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# Effect of Glass Powder & Pond Ash on the Strength Properties of Concrete

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***Abstract :***
*India is the most rapidly growing country and due to rapid growth of industrialization the demand of concrete is increasing simultaneously. Now days there are various researches are made based on the finding out the suitable alternative of concrete ingredients such as cement is replaced by fly ash, stone dust, ground granulated blast-furnace slag etc. and sand is replaced by stone dust, fly ash etc. Since in this study an attempt is made to find out the strength properties; compressive strength and flexural strength of concrete by partial replacement of both cement & sand in which cement is replaced by glass powder as a pozzolana and sand by pond ash in concrete. The cement & sang content were replaced by glass powder & pond ash respectively at the percentage of 5%, 10%, 15%, 20% and it is found that, at 10% addition of glass powder and 10% addition of pond as a replacement of cement and sand respectively shows higher compressive as well as flexural strength.*

***Keywords:*** *Glass Powder, Pond Ash, compressive strength, flexural strength*

## 1. Introduction

In present scenario 130 million tons of ash is being produced annually from the coal based thermal power plants in India. As the power requirements of the country are rapidly increasing with in industrial developments. Nearly, 73% of India's total installed power generation capacity is thermal of which coal based generation are nearly 90% (by diesel, wind, gas and steam adding of about 10%). Indian coal gives 35 to 45% ash which is responsible for large volumes of pond ash.

Pond ash differs from fly ash collected from electrostatic precipitator in thermal power plant in dry form in that it contains large amount of relativistic coarse particles. Since, waste generation and disposal in landfill sites are unsuitable. These wastes are causing the environmental problem. The efficient safe disposal or efficient recycling is one of the major challenging task for engineers. Considering these factors, effective utilization of pond ash in concrete constructions as a replacement of fine aggregate materials needs special attention.

It has also been estimated that several million tons of waste glasses are generated annually worldwide. Since recently the research studies are shown that the waste glass can be effectively used in concrete as a pozzolana. The waste glass when grounded to very fine powder shows some pozzolanic properties. Therefore the glass powder to some extent can replace the cement and contribute for the strength development. Utilization of waste, when used at optimum amounts can enhance the performance of concrete. Their use in concrete would substantially reduce carbon-dioxide emissions generated during the production process of ordinary Portland cement.

## 2. Experimental Details

### *2.1. Collection of Materials*

Cement, sand, coarse aggregates are collected from local sources of Indore city.

Glass powder is also derived from local consumer sources & Pond ash is collected from Maral overseas Ltd. Khalbujurg, Dist.-Khargone., M.P., India.

### *2.2. Characteristics of Material*

- Cement: Cement which is used in this study is of OPC (43 Grade) under the commercial name of Ultratech.
- Sand: Sand which is passing through 4.75mm and retained on 75micron and belongs to Zone II category is used in t his study.
- Aggregates: 20mm maximum size of aggregates is used in this study.
- Glass Powder: The fine glass powder with particle size is less than 90micron was used as a cement replacement.
- Pond ash: The pond ash used in this study is firstly drying at the temperature of 105-110 degree centigrade, then sample is prepared in a air tight container for subsequent use. The pond ash comes under the category of Zone II.

*2.3. Designing the Mix*

The mixes were designed as per IS 10262-2009. The mixes were designed with the varying percentage of replacement of Cement by glass powder from 5%, 10%, 15%, 20% and sand by pond ash from 5%, 10%, 15%, 20% and finding out their suitable combination at which concrete shows the higher compressive strength and flexural strength.

The concrete were proportioned to give 28 days compressive strength of about 35Mp based on 150mm cubes and days flexural strength of about 4.14Mp based on 100mmX100mmX500mm beams with a slump of 25-50mm

One controlled mix in which no replacement is made and 16 modified mix in which different-different combinations of glass powder and pond ash is prepared. These 16 Combinations are designated are shown in below table:

| Type of mix | Binding Material | | Fine Aggregate | |
|---|---|---|---|---|
| | **% Replacement of cement by Glass Powder** | **% of cement used** | **% Replacement of sand by pond ash** | **% of sand used** |
| CONTC | 0% | 100% | 0% | 100% |
| G05PA05 | 5% | 95% | 5% | 95% |
| G05PA10 | 5% | 95% | 10% | 90% |
| G05PA15 | 5% | 95% | 15% | 85% |
| G05PA20 | 5% | 95% | 20% | 80% |
| G10PA05 | 10% | 90% | 5% | 95% |
| G10PA10 | 10% | 90% | 10% | 90% |
| G10PA15 | 10% | 90% | 15% | 85% |
| G10PA20 | 10% | 90% | 20% | 80% |
| G15PA05 | 15% | 85% | 5% | 95% |
| G15PA10 | 15% | 85% | 10% | 90% |
| G15PA15 | 15% | 85% | 15% | 85% |
| G15PA20 | 15% | 85% | 20% | 80% |
| G20PA05 | 20% | 85% | 5% | 95% |
| G20PA10 | 20% | 85% | 10% | 90% |
| G20PA15 | 20% | 85% | 15% | 85% |
| G20PA20 | 20% | 85% | 20% | 80% |

