DESIGN OF FLEXIBLE PAVEMENT AND RIGID PAVEMENT BY USING FIY ASH AS A STABILIZING MATERIAL

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Abstract

Fly ash is the waste material, which is obtained after burning coal in Thermal Power Plants. It can be used as a stabilizer for soil due to its pozzolonic effect or an inherent self hardening property under favourable conditions of moisture and compaction. This project aim is to study the effect of fly ash on an expansive soil for rigid pavement design and to reduce the quantity of lime in lime fly ash by the effective use of Fly ash itself. Some percentage of Fly ash without any additives was utilized so as to reduce the cost of construction and this is a good method for disposal of it. Initially the index properties of the soil were studied by conducting liquid limit, plastic limit, shrinkage limit, grain size analysis and specific gravity tests. CBR, OMC and swell index tests confirmed that the soil had taken was clay which is highly expansive in nature. Unconfined compressive strength and soaked CBR tests were conducted for various proportions of Fly ash and optimum contents were obtained and found that soil strength improved. If the locally available soil is good in nature pavement construction becomes easier and cheaper. But if the soil is weak in nature instead of going for an alternative, which costs higher the available soil can be modified by adding this type of stabilizer which involves low cost.

Pavement foundations are treated with flyash for a variety of reasons: for construction facilitation, treatment of expansive soils, and to provide structural support for the pavement system. Many studies have shown that well engineered and constructed lime stabilized soil layers provide strong and durable support to pavement structures, improving their long term performance.

1. INTRODUCTION

Fly ash is a finely divided residue resulting from the combustion of ground or powdered coal and transported by the flue gases of boilers fired by pulverized coal. It is available in large quantities in the country as a waste product from a number of thermal power stations and industrial plants using pulverized coal as fuel for the boilers. At present there are more than 40 thermal power plants in the country producing over 5 million tonnes of fly ash per annum. The ash content of the coal used at most of these plants range from 17 to 45 percent. Since low ash, high grade, coal is reserved for metallurgical industries, railways, etc., the thermal power plants have to utilize high ash, low grade, coal and by-product fuel from coal washeries. It has been estimated that the average ash content of coal which will be available for thermal power plants in the coming years may range between 35 and 45 percent. Due to this factor, and increased industrialization, the present level of production of fly ash is expected to double in the next 10 years.

2. IMPORTANCE OF FLYASH

Fly ash is the finely divided residue that results from the combustion of pulverized coal and is transported from the combustion chamber by exhaust gases. Over 61 million metric tons (68 million tons) of fly ash were produced in 2001.

Fly ash is produced by coal-fired electric and steam generating plants. Typically, coal is pulverized and blown with air into the boiler's combustion chamber where it immediately ignites, generating heat and producing a molten mineral residue. Boiler tubes extract heat from the boiler, cooling the flue gas and causing the molten mineral residue to harden and form ash. Coarse ash particles, referred to as bottom ash or slag, fall to the bottom of the combustion chamber, while the lighter fine ash particles, termed fly ash, remain suspended in the flue gas. Prior to exhausting the flue gas, fly ash is removed by particulate emission control devices, such as electrostatic precipitators or filter fabric bag houses (see Figure 1.1).

Fly ash is most commonly used as a pozzolana in PCC applications. Pozzolans are siliceous or siliceous and aluminous materials, which in a finely divided form and in the presence of water, react with calcium hydroxide at ordinary temperatures to produce cementitious compounds.

The unique spherical shape and particle size distribution of fly ash make it a good mineral filler in hot mix asphalt (HMA) applications and improves the fluidity of flowable fill and grout. The consistency and abundance of fly ash in many areas present unique opportunities for use in structural fills and other highway applications. eful to other organizations facing similar workforce needs.

3. **Scope of the Project**.

Pavement subgrade over there is composed of clayey soil whose bearing capacity is extremely low. Due to this reason, the roads require periodic maintenance to take up repeated application of wheel loads. This proves to be costly, and at the same time, conditions of roads during monsoon seasons are extremely poor. Therefore, a thought on how to enhance the stability of roads by chapter means demands appraisal. Soil stabilization can be done using different additives, but use of fly ash which is a waste material from thermal power plants, at the same time difficult-to-dispose material will be much significant.

