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RESEARCH ARTICLE

INFLUENCE OF ADDITION OF POND ASH AND IRON SLAG AS PARTIAL REPLACEMENT OF SAND ON MORTAR

Shiva Kumar K[1]., Mallesh T G[2]., Kumar D S[3]., Sheetal K S[4] and Gopinath R[5]

[1,2,3,4,5] Department of Civil Engineering, CIT, Gubbi

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A B S T R A C T

This dissertation work deals with the potential use of using Pond ash and Iron slag as the partial replacement of sand in plastered mortar. Pond ash is rarely used due its pozzolonic reaction may be used as a fine aggregate in a mortar mix used for plastering purpose. Then iron slag and pond ash is improves the quality of plastered surface inn terms of strength and durability. When the pond ash and iron slag was used 20% replacement of sand to make mortar mix, produced higher percentages compressive strength as well as a higher development rate than those tradition cement-sand mortar mix. As a result of compressive strengths, it was concluded that pond ash could be used as a good replacement material in mortar. It is proposed to perform some field and laboratory experiments in different mix proportions of pond ash and plaster sand and compare with normal mortar. Due to the pond ash replacement, the initial strength gaining process is quite slow but in later stages it gains very good strength as compare to the normal mortar mixes.

INTRODUCTION

General

Mortar cement is specially formulated and manufactured to produce masonry mortar for use in brick, block, and stone masonry construction. Mortar cement mortars have similar attributes to masonry cement mortars, but they have lower air contents than masonry cements, and the mortar cement specification includes a minimum bond strength requirement. Mortar cement mortars are appropriate for use in structural applications that require masonry with high flexural bond strength.

Sand is the one of the main constituents of mortar. Natural sand is mainly excavated from river beds always contain high percentage of organic materials, chlorides, sulphates, silt & clay that are adversely affect the strength, durability of mortar and concrete and reinforcing steel there by reducing the life of the structure, when concrete is used for buildings in aggressive environments, marine structures, nuclear structures, tunnels, precast units, etc. Fine particles below 600 µ must be at least 30% to 50% for making concrete will give a good result. Normally these particles are not present in river sand up to required quantity. Digging sand, from river bed in excess quantity is hazardous to environment. The deep pits dug in the river bed, affects the ground water level. The sand in mortar does not add any strength but it is used as an adulterant for economy and with the same it prevents the shrinkage and cracking of mortar in setting. When fine particles are in proper proportion, the sand will have less voids. The cement required will be less when there will be less voids in sand. Such sand will be more economical. Only manufactured sand by VSI crusher is cubical and angular in shape. Sand made by other types of machines is flaky which is troublesome in working. There is no plasticity in the mortar hence the mason are not ready to work with machine made crushed stone sand. For the same reason inferior river sand may be used. Manufactured sand from jaw crusher, cone crusher and roll crusher often contain high percentage of dust and has flaky particles. Flaky and angular particles may produce harsh concrete, and may result in spongy concrete. There is standard specification for fine aggregates. It is divided in four gradations. Generally known as Zone I, Zone II, Zone III and Zone IV. There is sieve designation for each grade. Gradation is made as per the use of sand. VSI can produce any zone of sand. But in case of natural sand quality varies from location to location without any control.

Aims &Objectives of the Study

Influence of addition of pond ash and iron slag as partial replacement of fine aggregate on mortar. To evaluate the different strength properties of mortar mixture with pond ash and iron slag replaced in percentage to the fine aggregate for making compressive strength and split tensile strength.

MATERIALS USED

Pond Ash

Pond ash is the waste product from most of the thermal power plants in India. The fly ash gets mixed with bottom ash and disposed off in large pond dykes as slurry. Pond ash contains relatively coarse particles. The huge amount of pond ash accumulated around the thermal power stations is still posing threat to environment. The utilization of pond ash as a building material is one of the possible way of its sustainable management. In the present study, an attempt is made to ascertain the possibility of using the pond ash as a replacement of sand in plaster mortar. Pond ash (PA) means stacked particles containing Fly Ash (FA), Bottom Ash (BA) and small soil particles in reclamation site. It has several limitations for direct use for fine aggregate of concrete. More than 40% of Pond Ash is wetted in reclamation site and sometimes it contains much chloride contents in reclamation site since it is almost located near to sea. Furthermore quality control of Pond Ash is difficult for concrete aggregate since it contains various particles and mineral ions. In the previous research, comprehensive studies are performed for CCPs (Coal Combustion Products) but only the material of FA and BA are obtained and used from coal fired power plant. Domestic PA from reclamation and landfill sites is studied for a feasible replacement of sand in cement mortar. Two selected PAs from different reclamation sites are prepared considering two replacement ratio of sand (30% and 60%). For evaluation of durability performance in hardened PA cement mortar, several tests like strength, freezing and thawing action, chloride migration, and accelerated carbonation are performed, and their results are compared with those from control cases (without PA mortar). The effect of water content on workability and performance of PA mortar is also evaluated. Evaluation and discussion of engineering properties in PA cement mortar are dealt with in this paper as a construction material.