*Table 2.1: Concrete Material & their Compositions*

For each mixed three cubes and one beam are prepared for 7-days testing & 28-days testing respectively i.e. total 102 cubes and 34 beams are prepared.

*2.4. Testing of Materials*

The results of testing og concrete constituents are shown in Table 2.2:

| Name of Constituent | Name of Test | Obtained Value |
|---|---|---|
| Cement | Fineness of cement | 96% |
| | Specific gravity | 3.12 |
| | Consistency | 32% |
| | Initial setting time | 65 minutes |
| | Final setting time | 185 minutes |
| | Soundness | 1 mm |
| | 3-days compressive strength | 23 N/mm2 |
| | 7-days compressive strength | 34 N/mm2 |
| Fine Aggregates | Specific gravity | 2.478 |
| | Water absorption | 1.18 |
| | Fineness modulus | 2.53 |
| Coarse Aggregates | Specific gravity | 2.87 |
| | Water absorption | 0.370 |
| | Fineness modulus | 7.48 |
| Glass Powder | Specific Gravity | 2.29 |
| | Fineness | 100% |
| Pond Ash | Specific Gravity | 2.60 |
| | Water Absorption | 1.36 % |
| | Fineness Modulus | 2.45 |

*Table 2.2: Test Results of Concrete Constituents*

*2.5. Testing of Green Concrete*

- **Workability Test:** Workability of each concrete mix at every6 replacement level is conducted and following res7ults are obtained.

| Type of Mix | % Addition of Admixture (by Weight of Cement) | Slump Value (mm) |
|---|---|---|
| CONTC | 0% | 22 mm |
| | 0.7% | 32mm |
| G05PA05 | 0.7% | 30mm |
| G05PA10 | 0.7% | 26mm |
| G05PA15 | 0.7% | 23mm |
| | 0.8% | 37mm |
| G05PA20 | 0.8% | 31mm |
| G10PA05 | 0.8% | 40mm |
| G10PA10 | 0.8% | 38mm |
| G10PA15 | 0.8% | 34mm |
| G10PA20 | 0.8% | 29mm |
| G15PA05 | 0.8% | 37mm |
| G15PA10 | 0.8% | 32mm |
| G15PA15 | 0.8% | 29mm |
| G15PA20 | 0.8% | 27mm |
| G20PA05 | 0.8% | 33mm |
| G20PA10 | 0.8% | 29mm |
| G20PA15 | 0.8% | 25mm |
| G20PA20 | 0.8% | 22mm |
| | 0.85% | 31mm |

*Table 2.3: Workability Test Results*

*2.6. Testing of Hardened Concrete*

- **Compressive Strength Test**: the compressive strength test is the most common test which is conducted on the hardened concrete, partly because it is easy to perform and partly because of desirable characteristic properties are qualitatively related to compressive strength.

For compressive strength testing 150mm X 150mm X 150mm cubes are casted from the reference mix and kept in a curing pound up to 28-days. The specimens are tested after 7-days and 28-days, using a calibrated compressive strength testing machine of 2000KN capacity as per IS: 516-1959(2004).

Compressive strength of concrete= P/A

Where: P= load at failure of cube, A= cross-section area of cube

- **Flexural Strength Test**: Flexural strength test is a measure of tensile strength in terms of modulus of rupture

For flexural strength testing 100mm X 100mm X 500mm beams are casted from the reference mix and kept in a curing pound up to 28-days. The specimens are tested after 7-days and 28-days using universal testing machine as per IS: 516-1959(2004). The two point loading method was used in this study.

