

Effects of Pond Ash as Partial Replacement of Cement in High Performance Concrete

*¹K. Yuvaraj, ²K. Prasanth, ²L. Prabhakar, ²A. Rajini, ²P. Vijay Prasath²

¹Assistant Professor, Department of Civil Engineering, K.S.Rangasamy College of Technology, Tamilnadu, India

²UG Student, Department of Civil Engineering, K.S.Rangasamy College of Technology, Tamilnadu, India

ABSTRACT: Pond ash is defined as a residue and by-product of thermal power plants. In this research work, the use of pond ash as a partial replacement material for cement in concrete matrix. Cement is replaced in various percentage of pond ash and the performance were studied. The coarse pond ash is not directly used for cement replacement, so pond ash ground with the help of pulverizer. The 45 micron passing pond ash used for entire project with the replacement of 0%, 5%, 10%, 15% and 20% by cement in M20 grade of concrete. Themix design was carried out in accordance with IS 10262 2019. Three Specimen samples such as concrete cubes and cylinder are made for each proportion for determined mechanical properties (Compressive strength, splittensile strength) with the concrete cube size 150 x 150 x 150 mm and 150 x 300mm. are casted as per relevant codes of practice and tested for 7,28 days after curing. The optimum value was found the Concrete using pond ash as cement with 10 % replacement at M20 grade concrete which provides good result than conventional concrete and other mix proportion

KEYWORDS: M-Sand, Superplasticizer, Mechanical Properties, Flexural strength

I. INTRODUCTION

Pond ash, also called a coal ash basin or surface impoundment, is an engineered structure used at fossil fuel power station for the disposal of two types of coal combustion products: bottom ash and fly ash. The pond ash used as a landfill to prevent the release of ash into an atmosphere. Although the uses of ash pond in combination with air pollution controls (such as wet scrubbers) decreases the amount of airborne pollutants, the structures pose serious health risks for the surrounding environment.

In recent years, the use of composite plates also becomes a subject of great interest in the structural community especially for strengthening of deficient structures. Strengthening of existing structure may become necessary because of a required increase in loading capacity, a change in usage of concrete. Poor design or construction, due to aggressive and accident events such as earthquake and wind, or because of deterioration.

Concrete is a very versatile building material that is used in nearly every aspect of the infrastructure of developed countries. It is used in structural components such as beams, columns, floors, walls and dams. It is also used in pavement applications like parking lots, roads, etc.,. The high cost of conventional construction material affects economy of structure and also availability of raw material is very less due to higher use of concrete. Because of this, Waste materials are used for replacing the construction materials. Use of the waste materials not only helps in getting them utilized in cement, concrete and other construction materials, but also has numerous indirect benefits such as reduction in landfill cost, saving in energy, and protecting environment from possible pollution effect.

Cement is the most important ingredient of concrete. One of the important criteria for the selection of cement is its ability to produce improved microstructure in concrete. The selection of proper grade and good quality of cement is important for obtaining HSC. Some of the important factors, which play a vital role in the selection of the type of cement are compressive strength at various ages, fineness, heat of hydration, alkali content, tricalcium aluminate (C3A) content, tricalcium aluminate (C3S) content, di-calcium silicate (C2S) content and compatibility with admixtures etc.,.

The fly ash obtained from power station need suitable method for its disposal. So the best suitable method which all the power plant uses is wet disposal method. The fly ash, bottom ash and water are mixed until slurry is obtained and then the slurry is disposed in open lands. After the drying of that slurry clinkers are formed that can be collected as pond ash. Pond ash is used as replacement material for cement in concrete. Pond ash is the combination of coal; fly ash and bottom ash mixed together with water to form slurry and pumped to the ash pond area. In ash pond area, ash is settled and excess water is decanted. These deposited ashes are called pond ash. It is used as a filling materials.

II. MATERIALS

The collection of various materials like Ordinary Portland cement (OPC 53 grade), Fine aggregate (M-Sand), Coarse aggregate (20mm) and Super Plasticizer among various place under various conditions.



Fig.1 Materials used

III. EXPERIMENTALWORK

The strength of pond ash concrete is determined in the laboratory by testing the specimens. The chapter gives the details of the preparation of the specimens, curing and testing of the same to determine the compressive strength, split tensile, acid resistant of pond ash Concrete.

A/COMPRESSIONTEST

Compressive strength is one of the important test to check the properties of concrete cubes. Cube moulds are usually 150 x 150 x 150 mm can be made from steel. In addition to that the suitability of hooked and jute fibres are mixed with the concrete. The cubes are removed from the curing tank dried and grit removed.

