International Journal of Engineering, Management, Humanities and Social Sciences Paradigms (IJEMHS)
Volume 30, Issue 02, Quarter 02 (April to June 2018)
ISSN (Online): 2347-601X
www.ijemhs.com

STUDY OF FIBER REINFORCED- FLY ASH STABILIZED EXPANSIVE SOIL AS SUBGRADE MATERIAL IN FLEXIBLE PAVEMENT

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ABSTRACT

Reasonableness of fiber supported - fly ash settled sweeping soil blends as subgrade material in adaptable asphalt has been talked about in this paper. Polypropylene filaments having lengths of 6, 12 and 24 mm were amounted to 1.5% at an augmentation of 0.25% to an extensive soil balanced out with ideal rate (20%) of fly ash. Standard Proctor compaction, unconfined compressive strength, California bearing proportion, and enlarging pressure tests were directed on fiber built up - fly ash balanced out broad soil blends. The ideal rate and ideal length of not set in stone were 1% and 12 mm separately dependent on this load of tests. From the financial investigation it is tracked down that, significant saving in cost of development is conceivable if the subgrade is settled with ideal level of fly ash and supported with ideal rate and ideal length of polypropylene fiber.

KEY WORDS: Expansive soil, fly ash, polypropylene fiber, stabilized, reinforced.

INTRODUCTION

Expansive soil subgrades create problems for construction of flexible pavements, because of their, cyclic swell-shrink behavior, which damage pavements necessitating frequent repair and maintenance, and low California bearing ratio (CBR) values which increase the cost of construction. There are different techniques to counteract swell-shrink behavior of expansive soils and increase their CBR values. Stabilization using solid wastes with or without a binder is one of them. Expansive soil has been stabilized using different types of solid wastes like, phosphogypsum (Mishra and Mathur, 2004), cement kiln dust (Peethamparan and Olek, 2008),lime stone dust (AI-Azzo, 2009), waste tyre (Patil et al., 2011), rice husk ash-marble dust (Sabat and Nanda, 2011),bagasse ash-lime sludge (Sabat, 2012),ceramic dust (Sabat, 2012), quarry dust-lime (Sabat, 2012), glass cullet (Eberemu, 2012), mine tailings (Ramesh et al., 2013) etc..

Stabilization using class-F fly ash is also a very popular method adopted for improvement of engineering properties of expansive soil. By addition of only fly ash (class-F) to expansive soil though increases the strength its swelling pressure does not reduce substantially. That is why it is added along with some other materials like, lime, lime sludge, cement, cement kiln dust, sand, quarry dust etc. Fibers have high tensile strength, soil is weak in tension, fibers can be added as reinforcing elements to fly ash stabilized expansive soil to, increase the strength and reduce the swelling pressure.

Different types of fibers have been added to fly ash stabilized expansive soil for improvement of the engineering properties. Punthutaecha et al. (2006) had studied the individual and combined effects of fly ash and fiber (polypropylene and nylon) on volume change behaviors of expansive soil by conducting three dimensional free swell test, three dimensional shrinkage-strain test and modified pressure swell tests. Ramesh and Kumar (2009) had studied the effects of different percentages of coir fiber (lengths= 10, 15 and 20 mm) on compaction (modified) and CBR of fly ash stabilized expansive soil. Pasupuleti et al. (2012) had studied the effect of different percentages of 12 mm length polypropylene fiber on soaked CBR of fly ash stabilized expansive soil. Senol (2012) had studied the individual and combined effect of class-C fly ash and polypropylene fiber on compaction and CBR of expansive soil. Khan et al. (2013) had studied the effect of different percentages of nylon fiber on compaction and soaked CBR of fly ash stabilized expansive soil.

Study regarding, the effects of different percentages and different lengths of polypropylene fiber on compaction properties, unconfined compressive strength (UCS), soaked CBR and swelling pressure of fly ash (class-F) stabilized expansive soil, and the economy of, fly ash stabilization - fiber reinforcement is found to be limited in literature.

