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Development of High Performance Concrete using Different Admixtures

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ABSTRACT:

This research delves into the augmentation of concrete performance by incorporating various admixtures. The objective is to formulate high-performance concrete endowed with superior mechanical properties and workability. The study involves the utilization of different types of admixtures, namely GGBS, Quartz powder, and Quartz sand, along with superplasticizers and 2% steel fiber. These components are systematically investigated to discern their influence on the concrete's compressive strength, flexural strength, and resilience to environmental factors.

The experimental methodology includes the manipulation of admixture dosages to identify optimal combinations that yield the desired properties. The outcomes of this study provide valuable insights into the development of high-performance concrete mixes. This, in turn, presents potential advancements in construction materials, contributing to the creation of sustainable and resilient infrastructure.

Keywords: Keywords are important word in paper **Example**Weather Prediction, forecast accuracy

1. INTRODUCTION

Concrete is a composite material composed mainly of cement, aggregate and water. It is a widely used construction material for various types of structures due to its structural stability and strength. Increasing the construction challenges in combinations with the new innovations in materials and production techniques have provide new basis for producing high performance concrete structures. These days concrete is being used for wide varieties of purposes to make it suitable in different conditions. In these conditions ordinary concrete may fail to exhibit the required quality performance or durability. In such cases, pozzolanic or mineral admixtures are used to modify the properties of ordinary concrete.

The word 'Pozzolana' was derived from pozzuolu, a town in Italy, a few miles from Naples and mount vacuous. The materials are of volcanic region containing various fragments of pumice, obsidian, feldspars, and quartz etc. The name 'Pozzolana' was first applied exclusively to this material. But the term has been extended later to diatomaceous earth, highly siliceous rocks and other artificial products. Thus, the pozzolanic materials are natural or artificial having nearly the same composition as that of volcanic tuffs or ash found at pozzuolu.

Pozzolanic materials are siliceous or siliceous and aluminous material, which in themselves possess little or no cementitious value, but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide liberated on hydration, at ordinary temperature, to form compounds, possessing cementitious properties. On the hydration of tri-calcium silicate and di-calcium silicate, calcium hydroxide is formed as one of the products of hydration. This compound has no cementitious value and it is soluble in water and may be leached out by the percolating water. The siliceous or aluminous compound in a finely divided form react with the calcium hydroxide to form highly stable cementitious substances of complex composition involving water, calcium and silica. Generally amorphous silicate reacts much more rapidly than the crystalline form. It is pointed out that calcium hydroxide is converted in to insoluble cementitious material by the reaction of pozzolanic materials.

Concrete is an artificial material in which the aggregates both fine and coarse are bonded together by the cement when mixed with water. Concrete has unlimited opportunities for innovative applications, design and construction techniques. It exhibits great versatility and relative economy in filling wide range of needs which by other means has been made itself as competitive building material.

With the advancement of technology and increased field of applications of concrete and mortars, the strength, workability, durability and other characteristics of the ordinary concrete need modifications to make it suitable for challenging needs for construction environment(Added to this is the necessity to combat the increasing cost and scarcity of cement). Under these circumstances the use of admixtures is found to be an important alternative solution.

2. EXPERIMENTAL INVESTIGATION

2.1 Cement

In India, OPC is manufactured in three grades namely 33grade, 43 grade and 53 grade. The numbers indicating the compressive strength obtained after 28 days, when tested as per the stipulated procedure.

2.2 Ground-granulated blast-furnace slag :

Ground-granulated blast-furnace slag (GGBS or GGBFS) is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. The chemical composition of a slag varies considerably depending on the composition of the raw materials in the iron production process.

2.3 Quartz powder:

Quartz, most common of all minerals is composed of silicon dioxide, or silica, SiO_2. It is an essential component of igneous and metamorphic rocks. The size varies from specimens weighing a metric ton to minute particles that sparkle in rock surfaces. The luster in some specimens is vitreous; in others it is greasy or glossy.

2.4 Quartz sand:

Quartz sand is in the form of yellowish white high purity silica sand. It is brought from Sathya narayana minerals, Kodumur, Kurnool

2.5 Steel fiber:

Steel fibres are filaments of wire, deformed and cut to lengths, for reinforcement of concrete, mortar and other composite materials. It is a cold drawn wire fibre with corrugated and flatted shape.

2.6 Super plasticizer:

Superplasticizers, also known as high range water reducers, are chemical admixtures used where well-dispersed particle suspension is required. These polymers are used as dispersants to avoid particle segregation(gravel,coarse and fine sands), and to improve the flow characteristics of suspensions such as in concrete applications

2.7 Nano Titanium dioxide

Nano titanium dioxide is in the form of white powder. Particle size is 5 to 10nm. It is procured from sigma company, Hyderabad.

