

Use of Quarry Dust for Stabilising Expansive Soil

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ABSTRACT: The Stabilization of soil is important in construction of foundations and highways as it improves the Engineering properties of soil like Compressibility, Permeability and Shear Strength. . In this paper the experimental results obtained in the laboratory on expansive soil treated with low cost material (quarry dust) are presented. A study is carried out to check the improvements in the properties of expansive soil with addition of quarry dust in different percentages. The test results for as Atterberg's limit, compaction characteristics, differential Free Swelling Index, Unconfined Compressive Strength obtained from the tests on expansive clays mixed with different proportions of quarry dust as a admixture are presented and discussed in this paper. It is observed that the stabilized clay has reduced the Swelling and increased the maximum dry density.

KEYWORDS: Expansive Soil, Quarry dust, OMC, MDD, UCS, Cohesion

I. INTRODUCTION

Due to the presence of a clay mineral montmorillonite in expansive soil they exhibit alternate swelling and shrinkage when they are subjected to moisture content. Variations leading to so many geotechnical problems. In India this soil covers 20% of total soils. There are so many methods available to improve the engineering properties of expansive soil to make it suitable for construction activity. Quarry Dust is an industrial waste obtained from stone crushing/rock Quarries. Stabilization of expansive soil using Quarry Dust /powder without using a binding material like lime, cement etc. is one of them.

II. LITERATURE SURVEY

Quarry Dust is used as an effective admixture to stabilization of expansive soil as reported by many researchers. Some of them mention below.

1. Sridharan et. al (2005) , reported that quarry dust showed high Shear Strength and is beneficial for its use as a Geotechnical material.
2. Ali and Koranne (2011) used fly ash and stone dust in the proportions of 1:1 up to 50% to an expansive soil. Tests were conducted to determine Liquid Limit, Plastic Limit, IS heavy Compaction characteristics, Unconfined Compressive Strength (UCS), Free Swell Index and Soaked CBR values. Strength was reported to increase.
3. Sabat (2012), conducted tests for Atterberg's Limits, Compaction characteristics (Modified Proctor), Shear Strength parameters using lime with expansive soil stabilized with Optimum percentage of quarry dust (40%). Increase in percentage of addition of lime, decreased Liquid limit, Plasticity Index, Maximum Dry Density whereas Plastic Limit, Shrinkage Limit, Cohesion and Angle of internal friction, Optimum Moisture Content of the soil –quarry dust mixes increased. Addition of lime had made the soil –quarry dust mixes durable. Curing had positive effects on shear strength parameters and maximum values were reported at 5% addition of lime and 28 days of curing.
4. Satyanarayana et. al (2013) had reported that the strength characteristics of compacted crushed stone mixes through a series of CBR tests by varying the crushed dust.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

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Review of literature reveals various dust materials are used for improving/varying the properties of expansive soils. (Quarry Dust (Sabat, 2012), marble dust (Sabat and Nanda, 2011; Palaniappan and Stalin, 2009), baryte powder (Srinivasulu and Rao, 1995), , brick powder (Abd EI Aziz and Abo-Hashema, 2012) are some them collected from literature).

Limited research is available done on the effect of Quarry Dust on different geotechnical properties of expansive soil. The present paper discusses the properties of selected expansive soil and quarry dust mixed into it in different proportions. Index properties (Liquid Limit, Plastic Limit, Plasticity Index), Compaction properties (Optimum Moisture Content (OMC) and Maximum Dry Density (MDD)) Unconfined Compressive Strength (UCS) are considered in this investigation.

III. EXPERIMENTAL PROGRAM

Materials

Soil :

The expansive soil used in the experimental work was brought from Tirupati near Tiruchanoor, adjacent to National Highway (NH9).

The geotechnical properties of the expansive soil are presented in the table1 given below.

S.NO	PROPERTY	VALUE
1	% Gravel	0.62
2	%Sand	43.38
3	%Silt+Clay	56
4	Liquid Limit (%)	44
5	Plastic Limit (%)	20
6	Plasticity Index (%)	24
7	IS Classification	CI
8	Differential Free Swell Index (DFSI %)	323
9	Optimum Moisture Content (OMC) %	12
10	Maximum Dry Density (MDD) KN/m ³	19.14
11	Unconfined Compressive Strength (UCS) KN/m ²	133

Quarry Dust:

The Quarry Dust which is used for this investigation was collected from locally available quarries located in Tirupathi.

