Permeabilityof Dune Sand reinforced with Ceramic particles

Mayank Dave[1*] , Abhishek Arya[2], Deepanshu Solanki[1], Yagya Sharma[1], Tarun Gehlot[1]

[1]Department of Structural Engineering ,JNV University Jodhpur Rajasthan

[2] Assistant Professor, Jodhpur Institute of Engineering & Technology Jodhpur Rajasthan

Abstract: This report discusses experimental data on the usage of ceramic particles in stabilizing dune sands for potential applications in dune sand stabilization. Dune sand can be economically stabilized by mechanically modifying its gradation. Earlier attempts at dune sand stabilization with different admixtures and waste products like lime, cement, marble powder, fly ash, molasses, and so on were made in comparison to other approaches. The current work has been undertaken by the inclusion of particles smaller than 4.75 mm in size from shattered ceramic wash basins, water closets, and other items that cannot be salvaged and reused. Ceramic particles of varying sizes (passing 4.75 mm, 2.0 mm, 1.18 mm, and 425 sieve) were mixed with sand in percentages of 12, 22, and 32. Experimentally, the permeability characteristics of sand & composite material were observed. Based on these data, inferences about coefficients of permeability have been reached.

Keywords: Ceramic particles, Admixture, Dune sand, Permeability, Laboratory study.

1 INTRODUCTION:

Rajasthan is India's biggest state in terms of land area. Windblown sand, often known as dune sand, covers the western section of Rajasthan. Dune sand, according to the Indian Standard Classification System of Soil, is fine sand with minimal cohesiveness, no resistance to deformation under stress, and poor strength. Ameta, N.K., Purohit, D.G.M., and Wayal, A.S. (2009), Ameta, N.K., Wayal, A.S., and Hiranandani, P. (2013), Arya, A., Ranga, M., Vyas, D., & Bishnoi, R. (2018) revealed that being loose & cohesionless in natural form poses problems for base as well as subgrade construction of flexible pavement, [1,2,3]

Charan, H.D. (1989), Kumar, P., Das, V., Gupta, A., and Ameta, N.K. (2016), Prasad, J., and Purohit, D.G.M. (2017) explored the effective stabilisation of Dune sand with various admixtures. When compared to alternative ways, waste products like marble powder, fly ash, molasses, and so on may be utilised more inexpensively for sand stabilisation. The primary goal of this research is to determine the influence of ceramic particle admixture on dune sand permeability. Permeability is the most important factor in dune sand stability. [4,5,6]

A. Naas, D. Taha-Hocine, G. Salim, and Q. Michèle (2022). investigated an economic, environmental, and technological alternative, namely solar energy steam-curing, which uses solar radiation to accelerate cement hydration as well as increase the pozzolanic properties of powdered dune sand (PDS) by activating the less reactive silica, allowing the concrete to achieve high initial strengths. Furthermore, employing PDS as a cement additive minimises the need for clinker. [7]

H. S. Parihar and M. Verma (2021). According to research, the western section of India is essentially desolate, with primarily dune sand. The compressive strength of dune sand is lower. As a result of the stability of DS, we may use plastic trash such as polybags as an admixture to stabilise dune sand. The simulation results for dune sand combined with polybags are presented in this paper. Gehlot,T.(2018). Investigate the influence of nano clay addition on physical and mechanical qualities such as stiffness, fatigue resistance, toughness, & ageing resistance. [8,9]

2 MATERIALS & METHODS

The following are the qualities of materials used in experimental investigations:

Ceramic Particles: Ceramic drainage components are designed of clay by creating a casting, drying, and fire to the sintering temperature. A small percentage of final things are twisted during manufacture, as well as some finished goods are also damaged during transit. These deformed, damaged items constitute garbage, posing a disposal issue as well as a pollution risk.

Dune Sand: The sand used was found between the villages of Jajiwal and Banar, around 30 kilometres from Jodhpur on the Jodhpur-Jaipur route. According to the unified soil categorization system, dune sand is coarse-grained, uniformly clean sand. According to the Indian Standard Classification system, particle size varies from 75 to 1.0 mm, corresponding to fine to coarse sand with round to angular particle morphology. Dune sand has few to no plasticity, i.e., it is cohesion less, and its drainage is acceptable to good, with coefficients of permeability ranging from 10^{-4} mm/sec to 10^{-2} mm/sec..

