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Effect of Different Stabilization Agent on Shear Behavior of Sand

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Abstract*: *Stabilisation of soils is one of the area that catch interest of many research. Making soil more stable and ready to resist again more loading are the reasons behind the applications. Recently usage of by-product in soils gained a momentum due to the positive environmental effect in terms of removing waste. In this research, three different stabilsation samples were prepared. The stabilization materials effect on the shear strength of sand were compared. The samples were properly blended and checked for homogeneity. All of the mixes apart from sand, had 10% of either flyash or fibre. In order to investigate the effect, direct shear test was used and run in different normal stresses (i.e.50 kPa,100 kPa,150 kPa). After running the direct shear test, the peak values of shear at failure was recorded relevant to each sample and normal stresses. Then the failure envelope plotted for each trial and the results of cohesion and friction angle were compare. The results showed that powder form of material were more effective due to their bonding forces with sand particles.

Keywords: **Sand, fibre, flyash**

I. INTRODUCTION

The soil complex nature in current real world applications pushed researchers to work numerically and simulate the cases [1, 2]. A beam resting on a soil medium was considered and soil medium in this study was modeled with use of numerical software[2] or run experimental testing similar to [3]. Stabilization of sand once exposed to loading is one of the issues in geotechnical engineering [4,5]. Sand by itself has been studied in other research [3]. Soil stabilization is the way toward including different materials into normal soil to increase its attributes. Given the application of compaction and different advanced mixing procedure in reality engineers assure that they are homogenous and represent the proper blend. Normally the addition of additive will be tested against improving the settlement and strength properties of the soil. There has been many efforts to incorporate lime and cement into soil.[6]

Fibre always been one of the interest. There has been interest into rectify the issue of problematic soils while they are present in a field. Application of by-product/waste [7] is a benefit due to firstly usage of waste and secondly gaining benefit from them rather than landfills. Previous studies [7,8] considered flyash application into soil. Other studies studied application of fibre into soil [9-15]. Different characteristics of mixture such as compaction and strength were investigated in those study. The effect of different fibre in this study will be investigated. Fibre application into soil due to its help to improve the tensile strength [15]. One of the best strategy for expanding the quality of soil is fortifying it with fibres. A few analysts have presumed that bringing common or engineered fibres into the dirt improves its heap bearing limit under both dynamic and static burden conditions. The literature supports the idea of usage of fibre into soil due to its extra resistance against dynamic and static loading that mainly studied in cohesive soils. Right now fibres are being utilized by the development business in landfill systems and last covers. The fiber support of soil should be possible in two techniques; to be specific deliberate dispersion and irregular fiber conveyance. Deliberately strengthened soils allude to the dirt fortification utilizing materials arranged a foreordained way. [15] A new way of application of fibre recently gained interest due to its low cost. The method is called short discrete fibre . The easy application into the real project is one of the advantage in this method According to literature, the usage of fylash is valued due to its low density, low cost and energy saving benefit.[16]

Significance of this study

This study is designed to compare the effect of three stabilisers (i.e., flyash, fiber). The major development in this study is related to powder and solid effect on stabilization.

OBJECTIVE OF THIS STUDY

The main target of this research is a technical analysis of effect of 2 stabilisers in shear behavior of sand. In order to achieve that, minor targets defined as direct shear testing on:

1- clean sand
2- flyash-sand
3- fibre-sand

II. MATERIAL

A. Sand

The properties of the sand can be found in Table 1.

Table 1 Sand Properties [17]

Color	Yellow
SG	2.7
pH	7
Cu	2.2
Cc	1

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B. Flyash

The used flyash was source in Western Australia. The properties can be found in Table 2.

Table 2 Flyash Properties[18]

Item	Values/description
pH	6-9
SG	1.8-2.4
Density bulk	800-1000 kg/m3

C. Fibre

Table 3 presents the characteristics of used fibre.

