AN EXPERIMENTAL STUDY ON THE DURABILITY OF THE FLY ASH MIXED CONCRETE

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Abstract

Concrete is a composite material composed of both coarse and fine aggregates. River sand is considered as one of the most used fine aggregate in the world, but with the expansion of the Construction scale of our country, the shortage of river sand resources is becoming more prominent. Fly ash (FA) from the thermal plants is available in large quantities in fine and coarse form. Fine fly ash is used in construction industry in some amount and coarse fly ash is subsequently disposed over land in slurry forms. The fly ash can be used to overcome the shortage of river sand and avoid excessive sand mining which can bring ecological environment problems, because of the presence of chloride ions in the fly ash the steel in the concrete may be corroded and hence care should be ensured while using fly ash as a fine aggregate. The salt in the fly ash should be treated before used for construction to avoid disaster. In this paper the investigation is made on the developed concrete by adding fly ash as a fine aggregate. The river sand (fine aggregate) is replaced by fly ash in terms of 100% and 50%. Another test is carried out with replacing river sand with fly ash along with GGBS as coarse aggregate and then several tests were carried out to check its durability. The test results show that it is more significant to use fly ash as an aggregate to the concrete by partially replacing it with river sand.

Key words: Concrete, Fly ash, river sand, durability test.

1. INTRODUCTION

Concrete is used in the construction industry because of its greater advantages like flexibility and high compressive strength. Concrete is widely used for making architectural structures, brick/block walls, pavements, bridges, highways, runways, parking structures, reservoirs, pipes, footing, fences and even boats. It is a composite material composed of coarse granular material embedded in a hard matrix of material (the cement or binder) that fills the space among the aggregate particles and glues them together. In a concrete mix the aggregates consists of large chunks of material that are in general a coarse gravel or crushed rocks such as lime stone or granite, along with finer material such as sand. Cement**,** commonly Portland cement, and other cementations materials such as fly ash and slag cement, serve as binder for the material. Water is mixed to this dry composite, which produces a semi-liquid that can be shaped in to a required form. Concrete solidifies and hardens to rock-hard strength through a chemical process called hydration. The water reacts with the cement, which bonds the other components together, creating a robust stone like material.

In recent years, there is a considerable demand on the construction materials to be particular there is a shortage of natural fine aggregate, due to the deficiency of natural sand supply and increased construction demands. To overcome this there is a lot of research done and results are suggested by expatriates to replace the concrete materials with new alternatives. Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. The property of sand is not the same for all the locations. it is different from place to place. The composition of sand is highly variable, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica usually in the form of quartz. In the fast growing construction

in the country there is shortage of river sand that has become more prominent and in many coastal areas it has been promoted to use fly ash as fine aggregate of concrete. When used so it can reduce the shortage of the river sand and reduce excessive sand mining that lay grounds for the ecological environment problems and moreover the fly ash contains chloride ions which can corrode steel. e The reasons stated encouraged the research scholars about the importance and responsibility to find the durability of the fly ash concrete structure. The recent research mainly focused on the four aspects: desalted fly ash; performance of the fly ash concrete; steel corrosion and prevention measures; applications of fly ash concrete.

Sea beach sand is more stable (high SBC) than river sand, due to reason that it is brought by travelling water either pushed by sea shore or by river. During the continuous rolling in between water layers in rivers and sea shore, bigger stone particles continuously decaying during travelling toward sea and dissociate in to as small as possible. Remaining dissociate particle at beach will be of much strength than any other sand on the earth surface and hence residue sand at sea beach has much strength than sand at starting of any river. it is because particle at river starting have no much time to dissociate into most stable form. They will continuously roll toward sea (final destination) and gain higher and higher stability

II. REVIEW OF LITERATURE

The sand can be described as the solid particles of a certain size, between 0.0625mm and 2mm diameter. It can also be named in terms of grain size, color, composition, morphology (angularity and shape) and surface texture. Among the terms the Grain size obtained is a result of several factors, including composition, durability, severity of weathering condition and others. Sand is made of minerals and tiny pieces of rock that have come from the erosion and weathering of rocks. The global construction trade promoted to use the fly ash in the construction industry in the Asian region. Then, at the Civil Engineering Department of University of Moratuwa and the National Building Research Organization (NBRO) has confirmed that the fly ash pumped from a distance about ten kilometers is very suitable for the building construction industry because it has less chloride comparing with fly ash in beaches. The sand dunes are formed by sand particles blown by wind from sea shore. The top most layers of sand dunes contain higher chloride content due to continuous exposure to sea breeze (Shantha, 2006). In addition, Dias et al (2007) investigated their flakiness, which may reduce workability, has also been found to be offset by their smoothness, and also the greater roundedness of the fly ash itself. JuanHong LIU, YanFei, (2009), CUI College of Civil and Environmental Engineering University of Science and Technology Beijing Beijing, conducted a Study on the Performance and Microstructure of Fly ash on Ripe Pile Concrete. The survey was done to study the effects of fine aggregate of fly ash replacing some or all river sand on the pipe pile concrete.

