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Laboratory Review for Stabilization of Soil in Kashmir VALLEY by Using Surkhi and Ceramic Tile Waste

Nowsheena Fayaz[1], and Er. Ashish Kumar[2]

[1] Scholar, Department of Civil Engineering, RIMT University, Mandi, Gobindgarh, Punjab, INDIA
[2] Assistant professor, civil Engineering Department RIMT University Mandi Gobindgarh, Punjab, INDIA

Correspondence should be addressed to Nowsheena Fayaz; ernowsheena786@gmail.com

ABSTRACT- Clay soil has been identified as a concern all around the world due to its swelling and shrinking qualities when it comes into touch with water. The load characteristics of soil are particularly low due to this clay feature. The influence of surkhi and ceramic tile dust on the geotechnical characteristics of clay soil is investigated in this study. The main goal of this research is to investigate the use of surkhi and ceramic tile dust as soil stabilisers in order to reduce the cost of soil stabilisation. The varied percentages of surkhi and ceramic tile dust, as well as their various combinations, were employed. . The soil at lower proportions of Optimum Water Content since there was a substantial improvement in Maximum Dry Density (MDD) (OMC). These materials not only give an alternative to the use of traditional materials, but they also aid in the reduction of pollution. Most of the time, these waste items are dumped in open areas, causing a lot of problems for the people who live in the region as well as the professionals who work there. Surkhi and ceramic tile dust may definitely be regarded an excellent stabilising element for clayey soil based on the findings.

KEYWORDS- Ceramic tile dust, Stabilization, Maximum Dry Density, Optimum Moisture Content, Surkhi,

I. INTRODUCTION

Disposal of various by products of industries and manufacturing plants has become a serious problem as a result of increasing urbanisation and industrialisation, potentially causing a slew of environmental issues. As a result, several projects for technology development are being launched in order to provide improved management and safe utilisation of these waste materials. Surkhi trash and ceramic tile waste were employed in this study to help stabilise the soil. Soil stabilisation is a technique for enhancing soil engineering features such as load-bearing capacity, settlement, and shear strength. The fundamental goal of stabilisation is to increase the soil's strength while lowering building costs by making the most of readily available low-cost resources. Clayey soil covers over 20% of India's land area and exhibits a wide range of engineering qualities due to its broad expansiveness and malleable nature when it comes into touch with water.Because of the minerals included in clayey soil, it is pricey. When it comes to by-products that can be used as stabilisers, India is estimated to have over 100,000 brick kilns producing 150-200 billion bricks per year (Siddique 2015), making it the richest source of brick dust. Brick Dust is a by product of the brick kiln's burning process and is made up of burnt brick and waste powder. Ceramic dust is a waste product of the ceramic brick, roof, and floor tile industries, as well as the stoneware waste industry. The Indian ceramics sector produces between 15 to 30 MT of trash per year, which includes wall and floor tiles, sanitary ware, bricks and roof tiles, refractory materials, and ceramic materials for residential and other uses. 30 percent of total garbage is disposed of as waste and the powder is thrown in open space . The disposal of ceramic waste pollutes the earth, water, and air