Table 3 Fibre Properties

Item	Description
Filament diameter	17 µm *
Matrix type	Polypropylene (PP)
Tape width	25mm*

*measured in Curtin University laboratory

III. SOIL SAMPLE PREPARATION

Three different mixes were provided. Mix 1 was clean sand. The second mix (mix 2) sand and 10% flyash. The third one sand with 10% fibre .The direct shear test [19] tests were conducted at 50,100 and 150 kPa normal stress.

IV. METHODOLOGY

The designed test and mixes can be found in Table 4. In order to run the direct shear test, AS 1289.6.2.2-1998 [20] was employed and followed. The device has shear box which consist of two parts. One part slides against the other and shear the sample. The strain rate was set as 0.5 mm/min, the tests was conducted in unit weight controlled condition and the values relevant to that was obtained from compaction.

Table 4 Designed mixes and tests

Sand	without additive	50 kPa, 100 kPa, 150 kPa
Sand+Flyash	10% Flyash	50 kPa, 100 kPa, 150 kPa
Sand+Fibre	10% Fibre	50 kPa, 100 kPa, 150 kPa

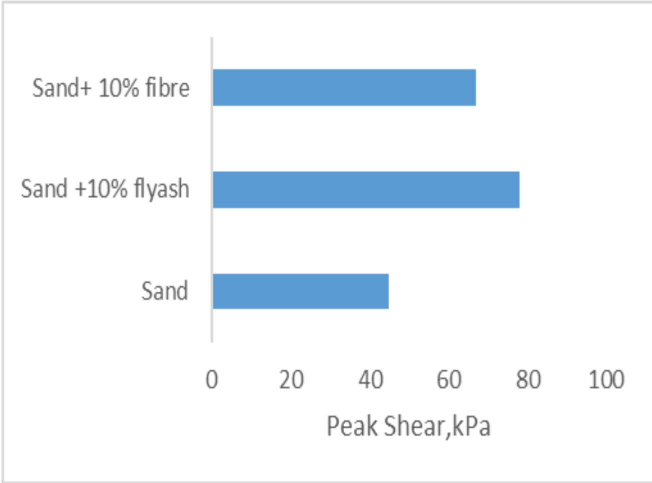
V. RESULTS AND DISCUSSION

The results of peak for each mixes are presented as follow in Table 5:

Table 5 Shear values for each mixes

Sample	Normal Stress, kPa	Peak Shear, kPa
Sand	50	47.7
	100	93
	150	142
Sand +10% flyash	50	78
	100	143
	150	204
Sand+fibre	50	67
	100	127
	150	191

The comparison of peak shear values can be seen in Figure 1 in different normal stresses.



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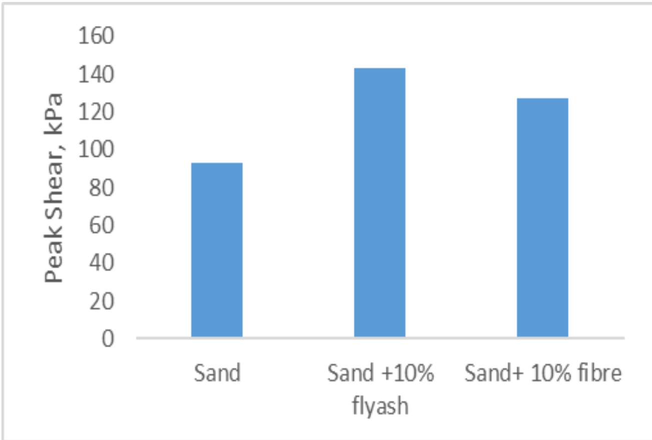

