ISSN: 2320-5407 Int. J. Adv. Res. 12(03), 460-465

Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/18415
DOI URL: http://dx.doi.org/10.21474/IJAR01/18415

RESEARCH ARTICLE

EFFECT ON COMPRESSIVE STRENGTH OF CONCRETE WITH ADDITION OF SOLID WASTE ASH

S. Kabilan[1], O.A. Mohammad Multhazim[1], R. Om Prasath[1], R. Arjun[1] and Mr. B. Palani Kumar[2]

1. Students, Department ofCivil Engineering,SethuInstitute ofTechnology, Pullor,Kariapatti.
2. AssistantProfessor, DepartmentofCivilEngineering,SethuInstituteofTechnology, Pullor, Kariapatti.

Manuscript Info

Manuscript History
Received: 10 January 2024
Final Accepted: 14 February 2024
Published: March 2024

Key words:-
Solid Waste Ash, Mix Ratio, Strength, Cement, Fine-Aggregate, Co- Aggregate

Abstract

The availability of raw material is very limited due to the increased use of concrete. The standard practice of concreting is dosing, mixing (all raw materials), transportation, on-site compaction, finishing and hardening of all raw materials are done industrially. In developed countries like India, the amount of concrete is more and the availability of raw materials is very limited. A complete replacement of concrete is not possible, because no material can fulfil the role of concrete in terms of strength, durability and workability. To achieve the desired workability, strength and durability of concrete, the entire material must be partially replaced. This article provides an explanation of solid waste ash materials used in concrete. The test procedure involved preparing concrete samples with a percentage of cement replaced by fly ash (0%, 5%, 10% and 15%) and evaluating their compressive strength (7 and 28 days) and split tensile strength after 28 days of curing.

Introduction:-

Energy plays a crucial role in the growth of developing countries like India. In the context of low availability of non-renewable energy resources coupled with the requirements of large quantities of energy for Building materials like cement, the importance of using industrial waste cannot be under estimated. During manufacturing of one tonnes of Ordinary Portland Cement we need about 1.1 tonnes of earth resources like limestone, etc. Further during manufacturing of 1 tonne of Ordinary Portland Cement an equal amount of carbon-di-oxide are released into the atmosphere. The carbon-di-oxide emissions act as a silent killer in the environment in various forms. In this Backdrop, the search for a cheaper substitute to OPC is a needful one.

The disposal of waste materials is always been a major problem for environmental engineers. Solid waste has the most adverse effect on the environment compared to liquid waste. Because liquid waste can be used for domestic purposes with the help of the treatment process. In recent times, the engineers and researchers have found the solution to reduce the effects of solid waste on the environment. The solution is using the solid waste incineration ash as one of the ingredients of concrete. The addition of solid waste improves the properties of concrete to ensure the maximum efficiency in the construction.

Literature Review:-

Chatterjee, (2011) reported that about 50 % of fly ash generated is utilised with present efforts. He also reported that, one may achieve up to 70% replacement of cement with fly ash when high strength cement and very high

Corresponding Author:- Mr. B. Palanikumar
Address**:-** Department of Civil Engineering, Sethu Institute of Technology, Pulloor, Kariapatti, Virudhunagar.

reactive fly ash is used along with the sulphonated naphthalene formaldehyde superplasticizer. He reported improvement in fly ash property could be achieved by grinding and getting particles in sub microcrystalline range.

Namagg & Atadero, (2009) described early stages of a project to study the use of large volumes of high lime fly ash in concrete. Authors used fly ash for partial replacement of cement and fine aggregates. Replacement percent from 0% to50% was tested in their study. They reported that concrete with 25% to 35% fly ash provided the most optimal results for its compressive strength. They concluded that this was due to the pozzolanic action of high lime fly ash. (Jones & McCarthy, 2005) made an extensive laboratory-based investigation in to unprocessed low lime fly ash in foamed concrete, as a replacement for sand. For a given plastic density, the spread obtained on fly ash concretes were up to 2.5 times greater than those noted on sand mixes. The early age strengths were found to be similar for both sand and fly ash concrete, the 28-day values varied significantly with density. The strength of fly ash concrete was more than 3 times higher than sand concrete. More significantly while the strength of sand mixes remained fairly constant beyond 28 days, those of fly ash foamed concrete at 56 and 180 days were up to 1.7 to 2.5 times higher than 28 days values respectively.

