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To Study and Design of Rigid Pavement by Fly Ash in Portland Cement Concrete

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Abstract: The use of fly ash in Portland cement concrete (PCC) has many benefits and improves concrete performance in both the fresh and hardened state. Fly ash a waste generated by thermal power plants is as such a big environmental concern. In modern decades, the industrialization and urbanization are the two phenomena that are spreading all over the world. Improved durability in the decrease in free lime and the resulting increase in cementations compounds, combined with the reduction in permeability enhance concrete durability

Keywords*— *Fly ash, Cement, Compressive strength, Fly Ash Properties.

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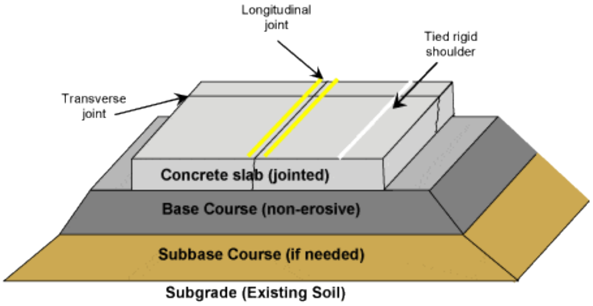
I. INTRODUCTION

The use of fly ash in Portland cement concrete (PCC) has many benefits and improves concrete performance in both the fresh and hardened state. Fly ash use in concrete improves the workability of plastic concrete, and the strength and durability of hardened concrete. Fly ash use is also cost effective. When fly ash is added to concrete, the amount of Portland cement may be reduced.

II. RIGID PAVEMENTS

A rigid pavement is constructed from cement concrete or reinforced concrete slabs. Grouted concrete roads are in the category of semi-rigid pavements.

The design of rigid pavement is based on providing a structural cement concrete slab of sufficient strength to resists the loads from traffic. The rigid pavement has rigidity and high modulus of elasticity to distribute the load over a relatively wide area of soil.



III. BENEFITS TO FRESH CONCRETE.

Generally, fly ash benefits fresh concrete by reducing the mixing water requirement and improving the paste flow behavior. The resulting benefits are as follows:

- **Improved workability.** The spherical shaped particles of fly ash act as miniature ball bearings within the concrete mix, thus providing a lubricant effect.
- **Decreased water demand.** The replacement of cement by fly ash reduces the water demand for a given slump. When fly ash is used at about 20 percent of the total cementations, water demand is reduced by approximately 10 percent.
- **Reduced heat of hydration.** Replacing cement with the same amount of fly ash can reduce the heat of hydration of concrete. This reduction in the heat of hydration does not sacrifice long-term strength gain or durability.
- **Benefits to Hardened Concrete.** One of the primary benefits of fly ash is its reaction with available lime and alkali in concrete, producing additional cementations compounds.
- **Increased ultimate strength.** The additional binder produced by the fly ash reaction with available lime allows fly ash concrete to continue to gain strength over time.
- **Reduced permeability.** The decrease in water content combined with the production of additional cementations compounds reduces the pore interconnectivity of concrete, thus decreasing permeability.
- **Improved durability.** The decrease in free lime and the resulting increase in cementations compounds, combined with the reduction in permeability enhance concrete durability. This affords several benefits:

IV. MIX DESIGN AND SPECIFICATION REQUIREMENTS

Procedures for proportioning fly ash concrete (FAC) mixes necessarily differ slightly from those for conventional PCC. Highway agencies generally use variations to this procedure. Fly ash is used to lower the cost and to improve the performance of PCC. Typically, 15 percent to 30 percent of the portland cement is replaced with fly ash, with even higher percentages used for mass concrete placements.

A mix design should be evaluated with varying percentages of fly ash.. A mix design should be performed using the proposed construction materials. It is recommended that the fly ash concrete being tested incorporates local materials in performance evaluation.

Cement Factors. Because fly ash addition contributes to the total cementations material available in a mix, the minimum cement factor (portland cement) used in the PCC can be effectively reduced for FAC. Fly ash particles react with free lime in the cement matrix to produce additional cementations material, and thus, to increase long-term strength.