The geotechnical properties of the Quarry Dust are:

S.No	Property	Values
1	Grain size distribution:	
1.1	Gravel (%)	3
1.2	Sand (%)	94
1.3	Fines (%)	
1.4	a.silt(%)	3
1.5	b.clay(%)	0
2	Consistency:	
2.1	Liquid limit(%)	NP
2.2	Plastic limit(%)	NP
2.3	Specific gravity	2.71
3	Compaction characteristics:	
3.1	Optimum moisture content (OMC %)	12.6
3.2	Maximum dry density(MDD) KN/m ³	19.1
4	Shear parameters	
4.1	Angle of shearing resistance(degree)	35

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

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IV. METHODS ADOPTED

The Quarry Dust which is passing through 4.75mm sieve was collected and mixed with the expansive soil from 0% to 25% at an increment of 5%. Totally 6 samples were prepared.

Tests for finding Liquid Limit, Plastic Limit, Differential Free Swell Index, compaction parameters(OMC&MDD), strength using Unconfined Compressive tests, were conducted on these prepared samples according to the relevant Indian Standard (IS) Codes.

V. ANALYSIS OF TEST RESULTS

The variations of Liquid Limit of expansive soil treated with different percentage of quarry dust are shown in Figure1.

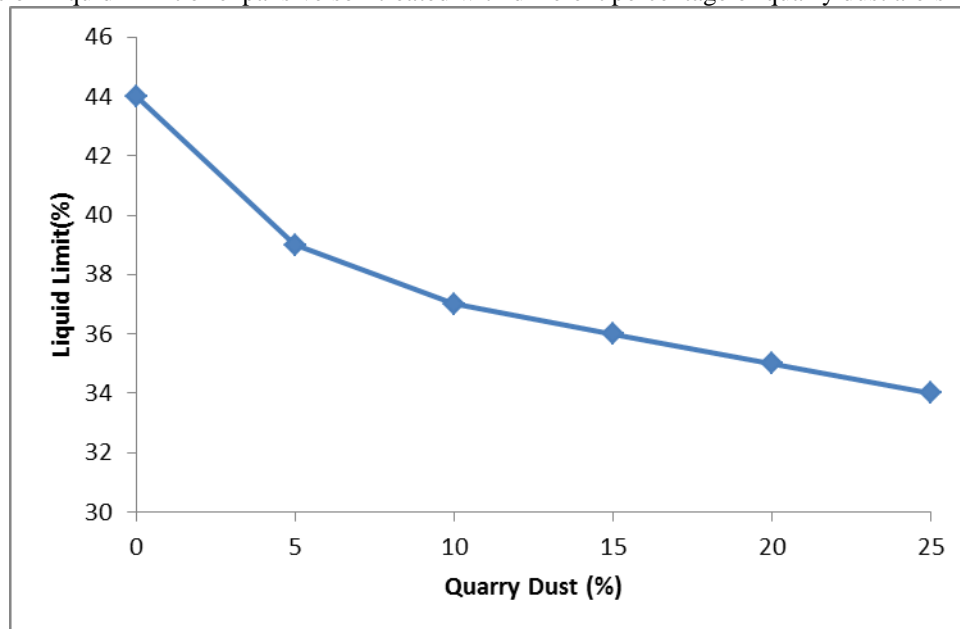


Figure 1: Variation of Liquid Limit with Quarry dust percentage

From the above figure it can be observed that with increase in percentage of Quarry Dust the Liquid Limit of soil is found to be decreasing from 0 to 25%.

International Journal of Innovative Research in Science, Engineering and Technology

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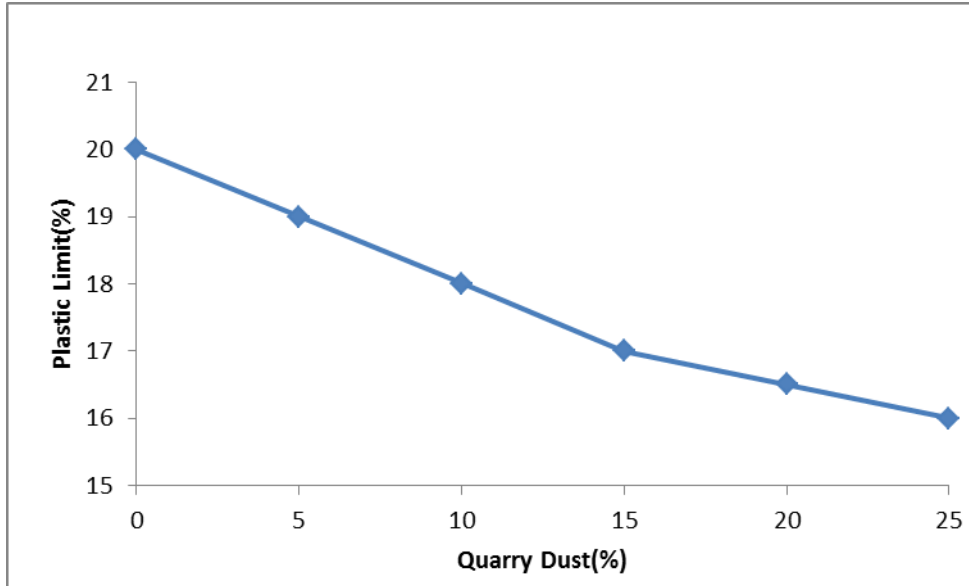