Malhotra, (2005) discussed the role of supplementary cementing materials and superplasticizers in reducing greenhouse gas emissions. Author also discussed different ways of reducing CO2 emission. With emphasis on developing countries the author discussed that their infrastructure needs lead them to use huge amounts of cements. This huge need of cement can be reduced by replacing cement with easily available good quality of fly ash from the thermal power stations. Author also mentions the development of high performance; high volume fly ash concrete that incorporates large dosages of super plasticizer which enhances the durability of concrete. The paper also discussed about different cementing materials that can be used in concrete making as replacement of cement to reduce the cement consumption and also reduce the CO2 emission to the atmosphere.

Subramaniam, Gromotka, Shah, Obla & Hill, (2005) investigated the influence of ultrafine fly ash on the early age property development, shrinkage and shrinkage cracking potential of concrete. In addition, the performance of ultrafine fly ash as cement replacement was compared with that of silica fume. The mechanisms responsible for an increase of the early age stress due to restrained shrinkage were assessed; free shrinkage and elastic modulus were measured from an early age. Comparing all the test results authors indicated the benefits of using ultrafine fly ash in reducing shrinkage strains.

Hwang, Noguchi & Tomosawa, (2004) based on their experimental results concerning the compressive strength development of concrete containing fly ash, the authors concluded that the pores in concrete reduce by addition of fly ash as replacement of sand.

(Rao, 2004) discussed the need to use about 650 kg/cu.m of fine material to make self-compacting concrete. This also requires fine aggregates more than 50% of total aggregate so that coarse aggregate can float in the fine material. This Requirement of fine materials can be easily fulfilled by use of fly ash.

Papadakis, 1999) used a typical low calcium fly ash as additive in mortar replacing, part of volume either of Portland Cement or aggregate. In both cases 10, 20 and 30% addition to the cement weight was done.

Material Used:-

Cement

Cement is a binding material used in the preparation of concrete. It bends the coarse aggregates and fine aggregates with help of water, to a monolithic matter and also it fills the voids in the concrete. OPC 53 Grade sample was tested to obtain the following characteristic as per IS 12269-1987:

Properties Of Cement (OPC 53 GRADE)

PROPERTIES	OPC USED IN PRESENT STUDY
Specific gravity	3.15
Standard consistency	31.0 %
Initial setting time	50 min
Final setting time	560 min
Fineness	28.50 %

Fine Aggregatge: -
In this present investigation, the M sand which was available near Madurai, was used as fine aggregate and the following tests, carried out on sand as per IS:2386-1963 PART (1), (111) &(1v)

Properties Of Fine Aggregates

S.NO	PROPERTIES	RESULTS
1	Specific gravity	2.56
2	Fineness modulus	2.74
3	Bulk density	17 KN/m3
4	Water absorption	0.82 %
5	Bulking fine grade	38.00 %

Coarse Aggregate:
In this present investigation, locally available crushed blue stone aggregate of size 20mm and down was used and the various tests carried out on the aggregates are given below as per IS: 2386-1963(1V)

Properties Of Coarse Aggregates

PROPERTIES	RESULTS
Specific gravity	2.78
Fineness modulus	6.80
Bulk density	16.50kN/m^3
Water absorption	12.0% (By mass)
Crushing strength	13.80%

Solid Waste Ash: -
Solid waste ash is the residue left after the combustion of solid wastes. This combustion can occur in various contexts, such as in incinerators used for waste-to-energy plants, municipal solid waste incineration, or other waste treatment processes.

