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Strength Characteristics of Ternary Blended Mix Concrete

Kamalakara G.K,*[1] Srikanth M. naik[2] and Suresh Kumar K.S[3]

[1]Dept. of civil Engineering, Rajarajeswari College of Engineering, Bangalore, Karnataka, India
[2] Dept. of civil Engineering, M.S.RamiahInstitute of Technology, Bangalore, Karnataka, India
[3]Department of Environmental Engineering, Govt. SJ Polytechnic, Bangalore, India
[1]kamal.cvkamal018@gmail.com

ABSTRACT

Use of industrial wastes materials and byproducts in concrete as ingredients will lead to greenenvironment. There are various types of waste materials that can be used as alternative materials to ingredients of concrete. The most commonly used waste materials to replace cement in concrete are Fly Ash, Rice Husk Ash, Silica Fume, Fumed silica, Blast Furnace Slag, Red Mud and to replace sand are Crushed Rock Powder etc. The Combinations of cement additions may provide more benefits for concrete than a single one. A ternary mixture is one that contains Portland cementand two other materials in the binder, blended eitherat the cement plant or at the batch plant. This study has investigated the strength characteristics concrete using ternary blended mix containing Portland cement (PC), with fly ash (FA) and ground granulated blast furnace slag (GGBS). Results indicated that ternary blends almost always made it possible to obtain higher strengths than normal mixtures provided that the replacement level by the additions was chosen properly.It is feasible to produce high-consistence concrete using ternary blended mix with FA and GGBS. It is possible to achieve similar or higher long-term compressive strengths with ternary binder mixes than with normal mixes for concrete with low water/cement ratio (<0.4).From this study it is observed that, optimum value of fly ash is 10% and the optimum value of ground granulated blast furnace slag is 20%. i.e., the total replacement of ternary Blended mix is 30%.

KEYWORDS: compressive strength, industrial wastes materials, normal mix, using ternary blended mix.

***Corresponding Author**

Kamalakara G.K

Assistant Professor, Department of civil Engineering,

Rajarajeswari College of Engineering, Bangalore,

Karnataka, India- 560074

E Mail - kamal.cvkamal018@gmail.com

INTRODUCTION

Concrete is the second largest material used worldwide next to water has emerged as the dominant construction material[1].At a time when so much of our natural resources are depleting we need to be resilient and thinkof alternative solutions that meet many objectives at the same time. Greening the infrastructurewith sustainable alternative materials for construction is one solution[2]. The use of waste material having cementitious properties as a replacement of cement in cement concrete has become the thrust area for construction material experts and researchers[4]. The main focus now a day's is on search of waste material or by product from manufacturing processes, which can be used as partial replacement of cement in concrete, without compromising on its desired strength. In the country like India, where the development of the infrastructures projects such as large irrigation, road and building projects are either being constructed or in completion of their planning and design stage, such uses of waste material in cement concrete will not only reduce the emission of greenhouse gases but also will be the sustainable way of management of waste. The Fly ash (FA), GGBS, Rice Husk Ash (RHA), and Silica Fume (SF) are some of the pozzolanic materials which can be used in concrete as partial replacement of cement[4]. A number of studies are going on in India as well as abroad to study the impact of use of these pozzolanic materials as cement replacements and the results are encouraging. These materials include fly ash, silica fume and ground-granulated blast furnace slag used separately or in combination. The strength, durability and other characteristic of concrete depends on the properties of its ingredients, proportion of mix, method of compaction and other controls during placing and curing. For concretes, a combination of mineral and chemical admixtures is always essential to ensure achievement of the required strength [2.]

