RESEARCH ARTICLE OPEN ACCESS

Enhance the Performance of Permeability of Fine Sand Using Ceramic Tiles Waste and Plastic Waste as Admixture

Kapil Panwar[1], Ankit Laddha[1], Dr. D.G.M. Purohit[2]
[1]*M.E. Scholar, Department of Civil Engineering, M.B.M. Engineering College, J.N.V. University, Jodhpur, Rajasthan, India*
[2]*Professor, Department of Civil Engineering, M.B.M. Engineering College, J.N.V. University, Jodhpur, Rajasthan, India*

ABSTRACT
This research paper concerned with the stabilization of fine sand with Ceramic tile waste and plastic waste as admixture. As the fine sand has very low bearing capacity and compressive strength along with nil cohesion, thus the construction of any structure on fine soil required stabilization. Fine sand is of prime importance since it can be used for various construction works and highways, airfields and helipads projects. The amount of wastes has increased year by year and the disposal becomes a serious problem. This investigation deals with the stabilization of fine sand with Ceramic tile waste and plastic waste as additive. Present research paper work has been taken up by addition of 4.75 mm sieve passed and 2.36 mm sieve retained Ceramic tile waste and Square Pieces of plastic waste 0.15%, 0.25%, 0.50% and 1.0% having size 5mm respectively as admixture. The varying percentage 3%, 6%, 9% and 12% of Ceramic tile waste and plastic waste 0.15%, 0.25%, 0.50% and 1.0% respectively were mixed with fine sand of density 1.58 gm/cc. Falling-Head Permeability Tests were performed on different mix compositions. On the basis of the experiments performed, it is determined that the stabilization of fine sand using Ceramic tile waste and plastic waste as admixture improves the strength characteristics of the fine sand and enhance the performance of permeability so that it becomes usable as construction of Road embankment.

Keywords - Ceramic tile waste, Fine sand, Permeability, Square Pieces of Waste Plastic.

I. INTRODUCTION

In many countries all-over the world, fine sand is found in ample. It is being unnoticed for the use of construction of embankment of roads because of its low bearing capacity and greater compressibility. The advancement of a soil at a site is necessary due to rising cost of the construction of the road in this situation the properties of soil can be advanced by soil stabilization.

There is a great scope of stabilization of Fine-Sand with the admixture of Ceramic Tiles Wastage and Square Pieces of waste plastic for construction of embankment and pavements, airfields and helipads. The main purpose of the present investigation is to develop a mix composition which can be economically used for stabilization of fine sand in any type of environment. The laboratory studies have been done on fine sand using Ceramic tile waste and Square Pieces of plastic waste. The test specimens were prepared in the laboratory by direct mixing of the Ceramic tile waste and Square Pieces of plastic waste in fine sand. The Ceramic tile waste and Square Pieces of plastic waste can be easily available from various construction sites and manufacturing units. If this waste can be used efficiently then we can obtain an economical mix of fine sand and ceramic tile waste and Square Pieces of plastic waste as a construction material. On the other hand, the problem of the disposal of Ceramic tile waste and Square Pieces of plastic waste can be overcome by using it for stabilization of fine sand. Many researchers like Panwar Kapil et al. (2016), Laddha Ankit et al. (2016), Purohit D.G.M. et al. (2013), Ameta et al. (2008), Jain O.P. et al. (1979), Kevin M.(1978) and Wayal A.S et al.(2012) have worked on stabilization of soils.

II. RELATED INVESTIGATION

Many stabilization techniques available are mechanical stabilization with special stabilizers, chemical stabilization, thermal stabilization, electrical stabilization, complex stabilization, stabilization by grouting and geotextiles. At surface, soil stabilization with waste material as admixture is more economic than any other method; hence we have selected tiles waste and plastic waste as our admixture in stabilization technique.

III. MATERIALS USED FOR PRESENT INVESTIGATION

3.1 Fine Sand

Fine sand is found in abundance in Western Rajasthan. The fine sand has similar characteristics which are found in various Towns of Jodhpur. Hence the sand used in present study was brought location near Dangiyawas-Banar villages, at about 30-35 kms away from Jodhpur on Jodhpur-Jaipur Road. Fine sand has nil cohesion and poor compressive strength and hence need stabilization. Fine sand is uniform clean sand as per Unified Soil Classification System. Particles size ranges between 75μ to 1 mm that is fine coarse sand, round to angular in particle shape as per Indian Standard Classification System.