Flexural strength of concrete=$Pl/bd^2$

Where:

- P= load at failure of cube
- l=Length of concrete beam
- b=width of concrete beam
- d=depth of concrete beam

| Type of mix | Compressive strength ($N/mm^2$) | | Flexural strength (N/mm2) | |
|---|---|---|---|---|
| | 7 days | 28 days | 7 days | 28 days |
| CONT. | 25.77 | 37.33 | 3.59 | 4.18 |
| G05PA05 | 24 | 35.11 | 3.47 | 4.11 |
| G05PA10 | 25.93 | 36.74 | 3.58 | 4.13 |
| G05PA15 | 23.7 | 34.00 | 3.41 | 4.06 |
| G05PA20 | 22.67 | 31.11 | 3.37 | 3.87 |
| G10PA05 | 24.15 | 34.82 | 3.52 | 4.15 |
| G10PA10 | 26.22 | 38.54 | 3.61 | 4.23 |
| G10PA15 | 23.11 | 33.40 | 3.39 | 4.19 |
| G10PA20 | 21.63 | 30.22 | 3.31 | 3.79 |
| G15PA05 | 24.89 | 36.59 | 3.49 | 3.91 |
| G15PA10 | 23.11 | 33.63 | 3.41 | 4.01 |
| G15PA15 | 21.185 | 29.11 | 3.29 | 3.78 |
| G15PA20 | 18.22 | 25.33 | 3.13 | 3.64 |
| G20PA05 | 20.44 | 27.33 | 3.22 | 3.77 |
| G20PA10 | 18.96 | 25.11 | 2.89 | 3.42 |
| G20PA15 | 16.59 | 22.44 | 2.7 | 3.28 |
| G20PA20 | 14.96 | 22 | 2.57 | 3.03 |

*Table 2.4: Compressive strength & Flexural strength test results*

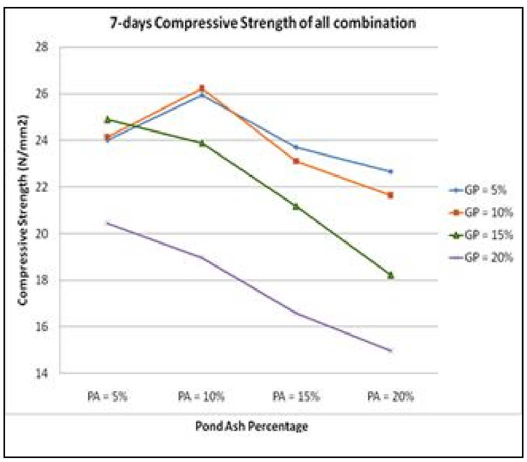


*Fig 1: 7-days Compressive strength of concrete*

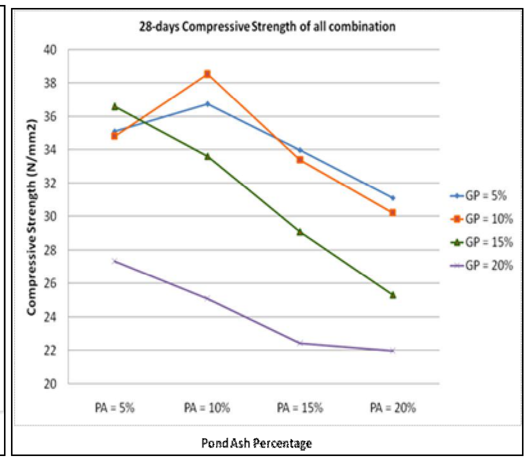


*Fig 2: 28-days Compressive strength of concrete*

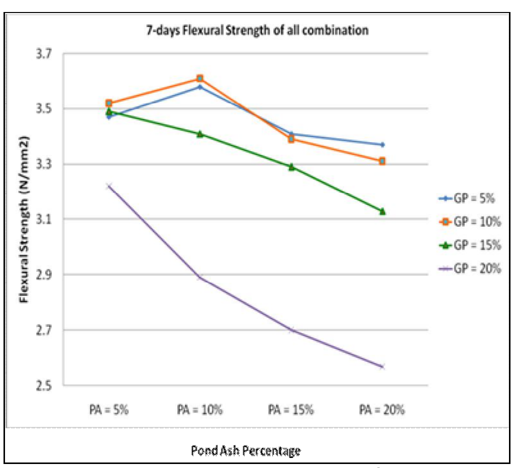


*Fig 3: 7-days Flexural strength of concrete*

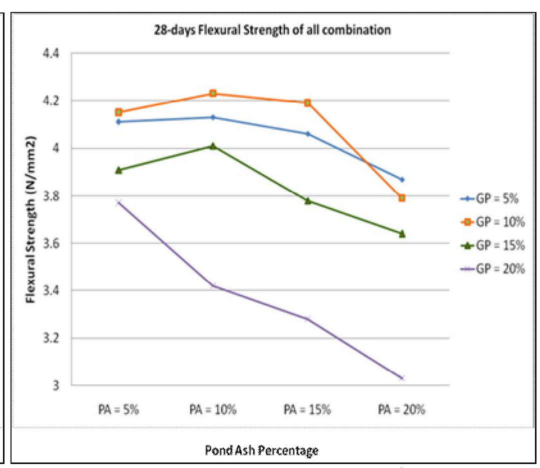


*Fig 4: 28-days Flexural strength of concrete*

**3. Discussion**

In all the above graphs, we can clearly seen that at the 10% replacement level of cement and 10% replacement level of sand by glass powder and pond ash respectively, concrete shows higher compressive strength and flexural strength because at this level concrete contain more C-S-H bond which is responsible for the highest compressive as well as flexural strength

**4. Conclusion**

The 28-days compressive strength of modified concrete is increased of about 3.24% of controlled concrete at the 10% replacement of cement by glass powder and 10% replacement of sand by pond ash.