Fly ashes are finely divided residue resulting from the combustion of ground or powdered coal from electric generating plants. Lime is another additive used, which is locally available, to improve subgrade characteristics. It is obtained by heating limestone at elevated temperatures

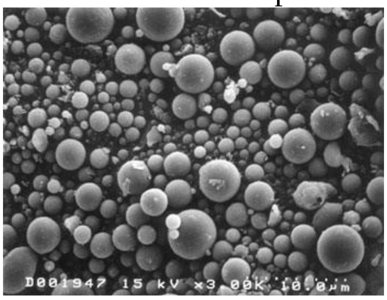
4. LITERATURE REVIEW

Pavement consists of more than one layer of different material supported by a layer called sub grade. Generally pavement is two type flexible pavement and rigid pavement. Flexible pavements are so named because the total pavement structure deflects, or flexes, under loading. A flexible pavement structure is typically composed of several layers of material. Each layer receives the loads from the above layer, spreads the amount then passes on these loads to the next layer below.

TYPES OF PAVEMENT

Based on structural behavior, the pavements are broadly classified into three categories as follows;

1. Flexible Pavement
2. Rigid Pavement
3. Composite Pavement



FLY ASH APPLICATIONS

Fly ash is used in concrete admixtures to enhance the performance of concrete. Portland cement contains about 65 percent lime. Some of this lime becomes free and available during the hydration process. When fly ash is present with free lime, it reacts chemically to form additional cementitious materials, improving many of the properties of the concrete.

Benefits. The many benefits of incorporating fly ash into a PCC have been demonstrated through extensive research and countless highway and bridge construction projects. Benefits to concrete vary depending on the

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type of fly ash, proportion used, other mix ingredients, mixing procedure, field conditions and placement. Some of the benefits of fly ash in concrete:

PRELIMINARY TESTS

Few tests were conducted on cement, fine aggregate and course aggregate which will help in design mix of the concret

5.1 Specific Gravity of Cement

In case of cement, specific gravity is determined by use of a Le Chatelier's flask. In the determination of specific gravity of cement, kerosene is used as a medium instead of water, because water undergoes hydration reaction with cement, while kerosene does not react. The specific gravity of OPC is generally around 3.15.

Apparatus Used

The apparatus used for the specific gravity test of cement are

i. Specific gravity bottle
ii. Weighing balance

Materials used

The materials used for the specific gravity test of cement are

i. Cement
ii. kerosene

Procedure

i. Dry the flask carefully and fill it with kerosene to a point on the stem between zero and 1 ml mark.
ii. Record the level of the liquid in the flask as initial readings.
iii. Introduce a weighed quantity of cement (about 64 g) into the flask. The level of kerosene will rise. Care should b e taken to avoid splashing and to ensure that cement does not adhere to the sides of the stem of the flask above the liquid level.
iv. After all the cement has been introduced into the flask, the stopper shall l be placed in the flask and roll the flask gently in an inclined position or gently whirled in a horizontal circle, so as to expel air until no further air bubble rises to the surface of the liquid.
v. Note down the new liquid level as final reading.
vi. Repeat the steps 1 to 5 at least for three different samples.
vii. The density of OPC is given by,

$$\text{Density of cement} = \frac{\text{Mass of cement in gm}}{\text{Displaced volume in cm}^3}$$

Displaced volume = Final Reading – Initial Reading.

viii. Calculate the specific gravity of cement for each of the three samples.
ix. Determine the mean spec ific gravity of the cement by averaging the results of all the three samples.

Tabulation and Calculations

Table 5.1: Specific Gravity of Cement tabulation.

