Study on High Performance Concrete using GGBS and Flyash (M50Grade)

Avula Sai Babu[1] Mrs. S. S. G. Sowjanya[2]
[1]PG Student [2]Assistant Professor
[1]Department of Transportation Engineering [2]Department of Structural Engineering
[1,2]MVRS College, Paritala, India

Abstract— Concrete has been the major instrument for providing stable, reliable Infrastructure .Deterioration, long term poor performance and inadequate resistance to hostile environment coupled with greater demands for more sophisticated architectural form, led to research into the micro structures of cements and concretes and more elaborate codes and standards. Modification in cement concrete to improve its strength and durability is need of the hour. Drawbacks of cement concrete such as low tensile strength, susceptibility to chemical attack, corrosion of reinforcement and low durability have to be overcome. An attempt is made in the present work to investigate the influence of this admixture on the compressive strength of concrete. The experimental study of this investigation consists of concrete mix for target mean strength. The mix was worked out giving certain proportions by keeping the obtained water-cement ratio constant. The mix is obtained with water cement ratio 0.3. For this mix the different percentages of admixtures was added i.e., 5%, 10%, 15% by weight of cement. These percentages were added in cement mortar 1:3 ratio, specimens were tested up to failure o study the behavior in compression and tension.

Keywords: GGBS, Flyash, Coarse Aggregate

I. Introduction

Concrete is generally classified as Normal strength concrete, high strength concrete and ultra-high strength concrete .high strength label was adapted to concrete having strength above 50 Mpa. In particular construction of high-rise buildings and long span bridges, concrete strengths of 90 to 120 Mpa are occasionally used.

"High performance concrete" is used for concrete mixture which posses high workability, high strength, high modulus of elasticity, high density, high dimensional stability and resistance to chemical attack. High performance concrete is also a high strength concrete but it has a few more attributes specially designed as mentioned above.

A substantial reduction of quantity of mixing of water is the fundamental step for making HPC. Adopting W/C ratio in the range of 0.25 to 0.3 and getting high slump is possible only with the use of super plasticizer. The use of appropriate super plasticizer is a key material for making HPC.

It will be slightly difficult to predict the effect the results of using admixture because, many a time, the change in the brand of cement, aggregate grading, mix proportions and richness of mix alter the properties of concrete.

II. Review of Literature

[1]D.de Araujo Dafico and L.R prudencio ,jr . (2002) prepared a model to explain the compressive strength of high performance concrete was developed using multiple liner regression correlating the compressive strength and variables representing volume ratios of paste materials. High correlation indices were found in most of studied regressions and the accuracy of the predicated values of compressive strength can be considered very good, especially when obtained from a set of concrete made with the addition of just one kind of pozzolan.

[2]KolluriV.Subramaniam, Roman Gromotka and resells hill (2005) found that increasing the volume of ultra fine fly ash and decreasing the volume of water cement ratio resulted in an increase in the compressive strength rate of strength gain and further improvement in age when the concrete cracks in the restrained shrinkage tests.

[3]Breitenbuecher (1998) observed that increased strength and improved micro stricter can be achieved in high performance concrete, using optimized concrete technology, namely an extremely low w/c ratio and addition of super plasticizer they future opined that in case of HPC, reinforcement can be minimized and / or the dimensions of structural members can be reduced. The dense micro structure and HPC is mainly used in cases where, because of chemical attack or abrasion, additional protective measures are necessary in normal concrete structures the measures can be avoided by using such a concrete.

[4]Gopal Krishnan et al (2001) reported on the performance of HPC mixes having different replacement levels of cement with low calcium fly ash (class F). A compressive strength of 80 M_{pa} at 28 days was achieved by using 25% replacement of cement with fly ash. Their results also showed that the fly ash concretes have superior durability properties.

[5]Robert and Cannon (1998) have come to a conclusion that concrete mixture can be proportioned for a given strength requirement as readily with fly ash as without for any placement situation and as ore them signification larger proportions can be used to reduce water requirements improve the workability and long range strength of concrete while reducing material cost.

III. Experimental Investigation

The experimental investigation work is divided into three series as A, B&C.