II. LITERATURE REVIEW

Koyuncu et al. (2004) used ceramic tile dust to stabilise Na–bentonite and discovered that by adding 40% ceramic tile dust waste, the PS and Sp were reduced by 86 and 57 percent, respectively[1]. Sabat (2012) used discarded ceramic dust to stabilise expanding soil. The addition of up to 30% ceramic dust has positive impacts on index, strength, and swelling properties. According to the economic study, ceramic dust with a content of up to 30% can be used to improve the subgrade of flexible pavement while saving money on construction[2]. Kumar et al., (2014) mixed clayey soil with foundry sand, fly ash, and tile waste to investigate its compaction and subgrade characteristics. These minerals were taken in a ratio of 10% to 50%, with a 10% increase. When all three elements were applied to the soil, the CBR value increased from 2.43 percent to 7.35 percent. As a result, they concluded that clayey soil mixed with foundry sand, fly ash, and tile waste can be utilised to construct sub-grade for low-traffic roadways[3]. Pokale et al., (2015) conducted an experiment to see if waste material-Brick Dust could be used to stabilise Black Cotton soil. According to the results of the experimental tests, the moisture content (MC) decreases after 7 and 28 days, respectively. The MC of 30% BD has been reduced to 26.46 percent. As a result, replacing brick dust is more effective[4]. Rachit Mishra and colleagues (2019) investigated the influence of polypropylene fibres and surkhi on the geotechnical parameters of expanding soil. The soil is replaced with surkhi and polypropylene fibre in various combinations to overcome the weak shear strength and high swelling/ shrinking concerns. The authors discovered that the stabiliser employed increases the CBR value and proctor density in stabilised soil tests such as Atterberg's limit, water content, UCS test, and standard proctor test[5]. E.Balasubramanian et al. (2020) investigated the use of surkhi and granite dust to stabilise compressible soil. After completing several tests on the stabilised soil, which was made by adding surkhi at 30 percent, 35 percent, 40 percent, and 45 percent, as well as granite dust at 5 percent, 10 percent, 15 percent, and 20 percent. The scientists discovered that the stabiliser employed increased the density, unconfined compressive strength (UCS), and CBR value of the soil, as well as a reduction in the soil's plasticity index[6].

III. MATERIALS AND METHODOLOGY

A. Surkhi

surkhi and its constituents Burnt brick powder is a waste product that results from the combustion of bricks in the presence of soil. Because the soil bricks were burned, they solidified, and when the set-up was removed, the bricks were in powder form. It is red in hue and has a delicate texture. It has significant power to minimise the swelling potential of black cotton soil. Brick hardened as a result of the burning of earth bricks, and when the set-up is removed, we get the powder form of brick. It has red colour and fine in nature. It has a strong ability to limit the propensity for black cotton soil to swell. Chemical composition of Surkhi shown in Table 1

Table 1: Chemical composition of Surkhi

Sr NO.	Chemical Constituent	Values
1	Alumina	20% to 30%
2	Silica	50% to 60%
3	Lime	5%
4	Oxide of iron	5% to 6%
5	Magnesia	2% to 3%

B. Ceramic Dust

The geotechnical properties of the ceramic dust used in the experimental programme are given below

1) Grain size Analysis
    - sand size -48%
    - silt size -31%
    - clay size -21%
2) Specific gravity-2.82
3) Compaction Characteristic
    - OMC- 16.5% ii) MDD- 21 kN /m³
4) Shear strength parameters
    - cohesion-8 kN/m2 ii)
    - angle of internal friction- 390

C. Testing Procedure

A local supplier provided us with broken/waste ceramic tiles. Using a hammer, these tiles were smashed into small pieces. To make it even smaller, the smaller pieces were fed into abrasion testing machines in Los Angeles. The expansive soil was used to conduct various tests. combined with ceramic dust in a 5 percent increase from 0 to 30 percent A total of seven mixes were created. Liquid limit testing, plastic limit tests, normal Proctor compaction tests, and UCS tests are all available. Swollen pressure tests, wet CBR testing, and consolidated undrained direct shear tests were used. carried out on these samples/mixes in accordance with Indian Standard (IS) Codes.

IV. TEST RESULTS ANALYSIS

The results of liquid limit tests on expanding soil that has been treated with various percentages of ceramic. The dust is depicted in Figure 1. As the graph shows, the number of women in the workforce grows in tandem with the percentage of women in the labor. Different samples are shown in Table 2. Ceramic dust continues to reduce the liquid limit of soil. When it comes to women, the percentage reduces from 61% to 36%.Ceramic dust concentrations in the air have been increased from 0 to 30%.