Figure 2: Variation of Plastic limit with percentage of Quarry dust

The variations of plastic limit of expansive soil treated with different percentages of quarry dust are shown in Figure 2. From the figure depicts that with increase in percentage of quarry dust from 0 to 25%, the plastic limit of soil is decreasing from 20% to 16%.

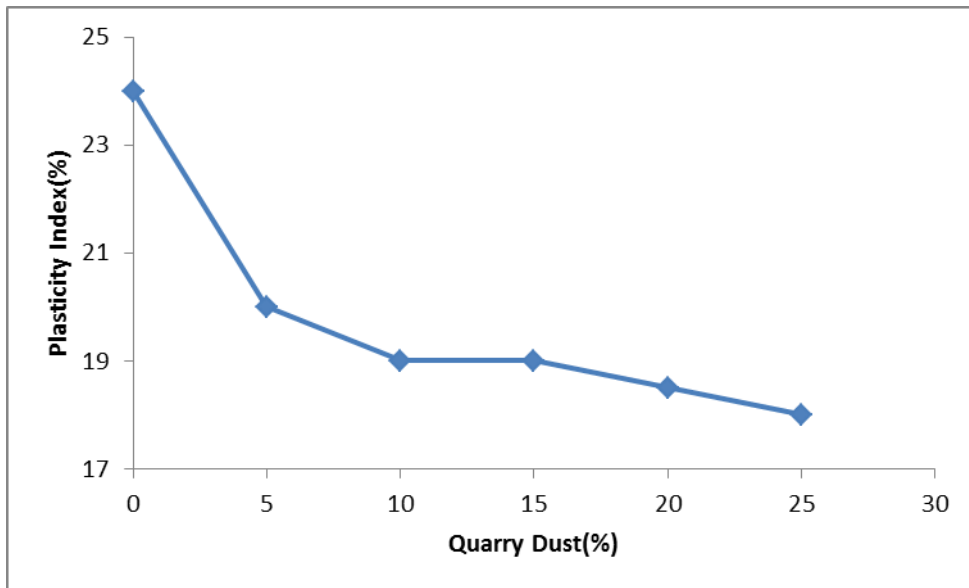


Figure 3: Variation of Plasticity Index with percentage of Quarry dust

The variation of Plasticity Index with percentage of quarry dust is shown in Figure 3. From the figure it can be observed that the Plasticity Index goes on decreasing from 24% to 18% with addition of Quarry dust from 0% to 25%.

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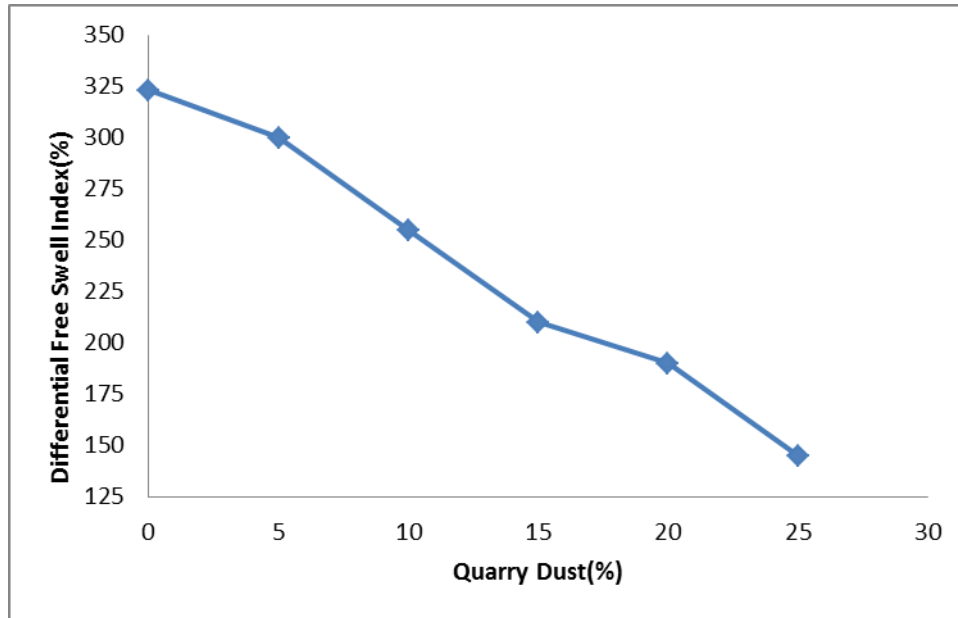


