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IMPROVING PIPING RESISTANCE USING RANDOMLY DISTRIBUTED FIBRE

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Abstract - *Piping is a problem that commonly occurs downstream of hydraulic structure under the influence of upward seepage . Piping is considered as the main mechanism of hydraulic structure failures. In this work an experimental programme was set for determining the seepage velocity and piping resistance for both unreinforced and randomly distributed sand sample .The experimental test is proposed to be carried out for different fibre content (0%,0.5%,1%,1.5%), fibre length (20mm) and different hydraulic heads. Discharge velocity and seepage velocity of water flow through unreinforced and reinforced samples will calculate and compared with unreinforced sample. The expected result is that the inclusion of fibres will reduce the seepage velocity and improve the piping resistance.*

Key words: **PP fibre, piping resistance, seepage velocity, randomly distributed, one dimensional piping test**

1. INTRODUCTION

Piping is a form of seepage erosion and refers to the development of subsurface channels in which soil particles are transported through porous media. Piping is considered as the main mechanism of hydraulic structures failure. Hydraulic structures such as earth dams, diversion dams, flood dams, embankments, irrigation canals and drainage systems are structures that may damaged by seepage flow. When the seepage velocity increases more than a critical value, the hydraulic structure may be damaged due to piping. Piping refers to the development of channels which begins at the downstream side of the structure where the flow lines converge. Associated with this, high seepage pressure occurs. The subsequent erosion process develops backwards and due to the natural non-homogeneity in the soil the channels are irregularly shaped. If the process continues the structure may in the end collapse.

Continues the piping phenomena on hydraulic structures is caused structural damage. From 1970s investigators such as Gray and Ohashi (1983), Maher and Gary (1990, Woods (1990), Yetimoglu et.al. (2003) and Yetimoglu and Salbas(2005) studied the mechanical behavior of soil reinforcement that doing the various tests on the sandy soil samples randomly reinforced and show that adding fiber on soil increasing the soil strength.

The fibers effectively restrict soil particles movement. Polypropylene fibers are effective in controlling seepage and improving the piping resistance of soils .The inclusion of fibers reduced the seepage velocity, increased the piping resistance and increased the critical hydraulic gradient hence, delaying the occurrence of piping

2. MATERIALS

2.1 Sea sand

The sand used for the test was collected from the campus of Marian Engineering college, kazhakuttom. Sand particles passing through 4.75 mm sieve were used for the experimental investigation. The fig 2.1 shows the sand collected for the present study and the sand passed through 4.75mm sieve. Fig 2.1 and Table 2.1 shows the particle size distribution curve and properties of sand respectively.

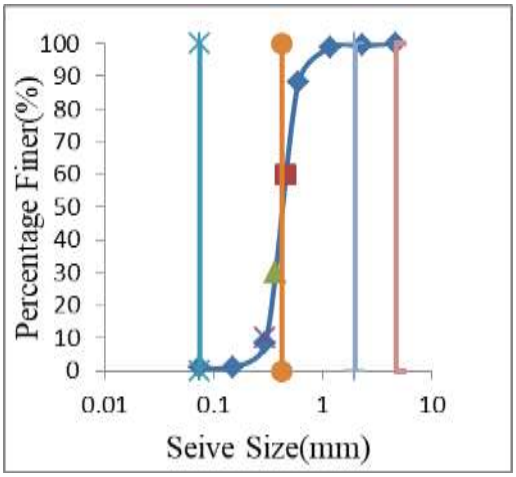

Fig 2.1 Particle size distribution curve for sea sand from sieve analysis

Table 2.1 Properties of Sea sand

Sl. No.	Properties	Result
1.	Percentage of gravel	0
2.	Percentage of sand	99.5
3.	Percentage of clay and silt	0.5
4.	Uniformity Coefficient, C_U	1.533
5.	Coefficient of Curvature, C_C	0.992

6.	Specific Gravity	2.64
11.	Angle of Shearing Resistance	39°
12.	Cohesion (kg/cm²)	0.2
13.	Classification of soil	SP

2.2 Polypropylene fibre

Polypropylene (PP) fibre was used in this study. PP fibre is the most widely adopted synthetic fibre for soil reinforcement. PP fibre performed better than polyester fibre in increasing seepage resistance, because the PET fibre has a specific gravity higher than the pp fibre. For the same fibre content, a greater specific gravity implies a lower fibre volume and a lower number of fibres, and hence reduces the benefit of improving the piping resistance of a soil. Table 2.2 summarises the physical and mechanical properties of the test fibre.