The first series i.e.… "A" indicates M-50 grade of concrete with Mix proportion 1: 1.0012: 3.004 with water cement ratio 0.32. In this phase of work cement is replaced with fly ash and Ground granulated blast furnace slag (GGBS) material for different proportions. For this, 06 cubes, 06 cylinders are cast and tested under compression testing machine.

- A_1: [C + 5% FLY ASH+05% GGBS] + F.A + C.A + 1.0% S.P
- A_2: [C + 5% FLY ASH+10% GGBS] + F.A + C.A + 1.0% S.P

- A_3: [C + 5% FLY ASH+15% GGBS] + F.A + C.A + 1.0% S.P

Where in

A_1 indicates: Cement is 90%, Fly Ash is 5% & GGBS is 5% with 1.0% Super plasticizer.

A_2 indicates: Cement is 85%, Fly Ash is 5% & GGBS is 10% with 1.0% Super plasticizer.

A_3 indicates: Cement is 80%, Fly Ash is 5% & GGBS is 15% with 1.0% Super plasticizer.

The second series is the "B" series in which cement is replaced with Fly ash and Ground Granulated blast furnace slag (GGBS), for the above said same mix proportions. For this, 09 cubes, and 06 cylinders are cast and tested under compression and flexural testing machine.

In this series the casting is carried as follows.

- B_1: [C + 10% FLY ASH + 05% GGBS] + F.A + C.A + 1.0% S.P
- B_2: [C + 10% FLY ASH + 10% GGBS] + F.A + C.A + 1.0% S.P
- B_3: [C + 10% FLY ASH + 15% GGBS] + F.A + C.A + 1.0% S.P

Where in

B_1 indicates: Cement is 85%, Fly ash is 10% & GGBS is 05% with 1.0% Super plasticizer.

B_2 indicates: Cement is 80%, Fly ash is 10% & GGBS is 10% with 1.0% Super plasticizer.

B_3 indicates: Cement is 75%, Fly ash is 10% & GGBS is 15% with 1.0% Super plasticizer.

The Third series is the "C" series in which cement is replaced with Fly ash & GGBS, for the above said same mix proportions. For this 09 cubes, and 06 cylinders are cast and tested under compression and flexural testing machine.

In this series the casting is carried as follows.

- C_1: [C + 15% FLY ASH + 05% GGBS] + F.A + C.A + 1.0% S.P
- C_2: [C + 15% FLY ASH + 10% GGBS] + F.A + C.A + 1.0% S.P
- C_3: [C + 15% FLY ASH + 15% GGBS] + F.A + C.A + 1.0% S.P

Where in

C_1 indicates: Cement is 80%, Fly ash is 15% & GGBS is 05% with 1.0% Super plasticizer.

C_2 indicates: Cement is 75%, Fly ash is 15% & GGBS is 10% with 1.0% Super plasticizer.

C_3 indicates: Cement is 70%, Fly ash is 15% & GGBS is 15% with 1.0% Super plasticizer.

Fig. 1: Moulds

The dimensions of the moulds for casting cubes, and cylinders are 100mm x 100mm x 100mm & 300mm x 150mm respectively are used. The casting was done on a smooth floor. After a day of casting moulds are de-moulded and then cubes & cylinders are moved to the curing tank carefully for curing.

IV. MATERIALS

A. *Cement*

Common Portland Cement-Grade 53: Having been ensured with IS12269:1987 benchmarks, Grade 53 is known for its rich quality and is exceptionally sturdy. Consequently it is utilized for developing greater structures like structure establishments, spans, tall structures, and structures intended to withstand overwhelming weight.

B. *Coarse Aggregate*

Coarse aggregate is a material that will pass the 3-inch screen and will be retained on the No. 4 sieve. As with fine aggregate, for increased workability and economy as reflected by the use of less cement, the coarse aggregate should have arounded shape.

C. *Fine Aggregate*

Aggregates that passing through 4.76 mm sieve and retained in 74μ sieve is known as fine aggregates.

D. *Ground Granulated Blast Furnace Slag (GGBS)*

The age of optional gel results in development of extra C-S-H, a foremost restricting material. This is the principle property of GGBS, which adds to the quality and sturdiness of the structure. The solid blend extent has a vital effect on delivering great quality cement. Normal information of qualities of cement for water-cementations of 0.32, materials proportions with various rates of fly fiery debris and ground granulated impact heater slag demonstrate that such cements are practically identical made utilizing 53-grade conventional Portland bond with no fly powder/ground granulated impact heater slag.

