IMPROVE THE PROPERTIES OF PERMEABILITY OF DUNE SAND BY USING SQUARE PIECES OF WASTE PLASTICS (MILK POLYTHENE)

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Abstract*—Soils are permeable materials because of the existence of interconnected voids that allow the flow of fluids when a difference in energy head exists. A good knowledge of soil permeability is needed for estimating the quantity of seepage under dams and dewatering to facilitate underground construction. This paper deals with the stabilization of dune sand with waste plastic square pieces of milk polythene as admixture to enhance the properties of permeability of dune sand and well as to reuse and reduce the waste plastic these hasincreased year by year and the disposal becomes a serious problem. 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. This analysis discusses the potential of dune sand stabilization with square pieces of plastic of milk polythene as admixture. Present work has been taken up by addition of 5mm square pieces of waste plastic of milk polythene as admixture. The varying percentage 0.15%, 0.25, 0.50%, 0.75%, 1% of square pieces of plastic wasteof milk polythene were mixed with dune sand of density 1.58gm/cc (M.D.D.). 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.

***IndexTerms*—Dune sand, Permeability, Square Pieces of Waste Plastic of Milk Polythene**

I. INTRODUCTION

Soil stabilization is the process of improving the Engineering properties of the soil and thus making it more stable. It is required when the soil available for construction is not suitable for the intended purpose. In its broadest senses, stabilization includes compaction, preconsolidation, drainage and many other such processes. Stabilization is being used for a variety of engineering works, where the main objective is to improve the performance of permeability, increase the strength, durability or to prevent dust generation and erosion of soil and to reduce the construction cost by making best use of locally available materials.

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. Dune sand stabilization using the square pieces of waste plastic of milk polythene as admixture has great extent for the base coarse in the construction of flexible pavement for roads. The amount of waste plastics has increased year by year and the disposal becomes a serious problem. Particularly recycling ratio of the plastic wastes in life and industry is low and many of them have been reclaimed for the reason of unsuitable ones for incineration.

Since the use of plastic in diversified forms such as chairs, bottles, polythene bags, etc., has been advancing speedily and its disposal has been a problem all the time regarding the environmental concern, using square pieces of waste plastics of milk polythene as soil stabilizer would reduce the problem of disposing the plastic as well as increases the bearing capacity of soil in an economical way. The laboratory tests studies have been done on by direct admix of fine sand with pieces of plastic waste. Many researchers like Ankit et al. (2016), Kapil et al. (2016), Punitetval. (2013), Purohit D.G.M. et al. (2009), AwadALKarni 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

Too 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 waste plastics of milk polytheneas our admixture in stabilization technique.

III. MATERIALS USED FOR PRESENT INVESTIGATION

Fine Sand

Dune sand is found in abundance in Western Rajasthan. The dune 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. Dune sand has nil cohesion and poor compressive strength and hence need stabilization. Dune sand is uniform clean sand as per Unified Soil Classification System. Particles size ranges between 75μ to 1 mm that is dune coarse sand, round to angular in particle shape as per Indian Standard Classification System.

Plastic Waste (milk polythene)

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 nearRatanada Jodhpur Rajasthan (India). Fig.1 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 1.

Figure 1 Square Pieces of Plastic Wasteof Milk Polythene Admixture

Table 1 Summary of the Physical and Engineering Properties of the Tested Plastic Wasteof 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 plastics of milk polythene as admixture was performed. This work is done for beneficial utilization of waste plastic square pieces of milk polytheneand 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 plastics of milk polythene as admixture. The present study has been undertaken with the following objectives:

1. To study the effect of moisture content on dry density of dune sand.
2. To study the changes in performance of permeability of dune sand mixed with waste of milk polythene in different proportions.

Test Program

The test program included the preliminary tests for dune sand and mix compositions of dune sand with waste plastics of milk polythene. 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 dune sand.
3. Permeability by Variable Head Permeability Test of dune sand and mix composition with pieces of plastic waste of milk polythene.

Table 2 shows the variables which are investigated in present study.

Table 2 Variables Investigated

S. No.	Effect of	Variables	Range Investigated
1	Moisture content in sand	Dry density	1.58 gm/cc
2	Square pieces of Plastics of milk polythene on different properties of sand	Square size	Plastic are 5mm square size
3	Mix Square pieces of Plastic waste by dry weight of sand	Proportion percentage	0.15%, 0.25%, 0.50%, 0.75% and 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,

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 3 and table 4, and fig. 2.