3.2 Ceramic tiles waste

A Ceramic Tile is an inorganic, nonmetallic solid prepared by the action of heat and subsequent cooling. Ceramic material may have crystalline or partly crystalline structure, or may be amorphous, because most common ceramics are crystalline materials. The earlier ceramics were pottery objects made from clay either by itself or mixed with other materials, hardened in fire. Later ceramics were glazed and fired to create a colored, smooth surface. The ceramic tiles used in present work were of Kajaria Company. The Ceramic tile waste was bought from a manufacturing unit from Bikaner, Rajasthan (India).

Fig: 1 Ceramic Tile Admixture

Table: 1 Summary of the physical properties of the tested Ceramic tile waste and material

Physical and Engineering Properties	
Density	2.27 gm/cc
Water Absorption in 24 hours	4% by dry weight

3.3 Plastic Waste

Plastics are considered as one of the important invention which has remarkably assisted in different aspects of life whether it might be in scientific field or others. The use of plastic has been enormously increasing these days. But now, plastic has become the significant pollutant of Environment because of the Use and Throw mechanism and everyone should think about this in the present scenario. The admixture used in present study was Polyethylene or polythene, as it is also known, as a polymer, produced by the polymerisation of ethylene gas, a derivative of the petroleum industry. The polymer consists essentially of long-chain molecules of very high molecular weight, made up of many thousands of the -CH2- repeating unit. The plastic waste used is of 4th type that is LDPE (Low Density Polyethylene) left after domestic, industrial etc. The plastic waste brought for the research work is a square of 5mm x 5mm pieces cut from plastic sheets of milk polythene by scissor and shredding machine. This plastic waste was availed from a tea stall near Ratanada Jodhpur Rajasthan (India). Fig.2 shows the square pieces of plastic waste of milk polythene admixture which is used for present research. Physical and engineering properties of plastic waste of milk polythene material are shown in table 2.

Fig: 2 Square Pieces of Waste Plastic

Table 2 Summary of the Physical and Engineering Properties of the Tested Plastic Waste of Milk Polythene Material

Physical and Engineering Properties	
Density	0.910-0.925 gm/cm^3
Water Absorption	Slight
Crystallinity	50-65%
Yield strength	4-16 MPa
Melting temperature	115ºC

IV. TEST PROGRAM AND PROCEDURE

The laboratory investigation on dune sand stabilization with waste tiles and plastic as admixture was performed. This work is done for beneficial utilization of ceramic tiles wastage and plastic waste and a mix proportion that can be mixed with fine sand as a best stabilizer with limited detrimental effects.

The objective of the present study is to evaluate the use of dune sand as a construction material after stabilizing it with waste tiles as admixture. The present study has been undertaken with the following objectives:

1. To study the effect of moisture content on dry density of fine sand.
2. To study the changes in performance of permeability of fine sand mixed with waste ceramic tiles and waste plastics in different proportions.

4.1 Test Program

The test program included the preliminary tests for fine sand and mix compositions of dune sand with waste tiles. Following tests were carried out:

1. Determination of particle size distribution of dune sand.
2. Standard Proctor Test (Proctor Compaction Test) for determining different dry densities for fine sand.
3. Permeability by Variable Head Permeability Test of dune sand and mix composition with Ceramic tile waste and plastic waste.
   Table 3 shows the variables which are investigated in present study.

Table: 3 Variables Investigated

S. No.	Effect of	Variables	Range Investigated
1	Moisture content in sand	Dry density	1.58 gm/cc
2	Tiles ware waste on different properties of sand	Size passing sieve size	4.75 mm sieve passed and 2.36 mm sieve retained
3	Mix tiles ware waste by dry weight of sand	Proportion percentage	3%, 6%, 9% and 12%
4	Square Pieces of Waste Plastics on different properties of sand	Square size	Plastic are 5mm square size
5	Mix Square Pieces of Plastic waste by dry weight of sand	Proportion percentage	0.15%, 0.25%, 0.50%, and 1%

4.1.1 Particle Size Distribution or Gradation Test of Fine sand

The particle size distribution test or gradation test was carried out with Indian Standard Sieve size 4.75 mm, 2.36 mm, 1.18 mm, 600 μ, 425 μ, 300 μ, 150μ, 75μ, pan and weigh balance in the laboratory.