E. *Fly Ash*

Fly fiery debris is finely separated buildup coming about because of the ignition of powdered coal and transported by the pipe gases and gathered by electrostatic precipitator. In U.K. it is alluded as pounded fuel fiery debris (PFA). Influenza slag is the most broadly utilized pozzolanic material everywhere throughout the world.

V. MIX DESIGN

Water Kg/m^3	Cement Kg/m^3	Fine Agrregates Kg/m^3	Coarse Agrregates Kg/m^3
144	450	450.54	1351.63
0.32	1	1.0012	3.004

Table 1: The mix proportion then becomes

VI. PREPARATION OF MOULDS

The dimensions of the moulds for casting cubes, and cylinders are 100mm x 100mm x 100mm & 300mm x 150mm respectively are used. The casting was done on a smooth floor. After a day of casting moulds are de-moulded and then cubes & cylinders are moved to the curing tank carefully for curing.

Fig. 2: Preparation of Moulds

Fig. 3: Preparation of Moulds

VII. TEST RESULTS AND DISCUSSIONS

It is surely understand that by and large fly slag and GGBS expands the compressive quality, elasticity and flexural quality of cement. In this examination it is discovered that the supplanting of concrete with 05% and 10% extent of admixtures will expand the compressive quality, ductile and flexural quality. At the point when extent of admixtures will increment to 15%, the compressive, flexural, elasticity is diminished

A. *Compressive Strength*

Compressive quality is the limit of a material or structure to withstand pivotally coordinated pushing powers. At the point when the cutoff of compressive quality is achieved, materials are pulverized. Cement can be made to have high compressive quality.

