Effect of Accelerated Curing on Concrete with Fly Ash and Glass Powder

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ABSTRACT

Both fly ash and glass dust are residues that, due to their cementitious properties, can be used as partial substitutes for cement in concrete. The accelerated hardening technique has the great advantage of verifying that the building mix has reached the specified strength as soon as possible. Concrete is a composite material widely used in all types of civil engineering works such as railways and airports as well as in the construction of skyscrapers and skyscrapers and all construction works. Cement reacts chemically with water and other components to form a strong, hard matrix that holds the material together to form a permanent stone-like material. The global consumption of cement in ready-mix concrete is very high, and during the decade many developing countries have opposed the supply of available natural resources to meet the growing demand for resources in the field. infrastructure segment. To offset the demand and stress on natural resources, researchers, large companies and construction professionals have suggested alternative products, such as fly ash, glass dust, sawdust, discarded binders, plastic sheets, steel fibers, recycled aggregates. , limestone dust, crushed aggregates, ceramics and much more. They are harmful, so use cement and many techniques that increase compressive strength. One of them is the accelerated polymerization technique. The different methods of acceleration of hardening in concrete using pozzolanic material (using fly ash and glass powder as pozzolanic material) are briefly described, and preliminary laboratory data on the effect of acceleration of hardening in concrete using fly ash and powder of glass.

KEYWORDS: Strength of concrete, accelated curing tank temperature.

INTRODUCTION

Concrete is a composite material widely used in all kinds of civil engineering works, environmental protection structures, defense structures, railways and airports, and civil engineering. About 60-70% of concrete is made up of coarse and fine aggregate, cement, water and admixtures. When aggregates are mixed with dry cement and water, they form a liquid mass that can be easily molded into any desired shape. Cement chemically reacts with water and other components to form a strong, hard matrix that bonds the material into a durable rock-like material. When initially mixed, the cement and water rapidly form a gel of

interlocking chains of interlocking crystals, and the components of the gel continue to react over time. Initially, the gel is liquid, which improves workability and helps position the material, but as the concrete hardens, the crystal chain solidifies into a rigid structure. Once the composite has been placed and cured to the desired shape, it too must be adjusted. The quality of concrete is determined by the compressive strength of the sample obtained by testing the cubic sample under a compression testing machine (CTM) after a curing time of 28 days and at a specified temperature. The highest percentage of final strength of any type of concrete is observed after 28 days of curing, so this strength is especially used for all construction engineering purposes. However, if the 28-day strength is in question, the concrete will be rejected for further construction and attempts should be made to improve the quality to meet the specified strength.

Problem Statement

The The consumption of cement in concrete is very high throughout the world and over the decade many developing countries have responded by providing natural resources to meet the growing demand for infrastructure resources. To meet the demand for natural resources, the price of resources has increased. To balance the demand and pressure on natural resources, researchers, large companies and construction professionals have developed alternative products such as fly ash, glass powder, sawdust, used tires, plastic sheets, steel fibers, recycled aggregates, limestone, crushed aggregates, ceramics and many more. Sustainable development, preservation of the environment and preservation of natural resources are the main perspectives of any construction or development. Waste from many industries is dumped on the ground, devastating the natural resources of the region. If this waste has suitable properties for the production of concrete, it will not only reduce construction costs, but will also contribute to nature conservation.

Objective of Research

The research focused on reducing the environmental problems caused by the construction industry and also attempted to reduce the cost of building with concrete.

The objective of this study is:

• Determine the effect of accelerated hardening with hot water on the compressive strength of the concrete mix and establish a correlation between the conventional hardening strength at 28 days and the accelerated hardening strength.

• A correlation is established between the two compressive strengths (28 days and accelerated setting) obtained when the cement is partially replaced by fly ash and glass powder, respectively, in percentages (from 0 to 30%).

In addition to the two main objectives mentioned above, some other objectives are:

• Determine the highest replacement percentage of fly ash powder or glass block that can be used without compromising the compressive strength of the concrete.

LITERATURE REVIEW

Denny Mayer (1997)[1] compared two methods of accelerated polymerization, viz. H. Hot water and hot water accelerated polymerization with respect to the accuracy of their predictions and the stability of the relationship between their concrete strength at 24 hours and 28 days. The result suggests that accelerated hardening with hot water is preferable to accelerated hardening of hot poured concrete and also suggests other methods to improve the accuracy of 28-day strength predictions.