V. FLY ASH PROPERTIES

Fineness. The fineness of fly ash is important because it affects the rate of pozzolanic activity and the workability of the concrete. Specifications require a minimum of 66 percent passing the 0.044 mm (No. 325) sieve.

Specific gravity. Although specific gravity does not directly affect concrete quality, it has value in identifying changes in other fly ash characteristics.

Chemical composition. The reactive aluminosilicate and calcium aluminosilicate components of fly ash are routinely represented in their oxide nomenclatures such as silicon dioxide, aluminum oxide and calcium oxide. Fly ashes tend to contribute to concrete strength at a faster rate when these components are present in finer fractions of the fly ash.

Sulfur trioxide content is limited to five percent, as greater amounts have been shown to increase mortar bar expansion.

Available alkalis in most ashes are less than the specification limit of 1.5 percent.

Carbon content. LOI is a measurement of unburned carbon remaining in the ash. It can range up to five percent per AASHTO and six percent per ASTM. The unburned carbon can absorb air entraining admixtures (AEAs) and increase water requirements. Further, if the fly ash has a very high carbon content, the carbon particles may float to the top during the concrete finishing process and may produce dark-colored surface streaks.

VI. OTHER CONSTRUCTION MATERIALS

Aggregates. As with any concrete mix, appropriate sampling and testing are needed to ensure that the aggregates used in the mix design are of good quality and are representative of the materials that will be used on the project. Aggregates containing reactive silica may be used in the FAC.

Cement. Fly ash can be used effectively in combination with all types of cements: portland cement, performance cement, and blended cements. Appropriate mix design and testing should be conducted to evaluate the impact of fly ash addition on the performance of high early strength concrete. Blended or pozzolanic cements already contain fly ash or other pozzolan.. The selected portland cement should be tested and approved on its own merit, as well as evaluated in combination with the specific fly ash to be used.

Air Entraining Admixtures (AEAs). The higher the carbon content in the fly ash, the more difficult it is to control the air content.

Retarders. Adding fly ash should not appreciably alter the effectiveness of a chemical retarder. Some fly ashes may delay the time of set and may reduce the need for a retarder.

Water reducers. Fly ash concrete normally requires less water, but it can be further improved with the use of a water-reducing admixture. The effectiveness of these admixtures can vary with the addition of fly ash.

VII. CONSTRUCTION PRACTICES

Fly ash concrete mixes can be developed to perform essentially the same as PCC mixes with minor differences. When mixing and placing any FAC, some minor changes in field operation may be desirable. The following general rules-of-thumb will be useful:

Plant Operations. Fly ash requires a separate watertight, sealed silo or holding bin for storage. Take care and clearly mark the loading pipe for fly ash to guard against cross-contamination when deliveries are made. As with any concrete mix, mixing time and conditions are critical to producing quality concrete.

Field Practices. Normal practices for consolidation should be followed. Excessive vibration should be avoided to minimize the loss of in-place air content.

Troubleshooting. First-time users of fly ash in concrete should evaluate the performance of proposed mixes prior to construction.

Air content. The fineness of fly ash and the improved workability of FAC make it naturally more difficult to develop and hold entrained air.. Quality assurance and quality control testing of ash at the source must ensure that the fly ash used maintains a uniform carbon content (LOI) to prevent unacceptable fluctuations in entrained air.

Lower early strength. Fly ash concrete mixes typically result in lower strengths at early ages. Lower early strengths can be overcome by using accelerators.

Seasonal limitations. Construction scheduling should allow time for FAC to gain adequate density and strength to resist de-icing applications and freeze-thaw cycling prior to the winter months. Strength gain of FAC is minimal during the colder months.

VIII. CONCLUSIONS

This research concludes the study of the effect of fly ash on the properties of concrete‖ for nominal mix of M25 grade of concrete are as follows. 1. Slump loss of concrete increases

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with increase in w/c ratio of concrete. 2. For w/c ratio 0.35 without any admixtures, initial slump cannot be measured by slump cone test as it is very less. 3. Ultimate compressive strength of concrete decreasing with increase in w/c ratio of concrete.

Benefits to Fresh Concrete : Improved workability. Decreased water demand Reduced heat of hydration Increased ultimate **strength** Reduced permeability Improved durability A mix design should be evaluated with varying percentages of fly ash.

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