RESEARCH SIGNIFICANCE

The advancement of technology in the field of concrete can reduce the consumption of natural resources and energy sources and lessen theburden of pollutants on environment. Presently large amounts of fly ash are generated in thermal industries with an important impact on environment and humans. In present years, many researchers have established that the use of supplementary cementitious materials (SCMs) like fly ash (FA), blast furnace slag, silica fume, metakaolin (MK), and rice husk ash (RHA) etc. can, not only improve the various properties of concrete - both in its fresh and hardened states, but also can contribute to economy in construction costs. Jayeshkumar Pitroda et al. research work describes the feasibility of using the thermal industry waste in concrete production as partial replacement of cement. The use of fly ash in concrete formulations as a supplementary cementatious material was tested as an alternative to traditional concrete. The cement has been replaced by fly ash accordingly in the range of 0% (without fly ash), 10%, 20%, 30% & 40% by weight of cement for M-25 and M-40 mix. Concrete mixtures were produced, tested and compared in terms of compressive and split strength with the conventional concrete. These tests were carried out to evaluate the mechanical properties for the test results for compressive strength up to 28 days and split strength for 56 days are taken. He concluded that the Compressive strength reduces when cement replaced fly ash. As fly ash percentage increases compressive strength and split strength decreases. Use of fly ash in concrete can save the coal & thermal industry disposal costs and produce a ‘greener’ concrete for construction. The cost analysis indicates that percent cement reduction decreases cost of concrete, but at the same time strength also decreases[2].Rajith M & Amritha E K[4] investigated the behaviour of M30 concrete by partial replacement of cement and fine aggregate by Ground granulated blast furnace slag (GGBS) and Granulated blast furnace slag (GBS). Cubes, cylinders, and beams are tested for compressive, split tensile and flexural strength after 28 days curing. Cubes are used to find the ultra-sonic pulse velocity. Percentage of cement and fine aggregate by GGBS and GBS are 20, 25, 30 and 25, 50, 75 respectively. Water cement ratio used in this work is 0.45. It is found that by partial replacement of cement with GGBS and sand with GBS helped in improving the strength of concrete compared to normal mix concrete.

Anjali Prajapati et. al.[1] studied the effect of the performance of HPC using mineral admixture i.e. fly ash and GGBS with M- 60 grade of IS cube specimen.We partially replaced Portland cement by weight of the binder. Fly ash and GGBS replacement vary from 10% to 30%. We used Conplast SP430-Sulphonated Naphthalene Polymers as a superplasticizer for better workability for high performance concrete. Dosage for superplasticizers is same for all mix proportions. Also, we have replaced fine aggregate in different proportions with foundry sand. We have investigated compressive strength, split tensile strength and flexural strength for all different cases. The HPC mix, grade M60concrete is designed as per Indian standards.

Praveen Kumar S R et. al. (2016) prepared a high strength SCC of grade M60 by partially replacing the cement content with the untreated industrial by-products like fly ash & ground granulated blast furnace slag (GGBS) and also by replacing 100% of natural sand with manufactured sand (M. Sand). With the use of these industrial by-products, it results in an eco-friendly environment and also solves the problem at its disposal.

K Nagarajet. al., has tested on concrete elements with Ground granulated blast furnace slag and Fly ash to obtain the desired strengths and properties. Finally they used in combination of fly ash and ground granulatedblast furnace slag in different percentages as replacement of cement and concrete was prepared. casted concrete cubes and prism are kept for curing for a period of 28 days. Finally compressive test and flexural test are conducted. To obtain such desired strength that cannot be obtained from conventional concrete and by the current method, a large number of trial mixes with different percentages of fly ash and different percentages of Ground granulated blast furnace slag are required to select the desired combination of materials that meets the required strength. Cement replacement by in combination of fly ash and adding Ground granulated blast furnace slag leads to increase in compressive strength and flexural strength up to 40% to 50% replacement for both M60 and M80 grades of concrete. Beyond 50% replacement of fly ash and ground granulated blast furnace slag compressive strength and flexural strength decreased. From their study it is observed that, being the fly ash is maintained 10% constant the optimum value of ground granulated blast furnace slag is 30%. i.e., the total replacement of ternary Blended cement was 40%, for the both M60 and M80grades.

MATERIALS

Cement used to carry out the investigation was ordinary Portland cement of grade 53 confirming to IS: 1269 – 1987 was used. M sand used for the investigation was confirming to IS: 383 – 1970. It was classified as zone two, based on the chart given in IS: 383 – 1970 and by performing sieve analysis. The test that was carried out on fine aggregate is given below.