1) *Compressive Strength of Cubes for 14days*

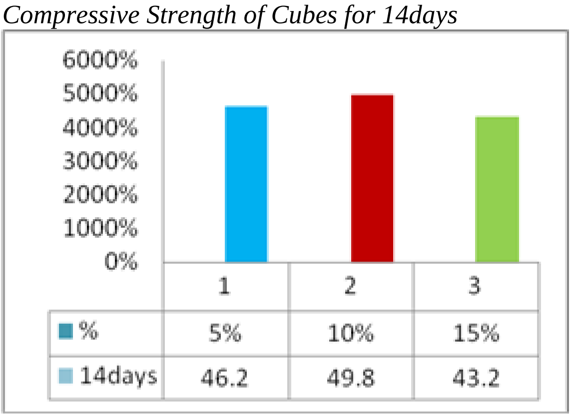

Fig. 4: Compressive Strength of Cubes for 14days, A Series

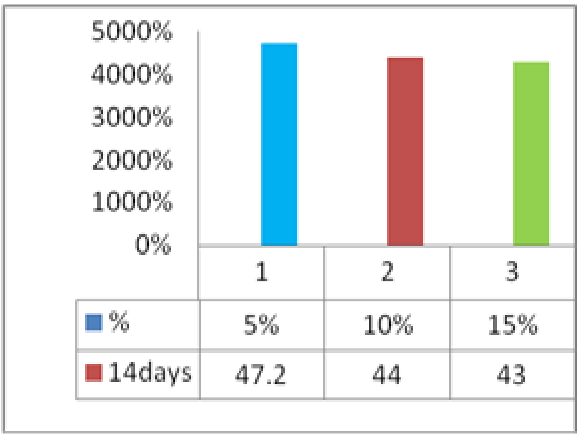

Fig. 5: Compressive Strength of Cubes for 14days B Series

2) *Compressive Strength of Cubes for 28days*

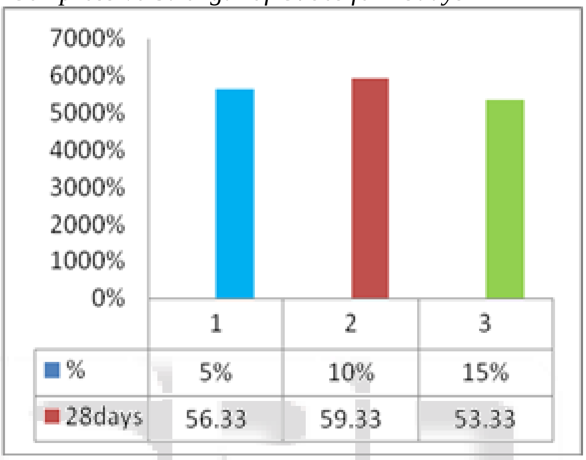

Fig. 6: Compressive Strength of Cubes for 28days, A Series

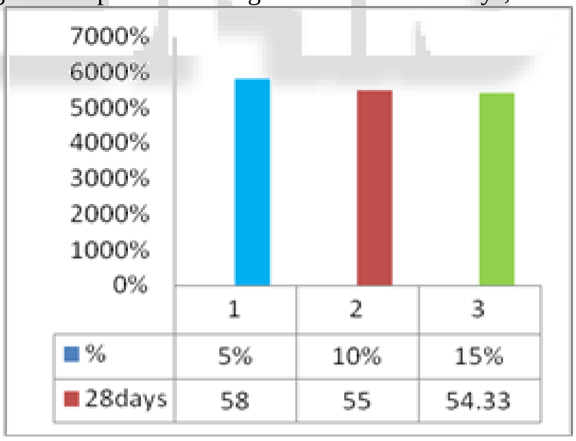

Fig. 7: Compressive Strength of Cubes for 28days, B Series

From the test results it is observed that strength increases while increasing the GGBS % up to a optimum limit of GGBS %, after that the strength values are decreasing.

B. *Tensile Strength*

Elasticity is the greatest pressure that a material can withstand while being extended or pulled before necking, which is the point at which the example's cross-segment begins to fundamentally contract.