Table 2: Different Samples

Sr NO.	Sample Name	Sample Content
1	Sample – A	Clayey soil + 0% Surkhi
2	Sample –B	Clayey soil + 10% Surkhi
3	Sample –C	Clayey soil + 20% Surkhi
4	Sample –D	Clayey soil + 30% Surkhi

Results of moisture content shown in Table 3 & In graphical manner in Fig.1 below

Table 3: Moisture content Test Result

Sr NO.	Sample Name	Moisture Content
1	Sample – A	8.90
2	Sample – B	7.23
3	Sample – C	6.65
4	Sample – D	6.20

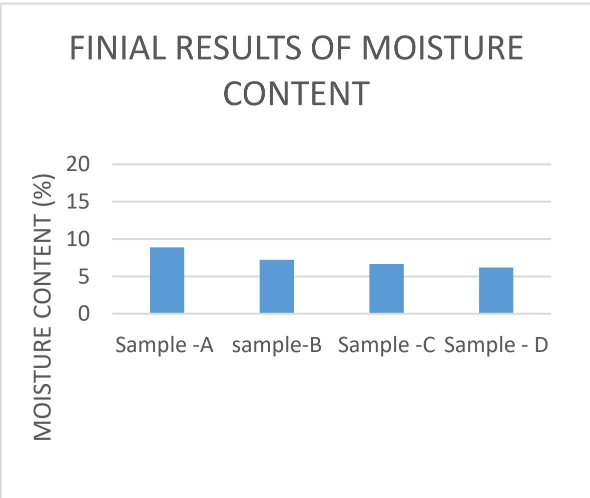

Figure 1: Results of Moisture Content Test

Result

When we added the Surkhi in clayey soil the initial moisture content present in the sample is decreases.

A. *Liquid Limit Test*

Results of liquid limit shown in Table 4 & Fig. 2

Table 4: Liquid Limit Test Result

Sr. No.	Sample Name	Liquid Limit
1	Sample - A	67.15
2	Sample – B	65.62
3	Sample – C	57.95
4	Sample - D	51.03

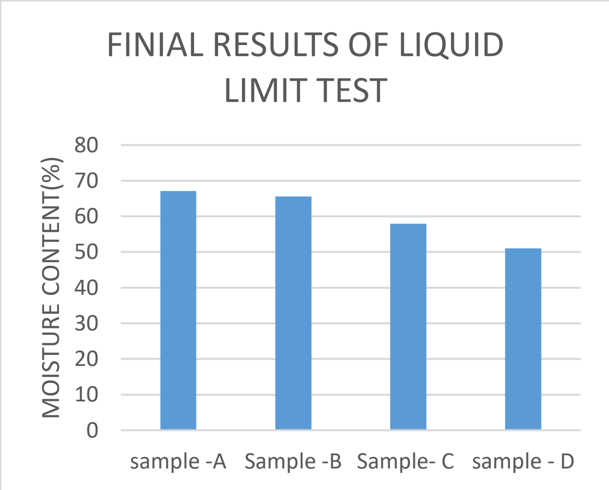

Figure 2: Results of Liquid Limit Test

Result

- On the basis of experimental test results, it is observed that the value of the Liquid Limit of plain clayey soil i.e. Sample-A is greater value as that of the Sample B,C&D
- From the above graph it is clear that the, If we increasing the % of surkhi in clayey soil it reduces the plasticity of that soil.

B. *Plastic Limit test*

Results of Plastic limit shown in Table 5 & Fig. 3

Table 5: Plastic Limit Test Result

Sr. No.	Sample Name	Plastic Limit
1	Sample - A	28.90
2	Sample – B	26.46
3	Sample – C	22.38
4	Sample - D	19.90