Properties Of Solid Waste Ash

PROPERTIES	RESULT
Specific gravity	2.56
Fineness modulus	6%
Bulk density	15.70
Water absorption	15 %

Mix Proportions
Cement = 380 kg/m3
Water = 160 kg/m3
Fine aggregate = 726.10 kg/m3
Coarse aggregate = 1222.04 kg/m3
Water cement ratio = 0.52
MIX RATIO – 1:1.87:2.22
Mix ratio for M30 concrete is shown in Table

Cement (Kg/m3)	Fine Aggregate (K g/m3)	Coarse Aggregate (Kg/m3)	Water (l/m3)
380	726.10	1222.04	160

1	1.87	3.22	0.52

Mix Proportion Of Cubes

S.NO	MIX	ASH %	CEMENT	FINE AGGREGATE	COARSE AGGREGATE	ASH (Gms)	W/C RATIO
1	M1	0	4.43	8.45	14.28	0	0.52
2	M2	5	4.43	8.45	14.28	22.15	0.52
3	M3	10	4.43	8.45	14.28	44.3	0.52
4	M4	15	4.43	8.45	14.28	88.6	0.52

Specimen Preparation: -

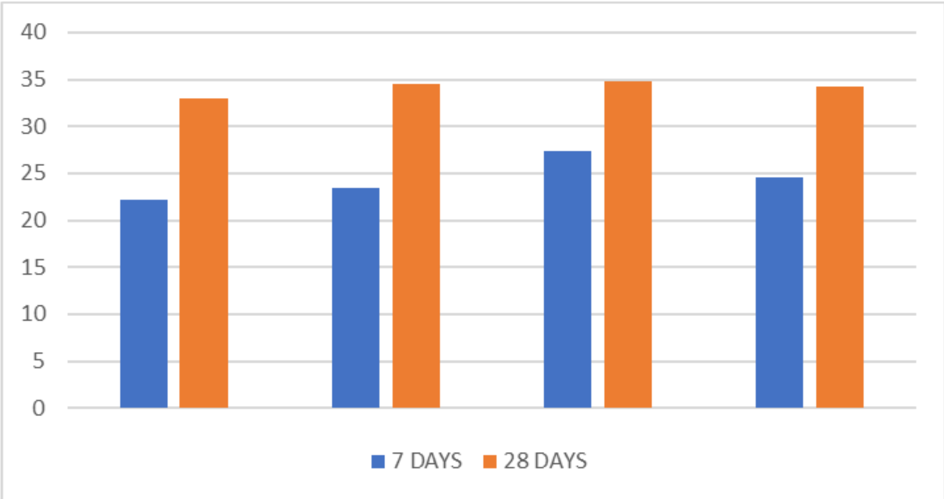
The cubes of size 150mmx150mmx150mm are prepared with 3 control specimens and 3 specimens each with addition of solid waste ash by various proportions such as 0%,5%,10%,15% by weight of cement. The following are the figures of the casted cubes with these various proportions.

Experimental Setup Of Specimens: -

The compression load test on the cube specimen was performed with the help of a compression testing machine (CTM) of 2000kN capacity. All the cubes were fitted vertically and the load was given until the failure of the cubes took place and the ultimate load was taken into consideration in order to find out the respective compressive strength of the cubes

Compressive Strength Of Cube(N/mm^2)

S.NO	ASH %	NO. OF SAMPLE TESTED	LOAD KN (7days)	LOAD KN (28days)	AREA mm^2	7 days strength N/mm^2	28 DAYS OF STENGTH N/mm^2
C	0	3	499	741	22500	22.18	32.93
M1	5	3	526	777	22500	23.38	34.53
M2	10	3	615	763	22500	27.33	34.86
M3	15	3	553	770	22500	24.58	34.22



Results For Compressive Strength:-

Mix Proportion Of Cylinder

S.NO	MIX	ASH %	CEMENT	FINE AGGREGATE	COARSE AGGREGATE	ASH (Gms)	W/C RATIO
1	M1	0	6.95	13.28	22.42	0	0.52
2	M2	5	6.95	13.28	22.42	34.75	0.52
3	M3	10	6.95	13.28	22.42	69.5	0.52
4	M4	15	6.95	13.28	22.42	139	0.52

Specimen Preparation

The cylinder of size 150mm dia & 300mm height are prepared with 3 control specimens and addition of solid waste ash by various proportions such as 0%,5%,10%,15% by weight of cement. The following are the figures of the casted cylinders with these various proportions.