The particle - size test was conducted using Indian Standard Sieve sizes of 2mm, 1mm, 600, 425, 300, 150, 75, and a weigh balance. A series of sieve sizes, beginning with 2mm at the top and declining in size, was coupled together, as was a pan at the bottom. 1000gm of dune sand sample was added on a 2mm sieve, and the entire set of sieves, as indicated above, was forcefully shaken for 10 minutes on a sieve shaker. The weight of the material retained on each filter was calculated. The percentage of particles that passed through each sieve were computed and displayed versus particle size. Because the proportion passing 75 is just within 1%, no hydrometer study was performed.

Table 1 : Particle Size Distribution of Dune Sand

S.No.	Sieve Size	Weight retained (gm)	% weight retained	Cumulative % weight retained	Cumulative % weight passing	% Finer
1.	2.0 mm	8.0	0.8	0.8	99.2	99.2
2.	1.0 mm	4.0	0.4	1.2	98.8	98.8
3.	600 μ	7.0	0.7	1.9	98.1	98.1
4.	425 μ	3.0	0.3	2.2	97.8	97.8
5.	300 μ	6.0	0.6	2.8	97.2	97.2
6.	150 μ	894.0	89.4	92.2	7.8	7.8
7.	75 μ	73.0	7.3	99.5	0.5	0.5
8.	Pan	5.0				

3 LABORTARY PERMEABILITY TESTS:

Permeability tests are carried out in the laboratory to help in the choice of materials to be manufactured. These experiments are performed to determine the degree of imperviousness supplied by the particles content for the specified soil and ceramic particle mix. The test was carried out in variable head permeameter in accordance with IS2720 (Part XVII). To analyze the influence of particle size and proportion, the permeability coefficient of dune sand and combined with ceramic particles was calculated. Table 2 shows the mix composition for the variable head permeability test. Results obtained have been graphically presented and tabulated in table 3.

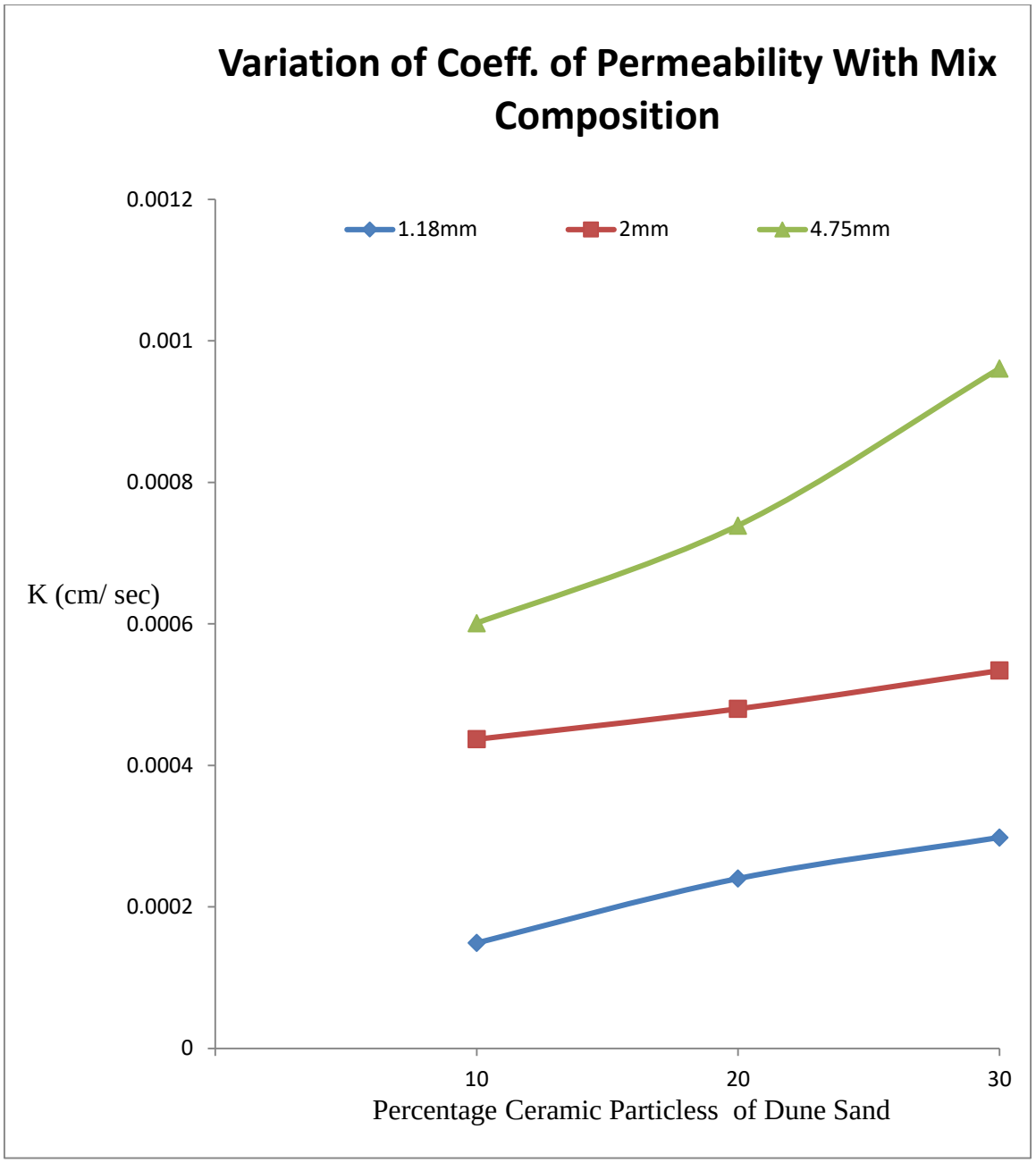
Table 2 : Mix Composition For Variable Head Permeability Test

