more water is needed in order to compact the soil-ESP mixture. The MDD decreases by increasing the content of ESP. The decrease in the MDD can be attributed to the replacement of soil by the ESP which has relatively lower specific gravity (1.32) compared to that of the raw soil which is 2.78.

4.1.3 Direct shear test

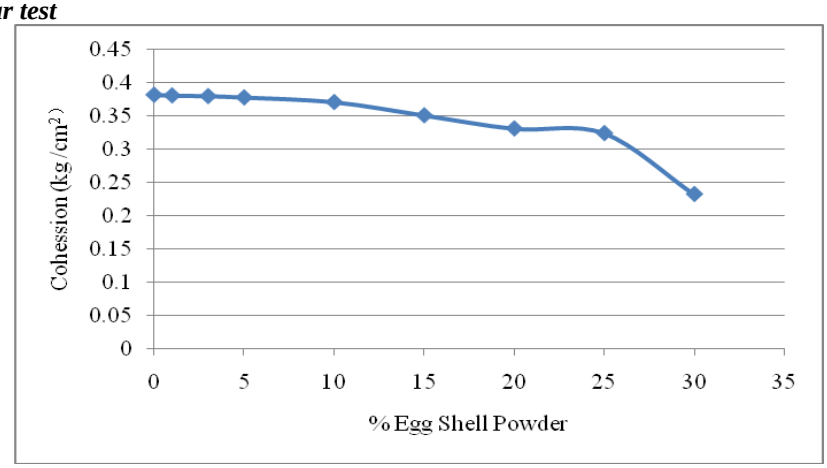

Fig. 4: Variation of Cohesion with Varying % of ESP

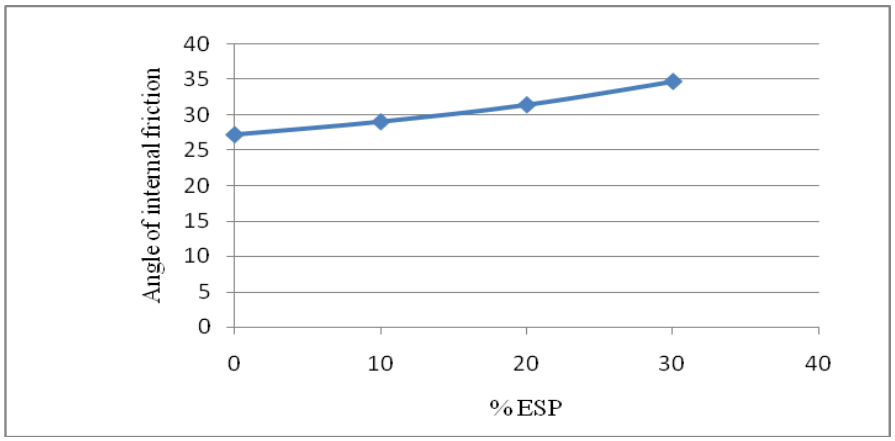

Fig. 5: Variation of Angle of Internal Friction with Varying % of ESP

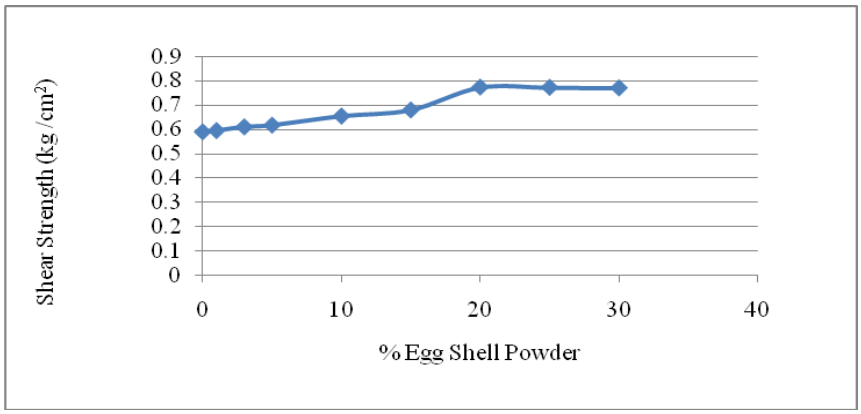

Fig. 6: Variation of Shear Strength with Varying % of ESP

From the figures 4 it has been found that with the increase in the percentage of ESP, the cohesion of the soil goes on decreasing. From the figures 5 it has been found that with the increase in the percentage of ESP, the angle of internal friction of the soil goes on increasing. This is attributed to the reduction in clay content of soil with increase in ESP