The 28-days flexural strength of modified concrete is increased of about 1.2% of controlled concrete at the 10% replacement of cement by glass powder and 10% replacement of sand by pond ash.

Cost per cubic meter of modified concrete is reduced 3.7% of controlled concrete.

Workability of concrete is decreases with increase the percentage of pond ash because pond ash absorbs more quantity of water.

Initial rate of gain of strength of concrete is low but at 28-days it meets with required strength in addition of glass powder and pond ash.

Using Glass powder can reduce the use of cement in concrete and the associated energy demand and impact on air pollution and CO2 emission.

Use of Pond ash in concrete can save the thermal industry disposal cost and produce a greener concrete for construction

Environmental effects from waste and residual amount of cement manufacturing can be reduced.

A better measure by an innovative supplementary construction material is formed to this research.

**5. Refrences**


1. Arumugam K, Ilangovan, James Manohar D, "A study on characterization and use of Pond Ash as fine aggregate in Concrete, International Journal of Civil and Structural Engineering", Volume 2, No 2, 2011.
2. Bharathi Ganesh, Dr. SharadaBai H, Dr. R. Nagendra, Netravathi K S, "Behaviour of Concrete with Pond Ash – Thermal Power Plant Waste as Constituent – Durability Perspectives", International Network of Women Engineers & Scientists (INWES),2012
3. Prof. P. P. Bhangale, Prof. P. M. Nemade, "Study of Pond ASH (BTPS) Use as A Fine Aggregate in Cement Concrete - Case Study", International Journal of Latest Trends in Engineering and Technology (IJLTET), Vol. 2 Issue 2 March 2013
4. S.A. Haldive, Dr. A. R. Kambekar, "Experimental Study on Combined Effect of Fly Ash and Pond Ash on Strength and Durability of Concrete", International Journal of Scientific & Engineering Research Volume 4, Issue 5, May-2013.
5. Gaurav Kantilal Patel, Prof.JayeshkumarPitroda, "Assessment of Natural Sand and Pond Ash in Indian Context", International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 10 - Oct 2013.
6. Prof.JayeshKumarPitroda, Gourav Patel, Dr. F.S. Umrigar, "Pond Ash: Opportunities for Eco-Friendly Material (As Fine Aggregate) in Green Concrete", Journal of International Academic Research for Multidisciplinary, vol.-1, issue-8, Sep. 2013.
7. Dr.B.R.Patagundi, Dr.K.B.Prakash, "Effect of Temperature On The Properties Of Concrete Containing Glass Powder As Pozzolana", International Journal of Engineering Research & Technology (IJERT), Vol. 1 Issue 8, October – 2012.
8. Dhanraj Mohan Patil, Dr. KeshavK.Sangle, "Experimental Investigation of Waste Glass Powder As Partial Replacement of Cement in Concrete", International Journal of Advanced Technology in Civil Engineering, ISSN: 2231 –5721, Volume-2, Issue-1, 2013
9. R.Vandhiyan, K. Ramkumar, R. Ramya, "Experimental Study on Replacement Of Cement By Glass Powder", International Journal of Engineering Research & Technology (IJERT), Vol. 2 Issue 5, May – 2013.
10. J.M. Khatib, E.M. Negim, H.S. Sohl, N. Chileshe, "Glass Powder Utilisation in Concrete Production", Europ. J. Appl. Sci., 4 (4): 173-176, 2012
11. Ahmad SHAYAN, "Value-added Utilisation of Waste Glass in Concrete", IABSE Symposium Melbourne, 2002.
12. Dr. G.Vijayakumar, Ms H. Vishaliny, Dr. D. Govindarajulu, "Studies on Glass Powder as Partial Replacement of Cement in Concrete Production", International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 2, February 2013.
13. Sunny O. Nwaubani and Konstantinos I. Poutos, The Influence of Waste Glass Powder Fineness on the Properties of Cement Mortars" International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 2, Issue 2, February 2013.
14. IS 10262:2009 Concrete mix Proportioning- Guidelines
15. IS: 516-1959 Indian Standard, Methods of tests for strength of concrete