S.No	Description	Sample 1	Sample 2	Sample 3
1	Weight of empty specific gravity bottle (w1)	25.8	25.8	25.8
2	Weight of specific gravity bottle + Cement (w2)	39.5	35.3	40.2
3	Weight of specific gravity bottle + cement + kerosene (w3)	77.8	75.0	78.3
4	Weight of specific gravity bottle + kerosene (w4)	67.9	67.9	67.9
5	Weight of specific gravity bottle + water (w5)	77.9	77.9	77.9

Specific Gravity of Kerosene, $S_k = \frac{w4-w1}{w5-w1} = \frac{67.9-25.8}{77.9-25.8} = 0.808$

Specific Gravity of Cement, S_c

$=\frac{(w2-w1)}{(w4-w1)-(w3-w2)}$ X Sk

Sample 1, S_c = 2.922

Sample 2, S_c = 3.199

Sample 3, S_c = 2.909

Average of the three samples is 3.01

Result

The specific gravity of Cement is found to be 3.0

MIX DESIGN

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete is governed by the required performance of concrete in 2 states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance.

The compressive strength of hardened concrete which is generally considered to be an index of its other properties, depends upon many factors, e.g. quality and quantity of cement, water and aggregates; batching and mixing; placing, compaction and curing. The cost of concrete is made up of the cost of materials, plant and labour. The variations in the cost of materials arise from the fact that the cement is several times costly than the aggregate, thus the aim is to produce as lean a mix as possible. From technical point of view the rich mixes may lead to high shrinkage and cracking in the structural concrete, and to evolution of high heat of hydration in mass concrete which may cause cracking.

RESULTS AND DISCUSSIONS

Twenty-seven specimens consisting of 9 cubes, 9 prisms and 9 cylinders castedwith three different plain normal-strength concrete grades (M20, M30 and M40) were tested under short-term uniaxial compression and two point bending test to determine the ultimate strength and to study the stress-strainbehaviour with different grade of concrete. In this chapter, experimental results will be presented and discussed. These experimental data will also be used to compare with the empirical equations proposed by other researchers.Three cylinder specimens of eachconcrete grade castedwith plain normal-strength concrete were tested under short-term uniaxial compression to determine the ultimate strength and to study the stress-strain behaviour with different grade of concrete. These experimental data will also be used to compare with the empirical equations proposed by other researchers. The variation of Crushing Energy will be discussed with respect to the grade of concrete.

CONCLUSIONS

- Maximum reduction in heave values are obtained for the lime-cement stabilized flash subbase stretch compared to other stretches on expansive soil subgrade.
- Heaving of the expansive soil has considerably decreased the load carrying capacity of flexible pavement system
- By addition of fly ash, the CBR value is increased by 27% when compared to unmodified soil.
- Fly ash can be successfully used in the cement concrete road pavements. Though it lowers the rate of hydration as well as final strength, it makes the section economical.
- □ Hence it is a safe and environmentally consistent method of disposal of fly ash
- Based on the Experimental Studies on M20 grade, M30 grade, M40 grade of concrete, the variation in mechanical properties of concrete is presented below.
- Compressive strength of concrete is found to be increasing with increase in the grade of concrete. This is may be due to reduction in the percentage voids and the increase in the toughness of the matrix with the increase in the grade of concrete.
- Flexural Strength of concrete is found to be increasing with increase in the grade of concrete. This is may be due to reduction in the percentage voids and the increase in the toughness of the matrix with the increase in the grade of concrete.
- Modulus of concrete is found to be increasing with increase in the grade of

concrete. This is may be due to reduction in the percentage voids and the increase in the stiffness due to increase in the toughness of the matrix with the increase in the grade of concrete.

- Peak Strain is found to be decreasing with increase in the grade of concrete and Peak Strain is found to be increasing with increase in the grade of concrete, this may be due to the increase in the stiffness and brittleness of concrete with the increase in the grade of concrete.
- Failure stress is observed to be increasing with increase in the grade of concrete and the failure strain is observed to be decreasing with increase in the grade of concrete. The difference between failure strain and peak strain is decreasing; this may be due to increase in the brittle nature of the concrete.
- The Crushing Energy of the concrete increases with the grade of concrete because the energy storing capacity of concrete increases with the compaction of concrete and becomes stronger and bears more loads.

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