percentage, ESP soil mixes have higher angle of internal friction values than the soil. By using Mohr – Coulomb's equation shear strength was calculated. It was found from figure 6 that with increase in percentage of ESP the shear strength increased, later on there is slight decrease in graph at 25% ESP. So the optimum value of shear strength was around 20% with ESP as additive.

4.1.4 Permeability

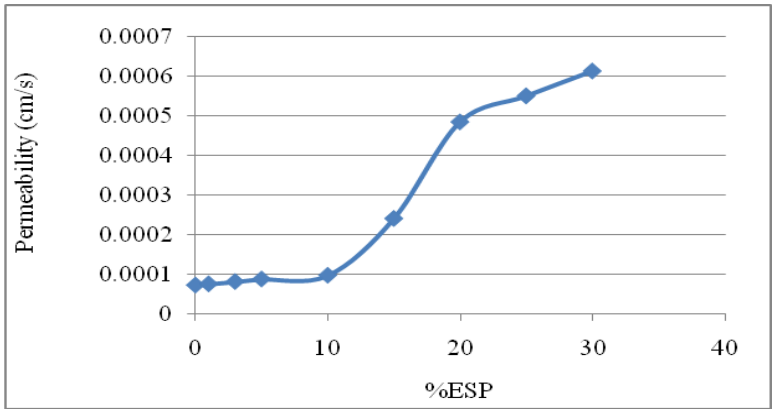

Fig. 7: Variation of Permeability with ESP

It can be inferred from figure 7 that the permeability goes on increasing with increase in percentage of ESP. Addition of ESP on expansive clayey soil increases the porosity which led to increase in permeability.

4.1.5 Consolidation

It can be inferred from figure 8 that the coefficient of consolidation increases with increase in percentage of ESP and from figure 9 compression index decreases with increase in percentage of admixture. This is due to the increase in porosity with addition of additive.

