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Stabilization of Black Cotton Soil using Waste Material Quarry Dust

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Abstract:- **Nowadays use of waste material are increasing due to its good engineering properties as well as its economy. When soil having a poor quality like Black Cotton Soil is available at the site of construction, the best parameter is to improve the properties of black cotton soil. Also, nowadays the increase in population growth, industrialization and development of different kinds of technology has drawn to uncontrollable storage of waste. Thus, proper disposal of this type of waste is become great importance in both urban and rural areas. The dust which is generally coming out from the aggregate crushing industries, namely called Quarry Dust which is harmful to the human health as well as environment also. This paper presents the different test for black cotton soil with addition of quarry dust (i.e. 05%, 10%, 15%) such as Atterberg's Limit, Compaction Test, California Bearing Ratio Test and unconfined compressive strength Test and the satisfactory results were obtained up to the addition of 10% of quarry dust and beyond 10% amount of quarry dust, results are not effective.**

Keywords: Soil Stabilization, Black Cotton Soil, Quarry Dust

I.INTRODUCTION

Natural soil is a complex material. Also, it is variable material. There is variation in the properties of soil at different places. There is also variation in the properties of black cotton soil with depth, loading; drainage as well as environmental conditions the variations in properties is observed. There is a mineral generally known as montmorillonite which presents in black cotton soil and it is responsible for the behaviour of shrinkage and swelling of soil is subjected to water. This variation creates so many geo technical problems. In India there is about 20% soil is black cotton soil.

There is so many methods are available to improvement of black cotton soil. Soil stabilization is carried out to improve soil strength and to increase resistance to softening by water through bonding the soil particles together. Also, it is done for water proofing the particles or combination of the two processes. Compaction and drainage are the simplest process of stabilization, which improve inherent shear strength of the black cotton soil. The improvement of gradation of particle size also comes under soil stabilization. The soil stabilization can be done by mixing weak soils with binders that can be mechanical stabilization, stabilization with cement, lime, bitumen and chemicals etc. To achieve desirable engineering properties in soft soils (like silt, clayey peat or organic soils), the stabilization of soils undertaken.

Lime is an inorganic mineral which contains mainly calcium and carbonates, oxides and hydroxides. Generally, lime and cement are most commonly used stabilizers for enhancing the poor soil properties. The solid waste materials such as Fly Ash, quarry dust can also be used as soil stabilizing materials. Rice husk ash is also used but it cannot be used alone for stabilization of black cotton soil because of it has lack of cementitious pproperties. So, it is used with a binder like Lime, cement, lime sludge, Calcium chloride etc. In this paper, the properties of the black cotton soil stabilized with different proportions of quarry dust are found.

Quarry dust is the by-product of extraction and processing of aggregates. Every year 20 MT quarry dust is produced in India. Generally, the quarry waste has a size below 90 microns. Quarry dust is the waste which is hazardous and effects the environment and human health. To eliminate the negative effect of these waste materials, these can be disposed in a proper and safe manner. Also, to ensure a more economically viable disposal, these are blended with other construction materials like clayey soil then it can be used best for various construction purposes like sub grade, foundation base and embankments. Quarry dust exhibits high shear strength which is highly beneficial for its use as

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a geotechnical material **Soosan et al., (2001a)**. It has a good permeability and variation in water content does not seriously affect its desirable properties. Figure 1 represents the quarry waste at the site.

Fig.1 Quarry waste at site

The waste materials must be disposed in proper and safe manner to eliminate the negative effect of them. To meet the engineering requirements, the technique used which improves the properties of expansive soil is called Soil stabilization. If these materials can't be disposed of properly and its disposal is not economically possible, but it is blended with other construction materials like clayey soil then it can be used best for various construction purposes like sub grade, foundation base and embankments. It removes environmental problems as well as also contribute to the economy. Quarry dust is having higher shear strength then other wastes, which is highly beneficial for its use as a soil stabilizer. With addition of quarry dust, the dry density increased with decrease in optimum moisture content.

II. LITERATURE REVIEW

A. General:

Compaction, chemical soil stabilization, soil replacement and soil reinforcement are used to improve soil properties. Soil stabilization is the process which improves the engineering properties of the black cotton soil and thus making it more stable. Generally, when the soil available at site is not much suitable for the intended purpose, the soil stabilization is required. Various researches have been done using different proportions of quarry dust for the stabilization of black cotton soil.

B. Review of literature (Quarry Dust):

- Naman Agarwal (2015) carried out tests such as compaction, specific gravity and CBR in the laboratory on expansive clays with different proportions of stone dust by dry weight of soil and from the test results, addition of stone dust to BC soil decreases its OMC and increases MDD, CBR value increased nearly by 50% by adding 30% stone dust and is found to be optimum.