TR Neelakantan et al. (2014)[2] compared the 28-day strength of M30 concrete with the microwave energy accelerated hardening method. In conventional accelerated hardening, heat conduction occurs from the surface to the core of the concrete sample and therefore there is a temperature gradient that causes thermal stresses in the concrete. In this article, microwave energy is used for accelerated hardening where the temperature change is uniform throughout the concrete.

S. Gnana Venkatesh et al. (2016)[3] carried out an experimental work to investigate the effect on concrete strength in terms of compressive strength and tensile strength of normal strength concrete M20, medium strength concrete M40 and high grade M60 concrete. endurance. carpet, normal water spray, hot water spray with temperature swing 50°C, 60°C, 70°C, wet sand cure, hug cure, warm water accelerated cure and boiling water accelerated cure per IS9013 : 1978 The variation of the different types of curing also influence the increase in the strength of concrete. The result of this study indicates that, regardless of the type of concrete, rain curing with hot water at 70°C achieves superior resistance to any other type of cut.

Ghalib Mohsin Habeeb et al. (2016)[4] investigated the effect of different accelerated curing methods on the compressive strength of high-strength nano-silica concrete using two types of curing. Curing methods are 21°C normal cure method, 80°C hot water method per ACI C517, 1992, and 110°C boiling water method per ACI 214, 1987. as nanosilica with one dimension

less than 35 nm, mineral additive with variable content of 1, 2 and 3% by weight of cementitious material as additive.

Jayant Damodar Supe et al. (2009)5 develop a mathematical model capable of instantly predicting the value of the compressive strength of concrete in situ. Mixdesign M20, M25, M30 and M40 test cubes were molded. The cubes are tested after curing for 7 and 28 days by immersion and some cubes are tested by the accelerated cooking residue method, seasoned with jute bags soaked for 23 hours, then placed in a bucket of boiling water at 100 °C for 3.5 hours ± 5 min before being tested in a compressible testing machine, the other cubes are immersed in a room temperature water bath for 28 days.

KT Phalak et al (2015)[6] aims to develop the relationship between the accelerated hardening method with boiling water and normal hardening after 28 days for individual concrete types M20, M25 and M30 according to the IS code. The model developed in this study is useful to calculate the resistance of the concrete in approximately 01 days against 28 days. Thus, the model allows to increase the speed of work and save on the cost of the project.

METHODOLOGY

The following tasks are performed to achieve the objectives of this study.

1. Collected all information and research paper related to accelerate curing methods, fly ash and glass powder as cement replacement and studied them thoroughly.
2. Brought sample of fly ash and glass powder and sieved glass powder from 600micron sieve, the sample retained on 300 micron sieve is taken for study.
3. Performed gradation of fine and coarse aggregate.
4. Prepared the mix for M30 grade of concrete with varying proportion of fly ash and glass powder ranging from 0%(without fly ash & glass powder), 10%, 15%, 20%, 25% and 30%.
5. Compressive Strength test is performed on all mixes formed and test result are recorded.
6. Conclusion drawn from test result and scope of study in future.

The total experimental program is carried out in mainly three stages.

1. Various tests are performed on different materials used, in order to obtain their properties.
2. Casting of various specimens.
3. Testing of cubes which are given accelerated curing and conventional curing to obtain their compressive strength.

Following are the materials required

1. Cement (OPC 43 grade)
2. Fine Aggregate (Sand)
3. Natural Coarse Aggregate
4. Fly Ash
5. Glass Powder
6. Admixtures
7. Water

Methods Of Curing

There are many different methods of curing which keep concrete moist and favorable hydration temperature. These methods are adopted on keeping in mind the actual site condition, nature of work, climatic conditions and available resources. The following methods of curing that are generally adopted are:

- Immersion curing (Ponding Method)
- Covering concrete surfaces with wet hessians or gunny bags.
- Membrane curing
- Sprinklings of water
- Steam curing
- Accelerated Curing methods

Figure: Curing of 66 cubes in Curing pond constructed outside of concrete lab in open air.