The concrete cubes are tested using a calibrated compression machine. The specimen should be placed at the centre of the pads located at the top and bottom portion of compression testing machine. The cubes are tested on the face perpendicular to the casting face. In this test the maximum load applied to the specimen the reading at failure is the maximum compressive strength of concrete. The compressive strength is determined using the given formula,

$$\text{Compressive strength, } f_{ck} = \frac{P}{N/\text{mm}^2}$$

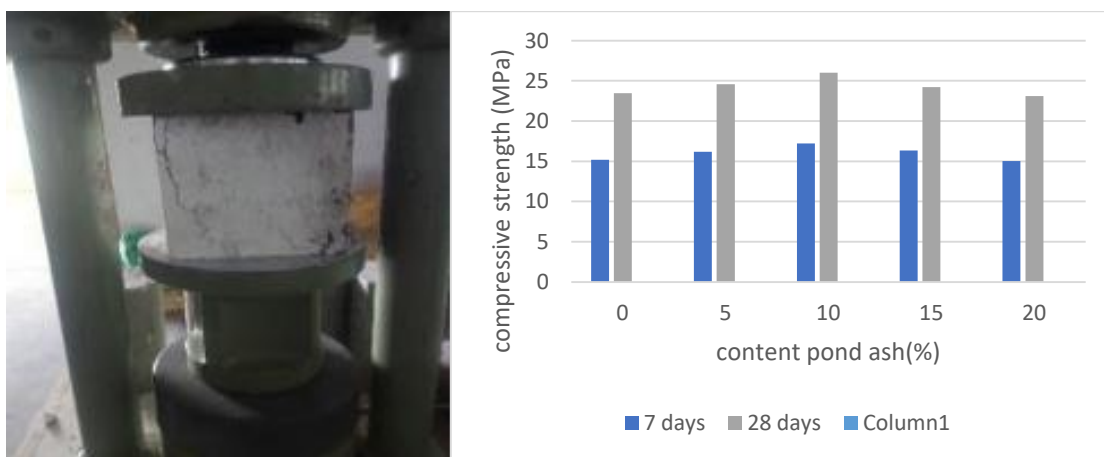


Fig.2 Compression strength

B. SPLIT TENSILE STRENGTH TEST

Concrete is strong in compression but weak in tension due to its brittle nature and is not expected to resist the direct tension. A standard test cylinder of concrete specimen of 300mm length and 150mm diameter is placed horizontally between the loading surface of compressive testing machine.

The compression load is applied diametrically and uniformly along the length of cylinder until the failure of the cylinder along the vertical diameter. To allow the uniform distribution of this applied load and to reduce the magnitude of the high compressive stresses near the point of application of this load.

A uniform lateral tensile stress of force acting along the vertical plane causes the failure of the specimen, which can be calculated from the formula as

$$F_t = \frac{2P}{\pi DL}$$

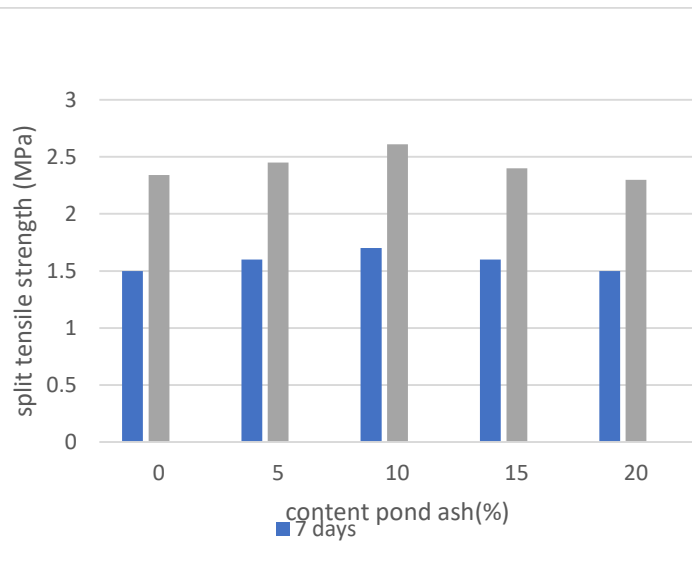


Fig.3 Split tensile strength

IV. CONCLUSION

Based on the work of various researchers it was seen that pond ash can be a suitable material for replacement of concrete mix. Following conclusions can be drawn. The compressive strength for 7 and 28 days was increased up to 15-20% replacement and after that compressive strengths were decreased for further more replacement. A marginal decrease was observed in the flexural strength upto 15-20% replacement level. A decrease in strength of concrete with the increase in levels of cement content replacement by pond ash is due to the replacement of the stronger material with the weaker material. Splitting tensile strength of concrete improved on use pond ash as cement in the ratio of 0%, 5%, 10%, 15% and 20%. These ratio of pond ash have been mixed and tested for result. Workability of concrete decreases with the increase in percentage of Pond ash as it is more porous, therefore absorb more water than sand hence some super plasticizer can be used in increasing dose as percentage of pond ash is increased. The densities of hardened concrete linearly decreased as the replacement ratio of ash was increased from 10% to 100% as compared to standard concrete

