CHARACTERIZATION OF MECHANICAL PROPERTIES OF PAVEMENT QUALITY CONCRETE INCORPORATED WITH SUSTAINABLE FLY ASH AGGREGATES

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Keywords

Fly ash, Pelletization, Binder, Alkaline solution, Sintering.

Introduction

In this growing Indian Civilization, 70-80% of power generation is from thermal power plant. This result in environmental pollution air pollution due to the particulate emission from plants, water pollution and shortage of lands due to dumping of fly ash. Also, the major problem is the high content of ash in Indian coals which worsens the problem of pollution. Chemical composition of Fly Ash is almost is same as cement. Portland Pozzolanic Cement (PPC) is used in construction industries with fly ash. The major problem of using only fly ash in concrete is its lower early age strength but on the other hand the advantage of fly ash is the improved compressive strength in concrete and thus improving sulphate resistance and durability. The approach of developing new eco-friendly and cost-effective building materials that integrates numerous kinds of wastes as a partial or full replacement of cement, sand, and aggregate has gained considerable attention.

The environmental impacts of crushed stone aggregate, extraction are a source of increasing in many parts of the country. The impacts include loss of forests, noise, dust, blasting, vibrations and pollution hazards. Unplanned exploitation of rocks may lead to landslides of weak and steep hill slopes. Concern about the depletion of natural sources and the effect on environment has particularly focused attention on possibility of use synthetically produced (from waste materials) aggregates as an alternative to naturally occurring materials.

For the manufacturing of fly ash aggregates, primarily, two types of agglomeration techniques, namely, pelletization or granulations and compaction are used for the consolidation of fly ash particles into larger shapes. In the method of granulations agglomerates are shaped by tumbling forces without any external compacting forces, and in the method of compaction the desired density is achieved with external compacting forces. Whereas, for the hardening of these fly ash granules cold bonding, autoclaving or sintering are the three approaches commonly adopted.

Objectives

The aim of the study is to produce highly efficient wintered aggregates and use it in partial replacement of coarse aggregates in Pavement Quality Concrete.

The following are the main objectives of the present study.

1. Mix design of fly ash aggregate concrete.
2. Estimating the optimum percentage replacement of aggregates.
3. Experiments on Mechanical properties of PQC.

4. Fatigue analysis of PQC.
5. Analytical analysis of PQC using KENPAVE.

Methodology

Materials- Class F fly ash was procured from Bellary Thermal power plant (BTPS). Bentonite and other chemicals like Sodium hydroxide and Sodium silicate were sourced locally. OPC 53 grade Cement was used for the production of Concrete with synthetic aggregates. Fine and Coarse aggregates were also locally sourced.
Pelletization- Fly ash and Bentonite was dry mixed in a mixer. A solution containing 7 molar Sodium Hydroxide and Sodium silicate was prepared for the alkaline solution. The solution was added to the dry mix and rotated at an angle of 45 degrees and 50 rpm speed. The mix was allowed to rotate for around 5 minutes and then aggregates were taken out and sieved on 4.36 mm sieve. The remaining mix was again rotated and adequate amount of solution was added for the formation of aggregates.
Pre-Heating-The aggregates were kept in air tight condition for the first 24 hours after pelletization and then the aggregates were heated at 60 degrees Celsius for 24 hours before sintering.

Sintering-The aggregates were sintered in a muffle furnace at a temperature of 800 degrees Celsius for 1 hour duration.
Material Testing-The sintered aggregates were tested for material properties such as physical and mechanical properties. Tests include specific gravity, water absorption, bulk density, Aggregate impact value, Aggregate crushing value, Abrasion test, Ten percent fines value, Soundness test.

Preparation of Concrete specimens- Mix design was prepared for M40 and M50 grade concrete with 10%,30% and 50% replacement of fly ash aggregates. Cubes, cylinders and prisms were casted for testing concrete properties.

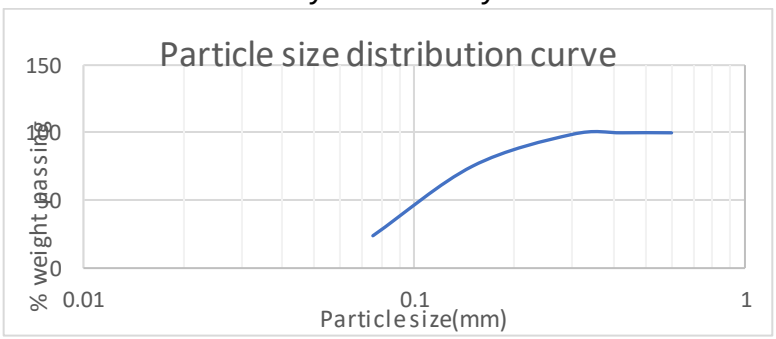
Results and Conclusions

Physical properties of Fly ash

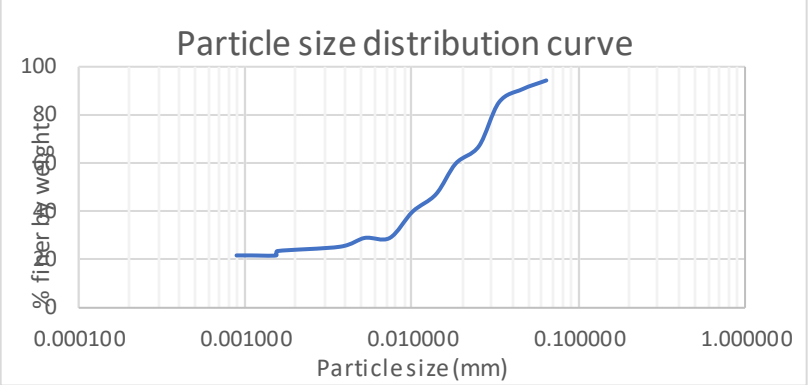
Physical Properties	Results
Specific Gravity	2.11
Specific Gravity (Material finer than 75 microns)	2.227
Blaine's air permeability	480.33 m^2/kg
Material finer than 90 microns	33%

Sieve Analysis

1. Dry Sieve analysis



2. Wet Sieve analysis (Hydrometer Method)



Properties of Fly ash aggregates

Properties	Results
Specific Gravity	1.712
Water Absorption	8.96%
Aggregate Impact Value	8.48%
Aggregate Crushing Value	31.77%
Aggregate Abrasion Value	23.22%

Conclusions

The following conclusions are made from the above study:

1.Maximum strength of pellets was attained when Bentonite was used as binder.

2.The strength of pellets increased when an alkaline solution was added to the pelletization process instead of water.

3.Impact value and Water absorption of aggregates with an alkaline solution containing 7 molar Sodium hydroxide and 200ml Sodium silicate was found to be optimum.

Innovation in the project

Use of Fly ash to make aggregates and change in binders and solution is an innovation in this project. The use of fly ash aggregates in Pavement Quality Concrete (PQC) is another innovation in this project.

Scope for future work

Further studies can be done by selecting different binders with the same alkaline solution to decrease water absorption and increase mechanical properties of aggregates. Introduction of fires in concrete made with fly ash aggregates can also be done. The durability tests on fly ash aggregate concrete can be studied. Different types of Chemical attacks on fly ash aggregate concrete can be compared with normal concrete and its effects can be studied. The effect of introduction of fly ash aggregates in Reinforced concrete can be studied and the interaction of fly ash aggregates and reinforcing bars can be studied and the effect of Corrosion can also be studied.