Iron Slag

Extraction of ‘iron’ from ores is a complex process requiring a number of other materials which are added as flux or catalysts. After making steel these ingredients forming a matrix are to be periodically cleaned up. Removed in bulk, it is known as steel –slag. It consists of silicates and oxides. Modern integrated steel plants produce steel through basic oxygen process. Some steel plants use electric arc furnace smelting to their size. In the case of former using oxygen process, lime (CaO) and dolomite (CaO. Mgo) are charged into the converter or furnace as flux. Lowering the launce, injection of higher pressurized oxygen is accomplished. This oxygen combines with the impurities of the charge which are finally separated. The impurities are silicon, manganese, phosphorous, some liquid iron oxides and gases like CO_2 and CO. Combined with lime and dolomite, they form steel slag. At the end of the operation liquid steel is poured into a ladle.

The remaining slag in the vessel is transferred to a separate slag pot. For industrial use, different grades of steel are required. With varying grades of steel produced, the resulting slags also assume various characteristics and hence strength properties. Grades of steel are classified from high to medium and low depending on their carbon content. Higher grades of steel have higher carbon contents. Low carbon steel is made by use of greater volume of oxygen so that good amount carbon goes into combination with oxygen in producing CO_2 which escapes into atmosphere. This also necessitates use of higher amount of lime and dolomite as flux. These varying quantities of slag known as furnace slag or tap slag, raker slag, synthetic or ladle slag and pit or clean out slag. Fig-1 presents a flow chart for the operations required in steel and slag making.

The steel slag produced during the primary stage of steel making is known as furnace slag or tap slag which is the major share of the total slag produced in the operation. After the first operation, when molten steel is poured into ladle, additional; flux is charged for further refining. This produces some more slag which is combined with any carryover slag from first operation. It helps the in absorbing of deoxidation products, simultaneously providing heat insulation and protection of ladle refractories. Slag produced on this operation is known as raker and ladle slag.

Table 1 Chemical composition of iron slag

Constituent	Composition %
CaO	40-52
SiO2	10-19
MgO	10-40
Al2O3	5-8
P2O5	5-10
S	<0.1
Metallic Fe	0.5-10

Fine Aggregate

The aggregate was sieved is completed by sieve. The fine aggregate might be natural and crumpled. It can be accessible in a riverbed. The seizes of sand elements differ from an extreme of 4.75mm down to 150micron i.e. 0.150mm. Good sand necessity contains all the particles with in the above range that is and it should be graded sand. The sand may be sieved through the Indian standards sieves 4.75 mm, 2.36mm, 1.18mm, 600 micron, 300 micron and 150 micron. The sand may be categorized as very course [zone 1], medium course [zone 2], and course [zone 3] mad fine [zone 4] Contingent upon its grain size distribution.

Cement

43 grade Ordinary Portland Cement (ACC) is used in this present investigation. Cement is a fine powder, when mixed with water and allowed to set and hardened components or members together to give a mechanically strong structure. Cement can be used as a binding material with water for binding solid particles of different sizes like bricks, stones or aggregates to form a monolith.

Table 2 The Replacement of Sand by Iron Slag & pond Ash

Mix Id	Sand	IS & PA
IP_0	100	0
IP_{30}	70	30
IP_{50}	50	50
IP_{70}	30	70

For 0% PA & IS only sand is used for making mortar, and tests are computed

Casting, Curing & Testing of the Specimen

Casting of Specimen

PA, IS, Sand & cement were taken in the mix proportion of 1:3. Sand is replaced with PA & IS with varying percentages like (0%, 30%, 50% & 70 %.). All the ingredients were dry mixed homogeneously. To this dry mix, water-cement ratio of 0.40 was added and the entire mix was again homogeneously mixed. This wet mortar was poured into the moulds which was compacted by tamping rod in three layers and then kept into the vibrator for compaction. After the compaction, the specimens were given smooth finishes and were covered with gunny bags. After 24 hours, the specimens were de moulded.

Curing of the Specimens

The de moulded specimens were transferred to curing. The curing is done in the water, where they were allowed to cure for 07, 14, 21 & 28 days.