Mix No.	Sand + Ceramic particles composition	Symbol
1.	12% of ceramic particles passing 4.75mm sieve by weight i.e. 50gm + dune sand 500gm.	PA1
2.	22% of ceramic particles passing 4.75mm sieve by weight i.e. 100gm + dune sand 500gm.	PA2
3.	32% of ceramic particles passing 4.75mm sieve by weight i.e. 150gm + dune sand 500gm.	PA3
4.	12% of ceramic particles passing 2.0mm sieve by weight i.e. 50gm + dune sand 500gm.	PB1
5.	22% of ceramic particles passing 2.0mm sieve by weight i.e. 100gm + dune sand 500gm.	PB2
6.	32% of ceramic particles passing 2.0mm sieve by weight i.e.150gm + dune sand 500gm.	PB3
7.	12% of ceramic particles passing 1.18mm sieve by weight i.e. 50gm + dune sand 500gm.	PC1
8.	22% of ceramic particles passing 1.18mm sieve by weight i.e. 100gm + dune sand 500gm.	PC2
9.	32% of ceramic particles passing 1.18mm sieve by weight i.e. 150gm + dune sand 500gm.	PC3

Table 3 :Variation of Coefficient of Permeability With Mix Composition

S.No	Mix Composition	Coefficient of Permeability (K) (cm/sec)
1.	PA1	6.01×10^{-4}
2.	PA2	7.39×10^{-4}
3.	PA3	9.61×10^{-4}
4.	PB1	4.369×10^{-4}
5.	PB2	4.8×10^{-4}
6.	PB3	5.34×10^{-4}
7.	PC1	1.456×10^{-4}
8.	PC2	2.403×10^{-4}
9.	PC3	2.98×10^{-4}

Figure 1: Variation of coefficient of Permeably with Mix Composition



4 CONCLUSIONS

- For the same proportion of mix composition, the permeability increases linearly size of ceramic particles. K ranged from 1.456 x 10-4 cm/sec for 1.18mm passing ceramic particles to 6.01 x 10-4 cm/sec for 4.75mm passing particles at a 12 percent mix composition (PC1) (PA1).
- For 4.75mm through ceramic particles, the coefficient of permeability rose with rise in mix ratio for 12.5% sand mixture composition (PA1), K was 6.01 x 10^{-4} cm/sec, and for 32.5% sand mixture composition (PA3), K was 9.61 x 10^{-4} cm/sec.
- The results of the coefficient of permeability of particles and dune sand admixture show that the dune sand is the best stable when there is a minimal percent (12%) of ceramic particles and their lowest size (1.18mm).

Declaration of Conflict of Interest : Authors Proclaim that they have no any Conflict of Interest

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