PERFORMANCE OF CERAMIC TILES WASTAGE ON PERMEABILITY OF DUNE SAND

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Abstract*—The amount of wastes has increased year by year and the disposal becomes a serious problem. This research paper deals with the stabilization of dune sand with Ceramic Tiles waste as admixture. The research work is regarding, how to make dune sand which has low compressive strength and thus has nil cohesion and high permeability, useful for construction. The research paper work has been taken up by addition of wastage of waste ceramic tiles less than 4.75mm size of broken ceramic tiles which cannot be recycled and reused elsewhere. Varying percentage 10%, 20%, and 30% of ceramic tiles Wastage size (passing 4.75mm, 2.0mm and 1.18mm sieve) were mixed with dune sand. Permeability properties and performance of dune sand and composite material were observed experimentally. On the basis of observations, conclusions have been drawn on values of coefficient of permeability.

***Index Terms*—Ceramic Tiles Wastage, Dune sand, Permeability.**

I. INTRODUCTION

Utilization of immense reserve of dune sand, the huge mass remained unnoticed, untouched from centuries, where life itself requires courage to move ahead to survive, in the absolute scarcity of basic needs. Our motive to explore the possibilities of utilization of dune sand, as a low cost building material with some limitations like may be quasi-permanent in nature etc. This can be achieved by its stabilization.

Soil stabilization is the alteration of one or more soil properties, by mechanical or chemical means, to create improved soil material possessing the desired engineering properties. Soils may be stabilized to increase strength and durability or to prevent erosion and dust generation. The properties of a soil may be altered in many ways among which a few are chemical, thermal, mechanical and other means. It must be realized, however, that because of the large variability of soils & engineering requirement, no one method is even adequate in more than a limited number of soils.

The advance technique of soil stabilization can be effectively used to meet the challenges of society to enhance the performance of permeability of dune sand, to reduce the quantities of waste, producing useful materials from non-useful waste materials. Since the use of tiles in diversified forms such as flooring tiles, roofing tiles, decorative tiles and sanitary items etc., has been advancing speedily and its disposal has been a problem all the time regarding the environmental concern, using waste ceramic tile as soil stabilizer would reduce the problem of disposing the waste tiles as well as increases the bearing capacity of soil and improve performance of permeability in an economical way. The laboratory tests studies have been done on by direct admix of dune sand with tiles granules of waste tiles. Many researchers like Laddha Ankit et al. (2016), Panwar Kapil et al. (2016), Purohit D.G.M. et al. (2009), Awad ALKarni et al. (2012), jain O.P. et al. (1979), V. Mallikarjuna et al. (2016), Kevin M. (1978) and Wayal A.S. et al. (2012) have worked on stabilization of soils.

II. RELATED WORK

Various 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 as our admixture in stabilization technique.

III. MATERIALS USED FOR PRESENT INVESTIGATION

Dune Sand

The Great Indian Desert Known as Thar Desert in the west of Rajasthan bordering Pakistan covers over 60% of its area and includes 12 of its 32 districts. The Thar Desert is one of the most densely populated desert environments in the word, occupying an area of 2, 10,000 sq. kms., covering 61.3% of the Rajasthan State and 6.3% of the country as a whole. The desert is bounded on the northwest by the Sutlej River, on the east by the Aravalli Range, on the south by the salt marsh known as the Rann of Kutch, and on the west by the Indus Valley. The Thar Desert is about 805 km long and about 485km wide.

Jodhpur district is a part of Thar Desert. The Dune Sand used n the present study was brought from location near Jajiwal-Banar villages, at about 20-25 km away from Jodhpur on Jodhpur-jaipur road. Dune sand has nil cohesion and has poor compressive strength and hence need stabilization. Dune sand is coarse grained, uniform clean sand as per Unified Soil Classification system. Particles size ranges between 75 u to 1.0 m.m i.e. fine coarse sand, round to angular in particle shape as per Indian Standard classification System. The coefficient of permeability of dune sand is 2.0x10-4 cm/s.

Waste Tiles

A ceramic tile is an inorganic, non-metallic solid prepared by the action of heat and subsequent cooling. Ceramic materials may have crystalline or partly crystalline structure, or may be amorphous. Because most common ceramics are crystalline, the definition of ceramic is often restricted to inorganic crystalline materials. The word “ceramic” comes from the greek word (kermos) which means “potter’s clay”. 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 coloured, smooth surface. The potters used to make glazed tiles with clay; hence the tiles are called “ceramic tiles”. The row materials to form tile consist of clay minerals mined from the earth’s crust, natural minerals such as feldspar that are used to lower the firing temperature, and chemical additives for the shaping process.

A lot of ceramic tiles wastage is produced during formation, transportation and placing of ceramic tiles. This wastage or scrap material is inorganic material and hazardous. Hence its disposal is a problem which can be removed with the idea of utilizing it as an admixture of stabilize dune sand, so that the mix prove to be very economical and can be used as subgrade in low traffic roads or village roads.