REFERENCES

[1] Malkit Singh, Rafat Siddique, (2014) "Strength properties and micro-structural properties of concrete containing coal bottom ash as partial replacement of fine aggregate" Construction and Building Materials, vol.50, pp. 246-256.
 [2] L.B. Andrade, J.C. Rocha*, M. Cheriaf (2008), "construction and building material," vol-23, Pg.no.609-614.
 HaifengWanga, DingyanWub, Zhen Meiaa (2019), "Construction and Building material," vol-210, Pg.no.620-626.
 [3] J.J. Chena, P.L. Ngb,c, L.G. Lid, A.K.H. Kwanc (2017), "Procedia Engineering," vol-172, Pg.no.165-171.

- [4] Malkit Singh, Rafat Siddique, (2015) "Effect of coal bottom ash as partial replacement of sand on workability and strength properties of concrete," *Journal of Cleaner Production*, vol.xxx, pp. 1-11
- [5] Papaa, M.R. Ricciardib, V. Antonuccib, V. Pagliaroloc, V. Lopresto, (2018) "Impact behaviour of hybrid basalt/flax twill laminates," *Composites Part B*, vol. 153, pp. 17-25.
- [6] D.Sivakumar, L.F. Ng, N.F.M. Zalani, M.Z. Selamat, A.F. Ab Ghani, S.H.S.M. Fadzullah, (2018) "Influence of kenaf fabric on the tensile performance of environmentally sustainable fibre metal laminates," *Alexandria Engineering Journal*, vol.57, pp. 4003-4008.
- [7] Daniele Ricci, FulvioBassetti, Simone Savastano, (2018) "Beneficial effects of dry bottom ash extraction and recycling in modern PCF power plants," *Fuel*, vol.215, pp. 13-21.
- [8] Wenjie Wang, NawawiChouw, (2017) "Behaviour of CFRC beams strengthened by FRP laminates under static and impact loadings," *Construction and Building Materials*, vol.155, pp. 956-964.
- [9] Luciano Machado Gomes Vieiraa, Júlio Cesar dos Santos , TúlioHallakPanzera,Juan Carlos Campos Rubioa, FabrizioScarpac, (2017) "Novel fibre metal laminate sandwichcomposite structure with sisal woven core," *Industrial Crops and Products*, vol.99, pp. 189-195.
- [10] Liang Huang, Bin Yan, Libo Yan, Qi Xu, Haozhi Tan and BohumilKasal, (2016) "Reinforced concrete beams strengthened with externally bonded natural flax FRP plates," *Composites Part B*, vol. 91, pp. 569-578.
- [11] RomiSukmawan, Hitoshi Takagi, Antonio Norio Nakagaito, (2016) "Strength evaluation of cross-ply green composite laminates reinforced by bamboo fiber," *Composites Part B*, vol.84, pp. 9-16.
- [12] ClaudioScarponi, FabrizioSarasini, Jacopo Tirillo, Luca Lampani, Teodoro Valente, Paolo Gaudenzi, (2016) "Low-velocity impact behaviour of hemp fibre reinforced bio-based epoxy laminates," *Composites Part B*, vol.91, pp. 162-168.
- [13] Min-Cheol Han, Dongyeop Han, Jae-Kyung Shin, (2015) "Use of bottom ash and stone dust to make lightweight aggregate," *Construction and Building Materials*,vol.99, pp. 192-199.
- [14] B.R.Phanikumar, A. Sofi, (2016) "Effect of pond ash and steel fibre on engineering properties of concrete," *Ain Shams Engineering Journal*, vol.7, pp. 89-99.
- [15] R.K. Mishra, R.K. Tripathi, Vikas Dubey, (2016) "Early age shrinkage pattern of concrete on replacement of fine aggregate with industrial by-product," *Journal of Radiation Research and Applied Sciences*,vol.9, pp. 386-391.
- [16] Min-Cheol Han, Dongyeop Han, Jae-Kyung Shin, (2015) "Use of bottom ash and stone dust to make lightweight aggregate," *Construction and Building Materials*,vol.99, pp. 192-199.
- [17] IS 383 (1970): Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete and Products, vol.99, pp. 189-195.
- [18] IS 456 (2000): Indian Standard Plain and Reinforced Concrete -Code of Practice.[22]IS 516 (1959): Indian Standard Methods of Tests for Strength of Concrete (18th reprint June 2006).
- [19] Navdeep Singh , Mithulraj M, Shubham Arya(2019),"Resources, Conservation and Recycling," vol-144,Pg.no.240
- [20] Hyeong-Ki Kim, (2015) "Utilization of sieved and ground coal bottom ash powders as a coarse binder in high-strength mortar to improve workability" *Construction and Building Materials*,vol.91, pp. 57-64