Use of fly ash as alternative stabilizer for Mud Concrete Block

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Abstract – This paper describes the behaviour of fly ash as a soil stabilizer. Compressive strength tests were carried out on the soil and fly ash mixers. The strength of dry samples of soil and fly ash increase when percentage of fly ash increase but the strength of wet samples don't exhibit significant variation. Further the strength of dry samples decrease when moisture content of samples increase and workability of samples increase when presence of fly ash percentage increases. So strength of samples of soil and fly ash mixtures show some increase when water content increase while kept the workability of samples as a constant by controlling fly ash percentage. The use of waste by-product, Fly ash as a soil stabilizer provide inexpensive and advantageous construction product.

Keywords: Fly ash, Soil stabilizer, Alternative stabilizer

1 Introduction

In ancient time, among the construction materials such that timber, sand, soil, mud, rock and animal bones etc., soil/mud take a major role than other construction materials due to its Workability, durability, strength and availability. Soil and mud have been used as a based construction material since Egyptian and Mesopotamian cultures especially Babylonian. In Asian civilization such that Harappa and Mohenjo-Daro in Indus valley were also famous for soil blocks structures. In Sri Lankan royal history, soil and mud were one of the most famous bases construction material to raise not only houses and palaces but also other high rise structures such that religious building called Dagaba.

But after the concrete is introduced, frequency of usage of soil/mud as a construction material is reducing little by little. Because concrete has a high strength and high durability but concrete or any other product of cement can be led to environmental pollution. Nowadays people are interesting on sustainable materials to reduce the environmental pollution. Further people are interesting about cost-effective and easy construction ways. So it is an opportunity to use the soil/mud again with remedial actions to overcome the issues of soil/mud which can be encountered while constructing.

Poor workability, less ultimate strength, less aesthetic appearance and exhibiting expansiveness are some major problems of mud/soil which should be overcome. To overcome the construction barriers of soil/mud as a construction material, there are so many additives can be added. In present, there are some common used additives to improve the characteristics of soil/mud, such that ordinary Portland cement, lime, fly ash or combination of above mentioned materials. But all of them have environmental issues while applying in construction field except fly ash. Among them, attention should be paid for Fly ash specially. Because it has interesting characteristics as a soil/mud stabilizer.

When fly ash added to the soil contents clayey minerals such as montmorillonite which directly reason to the expansiveness characteristics, hydration process is increased and simultaneous cautions are exchanged then it effects to reduce the characteristics of shrinking and swelling of soil.

Fly ash has finer spherical particles than cement. Due to these chiefly glassy particles, workability is increased when fly ash is mixed with soil/mud. Further usage of fly ash as a soil/mud stabilizer instead of lime or cement has several advantages such that,

- Minimize carbon dioxide emission
  Ex: - 1 ton Portland cement emit 0.82 tons CO2 but 1 ton fly ash emits 0.027 tons CO2
- Reduce the usage of natural resources ex: - Portland cement consist of many virgin resources such as limestone, clay and shell.
- Low heat of hydration of cement
- Low cost than cement
- Higher ultimate strength
- Improves workability (Due to ball bearing impact)
- Reduce shrinkage
- Leach of metal is reduced in to environment by using fly ash instead of going to the land fill.

Especially in Sri Lanka there is another point to consider Fly ash because about 100 tons of Fly ash is disposed per a day without gain any usage from them at Lak Wijaya Power Plant at Norochchole.

But still as an additive fly ash has to overcome some issues to become the soil/mud to a good quality construction material. In the industry, optimum mixer of soil/mud and fly ash is not introduced yet to prepare an effective soil/mud block.

2 Objective

Main objective of this study is that identifying how vary the strength of selected soil/mud with fly ash percentage and introducing the optimum mixer to get a good quality construction block with a high quality surface appearance for that particular soil/mud.