The present study has been undertaken to investigate the, effects of polypropylene fiber (both content and length) on compaction properties, UCS, soaked CBR and swelling pressure of an expansive soil stabilized with optimum percentage of fly ash, and the economy of, fly ash stabilization - fiber reinforcement.

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ECONOMIC ANALYSIS

To study the cost effectiveness of the combined effect of fly ash stabilization and fiber reinforcement an economic analysis has been done. A flexible pavement has been designed for a cumulative traffic of 10 million standard axles (MSA) having an unstabilized expansive soil subgrade, subgrade stabilized with optimum percentage (20%) of fly ash and subgrade stabilized with optimum percentage (20%) of fly ash and reinforced with optimum percentage (1%) and optimum length (12 mm) of polypropylene fiber . The design CBR for unstabilized soil has been taken as 2% and the fly ash stabilized soil as 3% and fiber reinforced and fly ash stabilized soil as 5%.The guidelines given in the Indian Roads Congress (IRC) code, IRC:37-2001 (Guidelines for the design of flexible pavements), are followed. Schedule of rates-2013, Government of Odisha, India is followed for estimation of cost.

Fig.13 shows the pavement composition for cumulative traffic of 10 MSA for unstabilized subgrade (designed CBR=2%), fly ash stabilized subgrade (designed CBR=3%) and fiber reinforced fly ash stabilized subgrade (designed CBR=5%).