A typical sieve analysis involves a nested column of sieve with wire mesh cloth (screen). A representative sample of 1000 gm is poured into the top sieve which has the largest screen opening of 4.75 mm. Each lower sieve in the column has smaller opening than the one above. The base is a round pan, called the receiver. The sample was shaken vigorously for 10 minutes on sieve shaker. After the shaking, the weight of material retained on each sieve was weighed. Percentage passing through each sieve was calculated and plotted against particle size. Since percentage passing 75 μ is within 1% only, hydrometer analysis was not done.

$$\text{Percentage (\%) Retained} = \frac{W_{sieve}}{W_{total}} \times 100\%$$

Where W_{sieve} is the weight of aggregate in the sieve in gm

W_{total} is the total weight of the aggregate in gm

The cumulative percentage passing of the aggregate is found by subtracting the percent retained from 100%.

Percentage (%) Cumulative Passing = 100% - Percentage (%) Cumulative Retained

The results of particle size distribution have been shown in table 4 and table 5, and figure 3.

Table: 4 Particle Size Distribution of Fine Sand

S.No.	Sieve Size	Weight Retained (gm)	% Weight Retained	Cumulative % Weight Retained	Cumulative % Weight Passing	% Finer
1.	4.75 mm	2.0	0.2	0.2	99.8	99.8
2.	2.36 mm	2.0	0.2	0.4	99.6	99.6
3.	1.18 mm	2.0	0.2	0.6	99.4	99.4
4.	600 µ	1.0	0.1	0.7	99.3	99.3
5.	425 µ	2.0	0.2	0.9	99.1	99.1
6.	300 µ	2.0	0.2	1.1	98.9	98.9
7.	150 µ	904.0	90.4	91.5	8.5	8.5
8.	75 µ	82.0	8.2	99.7	0.3	0.3
9.	Pan	3.0	0.3	100	0	0

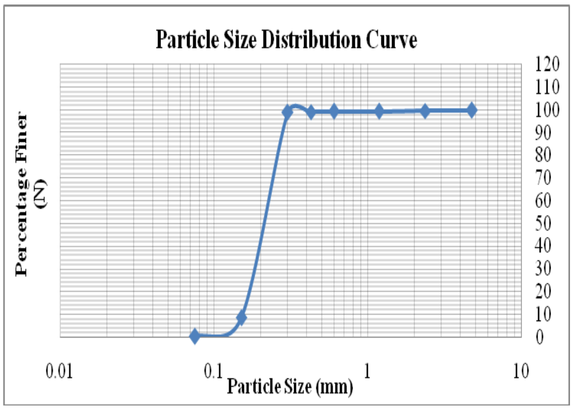

Fig: 3 Particle Size Distribution Curve

Table: 5 Results of Particle Size Distribution

S. No.	Property	Test Media (Fine Sand)
1.	Coefficient of Uniformity (C_u)	1.31
2.	Coefficient of Curvature (C_c)	1.08
3.	Mean Diameter (D_{50}) mm	0.20
4.	Effective Size (D_{10}) mm	0.16
5.	Fine Soil Fraction (75 µ)	0.10%

4.1.2 Standard Proctor Test

Standard proctor covers the determination of the relationship between the moisture content and density of soils. The standard proctor test was performed in accordance with IS 2720 (Part VII) on fine sand. In this test, a standard mould of 100 mm internal diameter and an effective height of 127.3 mm, with a capacity of 1000 ml are used. The mould had a detachable base plate and a removable collar of 50 mm height at its top. The soil was compacted in the mould in 3 equal layers; each layer was given 25 blows of 2.6 kg rammer falling through a height of 310 mm.

The result figure 4 shows that on increment of moisture content, dry density first decrease and then increase. In the curve dry density first decrease due to bulking of sand. After reaching maximum dry density on optimum moisture content, dry density decreases.