- Akanbi and Job (2014) done research on suitability of stabilized black cotton soils with cement and quarry dust for road sub base and foundations by mixing with 0-6% cement and 0-20% quarry dust by weight of dry soil. The laboratory tests like California Bearing Ratio (CBR), Unconfined Compressive Strength (UCS) and compaction and from the test results, there is an improvement in the Atterberg's limit of the soil, decrease in the plasticity index (PI), liquid limit (LL), plastic limit (PL) and an increase in maximum dry density (MDD) with increase in quarry dust content in all cement proportions used. It was also observed that as QD increased the UCS and CBR values of the stabilized black cotton soil increased with compactive effort. The peak UCS value of 1880kN/m2 was obtained for soil stabilized with 6% cement and 20% QD contents and 186% for CBR. Stabilized black cotton soil with 6% cement and 20% QD results in savings of approximately 20% cost compared with the only cement stabilized soil.

- Arun Kumar, Kiran B. Biradar (2013) studied the effect of quarry dust mixed in different % of expansive soil. From the experimental results, addition of the Quarry dust to the soil reduces the clay content and thus increases the percentage of coarser particles, reduces the Liquid limit by 26.86% and plasticity index by 28.48% of unmodified soil and OMC of soil is decreased by 36.71%, Maximum dry density of soil is increased by 5.88% by addition of (40%) Quarry dust and it is also identified that addition of (40%) Quarry dust yields high CBR value.

III. MATERIALS USED

A. Black Cotton Soil:

The soil used in this project is a black cotton soil collected from Jarimora village,Mandavi Taluka,Surat district, Gujarat State of India. The black cotton soil was collected by method of disturbed sampling after removing the top soil at 150mm depth and transported to the laboratory. The soil was air dried and sieved with is sieve 425 as required for laboratory test. The index and engineering properties of the black cotton soil were determined as per IS codes and are presented in table- I.

Laboratory Test	**Symbol**	**Results**	**Relevant IS Codes**
Atterberg's limits			
Liquid Limit	WL	72.62	IS 2720 Part V
Plastic Limit	WP	26.54	IS 2720 Part V
Plasticity Index	PI	46.08	IS 2720 Part V
Specific Gravity	G	2.53	IS 2720 Part III
Compaction Parameters			
Optimum Moisture Content (%)	OMC	14.29	IS 2720 Part VIII
Maximum Dry Density (gm/cc)	MDD	1.67	IS 2720 Part VIII
CBR value (Unsoaked)	CBR	11.53	IS 2720 Part XVI
CBR value (Soaked)	CBR	2.00	IS 2720 Part XVI
Shear Strength Parameters			
Cohesion (kg/cm2)	C	0.17	IS: 2720 Part-13-1986
Unconfined Compressive Strength (kg/cm2)	UCS	0.34	IS 2720 Part X
Differential Free Swell	DFS	100	IS 2720 Part XI

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B. Quarry Dust:

Quarry Dust for this study was collected from Chikhli, Surat, Gujarat, India. Quarry dust is the byproduct of the crushing process of rocks. It is the one type of industrial waste. It is the hazardous material for environment as well as human. It causes the Air pollution. It has a high shear strength due to which we can use as a stabilizer. It used as construction material to save material and cost. The shrinkage limit of this quarry dust obtained is 2.55.

IV. METHODS ADOPTED

The Quarry Dust which is passing through 4.75mm sieve was collected and mixed with the expansive soil from 0% to15% at an increment of 5%. Tests for finding the Atterberg's limits, Differential Free Swell Index, the compaction parameters (OMC & MDD), Unconfined Compressive strength, were conducted on the prepared samples as per the relevant Indian Standard (IS) Codes.

V. RESULT ANALYSIS

A. The Atterberg's Limit:

The variations of Liquid Limit, Plastic Limit and Plasticity Index of expansive soil treated with different percentage of quarry dust are shown in Figure2.

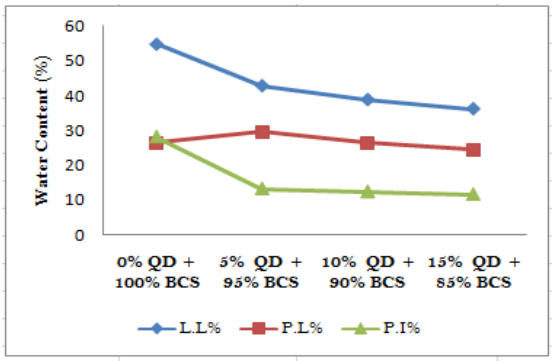

Fig 2 Variation of Atterberg's limit with Quarry dust percentage

From the above figure it can be observed that with increase in percentage of Quarry Dust the Liquid Limit, Plastic Limit and Plasticity Index of soil is
found to be decreasing. The values of LL,PL & PI at 10% QD + 90% BCS are 38.74%, 26.38% & 12.35% respectively.

B. The Differential free swell Index:

The variations of Differential Free Swell Index of expansive soil treated with different percentage of quarry dust are shown in Figure3.