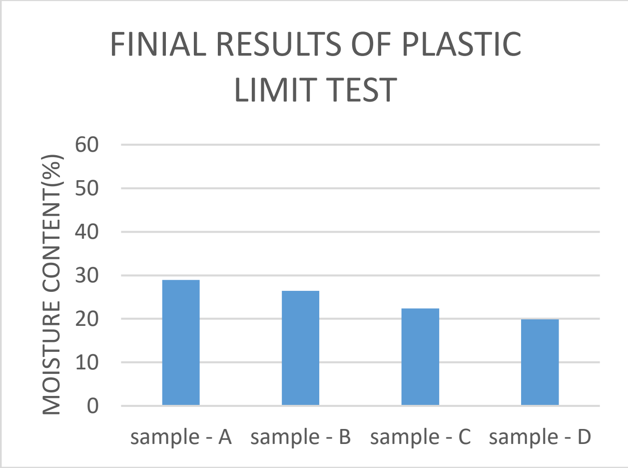

Figure 3: Results of Plastic Limit Test Result

On the basis of experimental test results, it is observed that the value of the plane clayey soil i.e. Sample-A is of greater value as that of Sample B,C & D.
Table 7 shown the values of Max. Dry Density.

Table 7: Max. Dry Density of Different Samples

Sr. No.	Sample No.	Max. Dry Density(Gm./Mm³)
1	Sample A	1.79
2	Sample B	1.82
3	Sample C	1.86
4	Sample D	1.88

From the above graph it is clear that the, If we increasing the % of surkhi in clayey soil it reduces the Plasticity of that soil.

C. *Plasticity Index*

It is the boundary between liquid limit and plastic limit. The Result of plasticity index is shown in Table 8 and Values of Atterberg's Limit is shown in Fig.4

Table 8: Values of Plasticity Index

Sr. No.	Sample Name	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI) PI=LL - PL
1	A	67.15	28.90	38.25
2	B	65.62	26.46	39.16
3	C	57.95	22.38	35.57
4	D	51.03	19.90	31.13

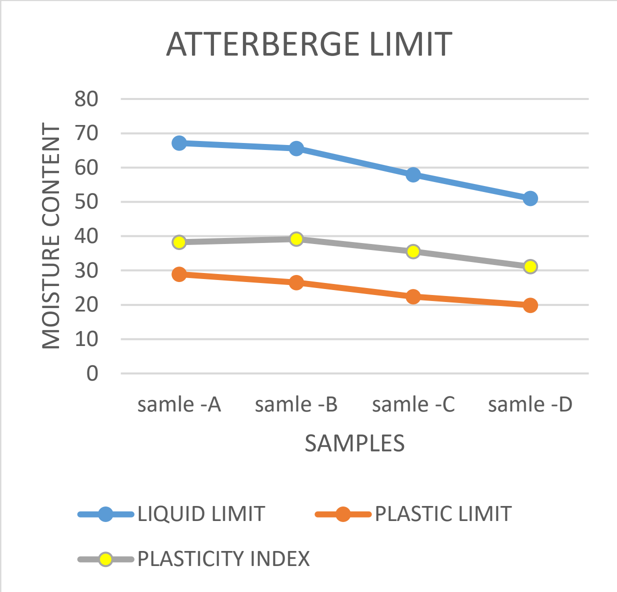

Figure 4: Atterberg's Limit

Result

The gray line shows the boundary of the soil between the soild states to liquid

D. Standard Proctor Test

In this test Max. Dry density of different samples will be calculated. In Standard Proctor Test (SPT) the mould used in 1000 cc and the hammer weighed 2.49kg. The free fall of hammer is 310 mm. The max. dry density will come when we are able to find out the (OPC) optimum moisture content. The result for max. dry density is shown in Fig.5 and the value of OMC shown in Table 9 and in Fig.6 shows the graphical values.

