EFFECT OF QUARRY DUST AND SODIUM CHLORIDE ON THE COMPACTION CHARACTERISTICS OF EXPANSIVE SOIL

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Abstract : The key factor in construction sector is the soil investigation. To decide upon a stable construction, characteristics of soil are required to ascertain its feasibility. Properties of soils differ from area to area since they are of different classification/ types. Some soils i.e expansive soils are problematic soils due to their swelling and shrinkage nature. Many stabilization methods are in use in construction industry. Thus in this study, additives quarry dust and sodium chloride has been used to improve the compaction characteristics of the expansive soil. Using quarry dust as a additive is environment friendly where as sodium chloride involves less cost involvement. Quarry dust is used in percentages (10%, 15%, 20%) whereas sodium chloride is used in percentages (0.5%, 1%, 1.5%, 2%). Addition of these additives has significantly improved the compaction characteristics. Optimum combination of quarry dust and sodium chloride generated is in proportion 15% and 1% respectively.

Keywords **- Quarry dust , NaCl , black cotton soil.**

I. INTRODUCTION

The development of any country depends upon the development of infrastructure of that country and infrastructural development has been measured by the quantam of construction activities being executed in that country to enhance the infrastructure which ultimately lead to rise in the living standard of citizens of that country. The acceleration in the economic growth of a country is directly proportional to the growth in construction sector. The construction sector is the key sector which determine whether the country is progressing or not. If the country lacks the growth in construction sector, it is generally believed that the coutry is not progressing and it is a fact, as the growth, development, property, high living standard, economy of a country or its people is related to the infrastructural development of that country. The construction of any project cannot be imagined without the civil engineer is considered as best and will stay longer in the competition who works take all key factor like safety, acceptability, innovation and cost effectiveness while work on a specific project.

To design a project, the preliminary requirement is know about the nature of the soil on which the project is to be constructed or in other words, soil investigation is the key to design a project. In certain cases, the available soil is not upto the mark to construct or raise a civil structure on it and in such case the solution available is to stabilize/strengthen the soil strata to achieve desire strength to withstand structural thrust as well as climatic and atmospheric effects.

Soil Stabilization is generally referred to improve the soil properties by various methods to withstand the structure to be buit on it. Since the stability of the project depends on the soil therefore soil stabilization plays an important role. The expansive soil which varies with variation in climatic conditions has to be stabilized to meet site requirements. Using of additives quarry dust and sodium chloride increase the strength of soil significantly and that too with low cost involvement and is environment friendly measure.

Many researchers have done various studies about utilization of quarry dust and sodium chloride in soil stabilization. Afrin (2017) investigated the impact of chloride compounds on the stabilisation of clayey soils. The author performed experiments to investigate the impact of chloride compounds NaCl, Cacl2 and MgCl2 used in proportions of 0%, 4%, 8% and 12% , individually with each additive. It was found out that dry density of virgin soil was 1.82 gm/cc, in case of NaCl it was increased to 1.84 gm/cc, in Cacl2 it was increased to 1.87 gm/cc and in MgCl2 it was increased to 1.86 gm/cc. This is due to the reason that low moisture content transforms the edge to edge flocculation to face to face flocculation. Koganti et al. (2016) tested the black cotton soil and murrum soil with replacement with stone dust by varying percentage from 5% to 20% having interval of 5%. Compaction characteristics and CBR values were evaluated. OMC and MDD showed decreasing and increasing trend respectively. Murthy et al. (2016) performed the experiments to ascertain the effect of NaCl and gypsum on the properties of silty clay soil. Atterberg's limits, compaction characteristics and CBR test were performed with 15%, 20%, 25% NaCl and Gypsum individually. It was found out that OMC was decreased from and MDD was increased. Venkateswarlu et al. (2015) studied the deviation of index and engineering properties of expansive soil such as liquid limit, plastic limit, plasticity index, compaction characteristics, CBR on addition of quarry dust in various proportions (0%, 5%, 10% and 15%). It can be concluded that optimum value of stone dust that can be used to enhance the strength parameters was 10 %. Dubey et al. (2015) had studied about the black cotton soil of Jabalpur, Madhya Pradesh and the effect of common salt on it. They performed experiments with the number of proportion of common salt i.e 2%, 4%, 6%, 8% to study its effect on index properties of the soil. There was improvements in the properties of soil when treated with common salt. Ramadas et al. (2010) performed various experiments such as compaction, swelling , UCS and CBR on the expansive soil blended with various percentages of fly ash and stone dust. It was found that with decrease in OMC there was

increase in MDD and MDD was maximum at soil with 30% stone dust whereas in case of flyash it was maximum at 25%. Soosan et al. (2005) explained the impact of quarry dust on properties of cohesive soils (kaolinite and marine clay) and red earth. It was found that CBR values and MDD improved by adding quarry dust. Thus it can be used when highway is constructed over the clayey subgrade.