Table 2.2 Physical properties of polypropylene fibre

Properties	Value
Type	Polypropylene fibre (pp)
Cross-section type	circular
Equivalent diameter (mm)	0.0557
Length Lf(mm)	20mm

3. EXPERIMENTAL PROGRAM

Piping behavior of both river and sand was studied and compared with that of specimen prepared by mixing polypropylene fibre. The experimental setup used in this study is shown in fig. 3. It consisted of a tank 40 cm in diameter and 100 cm in height with an attached graduated scale to measure the level of water. The mould for the soil specimen has a diameter of 10cm and height of 11.7cm.The soil mixture was filled in the cylindrical mould and then the mould was connected to the water tank. Water was connected to the water tank. Water was permitted to flow through the sample in an upward direction and discharge was collected in measuring jar. Discharge under various heads was monitored. The experiments were conducted for different fibre content (0.5%,1%,1.5%) and fibre length 20mm.

It was observed that seepage velocity increased with the increase in hydraulic gradient. When the hydraulic head reached a certain level, small bubbles and local boiling were observed and finally the specimen failed by piping. Fig. 3 shows the apparatus.

Fig. 3 piping test setup

4. RESULT AND DISCUSSIONS

4.1. Variation of permeability

The result of variable head permeability test is shown in fig 4. The test is conducted for the fibre content 0.5%, 1%, 1.5%, and for fibre length 20mm. The results shows that the permeability decreases for sand as fibre content increases. This is because an interlocking between sand and fibre is formed in turn reduces the void space.

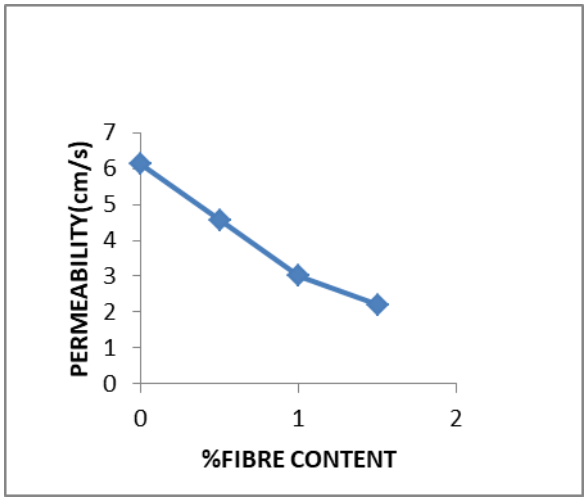

Fig 4.1 variation of fibre content with k

4.2. Seepage velocity- fibre content

Fig 4.2 shows the hydraulic seepage velocity-fibre content plot for sea sand.The seepage velocity decreases with increase in fibre content. Similar trend also shown by Yang.et.al (2017).The seepage velocity decrease as fibre content increases due to decrease in void ratio and blocking of pore space of sand by fibres replacing sand solids

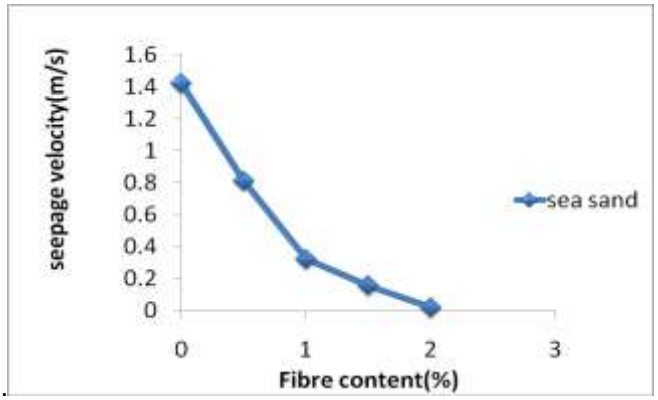

Fig 4.2 Seepage velocity-fibre content plot

5. CONCLUSION

Experimental studies have been carried out on sand mixed with fibers and their effect on the seepage and piping resistance is studied. The study shows that the addition of fibres in sand is an effective method in improving the piping resistance of sand. Inclusion of fibres in sand reduced the lifting of individual soil particles. Sand mixed with polypropylene fibre shows an improved resistance to the piping due to higher shear resistance offered by the fibre.

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