3 Methodology

120 soil cubes were casted for 5 different soil mixtures which shown in Table 1. For each soil mixtures, 24 cubes were casted, half of them to check wet compressive strength and other half for dry compressive strength.

After mixing soil prepared according to above mentioned proportions, water was added 30% of total dry weight little by little and mixing was done manually. After finishing mixing, mixture was poured into 100mm × 100mm × 100mm moulds by 3 layers and each and every layer was compacted by using 25 number of blows.

Once the casting process was completed, Soil cubes were cured for 7 days and after 7 days, 14 days, 21 days, and 28 days, cubes were loaded by using compressive strength machine to find the compressive strength of cubes as 3 for wet and 3 for dry per one time.

Before checking the wet compressive strength, relevant cubes were immersed in water for 24 hours before testing to obtain saturated surface condition.

4 Results and Discussion

Compressive strength of soil cubes

Average wet compressive strength and dry compressive strength of soil cubes have been shown in Table 02 and Table 03 respectively.

Table 1: Results of Wet tests

Dry	0%	2%	4%	6%	8%
D7	0.34N	0.30N	0.32N	0.37N	0.30N
D14	0.73N	0.50N	0.46N	0.41N	0.47N
D21	0.66N	0.66N	0.81N	0.47N	0.49N
D28	0.67N	0.61N	0.74N	0.69N	0.58N