II. METHODOLOGY

a. To find the properties of virgin expansive soil.

Table 1: Tests to be conducted on Virgin soil

S.No	Properties of Soil	Tests to be performed
1	Atterberg's Limits	Casagrande Test and Thread test
2	Specific gravity	Pycnometer test
3	Optimum Moisture Content and Maximum Dry density	Standard Proctor Test
4	Strength Characteristic	Unconfined Compressive strength test.

b. To find properties of soil containing different proportion of Quarry Dust.

Table 2: Tests to be conducted on soil mix with different ratio of QD

Soil: Quarry Dust ratio	Properties of Soil	Tests to be performed
90: 10	Optimum Moisture Content and Maximum Dry density	Standard Proctor Test
85: 15	Optimum Moisture Content and Maximum Dry density	Standard Proctor Test
80: 20	Optimum Moisture Content and Maximum Dry density	Standard Proctor Test

Optimum Value of Quarry Dust using MDD value obtained by Standard proctor test for further work.

c. To evaluate the impact of different proportions of NaCl using optimum value of quarry dust.

Table 3: Tests to be conducted on soil mix with optimum value of QD and different ratio of NaCl

Proportion of NaCl	Properties of soil to be evaluated for each proportion of NaCl using optimum value of quarry dust
0.5%	Compaction Characteristics
1%	
1.5%	
2%	

On the basis of above , final mix of Quarry dust and NaCl will be obtained.

Table 4: Variables of Study

S. No.	Set type	Quarry Dust (%)	NaCl (%)
1	Virgin Soil	0	0
2	S_{QD}	10	0
3	S_{QD}	15	0
4	S_{QD}	20	0
5	$S_{QD+NaCl}$	Y	0.5
6	$S_{QD+NaCl}$	Y	1
7	$S_{QD+NaCl}$	Y	1.5
8	$S_{QD+NaCl}$	Y	2

Where, Y is optimum value of Quarry Dust.

III. MATERIALS AND TEST CONDUCTED

Black Cotton Soil:

Soil is collected from Nasik district of Maharashtra State. Various investigations are done to find out the properties of soil which is tabulated below:

Table 5: Soil Properties

S.NO.	Properties	Result
1.	Liquid Limit	63 %
2.	Plastic Limit	30.33 %
3.	Plasticity Index	32.67 %
4.	Optimum Moisture Content	19.1 %
5.	Maximum Dry Density	13.5 kN/m³
6.	Specific Gravity	2.38
7.	UCS (7days Curing)	250 kN/m²
9.	Soil Classification	CH

Quarry Dust:

Quarry dust is a by-product of stone industry and is usually left as industrial waste at crusher plant and also called as stone dust. Stone is processed in stone crusher plant to produce aggregates of various sizes for road construction and building structures by various methods ie drilling, blasting, crushing and screening. In this process, some quantity of stone is left with a size which cannot be used as coarse aggregates which leads to production of quarry dust. It comprises of coarse , medium and fine sand particles. The use of quarry dust in soil stabilization is also an environmental friendly act since it reduces the problem of stacking and its air pollution effects on the environment.The Quarry dust is collected from Swar Stone Crusher, Ramnagar, Distt Udhampur, Jammu & Kashmir.

Sodium Chloride:

Sodium chloride is also easily available on less cost involvement. Sodium chloride is an ionic compound having chemical composition of two chemical ions Sodium (Na) and Chloride (Cl) in proportion of 1:1 with chemical formula NaCl. NaCl is delisquent and hygroscopic. As it lowers the vapour pressure and thereby it results in reducing the formation of front heave in soil. No chemical reaction occurs when salt dissolve in water because it is a salt of strong acid and base and thus it under goes hydration and attains stability due to presence of free ions around water molecules. The addition of sodium chloride in soil improves its binding character, converting the fine particles to aggregates and thereby modifying the engineering properties of the soil. The addition of sodium chloride or salinization of soil increase the dry density of the soil and increases its bearing capacity. It can be used to secure the soil and to provide firmness to the foundation on which highways are built. The salt acts to minimize the effects of shifting caused in the subsurface by changes in humidity and traffic load. The Sodium Chloride was collected from High Purity Laboratory Chemicals Pvt. Ltd, Mumbai.