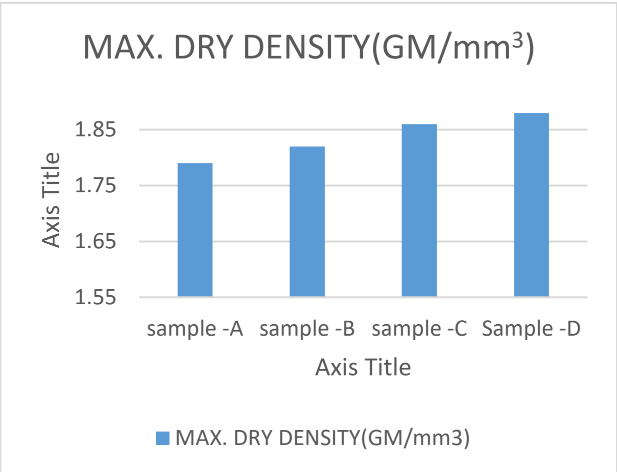

Figure 5: Dry Density of SPT

Result

- On the basis of experimental test results, it is observed that the value dry density of the plane clayey soil i.e. Sample-A is less valuable as that of Sample B, C & D.
- From the above graph it is clear that the, If we increasing the % of Surkhi in clayey soil its increasing density of that soil and gives the denser medium of hard surface

E. Optimum Moisture Content of Standard Proctor Test Result

Table 9: Values of OMC

Sr. NO.	Sample No.	Optimum Moisture contents (%)
1	Sample A	17
2	Sample B	16.10
3	Sample C	15.59
4	Sample D	14.12

Optimum Moisture Content of Standard Proctor Test Result

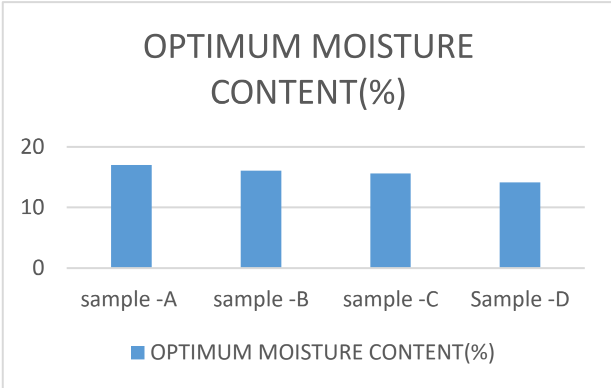

Figure 6: Results of Moisture Contents of Standard Proctor

Result

- According to the findings of the experimental tests, the value of optimum moisture content of the plane clayey soil, i.e. Sample A has a higher value than Samples B, C, and D.
- It is obvious from the graph above that raising the percent surkhi in clayey soil lowers the moisture content of such soil. It indicates that it absorbs less water and provides a firm surface.

F. *Ceramic Test Result*

G. *liquid limit*

Results for Ceramic Test Result are shown in Table 10 and Variation of Liquid limit with percentage of Ceramic dust shown in Fig.7

Table 10: Ceramic Test Result

Ceramic dust%	Liquid limit%
0	61
5	56
10	52
15	48
20	43
25	40
30	36

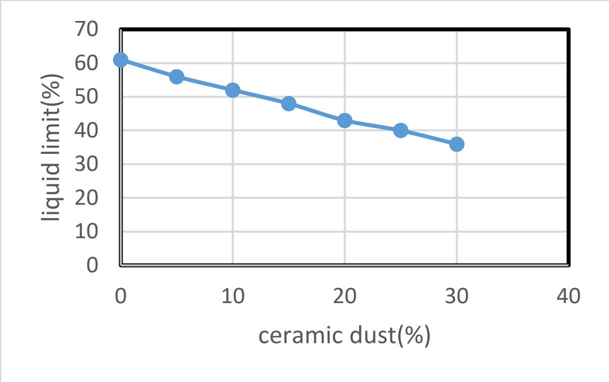

Figure 7: Variation of Liquid limit with percentage of Ceramic dust

Table 11 shows the results of plastic limit (P.L) tests on expansive soil treated with various percentages of ceramic dust. The Fig.8 shows that when the percentage of ceramic dust in the soil increases, the plastic limit of the soil decreases. When ceramic dust is increased from 0 to 30 percent, the plastic limit drops from 29 to 20 percent.