Specimen Preparation

Experimental Setup Of Specimens

The uni-axial compression load test on the cylinder specimen was performed with the help of compression testing machine (CTM) of 2000kN capacity. All the cylinders was fitted horizontally and the load was given until the failure of the cylinders takes place and the ultimate load was taken into consideration in order to find out the tensile strength of the cylinders

Loading Setup

Tensile Strength Of Cylinders

For cylinder specimen, tensile strength test was conducted to find out the strength development of concrete containing 0%,5%,10%,15% by weight of cement for each type at the age of 28days.

Tensile Strength Of Cylinders(N/mm^2)

S.No	Mix	No. Of Sample Tested	Ash %	Load KN 28 Days	28 Days of Strength N/mm^2
1	C	3	0	175	2.47
2	M1	3	5	159.6	2.26
3	M2	3	10	180.9	2.56
4	M3	3	15	160.4	2.27

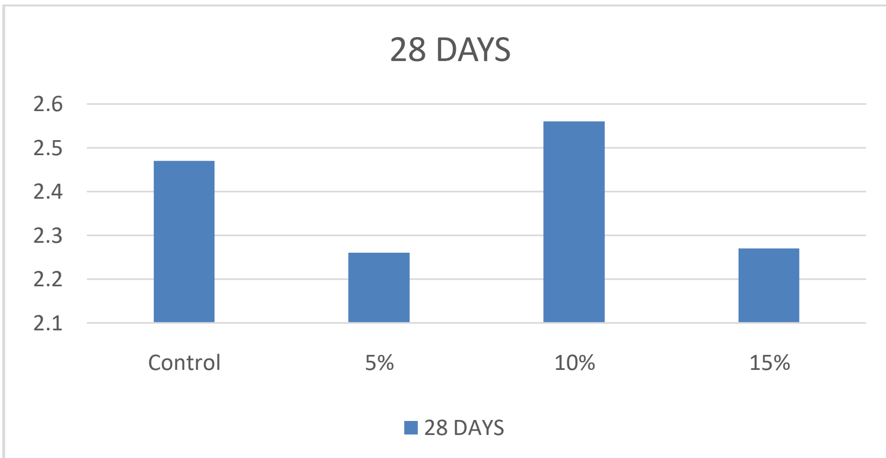


Fig 4.4:- Results For Tensile Strength.

Conclusions:-

The following conclusions are arrived based on the laboratory investigation carried out,

- M30 - Mix proportion for Indian code IS 10262: 2009.
- Maximum compressive strength of 10% mix of M30 were 34.86 N/mm^2 as compared to control mix of 32.93 N/mm^2.
- This is 16.2% increase for the replacement of 10% of solid waste.
- Maximum split tensile strength of 10% mix of M30 were 2.56 N/mm^2 as compared to control mix of 2.47 $N/mm^{2.}$
- This is 10% increase for the replacement of 10% of solid waste.

Reference:-

1. Hashim Mohammed Alhassan, Ahmed Musa Tanko, "characterization of solid waste incinerator bottom ash and the potential for its use"" volume: 2 issue:4 | July-august- 2014 ,IJERA
2. B.V.Bahoria, Dr.D.K.Parbat, Dr.P.B.Naganaik,Dr.U.P.Waghe, "Comprehensive literature review on use of waste product in concrete", IJAIEM Volume 2, Issue 4, April 2013
3. IS: 456. (2000), "Plain and Reinforced Concrete - Code of Practice", Bureau Indian Standards, New Delhi.
4. IS: 10262. (2009), "Recommended Guidelines for Concrete Mix Design", Bureau Indian Standards, New Delhi.
5. IS: 516. (1979), "Method of test for strength of concrete", Bureau Indian Standards, New Delhi.