Experiments were conducted on concrete specimens with ash mixing at a proposal of 50%, 60%, 70%, 80%, 90% and 100% as fine aggregate, after curing the specimens test were done to find the strength and chloride diffusion coefficient. Analysis using microscope mechanism by mercury injection test and SEM were also carried out. The test results show that the strength and durability of pipe pile concrete is little. When the mixing quantity of fly ash reaches 90%, then the strength and anti-permeability proved to be the best which were respectively 86.3MPa and 144×10-14m2/s. The mercury injection test indicate that tobermorite was produced in the internal-structure of pipe pile concrete and none Cl- exsited which further was verified that the increasing of fly ash mixing quantity did not influence the strength and durability of pipe pile concrete. This let the possibility of mixing a large quantity of fly ash for various type of construction.

III. METHODOLOGY

MATERIALS AND MIX DESIGN

The ingredients used for the making of concrete are cement, coarse aggregate, river sand, water and offshore sand.

Cement:

S.No	Cement Specification	
1	Grade	43 grade
2	Type	Portland Pozzolona Cement
3	Fineness	300 – 500 m^2/kg
4	Specific gravity	3.15

Table 1 Specification of Cement

Coarse Aggregate used in the study was of size 20 mm with specific gravity 2.74. Potable water was used. River sand sieved in 4.75 mm sieve with specific gravity 2.74 was used as fine aggregate. Offshore sand samples were collected from a stock pile at nagapattinam district coasts, tamil nadu, india.

Tests on offshore sand:

The stockpile filled by drained offshore sand was created on reclaimed land, where the water table was around 2 m below ground level. A large sample of sand was obtained that appeared to be a typical dredged material. In addition, smaller samples of sand were also obtained that appeared to be of coarse, fine and medium grading. The fine sand was obtained from the top surface of material that had been just dredged and settled. The fine aggregate grading test was carried out as per BS 812-103.1: 1985(2000). For the offshore sand samples, the shell content were obtained separately for the aggregate fractions greater than and less than 5 mm, using a hand picking method and dissolving in HCl respectively. The shell contents were measured for coarse, medium, fine and typical grading of offshore sand, from a sample size of 1000 g.

Chloride content tests

The samples were be sealed or drained in a sump with an outlet valve. The container had four openings (that could be plugged and made watertight) at three levels (including the base) so that the sand could be sampled at the top, bottom and third points along the height, called levels A–D. Initially the container was filled with offshore sand of typical grading and sea water, then the sand was fully saturated for over 24 hours. The sump valve was opened for the sea water to drain freely. First set of samples were taken after 5 days of draining, samples were taken from the top, bottom and third points (using one each of the openings) in order to obtain a chloride profile with a depth for the drained condition. Second set of samples were taken after 27 days of draining. Then fresh water with a size of height of 80 mm over the 250 mm x 600 mm area of container was sprinkled from the top with an open valve. A third set of samples were taken after 5 days of draining. This sprinkling was repeated with a further 220 mm height of water (to obtain a total of 300 mm of sprinkled water) and once again. The final sets of samples were taken after 5 days of draining. The sprinkling of fresh water was done to study the change in chloride levels after various amount of rain, with the 80 mm and 320 mm corresponding roughly to the minimum and maximum values of average monthly rainfall for the region containing the offshore sand stockpile. The samples were oven dried prior to chloride testing as per BS 1377: Part 3 (1990). To obtain moisture and chloride contents. The proportioning of concrete mix is a process to achieve a right combination of cement, aggregate and water for making concrete according to the given specification. Mix proportion is done as per IS 10262:2009. Chloride content test was performed to study the chloride content in the offshore sand under various conditions as given in the table 2. The sea water was obtained from the pump outlet at the stock pile.

Description	Saturation Condition
Set 1	After 5 days of ND
Set 2	After 27 days ND with 80 mm rain
Set 3	After 5days ND with 300 mm rain
Set 4	After 5days ND with 80&320 mm rain average

Table 2 Different Saturation Condition

IV. RESULTS AND DISCUSSIONS

Fine aggregate grading

CHARACTERISTICS	OFFSHORE SAND TYPES			
	TYPICAL	COARSE	MEDIUM	FINE
<.6mm(%)	44	42	49	85
<.15mm(%)	2.6	2.5	2.7	12
D_{50} mm	0.63	0.66	0.60	.21

Table 3: Grading of concrete

Table 3 Show the key characteristics of the grading curves for various offshore sand samples. This shows that differences between the typical, medium and coarse offshore sand samples are small, with a D_{50} value around 0.6 mm, while the fine sample is considerably different. A D_{50} value of around 0.6 mm is very good for concrete production. Such values tend to be much lower in the European offshore sand deposits, say between 0.2 and 0.4 mm. It must also be appreciated that previous work indicate

that offshore sand gradings can vary from one location to another.

Both moisture content and chloride contents could be obtained. The proportioning of concrete mix is a process to obtain a right combination of cement, aggregate and water for making concrete according to the given specification. This Mix proportion is done as per IS 10262:2009.

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