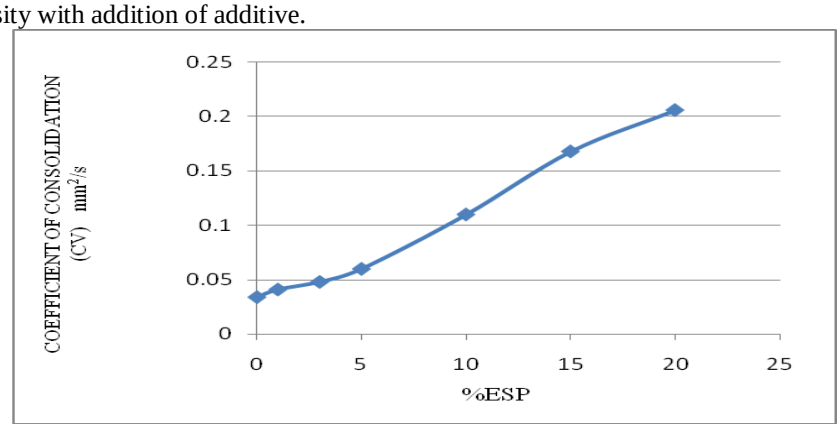

Fig. 8: Variation of Cv with ESP

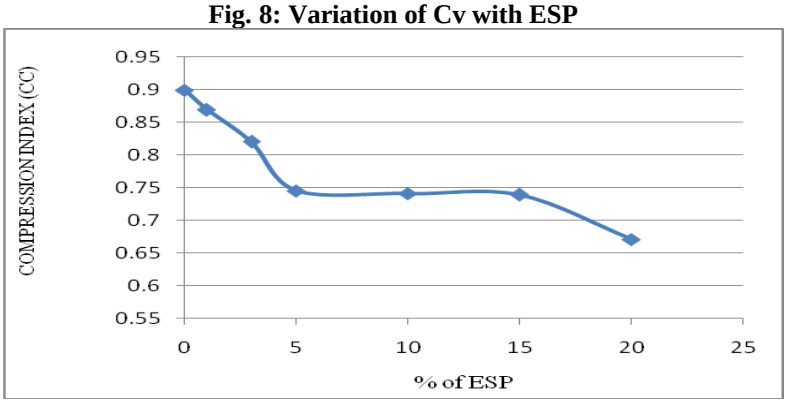

Fig. 9: Variation of compression index with ESP

From the experiments conducted with ESP, 20% was obtained as optimum percentage of egg shell powder. Then experiments were conducted with optimum percentage of egg shell powder and varying percentage of quarry dust.

4.2 Influence of Quarry Dust on soil properties

4.2.1 Atterberg's limits

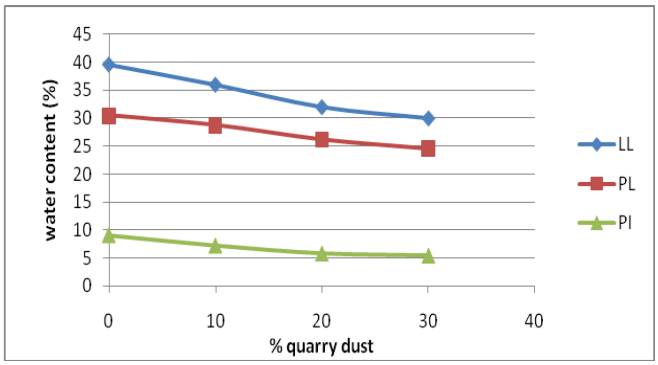

Fig. 10: Variation of LL, PL & PI with optimum percentage of ESP and varying percentage of QD

Result of L.L, P.L & P.I tests on clay treated with ESP & QD are shown in the Figure 10, it is observed that as the percentage of additive increases, there is a reduction in liquid limit, plastic limit and plasticity index of clay tested. From this, it can be deduced that the plastic characteristics of the soil sample are gradually decreasing with increase in the percentage of ESP & QD.

4.2.2 Standard proctor test

The MDD increases by increasing the content of QD. This increase in MDD may be explained by considering the replacement of clay (2.78) with higher specific gravity QD (2.89).With increase in percentage of quarry dust the OMC of soil goes on decreasing. This is attributed to the reduction in clay content of soil by replacement with quarry dust which have less attraction for water molecules.

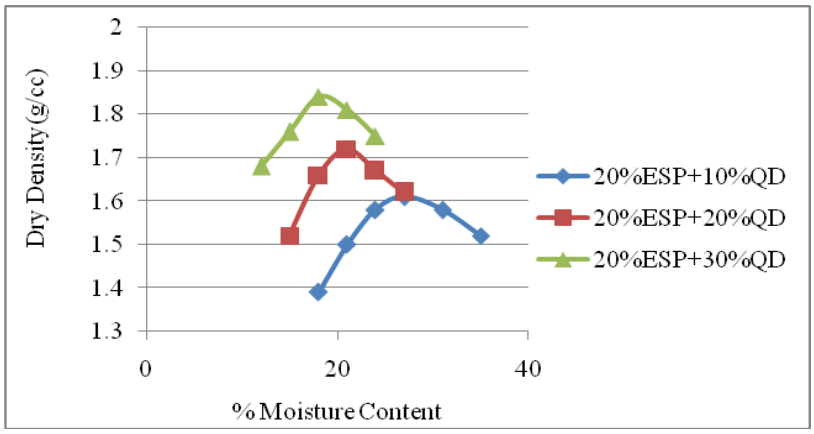

Fig. 11: Variation of OMC & Max Dry Density on ESP&QD

4.2.3 Direct shear test

From the figure 12 it has been found that with the increase in the percentage of ESP & QD, the cohesion of the soil goes on decreasing. From the figures 13 it has been found that with the increase in the percentage of ESP & QD, the angle of internal friction of the soil goes on increasing. This is attributed to the reduction in clay content of soil with increase in ESP & QD percentage, ESP & QD mixes have higher angle of internal friction values than the soil. By using Mohr – Coulomb's equation shear strength was calculated. It was found from figure 14 that with increase in percentage of ESP & QD the shear strength increased.