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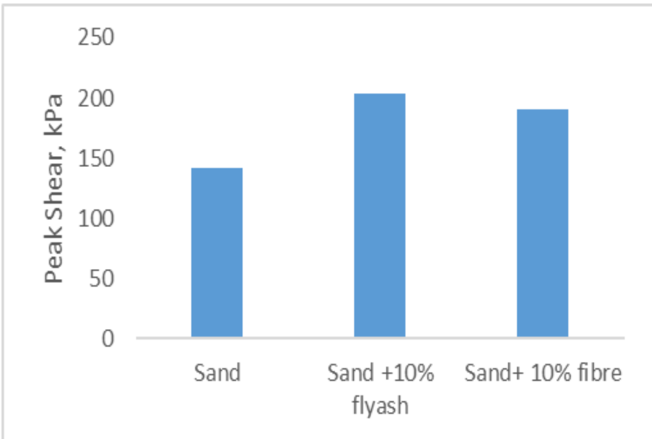
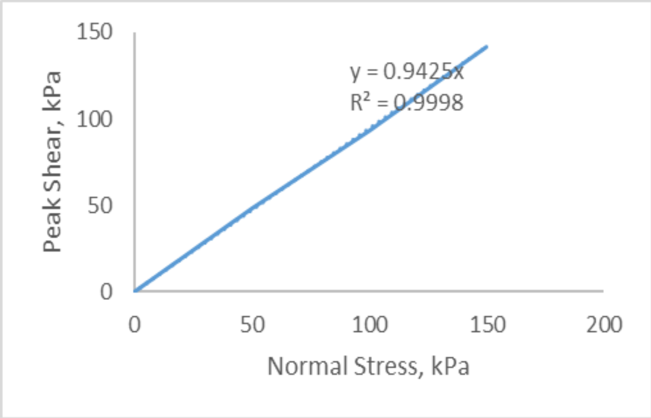


c)

Figure 1 Peak shear under different normal stresses a)50 kPa b)100 kPa c)150 kPa

A. Failure envelop of the samples

The Mohr – Coulomb theory was applied to get the failure envelope of the samples. The peak shear recorded from the tests were plotted against the normal stress. The results can be found in Figure 2.



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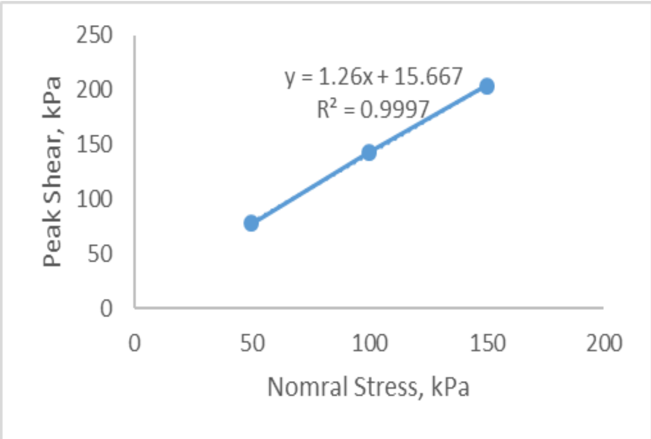

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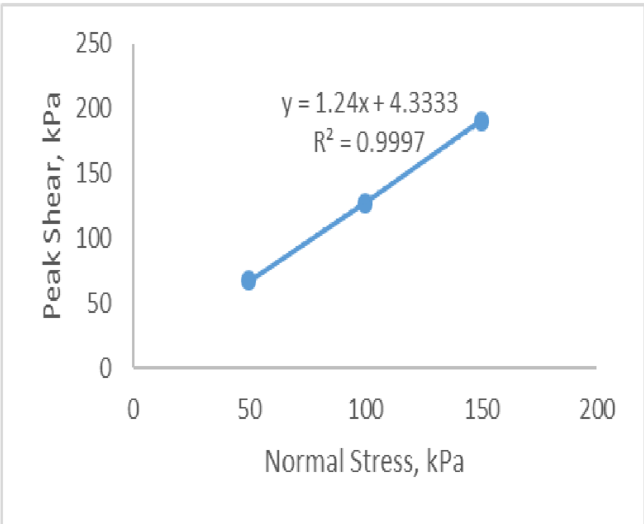

c)

Figure 2 Failure envelope a) sand b)sand-flyash c)sand-fibre

B. Effect on Cohesion

While the sand has zero cohesion, yet due to addition of 10% of additives the results showed changes in the cohesion which was derived via Mohr –Coulomb theory. The results is presented in Figure 3. The value of sand-flyash mixture is recorded as 15.66 kPa comparing 4.33 kPa for fibre mixture.