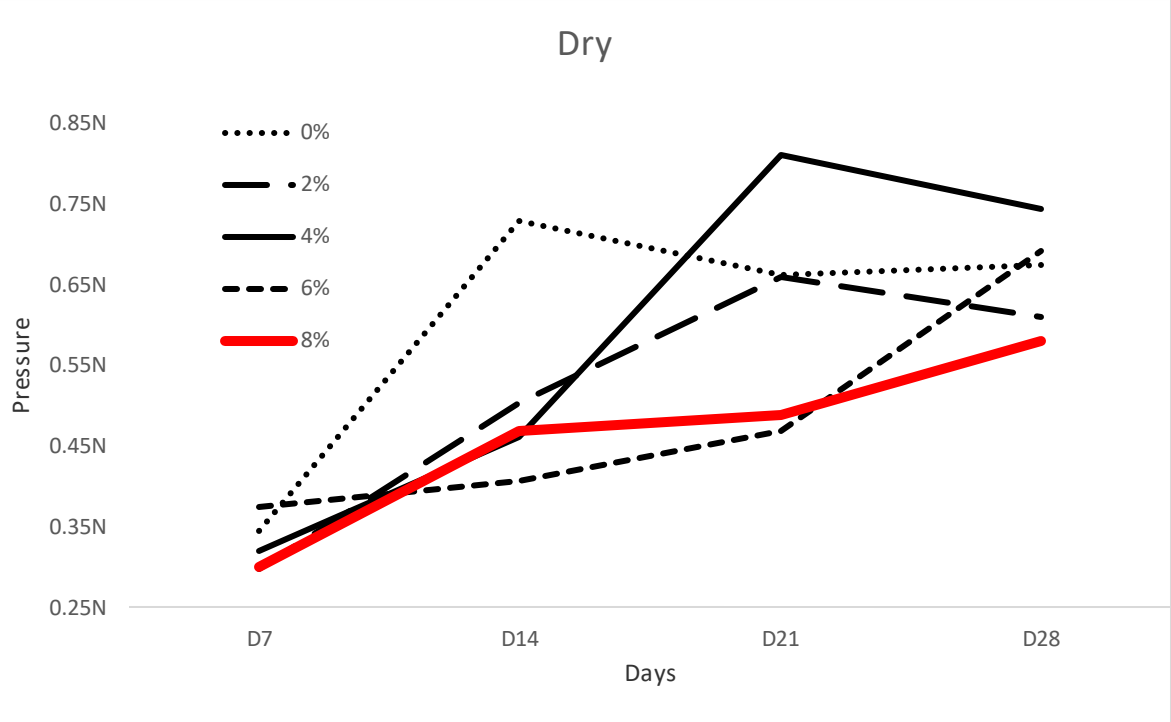

Figure 1 Results of Dry tests

Table 2: Results of Wet tests

Dry	0%	2%	4%	6%	8%
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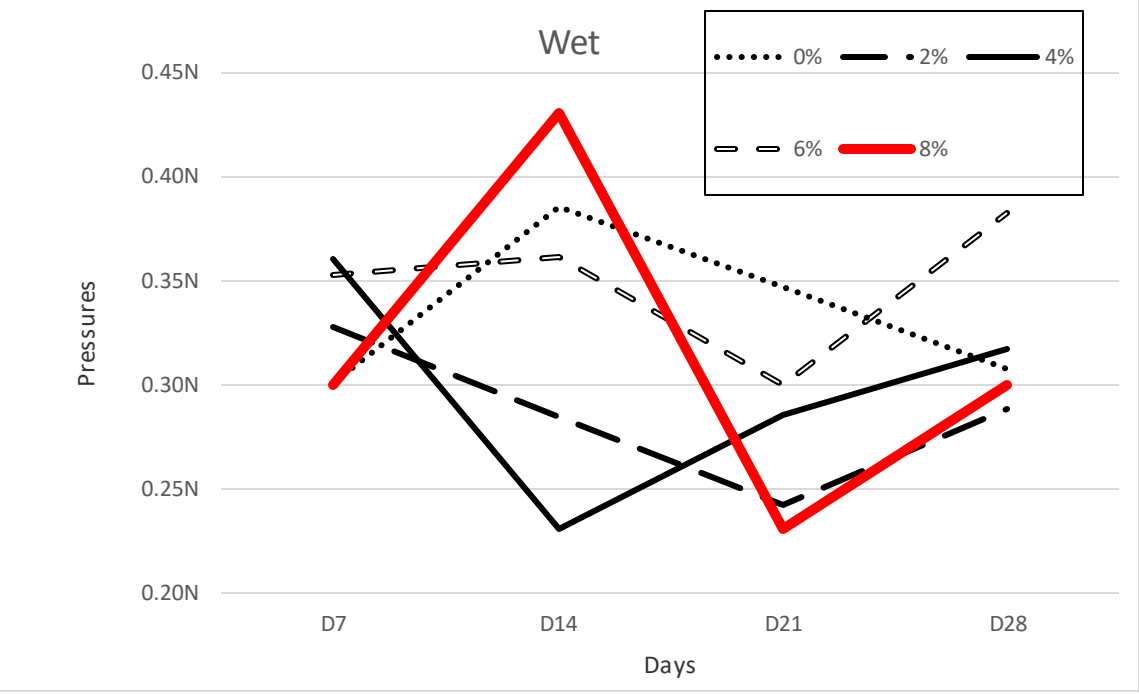

Figure 2 Results of Wet tests

5 Conclusions

This research study was done to study the suitability of Fly ash as an alternative stabilizer. The main studies carried out on the variation of compressive strength and workability. In first experimental attempt, after analyzing the obtained data can be concluded that there is no significant impact to the enhancement of both wet and dry compressive strength of soil mixture if the amount of added Fly ash is less than 12%. But there are little change of compressive strength values especially in dry compressive strength therefore can be decided that if fly ash is added more than 12% can suppose an improvement in compressive strength.

Adding Fly ash can increase the workability of the soil mixture and as well as deducting moisture content can increase the compressive strength of soil cubes. But when the moisture content is reduced workabilityty of the mixture will dropped. Therefore compressive strength of soil cubes can be increased by reducing percentage of moisture content if the workability can be maintained at a proper level. As the result of this research, can be concluded that when the moisture content is reduced to increase the compressive strength of soil cubes, fly ash can be used to maintain the workability but all of these variation can be done in a limited range.

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