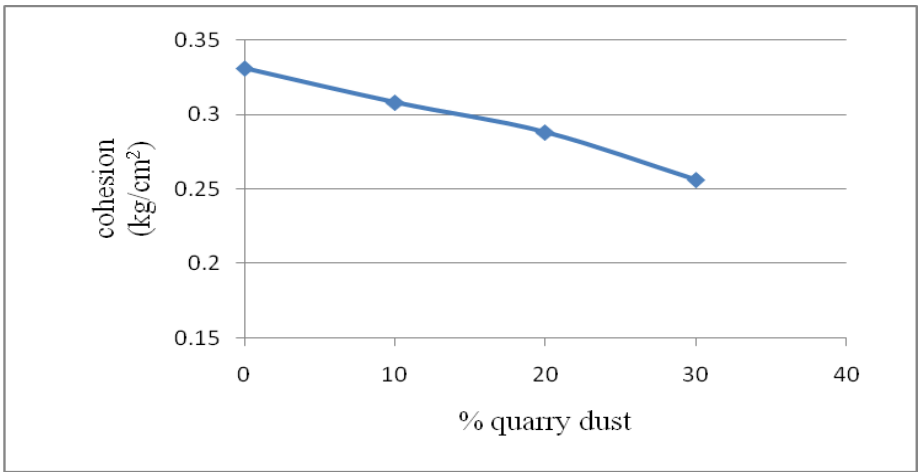

Fig. 12: Variation of cohesion with optimum % of ESP and varying % of QD

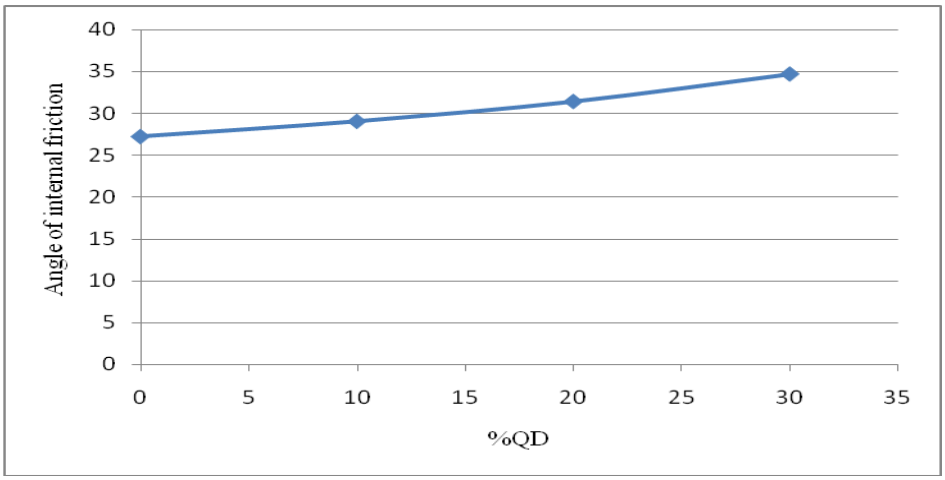

Fig. 13: Variation of Internal angle of friction with optimum % of ESP and varying % of QD