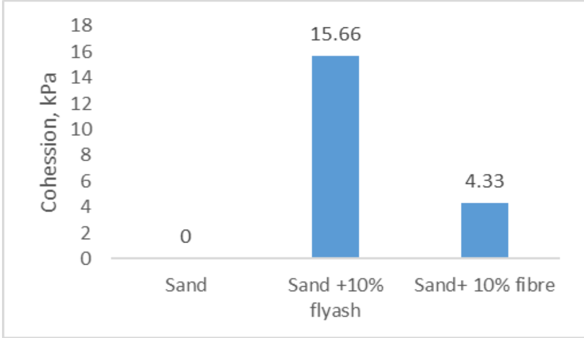

Figure 3 Cohesion values for mixes

Effect on friction angle

The value of friction angle for three samples are presented in the Figure 4. The figure proved that once gain the values of friction angle for sand has improved by inclusion of both additive. Once comes to comparing the values of friction angle for fibre and flyash mixed, the flyash shows slightly better performance in friction angle.

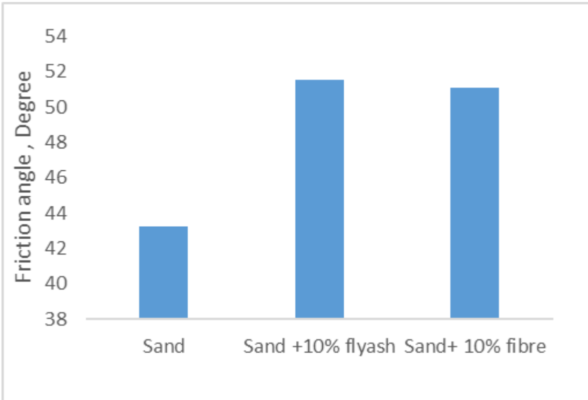

Figure 4 Friction angle values for mixes

VI. CONCLUSION

A series of direct shear test was conducted on three different mixes (i.e. sand, mixed with flyash, mixed with fibre). The normal stresses were recorded as 50,100,150 kPa. The peak shear strength was recorded for each mixes and then cohesion and friction angles were recorded. The outcome can be noted as:

- The flyash additive worked better compare to fibre additive in 10 % inclusion
- Cohesion of flyash for flyash mixture was higher than other samples
- Friction angle of flyash samples was higher than the other samples

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Mahdi Keramati, is civil engineer working in Arup. He hols PhD in civil engineering. He has published many journal paper and is very active in research.

Amin Chegenizadeh, is senior lecturer in civil and mechanical engineering schools in Curtin University, Australia. His area of expertise is soil stabilization along with other geotechnical Cooperated in industry and engineering teams for 10 years to pursuit the goals of projects, collaborated and shared the progress of works in regular construction meetings, worked with the different discipline of engineers. Extensive knowledge of local geotechnical challenges of pavements and mine infrastructures in WA throughout and Australia my career. Knowledgeable and skilled at standard laboratory tests and operation of delicate and advanced laboratory equipment. Developing the hands on practice in geomechanics lab in Curtin University.

Hamid Nikraz is an emeritus professor in civil and mechanical engineering schools in Curtin University, Australia. He is well known for his research on geotechnical and pavement engineering. He has delivered research excellence of high international standing and is a leading international authority in the field of geotechnical and pavement engineering, with particular interest to the sustainable use of industrial by-products in soil stabilisation, a study area that is applicable to the proposed research project. Several waste products are now finding alternative uses and are becoming more acceptable and commercially attractive as a result of his efforts.