Figure 1 Waste Ceramic Tiles Admixture

IV. TEST PROGRAM AND PROCEDURE

The laboratory investigation on dune sand stabilization with waste tile as admixture was performed. This work is done for beneficial utilization of ceramic tiles wastage and a mix proportion that can be mixed with dune 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 dune sand mixed with waste granules in different proportions.

Test Program

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Table 1 Variables Investigated

S. No.	Effect of	Variables	Range Investigated
1	Moisture content in sand	Dry density	1.656 gm/cc
2	Tiles ware waste on different properties of sand	Size passing sieve size	1.18mm, 2.00mm and 4.75mm mm Passing sieve
3	Mix tiles ware waste by dry weight of sand	Proportion percentage	10%, 20% and 30%

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,

Wsieve is the weight of aggregate in the sieve in gm

Wtotal 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 2 and table 3, and fig. 2.

Table 2 Particle Size Distribution of Fine Sand

S.No.	Sieve Size	Weight Retained (gm)	% Weight Retained	Cumulative % Weight Retained	Cumulative % Weight Passing	% Finer
1.	2.0	8.0	0.8	0.8	99.2	99.2
2.	1.0	4.0	0.4	1.2	98.8	98.8
3.	0.6	3.0	0.3	2.2	98.1	98.1
4.	0.425	3.0	0.3	2.2	97.8	97.8
5.	0.3	6.0	0.6	2.8	97.2	97.2
6.	0.15	897.0	89.7	92.2	7.8	7.8
7.	0.075	73.0	7.3	99.5	0.5	0.5
8.	Pan	5.0				

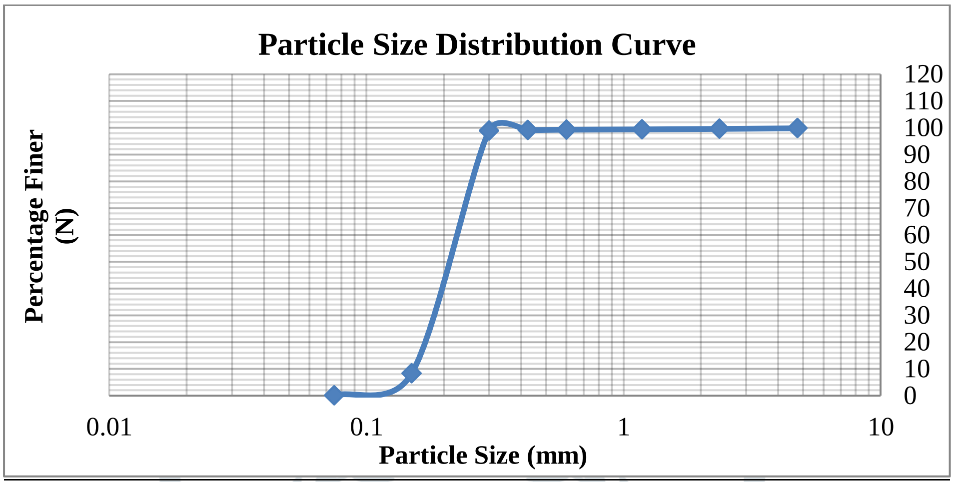

Figure 2 Particle Size Distribution Curve

Table 3 Results of Particle Size Distribution

S. No.	Property	Test Media (Fine Sand)
1.	Coefficient of Uniformity (C_u)	1.33
2.	Coefficient of Curvature (C_c)	1.06
3.	Mean Diameter (D_{50}) mm	0.22
4.	Effective Size (D_{10}) mm	0.16
5.	Fine Soil Fraction (75 µ)	0.10%

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 shown in figure 3 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.

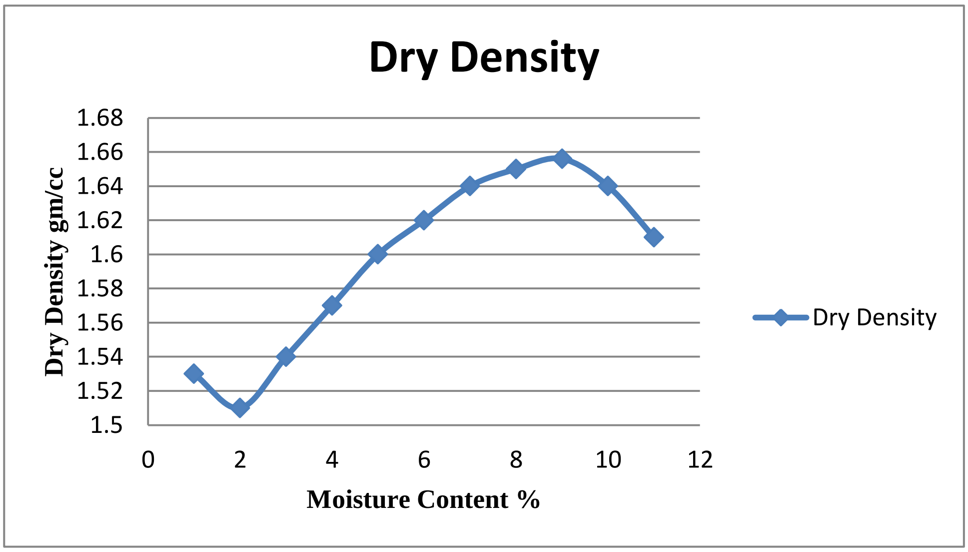

Figure 3 Dry Density v/s Moisture Content Curve

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 1.656 gm/cc dry density dune sand and tiles ware waste in varying percentages of 10%, 20%, and 30% and size to waste tiles that is 1.18mm, 2.00mm and 4.75mm sieve according to IS 2720 (Part XVII). A conclusion from the test results obtained that coefficient of permeability (k) increases with increase in percentage of Ceramic tiles wastage and increase in size also. The test results of variable head permeability tests are given in table 4 and table 5 and fig. 4.