Table. 1 Sieve analysis of fine aggregate

Sl. No	Sieve size	Mass remained (grams)	Percentage remained	Percentage infiltered	Cumulative % remained
1	4.75 mm	0.010	1	99	1
2	2.36 mm	0.160	16	83	17
3	1.18 mm	0.235	23.5	59.5	40.5
4	600 µm	0.160	16.0	43.5	56.5
5	300 µm	0.275	27.5	16	84
6	150 µm	0.125	12.5	3.5	96.5
7	pan	0.035	3.5		

Coarse aggregate used to carry out this investigation was 20mm and down aggregates. Sieve analysis was performed, and it was known that, the aggregates were well graded and nosingle sized. It was found by IS: 383 – 1970 and aggregates were confirming to IS code.

To check the physical properties of coarse aggregate tests like specific gravity, elongation index, flakiness index and fineness index were carried. The results of those tests are within the permissible limits as specified in the IS code.

MIX PROPORTIONS

The investigation involved totally 6 combinations of mix proportions including the control mix, varying the content of cement, GGBS and FA. The water to binder ratio was kept constant throughout the investigation. The water to binder used in my investigation was 0.40. The GGBS content was varied from 0 to 25 percent of cement content. The content of FAwasalso varied from 0 to 25% of cement content. The following table gives the exact idea of proportions varied in the investigation.

Table. 2 Proportions used in the investigation

Sl no	Cement, %	GGBS, %	FA, %
1	100	0	0
2	70	5	25
3	70	10	20
4	70	15	15
5	70	20	10
6	70	25	5

STRENGTHS OF CONCRETE MIX

The performance (strength) comparison of the ternary binder mixes and control mixes, can be seen that some of these mixes attained relatively higher strengths. All the ternary binder mixes had lower compressive strengths at early ages (up to 7 days) compared to the control mixes. This could be attributed to the fact that in the ternary binder blends, the inclusion of GGBS and FA means less Portland cement available to hydrate. Looking at the 28-day strength, the ternary binder mix with 20% GGBS plus 10%FA attained a compressive strength (46.30 MPa) higher than the corresponding ternary binder mix but this is still lower that the control cement mix (46.50 MPa).This is illustrated in the Figure 1 and Figure 2.