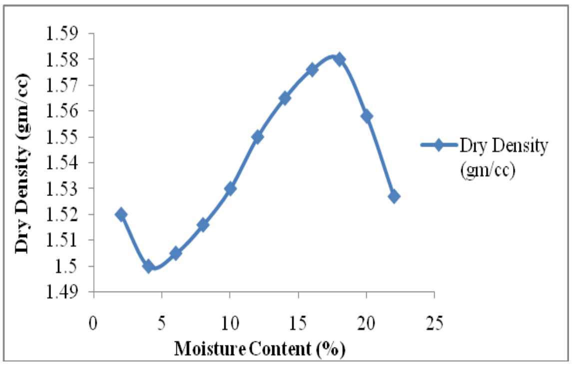

Fig: 4 Dry Density v/s Moisture Content Curve

4.1.3 Variable Head Permeability Test

Permeability is the measure of the ease with which water can flow through a soil sample. Test investigations were carried out on variable head permeameter with mix compositions of 1.58 gm/cc dry density fine sand and Ceramic tile waste and plastic waste in varying percentages of 3%, 6%, 9%, 12% and 0.15%, 0.25%, 0.50%, 1.0% respectively. A conclusion from the test results obtained that coefficient of permeability (k) increases with increase in percentage of sanitary ware waste and plastic waste and increase in size also. The test results of variable head permeability tests are given in table 6 and fig. 5.

Table: 6 Variation of Coefficient of Permeability k (cm/sec) with Mix Composition

S.No.	Percentage (%) Admixture	Coefficient of Permeability (cm/sec)
1.	3% and 0.15%	1.21×10^{-3}
2.	6% and 0.25%	1.27×10^{-3}
3.	9% and 0.50%	1.52×10^{-3}
4.	12% and 1.0%	1.57×10^{-3}

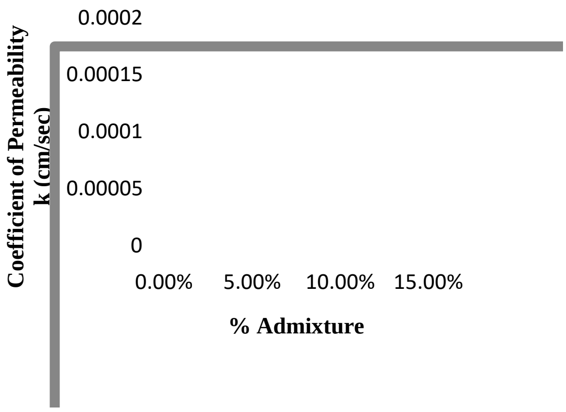

Fig: 5 Variation of Coefficient of Permeability k (cm/sec) with Mix Composition

V. CONCLUSIONS

In this investigation we have used wastage of Ceramic tiles and waste plastic in different proportions to study its effect on various geotechnical properties of fine sand of Western Rajasthan. The results of the testing program clearly show that the engineering properties of the fine sand improved considerably due to stabilizing with waste ceramic tiles and waste plastic. In the present investigation, as we are increasing the quantity of admixture of waste tiles and waste plastic materials, the performance of permeability increases. So we have stopped the further increment of admixture. Further study can be done by addition of more amount of admixture.

REFERENCES

[1] Ameta N.K. and Abhay Shivaji Wayal, "Effect of Bentonite on Permeability of Dune Sand". E.J.G.E., Vol. 13 – Bundle A, 2008.

[2] Ameta N.K., Purohit D.G.M. and Wayal A.S., "Behavior of Square Footing on Dune Sand Reinforced with Nylon Fibre", April 2009,International Journal of Geotechnical Engineering, Volume 3, Issue 2, pp 313-317.

[3] Laddha ankit and Purohit DGM "stabilization of fine sand using square pieces of waste plastic as a admixture for construction of embankment of road" Vol. 5, Issue 10, October 2016.

[4] Awad AlKarni, Sherif M. EIKholy, "Improving Geotechnical Properties of Dune Sands through Cement Stabilization", J.E.C.S., Vol. 5, No.1, pp 1-9.

[5] AwadAlKarni, Sherif M. EIKholy, "Improving Geotechnical Properties of Dune Sands through Cement Stabilization", J.E.C.S., Vol. 5, No. 1, pp 1-9.

[6] Dr. N.K. Ameta, Dr. Wayal A.S., PuneetHiranandani, "Stabilization of Dune Sand with Ceramic tile waste and plastic waste as Admixture", A.J.E.R., Vol. 02, Issue 09, pp 133-139.

[7] K.R. Arora, "Soil Mechanics and Foundation Engineering", Standard Publishers and Distributors, New Delhi.

[8] Wayal A.S., Ameta N.K., Purohit D.G.M., "Dune Sand Stabilization using Bentonite and Lime", J.E.R.S., Vol. III, Issue I, Jan-March 2012, pp 58-60.

Kapil Panwar Enhance the Performance of Permeability of Fine Sand Using Ceramic Tiles Waste and Plastic Waste as Admixture." International Journal of Engineering Research and Applications (IJERA) , vol. 7, no. 11, 2017, pp. 56-60.