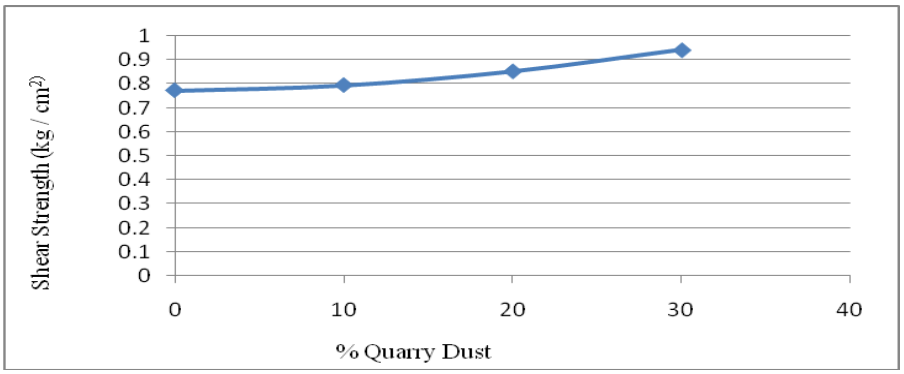

Fig. 14: Variation of shear strength with optimum % of ESP and varying % of QD

4.2.4 Permeability

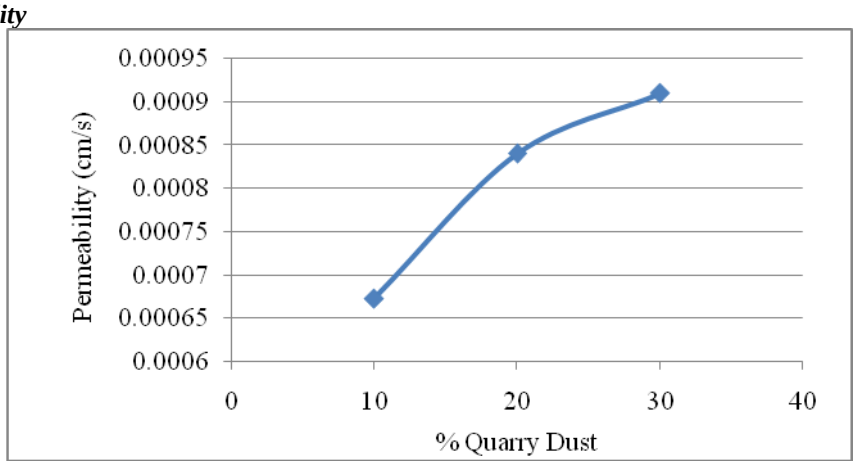

Fig. 15: Variation of Permeability with Optimum % of ESP and varying %s of QD

It can be inferred from figure 15 that the permeability goes on increasing with increase in percentage of ESP & QD. Addition of ESP & QD on expansive clayey soil increases the porosity which led to increase in permeability.

4.2.5 Consolidation

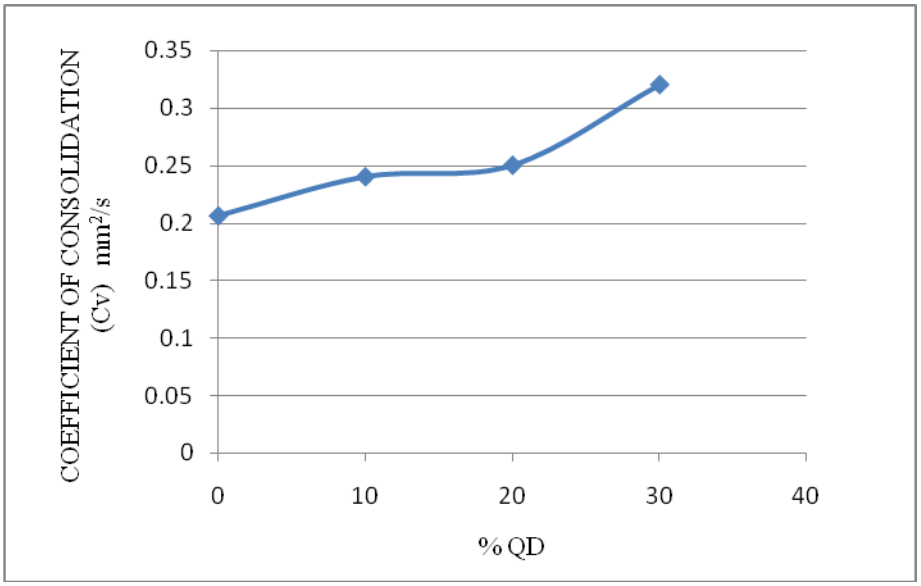

Fig. 16: Variation of coefficient of consolidation with optimum % ESP and varying % of QD