Test Conducted in Laboratory: The tests conducted are listed below:

- Pycnometer test (Specific gravity).
- Casagrande's test (Liquid limit).
- Thread test (Plastic limit).
- Standard proctor test (MDD & OMC).
- Unconfined compression test (UCS).

IV. RESULTS AND DISCUSSIONS

A number of standard Proctor test at expansive soil is done to determine the Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) at different proportions of quarry dust. Thereafter taking an optimum dose of quarry dust, the sodium chloride is taken in different ratios.

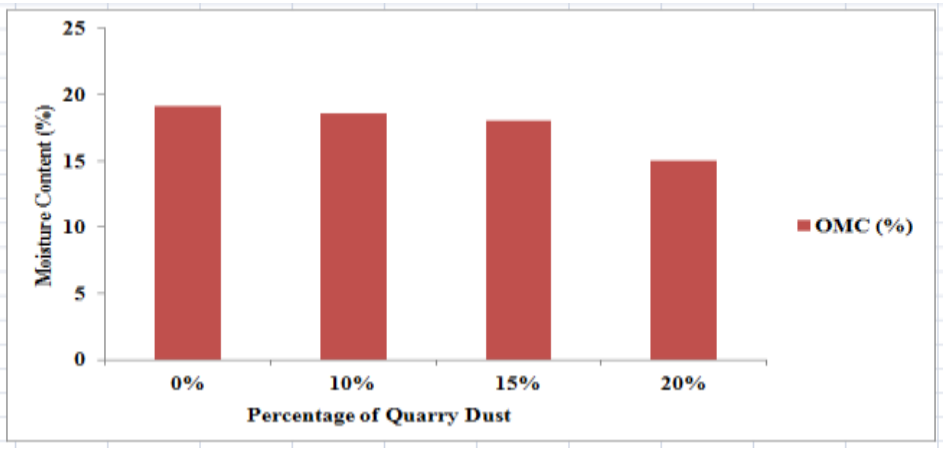

Figure 1: Effect of QD on OMC of Soil

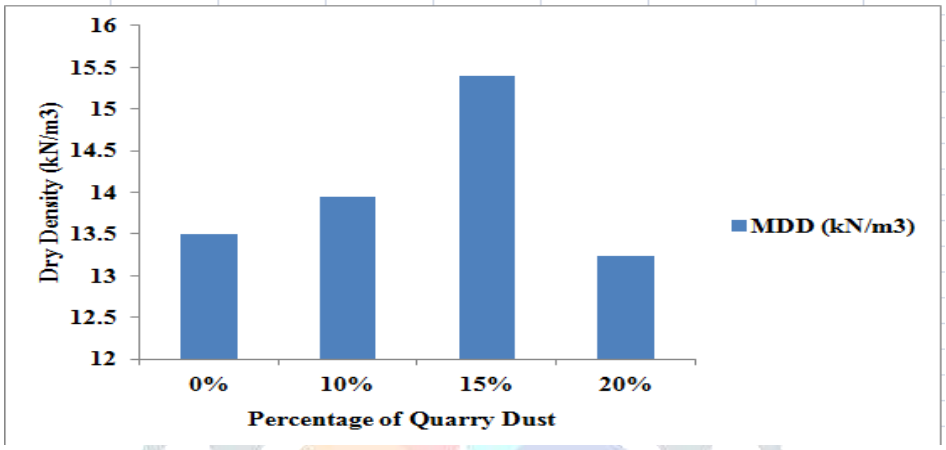

Figure 2: Effect of QD on MDD of Soil

Table 6: Compaction Test Results for (Soil: QD) at different proportions

SOIL: QUARRY DUST	MDD (kN/m³)	OMC (%)
100:0	13.5	19.1
90:10	13.95	18.6
85:15	15.4	18
80:20	13.24	15

In Standard Proctor Test, the value of MDD increases from 13.5 (kN/m³) to 15.4 (kN/m³) till 15% Quarry dust and thereafter decreases to 13.24 kN/m³ and OMC decreases from 19% to 15% with the proportion of Soil: QD (100:0) to Soil: QD (80:20) respectively.