RESULT ANALYSIS AND DISCUSSION

Test Result of Cement

1. Fineness of Cement:
2. Soundness of Cement:
3. Compressive Strength:

Tests on Concrete

Mainly two test is performed on the concrete with respect to concrete strength and workability. The result of these test are discussed here and the test performed are

(i.) Compressive Strength.

(ii.) Workability.

Table: Strength obtained in different curing with varying percentage of fly ash.

Fly Ash %	Acceleration Curing (24 hours)	7 Days Curing	28 Days Curing	Accelerated Curing (54 hours)
0	28.8	25.17	36.38	35.94
10	26.055	24.02	34.56	33.39
15	25.17	23.59	33.34	32.51
20	23.21	22.28	32.392	31.45
25	23.35	22.26	31.35	30.66
30	23.166	20.59	30.47	29.86

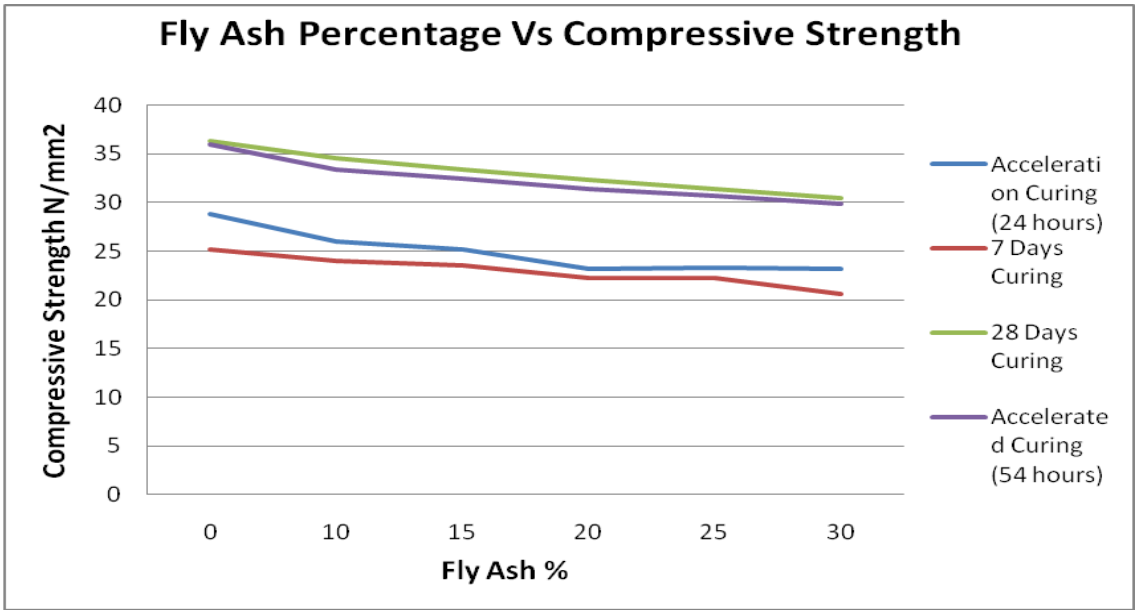

Figure: Showing the compressive strength in different curing with varying fly ash %

Table: Strength obtained in different curing with varying percentage of glass powder.

Glass Powder %	Acceleration Curing (24 hours)	7 Days Curing	28 Days Curing	Accelerated Curing (54 hours)
0	28.8	25.17	36.38	35.94
10	26.055	19.33	28.86	28.02
15	25.17	20.65	30.08	29.23
20	23.21	18.40	27.91	27.10
25	23.35	18.05	27.72	26.92
30	23.166	17.30	26.67	28.03