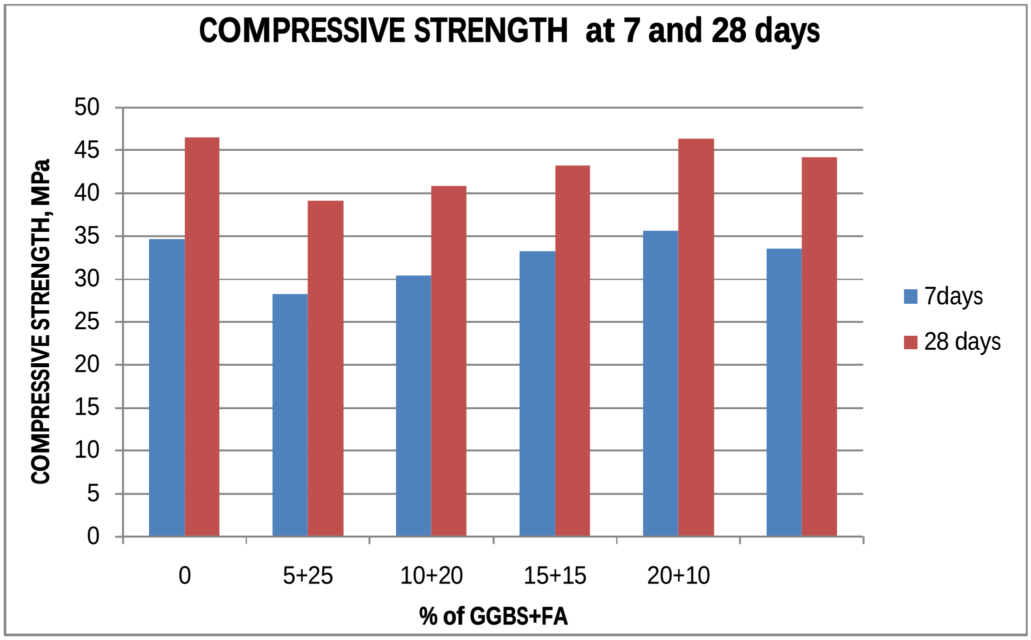

Fig.1Compressive strength at 7 and 28 days

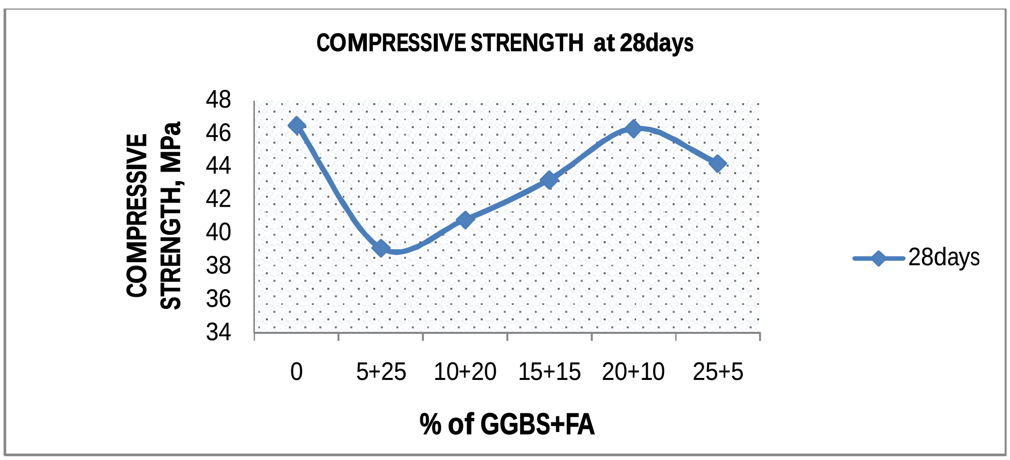

Fig. 2. Compressive strength at 28 days

DISCUSSIONS AND CONCLUSIONS

It is possible to achieve similar compressive strengths with ternary binder mixes (with GGBS and FA replacements of up to 20 and 10% respectively) relative to conventional mix for concrete with low water/cement (w/c) ratio (<0.4). Hence there exists some synergistic effect between the GGBS and FA. Ternary blended binders have less cement which in itself can have potential economic and environmental advantages by reducing the total embodied carbon of the concrete.

This research has shown that it is possible to use ternary binder combinations of well-known additions such as GGBS and FA concrete and achieve a similar strength that the conventional cement concrete. There is scope for further investigating this synergistic effect GGBS and FA to further reduce the Portland cement content leading to greater potential economic and environmental advantages.

REFERENCES

1. Anjali Prajapati, PiyushPrajapati, Mohammed Qureshi, "An experimental study on high performance concreteusing mineral admixtures", International Journal of Engineering Development and Research,2017;5(2):2080-2086.
2. K Nagaraj, P Himabindu, "Experimental Investigations of High Strength Concrete Using GGBS & Fly ash", International Journal of Research Sciences and Advanced, 2017; 2(18):170 – 181.
3. Praveen kumar S R, Manjunath K A, G. Narayana, "A Comparative Study On Mechanical Properties of SCC ByPartial Replacement Of Cement With Fly Ash & Ggbs With the Use of Glass Fibers", International Journal of Research inEngineering and Technology,2016; 05(08): 161 -165.
4. Rajith M, Amritha E K, "Performance of Concrete with Partial Replacement of Cement and Fine Aggregate by GGBS and GBS", International Journal of Research in Advent Technology, 2015; 2(5): 68-72.
5. Indian Standard Specification for granulated slag for the manufacture of Portland Slag Cement. IS 12089:1987, Bureau ofIndian Standards, New Delhi.
6. IS 456: 2000, "Indian Standard Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standard, New Delhi.
7. IS 10262: 2009 "Recommended Guidelines for Concrete Mix Design", Bureau of Indian Standard, New Delhi
8. IS 383: 1970, "Specification for Coarse Aggregate and Fine Aggregate From Natural Sources for Concrete", Bureau ofIndian Standard, New Delhi.
9. IS 9103: 1999, "Indian Standard Concrete Admixture Specification", Bureau of Indian Standard, New Delhi.