Table 4 Variation of Coefficient of Permeability k (cm/sec) with Mix Composition

Sr. No.	**Mix Composition**	**Coefficient of Permeability (cm/sec)**
1	10% Admixture of 1.18 mm Sieve	$1.34x10^{-4}$
2	20% Admixture of 1.18 mm Sieve	$2.21x10^{-4}$
3	30% Admixture of 1.18 mm Sieve	$2.74x10^{-4}$
4	10% Admixture of 2.00 mm Sieve	$4.02x10^{-4}$
5	20% Admixture of 2.00 mm Sieve	$4.41x10^{-4}$
6	30% Admixture of 2.00 mm Sieve	$4.91x10^{-4}$
7	10% Admixture of 4.75 mm Sieve	$5.52x10^{-4}$
8	20% Admixture of 4.75 mm Sieve	$6.79x10^{-4}$
9	30% Admixture of 4.75 mm Sieve	$8.84x10^{-4}$

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

Admixture (%)	Coefficient of Permeability k (cm/sec)		
	Mix Composition		
	1.18 mm pass sieve	2.00 mm pass sieve	4.75 mm pass sieve
10%	$1.34x10^{-4}$	$4.02x10^{-4}$	$5.52x10^{-4}$
20%	$2.21x10^{-4}$	$4.41x10^{-4}$	$6.79x10^{-4}$
30%	$2.74x10^{-4}$	$4.91x10^{-4}$	$8.84x10^{-4}$

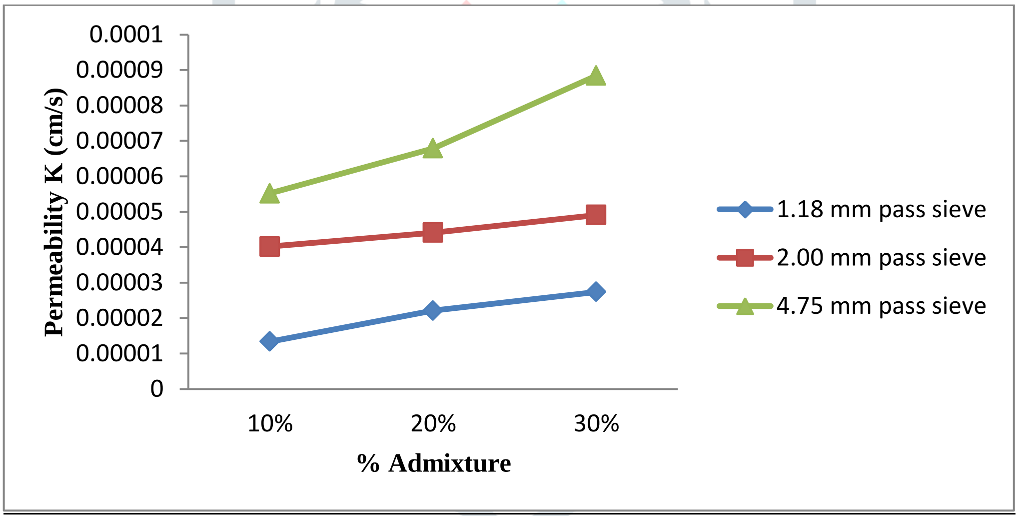

Figure 4 Variation of Coefficient of Permeability k (cm/sec) with Mix Composition

V. CONCLUSIONS

In this investigation we have used wastage of waste tiles 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 dune sand improved considerably due to stabilizing with wastage of ceramic tiles. In the present investigation, as we are increasing the quantity of admixture of waste tiles 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.

A few generalized conclusions are summarized below:

1. From the investigation it can be concluded that coefficient of permeability increases with increase in size of waste ceramic tiles wastage for the same percentage of mix composition. For 10% mix composition, K varied from 1.34x10-4 cm/sec for 1.18mm to 5.52x10-4 cm/sec for 4.75mm passing ceramic granules.
2. Also for same ceramic tiles wastage size K increased with increase in mix ratio for 4.75mm passing ceramic wastage 10% sand mix composition, K observed as 5.52x10-4 cm/sec and for 30% sand mix composition, K observed 8.84x10-4 cm/sec.
3. From this research the data obtained for coefficient of permeability of wastage of ceramic tiles and dune sand admixture reveals that the minimum percentage (10%) of ceramic granules and their smallest size (1.18mm) make the dune sand most stable.

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