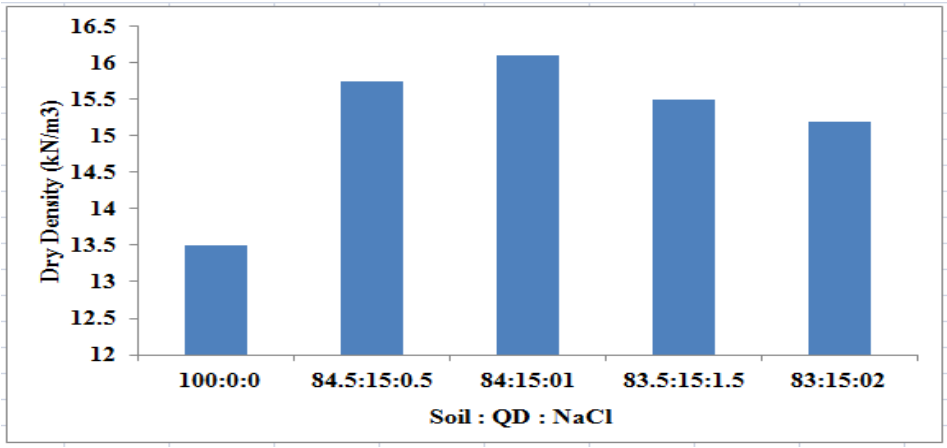

Figure 3: Effect of QD and NaCl on MDD of Soil

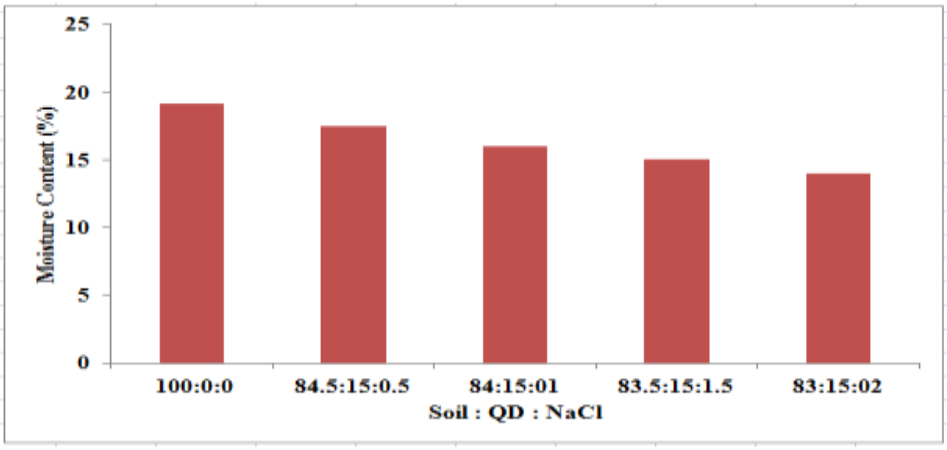

Figure 1 : Effect of QD and NaCl on OMC of soil

Table 7: Compaction Test Results for (Soil: QD: NaCl) at different proportions

SOIL: QD: NaCl	MDD (kN/m³)	OMC (%)
84.5:15:0.5	15.8	16.2
84:15:1	16.1	16
83.5:15:1.5	15.5	15
83:15:2	15.2	14

From table 7, it can be seen that the value of MDD increases from 15.8 (kN/m³) to 16.1 (kN/m³) till 1% NaCl and thereafter decreases to 15.2 kN/m³ and OMC decreases from 16.2% to 14%. When quarry dust is added to soil, particles of soil are cemented together. As the water content is reduced, the soil becomes stiffer and starts developing resistance to shear deformation. further adding the sodium chloride in the soil mix, properties of soil get modified due to the fact that they cause binding in fine particles to transform into aggregates which can also be termed as flocculation. The clay particles get more binded and the MDD increases. The decreasing trend in the OMC may be due to the fact that more is the face-to-face flocculation, less is the water required to lubrication.

V. CONCLUSION

The present study is conducted to explore the suitability of quarry dust and sodium chloride as additives in soil stabilisation. Compaction characteristics are investigated by blending soil with different proportion of quarry dust and sodium chloride. Test results indicate that sodium chloride and quarry dust in combination can be used as stabilizers in soil stabilization.

From the research work, following conclusions are drawn:

1. OMC and MDD of virgin soil comes out to be 19.1 % and 13.5 KN/m^3. From the series of investigations in this research, proportion of quarry dust of 15% by weight of soil comes out to be the optimum value. OMC and MDD comes out to be 18% and 15.4 KN/m^3 . There is significance increase in MDD of soil .
2. Further adding the 1% NaCl in soil with 15% Quarry dust, OMC and MDD comes out to be 15.5% and 16.1 KN/m^3.

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