Table 3 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

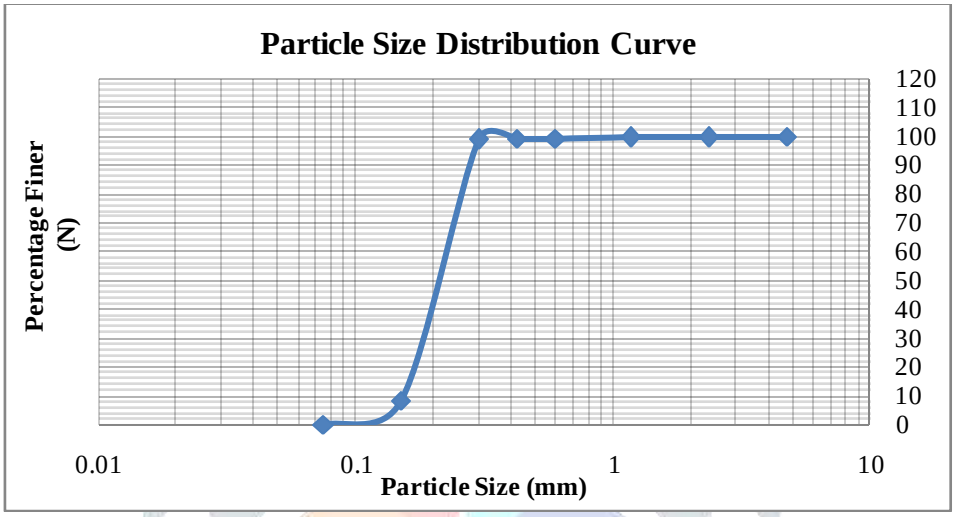

Figure 2 Particle Size Distribution Curve

Table 4 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%

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.

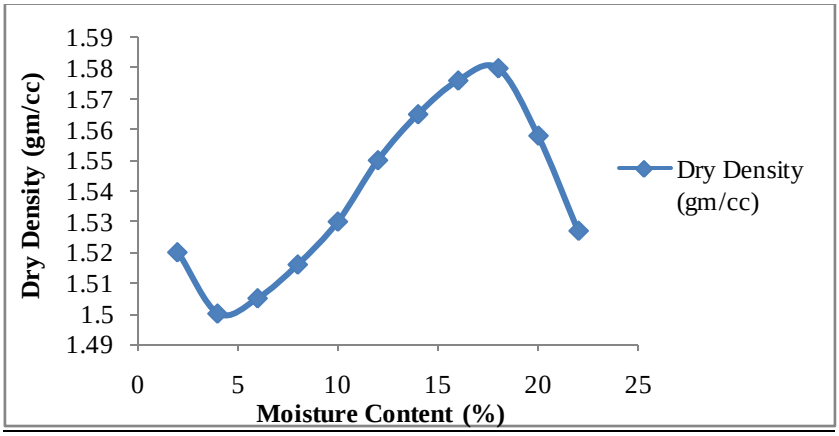

Figure 3Dry Density v/s Moisture Content Curve

Variable Head Permeability Test

Permeability is the measure of the ease with which water can flow through a soil sample. The tests were conducted in variable head permeameter according to IS 2720 (Part XVII).Test investigations were carried out on variable head permeameter with mix compositions of 1.58 gm/cc dry density fine sand and square pieces of plastics of milk polythene waste in varying percentages of 0.15%, 0.25, 0.50%, 0.75% and 1%.

A conclusion from the test results obtained that coefficient of permeability (k) increases with increase in percentage of square pieces of plastics of milk polythene waste as given in table 5 and figure 4.

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

S.No.	Percentage (%) Admixture	Coefficient of Permeability (cm/sec)
1.	0.15%	1.53×10^{-3}
2.	0.25%	1.59×10^{-3}
3.	0.50%	1.83×10^{-3}
4.	0.75%	1.91×10^{-3}
5.	1%	2.09×10^{-3}

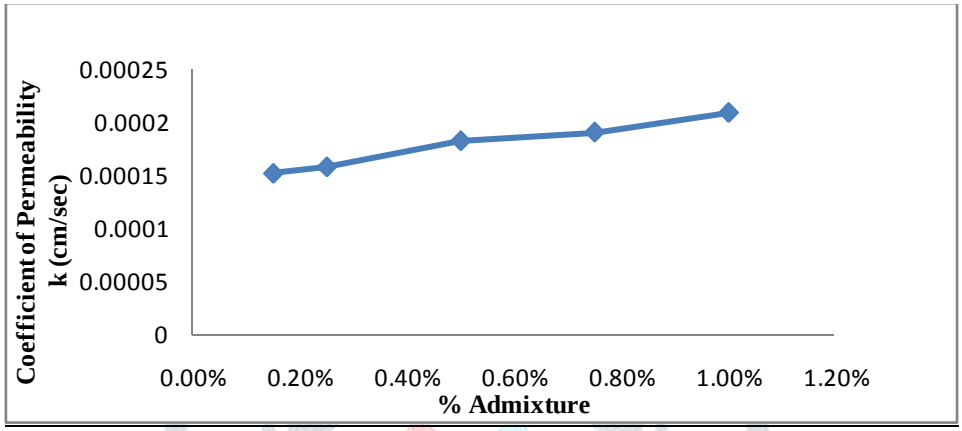

Figure 4 Variation of Coefficient of Permeability k (cm/sec) with Mix Composition

V. CONCLUSIONS

In this investigation we have used square pieces of plastic waste of milk polythene in different proportions to study its effect on various geotechnical properties of dune sand of Western Rajasthan. Permeability Tests were performed for mix composition of 0.15%, 0.25%, 0.50%, 0.75%, and 1% of square pieces of plastic waste of milk polythene and fine sand of 1.58 gm/cc dry density. The coefficient of Permeability k (cm/sec) increases with increase in the percentage of square pieces of plastic waste of milk polythene mixed to dune sand. Greater the percentage of square pieces of plastic waste of milk polythene more was the mix composition permeable. Hence, the impermeable material should be used in the mix composition to reduce the permeability. In the present investigation, as we are increasing the quantity of admixture of waste plastic square pieces of milk polythene 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.

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