Testing of the Specimens

The test specimens for compressive strength test were made of cubes having a size of 75mm x 75mm x 75mm cast iron steel moulds were used. For each mix proportion four numbers of cubes were cast and tested at the age of 7 days, 14 days, 21 days and 28 days. The test specimens for split tensile strength test were made of cylinders having a size of 100mm diameter and 300mm high cast iron moulds were used. For each mix proportion two numbers of cylinders were cast and tested at 7 days, 14 days, 21 days and 28 days.

Compressive Strength Test

Specimens of dimensions 75x75x75mm were prepared. They are tested on 2000kN capacity compression testing machine as per IS 516-1959. The compressive strength is calculated by using the equation,

F=P/A

Where; F=> Compressive stress in N/mm2
P=> Maximum load in N
A=> Cross sectional area in mm2

The average Compressive strength of various proportions is given in table.

Table 3

curing in days→ percentages↓	7 days (mpa)	14 days (mpa)	21 days (mpa)	28 days (mpa)
0%	24.88	26.67	27.55	28.33
30%	25.77	26.67	26.90	27.55
50%	22.22	23.11	24.00	24.8
70%	17.77	18.66	19.20	20.44

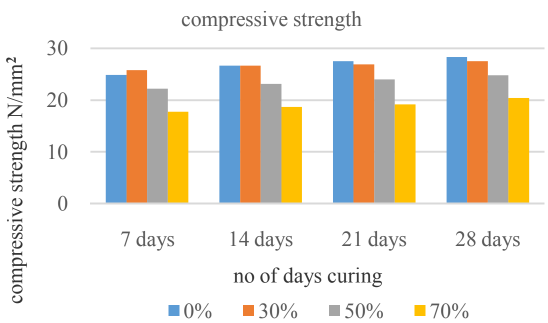

Figure 1

Compressive strength of 28 days curing of 50% replaced PA & IS to fine aggregate gives 24.80 N/mm^2 and it is observed that 28% of strength is decreased when compared to conventional mortar.

Split Tensile Strength Test

Cylindrical specimens of diameter 100mm and length 300mm were prepared. Split tensile test was carried out on 2000 KN capacity compression testing machine as per IS 5816-1999. The tensile strength is calculated using the equation.

F=2P/ (π x D x L)
Where; F=> Split tensile stress in N/mm2
P=> Load at failure in N
D=> Dia of the cylindrical specimen in mm
L=> Length of the cylindrical specimen in mm

The average split tensile strength of various proportions is given in table.

Table 4

curing in days→ percentages↓	7 days (mpa)	14 days (mpa)	21 days (mpa)	28 days (mpa)
0%	2.51	2.58	2.68	2.82
30%	2.68	2.79	2.89	2.93
50%	2.61	2.65	2.72	2.84
70%	2.26	2.40	2.47	2.58

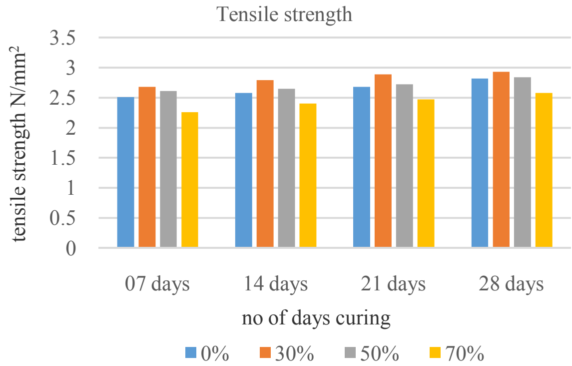

Figure 2

Tensile Strength

Split tensile strength of 28 days curing of 70% replaced PA & IS to fine aggregate gives 2.58 N/mm^2 and it is observed that 26% of strength is decreased than conventional mortar.

RESULTS & DISCUSSION

Test results on materials used

Table 4

Materials	Characteristics	Result
Cement	Standard consistency	30%
	Initial setting time	150min
	Final setting time	300min
	Specific gravity	2.98
Fine aggregate	Specific gravity	2.6
	Sieve analysis	zone IV
	Water absorption	1%
	Moisture content	Nil
PA	Specific gravity	2.17
IS	Specific gravity	2.87

The comparison graph shown in graphs which shows the compressive strength of cubes & split tensile strength of cylinders respectively shows for different percentage PA & IS. For ambient curing of specimens of 50% of PA & IS which gives 20.44 N/mm^2, when compared to the others specimens using different percentage of PA & IS and 50% replaced Sand gives maximum strength at 11%. The maximum strength achieved in 28 days curing. For split tensile also there is maximum increase in 30% replacement.

CONCULSION

- It can be conclude that the higher strength characteristic of mortar can induced with 30% replacement of fine aggregate by pond ash and iron slag.
- Higher percentage additions of pond ash and iron slag reduces the strength of mortar.

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