Table 11: Result of P.L of Ceramic Dust

Ceramic dust(%)0	Plastic Limit(%)
0	29
05	28
10	27
15	25
20	23.5
25	21.5
30	20

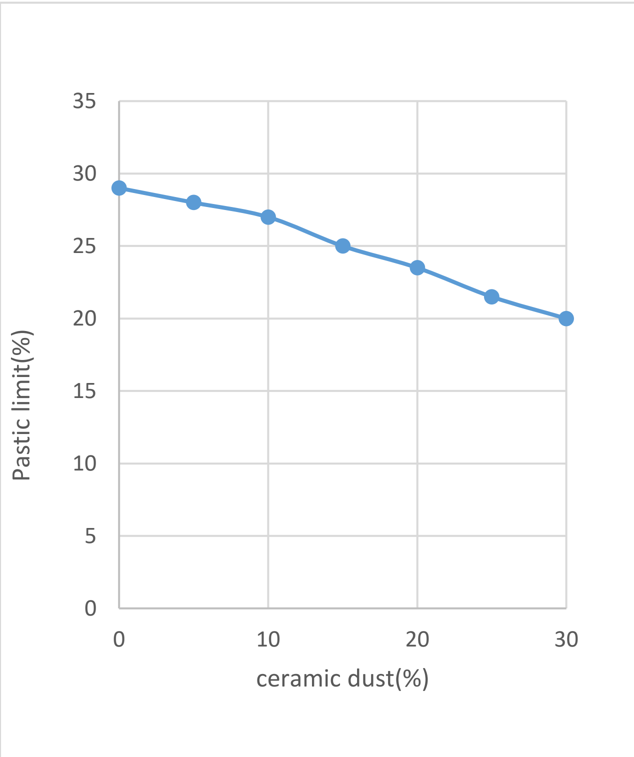

Figure 8: Variation of Plastic limit with percentage of Ceramic dust

Table 12: Result of Plasticity Index

Ceramic dust (%)	Plasticity Index(%)
0	32
5	29
10	26
15	24
20	22
25	19
30	16

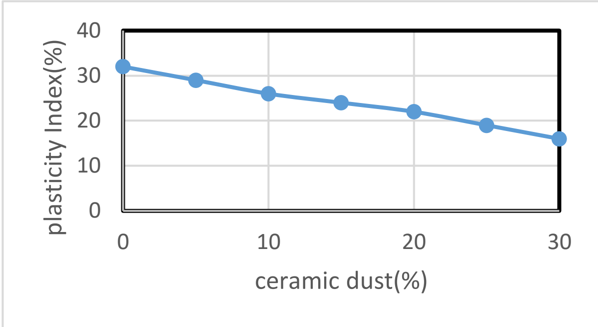

Figure 9: Variation of Plasticity index with percentage of Ceramic dust

Table 12 shows the result of the Plasticity Index (P.I). Figure 9 depicts the fluctuation of the plasticity index as a function of the percentage of ceramic dust. With the addition of ceramic dust, the plasticity index continues to decrease, as shown in the graph. When ceramic dust is increased from 0 to 30 percent, the plasticity index drops from 32 to 16 percent.