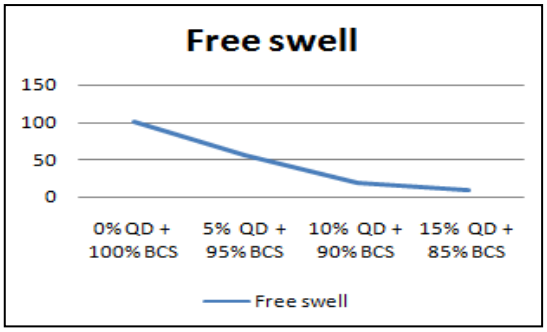

Fig 3 Variation of Differential free swell with Quarry dust percentage

From the above figure it can be observed that with increase in percentage of Quarry Dust the Differential Free Swell Index of soil is found to be decreasing. At 10% QD + 90% BCS, the free swell index value is 20%.

C. The compaction test:

The results of standard proctor test on the black cotton soil are shown in following figures. Fig 4 and fig 5 shows the variation in Max Dry Density and optimum moisture content with different percentage of quarry dust, respectively.

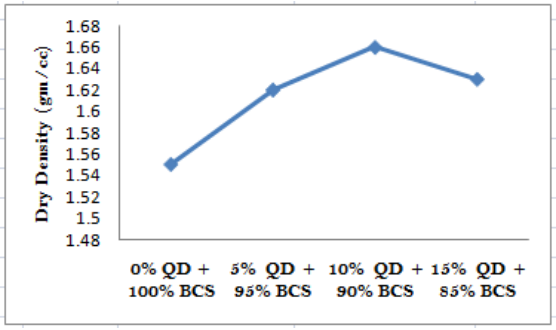

Fig 4 Variation of Dry Density with Quarry dust percentage

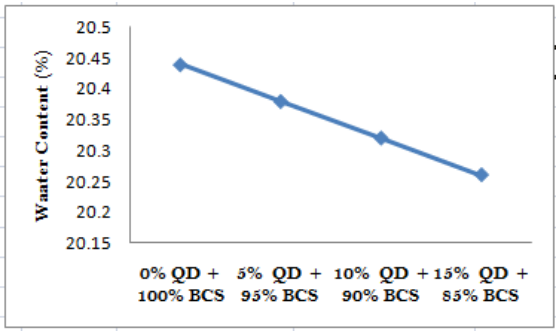

Fig 5 Variation of Moisture content with Quarry dust percentage

With increase in percentage of quarry dust, the moisture content of soil is decreasing and the dry density is increasing. The OMC and MDD obtained at 10% of Quarry Dust + 90% of black cotton soil are 20.32% and 1.66gm/cc respectively.

D. The unconfined compressive strength:

The figure below shows the variation in UCS with different proportions of QD and Black Cotton Soil.

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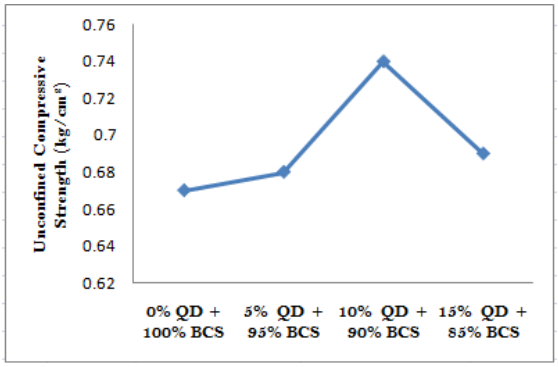

Fig 6 Variation of UCS with Quarry dust (%)

The maximum Unconfined Compressive Strength is obtained at 10% QD with 90% of black cotton soil is 0.74 kg/cm².

E. The California Bearing Ratio value:

From the CBR test, the obtained results are shown in following fig.7

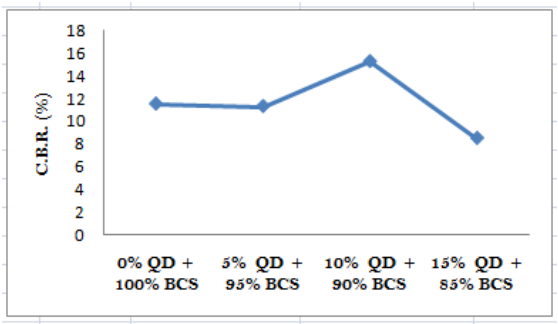

Fig 7 Variation of CBR value with Quarry dust (%)

The fig shows that at 10% QD + 90 % BCS, the results of CBR value are satisfactory. The CBR value obtained at 10% QD + 90 % BCS is 15.28%.

VI. CONCLUSION

On the basis of experiments conducted on the black cotton soil mixed qith quarry dust in different proportions, the following conclusions can be made.

- The Shrinkage limit and swell index of soil observed as 20.18% and 90% respectively which indicates high swelling properties of soil.
- The LL decreased from 54.8% to 38.74%, the PL decreased from 26.54 to 26.38% and the PI also decreased from 28.27% to 12.35% at 10% QD + 90 % BCS.
- The maximum dry density obtained at 10% QD + 90 % BCS is 1.66 gm/cc from 1.55 gm/cc and the moisture content decreased from 20.44% to 20.32 %.
- After equal amount of addition of quarry dust, it is concluded that up to 10% amount of quarry dust, the CBR value is increased from 11.53% to 15.28%.
- The UCS value increased from 0.67 kg/cm² to 0.74 kg/cm².

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