Figure 4: Variation of Differential Free Swell Index with Percentage of Quarry Dust

The variation of Differential Free Swell Index with percentage of Quarry Dust is shown in Figure 4. From the figure it can be observed that the Differential Free Swell Index is decrease from goes on decreasing with addition of Quarry dust from 0% to 25%.

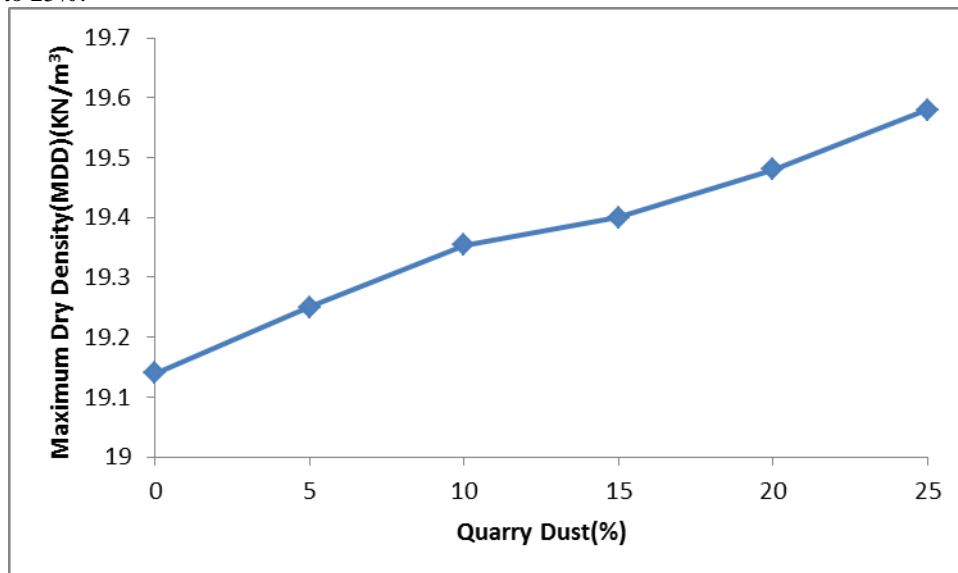


Figure 5: Variation of Maximum Dry Density with percentage of Quarry Dust

The results of standard Proctor tests on expansive soil treated with different percentages of Quarry Dust are shown in Figures 5 and 6. Figure 5 shows the variation Maximum Dry Density (MDD) with percentage of Quarry Dust. With

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increase in percentage of Quarry Dust, the Maximum Dry Density (MDD) of soil goes on increasing. The Maximum Dry Density (MDD) increases from 19.14KN/m³ to 19.58KN/m³ when quarry dust is increased from 0 to 25%