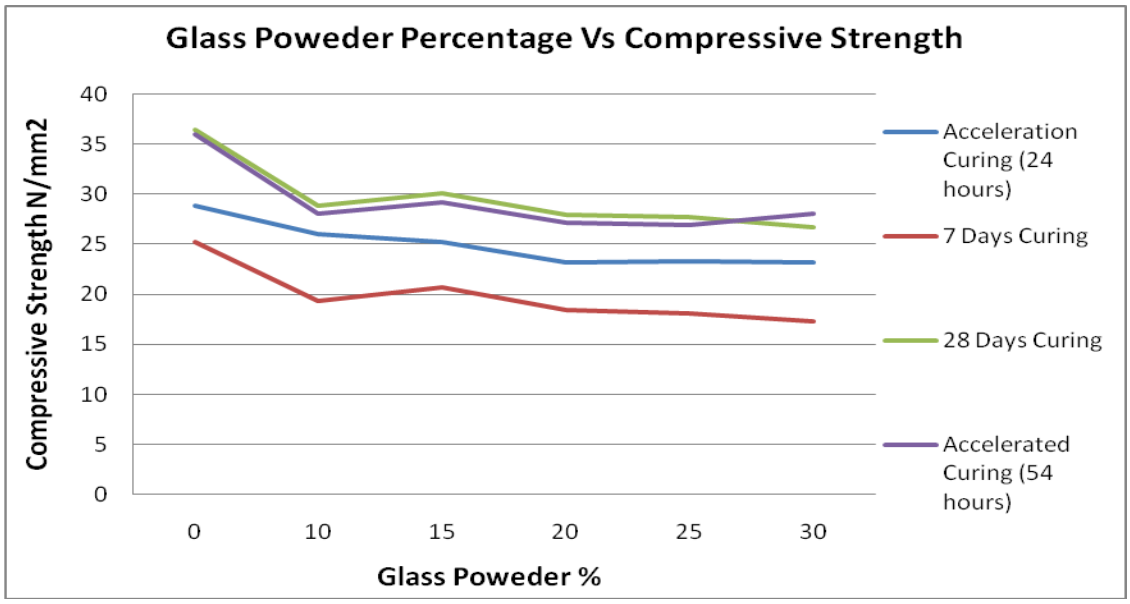

Figure: Showing the compressive strength in different curing with varying Glass Powder %

DISCUSSION ON RESULTS:

From the result of this study, it was observed that compressive strength result decrease with increase in the percentage of fly ash and glass powder. On increasing the percentage of fly ash at an increment of 5%, the compressive decrease about 4%. In case of Glass powder with increase in the percentage of glass powder, the compressive strength first decrease and then increase till the glass powder percentage is 15% and then with further increase in glass powder percentage, compressive strength continuous to decrease. The highest compressive strength in case of fly ash as partial cement replacement can be seen with the 10% fly ash by weight of cement. While in case of glass powder, the highest compressive strength is observed with 15% glass powder by weight of cement is used as replacement of cement.

The compressive strength in 54 hours by accelerated warm water curing is almost 98% which is equal to conventional 28 days compressive strength. And the compressive strength in 24 hours of accelerated curing is **80- 85%** of 28 days compressive strength.

From the equation, we can correlate the compressive strength by accelerated warm water curing equivalent to 28 days of compressive strength by immersion curing, with varying percentage of fly ash and glass powder as partial replacement of cement.

CONCLUSION

Following Conclusion can be drawn from this experimental study:

- A replacement of 10% by fly ash and 15% by glass powder respectively shows highest development of compressive strength of M30 concrete after 28 days of curing.
- On increasing the percentage of fly ash at an increment of 5%, the compressive decrease about 4%. In case of Glass Powder with increase in the percentage of glass powder, the compressive strength first decrease and then increase till the glass powder percentage is 15% and then with further increase in glass powder percentage, compressive strength continuous to decrease.
- The average compressive strength of concrete cubes (with no replacement of cement) with accelerated warm water curing method in 24 hours and 54 hour**s** of curing which is 8**5%** and **98.0%** respectively of 28 days conventional curing strength.
- The average compressive strength of concrete cubes (having fly ash as partial replacement of cement) with accelerated warm water curing method in 24 hours and 54 hours of curing is **82%** and **95%** respectively of 28 days conventional curing strength.
- The average compressive strength of concrete cubes (having marble powder as partial replacement of cement) with accelerated warm water curing method in 24 hours and 54 hours of curing is **80%** and **95%** respectively of 28 days conventional curing strength.
- The correlation model developed is useful for calculating the strength of concrete by accelerated curing (in approx. 54 hours) as against 28 days strength with varying percentage of fly ash and glass powder.
- Since accelerated curing shows rapid gain in strength at initial stage, the technique is very useful in the pre-fabrication industries, where high early age strength enable the removal of formwork in 24 hours.

- Considering the strength criteria, the replacement of cement by fly ash and glass powder is feasible. Hence it can be concluded that utilization of fly ash and waste glass powder in concrete as cement replacement is possible.

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