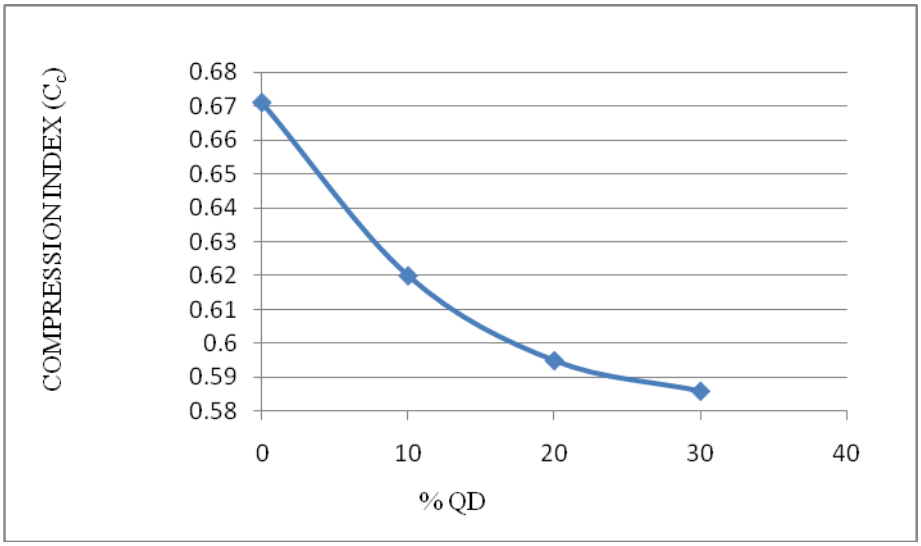

Fig. 17: Variation of compression index with optimum percentage of ESP and varying percentage of QD

It can be inferred from figure 16 that the coefficient of consolidation increases with increase in percentage of ESP & QD and from figures 17 compression index decreases with increase in percentage of additive. This is due to the increase in porosity with addition of additive.

V. Conclusion

The following conclusions can be drawn on the basis of the results obtained and discussions made in this study.

1. With addition of ESP, there is a considerable decrease in Atterberg's Limits, and after 20% the value seems to be almost constant.
2. OMC increases and maximum Dry Density decreases with increase in percentage of ESP.
3. With addition of varying percentage ESP Cohesion decreases and Angle of Internal Friction increases.
4. Shear Strength increases with increase in percentage of ESP and after 20% strength is almost constant.
5. Permeability increases with increase in ESP.

6. Coefficient of Consolidation increases and Compression Index decreases with increase in percentage of ESP.
7. From the analysis it is obtained that 20% of ESP gives considerable improvement in properties of clay soil. So 20% selected as optimum percentage.
8. Maximum Dry Density increases and Optimum Moisture Content decreases considerably with addition of optimum percentage of ESP and varying percentage of QD.
9. Shear Strength and Angle of Internal Friction increases and Cohesion decreases with addition of optimum percentage ESP and increase in percentage of QD.
10. Atterberg's limits decreases considerably with addition of optimum percentage of ESP and QD. PI is almost constant for 20% and 30% QD with optimum percentage of egg shell. Hence 20% ESP & 30% QD is selected as optimum percentage.

In the light of above observation it can be concluded that ESP along with QD used in combination with clay possessed certain properties which enables it to be used economically for improvement of clayey soil. Since Egg shell and Quarry dust are waste products, usage of same reduces the environmental problems.

References

[1]. IS 2720 Part- III/ Section2, 1997, "*Methods of Tests for soils*" (Specific Gravity), BIS, New Delhi.
[2]. IS 2720 Part- IV, 1995, "*Methods of Tests for soils*" (Grain Size Analysis), BIS, New Delhi.
[3]. IS 2720 Part- V, 1995, "*Methods of Tests for soils*" (Atterberg Limits), BIS, New Delhi.
[4]. IS 2720 Part- VIII, 1997, "*Methods of Tests for soils*" (Proctor's Compaction Test), BIS, New Delhi.
[5]. IS 2720 Part- X, 1991, "*Methods of Tests for soils*" (Direct Shear), BIS, New Delhi.
[6]. Mehdhi Gharib, "*Laboratory Investigation on the Effect of Egg Shell Powder on the Plasticity Index in Clay and Expansive Soils*", European Journal of Experimental Biology, 2012, vol:2(6), pp: 2378-2384.
[7]. A. V. Narasimha Rao, "*Applications of Agricultural and Domestic Wastes in Geotechnical Applications: An Overview*", Journal of Environmental Research and Development, 2011, vol:5(3), pp: 202-208.