1) *Tensile Strength of Cylinders for 14days*

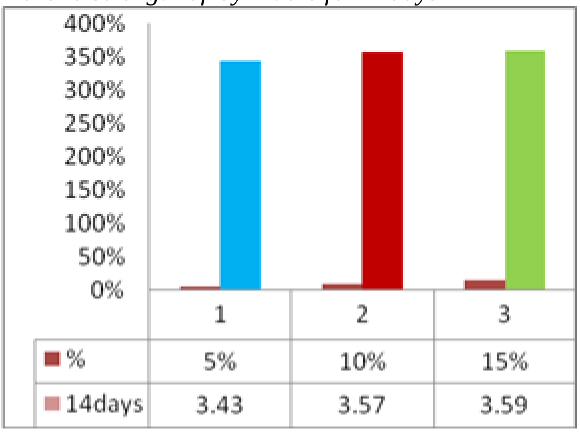

Fig. 8: Tensile Strength of Cylinders for 14days,A Series

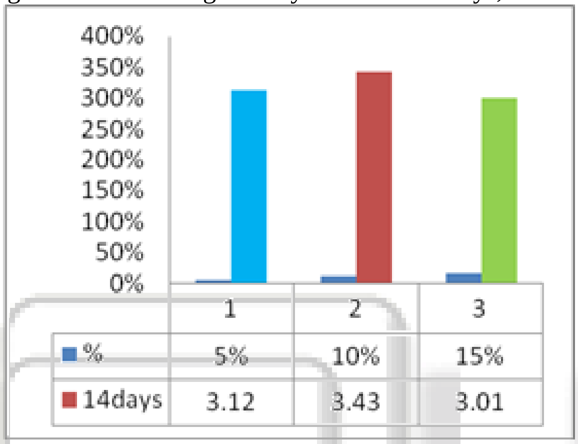

Fig. 9: Tensile Strength of Cylinders for 14days, B Series

2) *Tensile Strength of Cylinders for 28days*

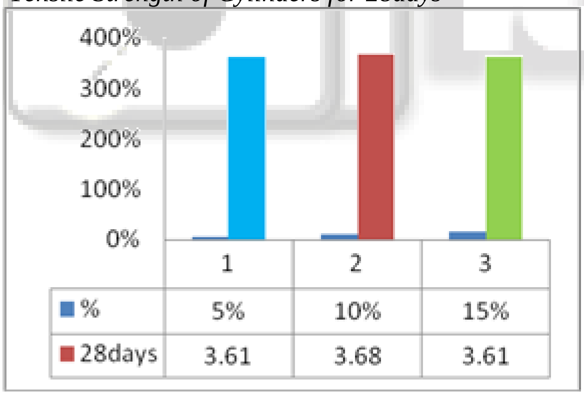

Fig. 10: Tensile Strength of Cylinders for 28days, A Series

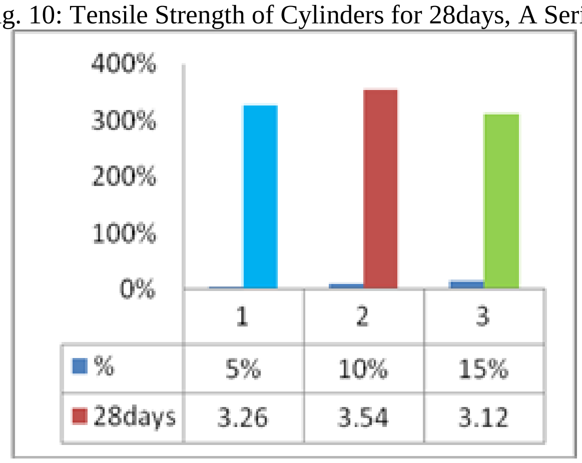

Fig. 11: Tensile Strength of Cylinders for 28days, B Series

VIII. CONCLUSIONS

In 'A' series, i.e. the mix with fly ash and ggbs in different proportions, the compressive strength, tensile strength, flexural strengths values are:

In the first set of casting, i.e. Fly ash and GGBS as an admixture, with Fly ash is constant at 05% & GGBS has a different mix proportion.

- Then the compressive strength values are increased by increasing the GGBS % up to 10% respectively. The compressive strength value at 10% GGBS is 5.3% more than 05% of GGBS. While in increase of GGBS up to 15% the value decreased by 11.25%.
- Then the Tensile strength values are increased by increasing the GGBS % up to 10%. The tensile strength value at 10% of GGBS is 1.92% more than the tensile strength value at 05% GGBS and The tensile strength value at 15% of GGBS is 1.92% less than the tensile strength value at 10% GGBS.

In 'B' series, i.e. the mix with fly ash and GGBS in different proportions, the compressive strength, tensile strength, flexural strengths values are:

In the second set of casting, i.e. Fly ash and GGBS as an admixture, with Fly ash is constant at 10% & GGBS has a different mix proportion

- Then the compressive strength values are decreasing by increasing the GGBS%. The compressive strength value at 10% of GGBS is 5.5% less than at 05% of GGBS. While in increase of GGBS up to 15% the values decreased by 1.2%.

Then the Tensile strength values are increased by increasing the GGBS % up to 10%. The Tensile strength value at 10% of GGBS is 8.6% more than the tensile strength value at 05% of GGBS and the tensile strength value at 15% GGBS is 13.5% less than the tensile strength value at 10% GGBS.

IX. SCOPE OF FUTURE WORK

- Structural stiffness can be enhanced and load deflections minimized.
- Durability studies can also be continued.
- Research on the investigation of high strengths can also be continued.
- Ensures better durability of structures.
- GGBS can be an ideal choice in civil infrastructural applications.
- Cement production is highly energy intensive.

REFERENCES

[1] Berra, M. and Ferrara, G. "Normal weight and total-light weight high-Strength concretes: A comparative experimental study," SP-121, 1990, Pp.701-733.
[2] British Standards Institution, "Specification for Aggregates from Natural Sources for Concrete," BSI, London, 1992, BS 882.
[3] British Standards Institution, "Methods for Determination of Slump," BSI, London, 1983, BS 1881: Part 102

[4] British Standards Institution. "Method for Determination of Compressive Strength of Concrete Cubes," BSI, London, 1983, BS 1881: Part 116.
[5] British Standards Institution, "Methods for determination of density of hardened concrete," BSI, London, 1983, BS 1881: Part 114.
[6] British Standards Institution, "Method for determination of water absorption." BSI, London, 1983, BS 1881: Part 122.
[7] Long, A.E. and Murray, A.M. "Pull-off test for in-situ concrete strength," Concrete, Dec. 1981, pp. 23-24.
[8] Indian standard recommended method of concrete mix design(I.S 10262-1982)
[9] Concrete technology by M.S.Shetty.
[10] properties of concrete by A.M.Neville.
[11] Indian standard code of plain and reinforced concrete (I.S456:2000).