H. Maximum Dry Density (M.D.D)

Table 13 shows the result of Maximum Dry Density

Table 13: Result M.D.D

Ceramic dust(%)	MDD(gm/cc)
0	1.74
5	1.76
10	1.78
15	1.8
20	1.82
25	1.84
30	1.86

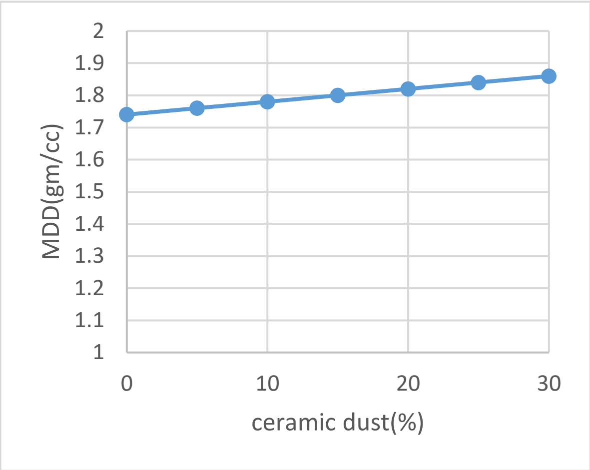

Figure 10: Variation of MDD with percentage of Ceramic dust

Figures 10 and 11 illustrate the results of typical Proctor tests on expanding soil with various percentages of ceramic dust. The fluctuation in MDD with the proportion of ceramic dust is seen in Figure 4. The MDD of soil continues to rise as the percentage of ceramic dust rises. When ceramic dust content is increased from 0% to 30%, the MDD rises from 1.74gm/cc to 1.86gm/cc. Table 14 shows the OMC values

I. Optimum Moisture Content

Table 14: Value of OMC

Ceramic dust(%)	OMC(%)
0	20.4
5	19.7
10	19.2
15	18.8
20	18.4
25	18.2
30	17.9

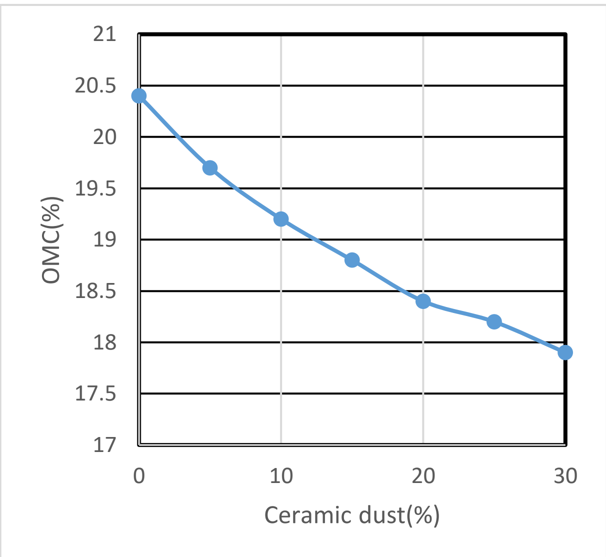

Figure 11: Variation of OMC with percentage of Ceramic dust

Figure 11 depicts the relationship between OMC and the proportion of ceramic dust. The OMC of soil decreases as the proportion of ceramic dust increases. When ceramic dust is increased from 0 to 30%, the OMC drops from 20.4 percent to 17.9 percent. The explanation for this behavior is that when ceramic dust particles are replaced with soil particles, the attraction for water molecules decreases, and hence the OMC drops.

J. L Unconfined Compressive Strength

Table 15 shows the value of Unconfined Compressive Strength (UCS) values and Figure 12 shows the Variation of UCS with percentage of Ceramic dust

Table 15: Value of UCS

Ceramic dust(%)	UCS(KN/m2)
0	56
5	59
10	65
15	72
20	79
25	87
30	99

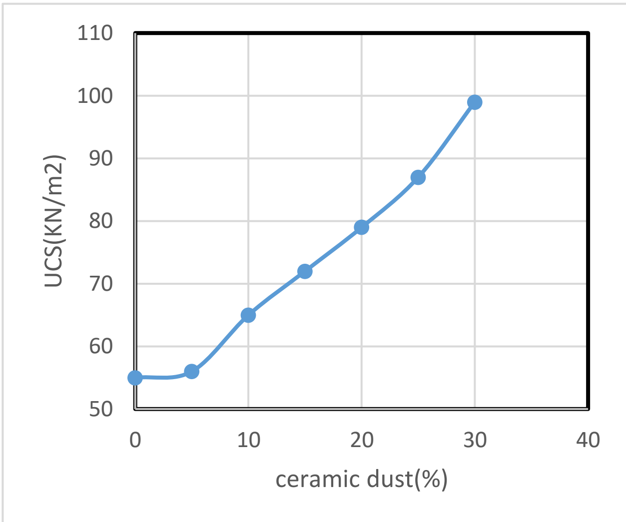

Figure 12: Variation of UCS with percentage of Ceramic dust

K. MDD relation for clayey soil with Surkhi and ceramic tile dust

Table 16: Combine Values

S.NO.	Clayey soil%	Surkhi%	Ceramic dust%
1	85	10	5
2	75	15	10
3	65	20	15
4	55	25	20