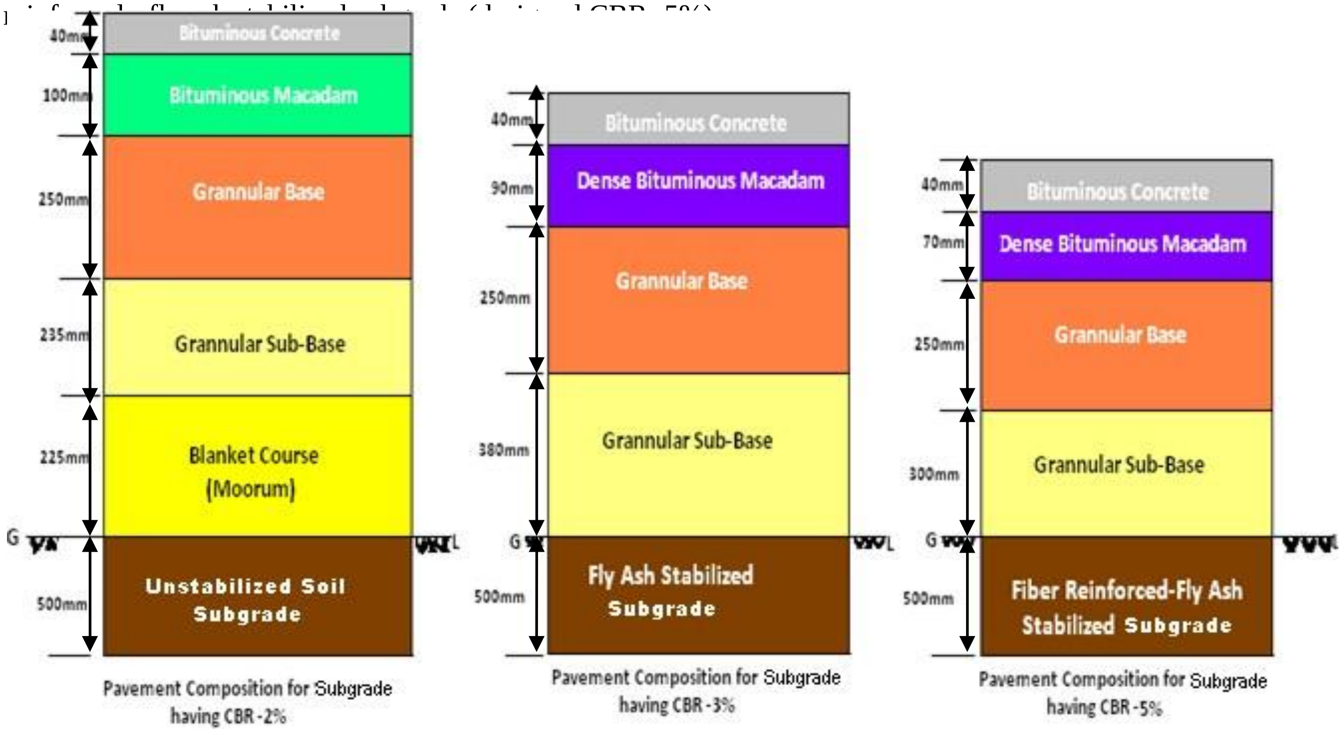

Figure 13: Pavement composition for unstabilized subgrade, Fly ash stabilized subgrade and Fiber reinforced - Fly ash stabilized subgrade for 10 MSA Traffic

The cost/m^2 of the pavement area is found to be $35.12, $32.67 and $30.34 for the pavement having, unstabilized expansive soil subgrade, subgrade stabilized with 20% of fly ash and, subgrade stabilized with 20% of fly ash and reinforced, with 1%, 12 mm length polypropylene fiber respectively. (1US$=60 Indian Rupees).There would be 7% saving in cost of construction per m^2 of pavement area, for the pavement having subgrade stabilized with 20% of fly ash and 13.6% saving in cost of construction for the pavement having subgrade stabilized with 20% of fly ash and reinforced, with 1%, 12 mm length polypropylene fiber, for 10 MSA of traffic, in comparison to pavement having subgrade of unstabilized expansive soil.

CONCLUSIONS

The following conclusions are drawn from this study.

- The optimum percentage of fly ash for stabilization of expansive soil is found to be 20%. At 20% addition of fly ash to expansive soil there is, 58% increase in UCS, 91% increase in soaked CBR and 38% reduction in swelling pressure.
- The MDD of fly ash stabilized expansive soil goes on decreasing and OMC goes on increasing with increase in percentage addition of polypropylene fiber, irrespective of the length of the polypropylene fiber.
- The UCS of fly ash stabilized expansive soil goes on increasing up to 1% addition of polypropylene fiber, thereafter it decreases irrespective of the length of the polypropylene fibers. The maximum value of UCS is achieved with sample reinforced with 12 mm length fiber. There is 70% increase in UCS as compared to fly ash stabilized soil and 170% increase in UCS as compared to virgin soil.
- The soaked CBR of fly ash stabilized expansive soil goes on increasing up to 1% addition of polypropylene fiber thereafter it decreases irrespective of the length of the polypropylene fiber. The maximum value of soaked CBR is achieved with sample reinforced with 12mm length fiber. There is 81% increase in soaked CBR as compared to fly ash stabilized soil and 247% increase in soaked CBR as compared to virgin soil.
- The swelling pressure of fly ash stabilized expansive soil goes on decreasing with increase in percentage addition of polypropylene fiber irrespective of the length of polypropylene fiber. The maximum reduction of swelling pressure occurs on sample reinforced with 12 mm length of fiber. At 1.5% addition of 12 mm length polypropylene fiber, the swelling pressure is zero. Making the sample a non-swelling material. At 1% addition of polypropylene fiber the swelling pressure reduces to 17 kN/m^2, this swelling pressure will not create any problem of swelling if any construction is made over it.
- The optimum percentage of polypropylene fiber for reinforcement of expansive soil stabilized with optimum percentage of fly ash (20%) is found to be 1% and the optimum length as 12 mm.
- From the economic analysis it is found that there would be, 7% and 13.6% saving in cost of construction per square meter of pavement area, for the pavement having sub-grade stabilized with 20% of fly ash and sub-grade stabilized with 20% of fly ash and reinforced with 1%, 12 mm length polypropylene fiber, respectively as compared to pavement having sub-grade of unstabilized expansive soil.

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