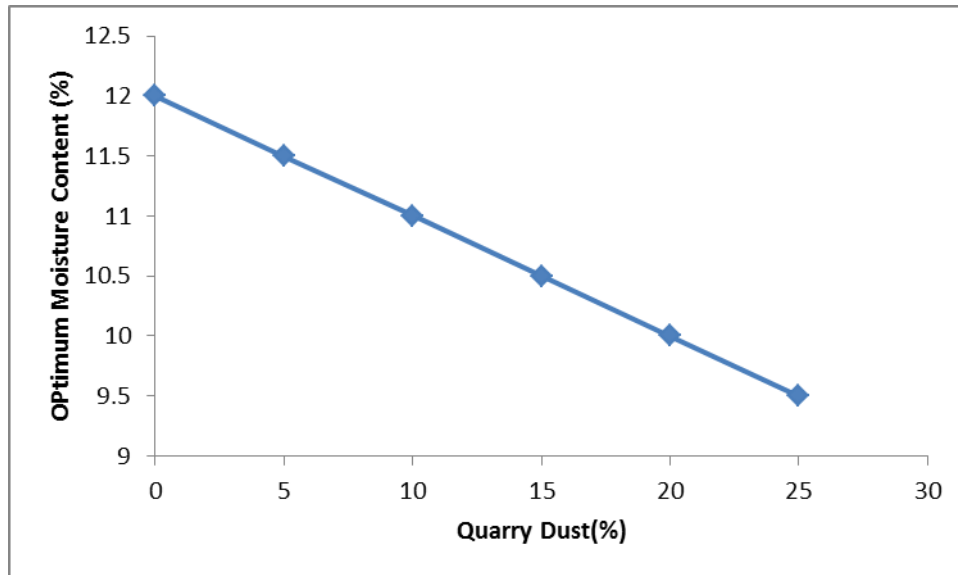


Figure 6: Variation of Optimum Moisture Content (OMC) with percentage of Quarry Dust

The above figure shows the variation Optimum Moisture Content (OMC) with percentage of Quarry Dust. With increase in percentage of quarry dust, the Optimum Moisture Content (OMC) of soil is decreasing. The Optimum Moisture Content (OMC) decreases from 12% to 9.5% when quarry dust is increased from 0 to 25%.

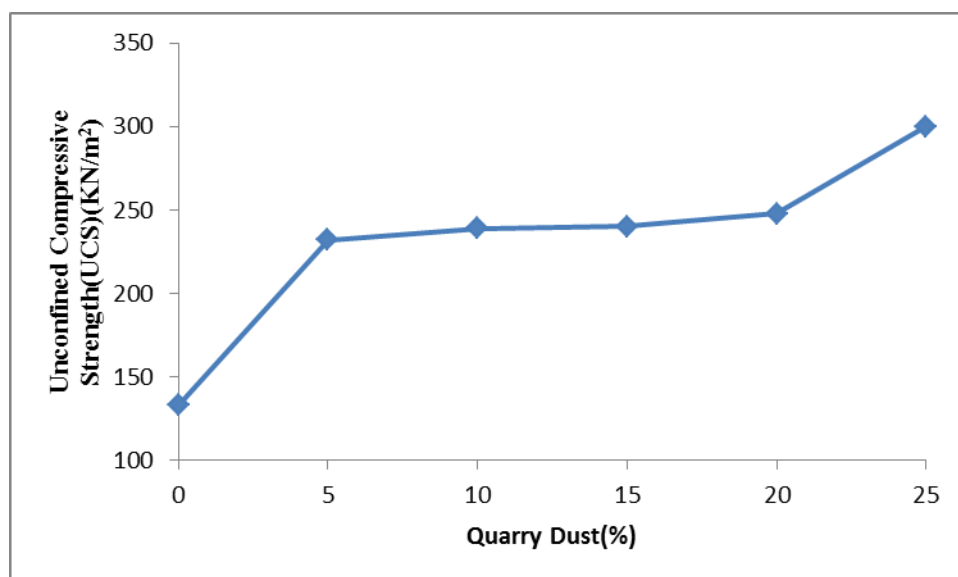


Figure 7: Variation of Unconfined Compressive Strength (UCS) with percentage of Quarry Dust

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The results of Unconfined Compressive Strength (UCS) tests on expansive soil treated with different percentages of quarry dust are shown in Figure 7. From the figure it can be observed that with increase in percentage of quarry dust, the Compressive Strength of soil is increasing. The Unconfined Compressive Strength (UCS) increases from 0 to 25%.

VI. CONCLUSIONS

A series of laboratory tests were conducted to study the effects of quarry dust on the, Plasticity Characteristics, Differential Free Swell Index, Compaction Characteristics (MDD, OMC) and Compressive strength of an expansive soil collected from Tiruchanoor in Tirupati beside National Highway(NH9). Based on the observations and discussions, following conclusions are drawn from this study.

- The Liquid Limit, Plastic Limit and Plasticity Index are on decreasing with addition of quarry dust in different percentages.
- The Maximum Dry Density (MDD) is on increasing and Optimum Moisture Content (OMC) is decreasing with increase in percentage of Quarry Dust.
- The Unconfined Compressive Strength (UCS) is increasing with increase in percentage of Quarry Dust.
- The Differential Free Swell Index (DFSI) is decreasing with increase in percentage of Quarry Dust.

From the above conclusions drawn it can be inferred that Quarry Dust can be used as stabilizing admixture for expansive soil.

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