The combine result values are shown in Table 16 and the graph showing these values are shown in Figure 13,

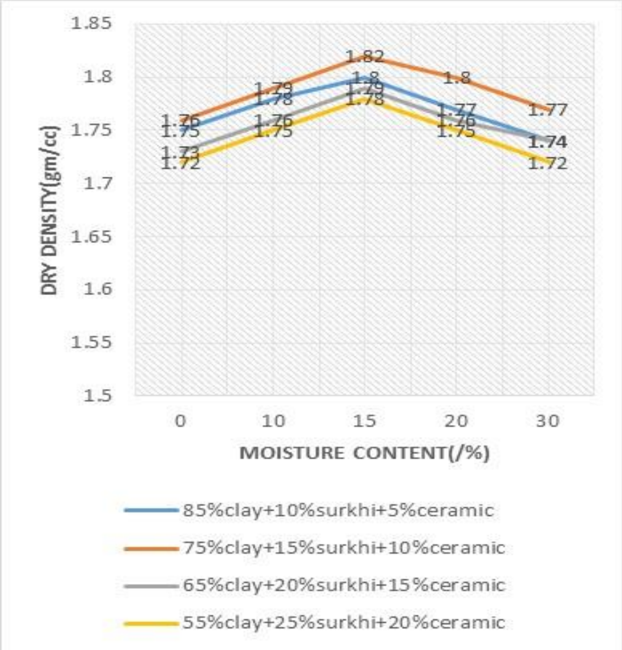

Figure 13: Combine graph of surkhi and ceramic

Result

The MDD of the soil increases up to 15% then the MDD decreased

V. CONCLUSION

The effects of waste ceramic dust and Surkhi from a clayey soil on the liquid limit, plastic limit, plasticity index, MDD, and OMC were investigated in a series of laboratory studies. The following findings are taken from this study based on the observations and conversations.

- Regardless of the percentage of ceramic dust added, the liquid limit, plastic limit, and plasticity index continue to decrease.
- Liquid limit of the soil will be decreases if we increase Surkhi in clayey soil if we add 0%, 10%, 20%and 30% Surkhi. It reduced limit 67.15%, 65.62%, 57.95% and 51.03% respectively from original soil liquid limit. Plastic limit of the soil sample will be decreases when we add 0%, 10%, 20%and 30% of Surkhi separately in soil and the result we get are28.90%, 26.46% , 22.38% and 19.90% respectively.
- The maximum dry density increased by 1.79%, 1.82%, 1.86%and 1.88 for the sample 0%,10%,20%and30% Surkhi in clayey soil. Optimum moisture content decreases by 17%,16.10%,15.59% and 14.12% for the sample 0%, 10%, 20%and 30% Surkhi respectively in clayey soil.
- Liquid limit of the soil will be decreases if we increase ceramic dust in clayey soil if we add 0%,5%,10%,15%, 20%,25% and 30% CD.it reduced limit 61%,56%,52%,48%,43%,40% and 36%respectively from the original soil liquid limit. Plastic limit of the soil sample will be decrease when we add 0%,5%,10%,15%, 20%,25% and 30% CD separately in soil and result we get are 29%,28%,27%,25%,23.5%, 21.5% and 20% respectively.
- The maximum dry density increased by 1.74,1.76,1.78,1.8,1.82,1.84, and1.86 CD for the sample 0%,5%,10%,15%, 20%,25% and 30% CD respectively in clayey soil. Optimum moisture content decreases by 20.4%,19.7%,19.2%,18.8%,18.4%,18.2%and17.9% for the sample 0%,5%,10%,15%, 20%,25% and 30% CD respectively in clayey soil.
- The MDD of the soil increases upto 15% then the MDD decreased.

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