2.8 AGGREGATE

Aggregates are the important ingredient materials in concrete. They impart bulk volume to the concrete and reduce the shrinkage effect. They occupy 70 to 80 percent of the total volume of concrete.

2.8.1 Fine Aggregate:

Locally available sand collected from River Tungabhadra was used. The following tests are conducted on fine aggregate according to IS: 383-1987

2.8.2 Coarse Aggregate:

The crushed aggregate was used from the local quarry. In this experiment the aggregate was used of 20mm down and tested as per IS: 2386-1963(I, II, III) specification. The following tests are conducted on coarse aggregate.

3. RESULTS AND DISCUSSIONS

3.1 Compressive strength

Compressive strength ofM80Gradeconcrete .Compressive strength results of all concrete mixtures determined at 28 and 56 days of curing are listed in Table 3 compressive strength was increased with increase of ggbs up to 20% and then decreased as compared with the control mixture. Maximum compressive strength obtained by M3 is 87.6 N/mm^2 with is more than 5.54% at 28days and Maximum compressive strength obtained by M3 is 88.8 N/mm^2 with is more than 5.996% at 56 days compared to control mix. Figure 1 show Variation of compressive strength for ggbs.

Compressive strength were study with 10,30,50,70 and 90% with 20% of ggbs are shown table 4 .it was observed Maximum compressive strength obtained by M8 is 94.89 N/mm^2 with is more than 14.32% at 28days and Maximum compressive strength obtained by M8 is 96.84 N/mm^2 with is more than 15.32% at 56 days compared to control mix. Figure 2 show Variation of compressive strength for ggbs.

Compressive strength of M80 Gradeconcretewere study with 1, 2, 3 and 4% of tio_2 and70 % with 20% of ggbs are shown table 5. .it was observed Maximum compressive strength obtained by M12 is 99.03 N/mm^2 with is more than 19.32% at 28days and Maximum compressive strength obtained by M12 is 102.2 N/mm^2 with is more than 20.32% at 56 days compared to control mix. Figure 3 show Variation of compressive strength for Tio_2.

Table 3 Compressive strength of Ggbs testing results

Concrete mixes	% of Ggbs	Compressive strength	
		28 days	56 days
M1	0%	83	83.8
M2	10%	85.5	86.95
M3	20%	87.6	88.8
M4	30%	86.7	87.9

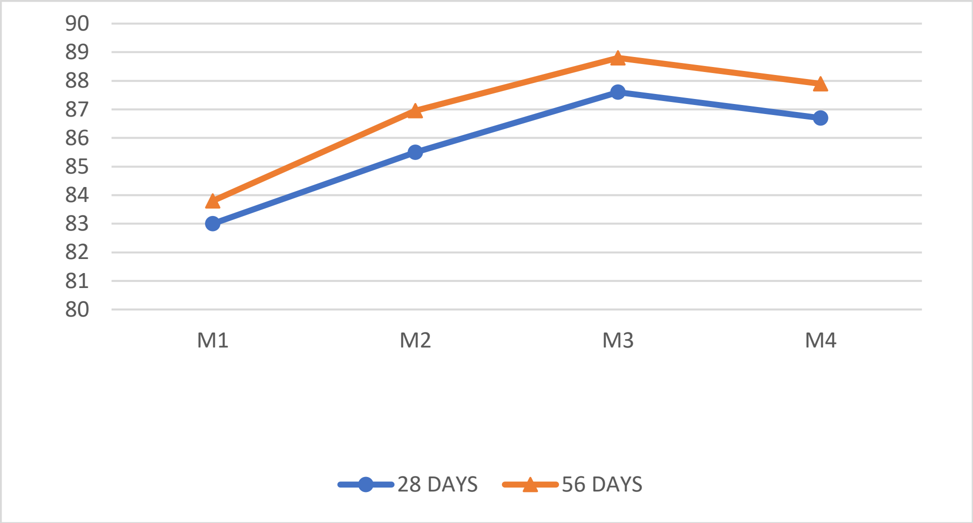

Fig 1:- Relation between compressive strength of ggsb and concrete mixes

Table 4 Compressive strength of Gbs testing results

Concrete mixes	% of Ggbs	% of Gbs	Compressive strength	
			28 days	56 days
M5	20%	10%	88.3	89.23
M6	20%	30%	90.23	91.45
M7	20%	50%	92.03	94.3
M8	20%	70%	94.89	96.84
M9	20%	90%	91.31	95.21

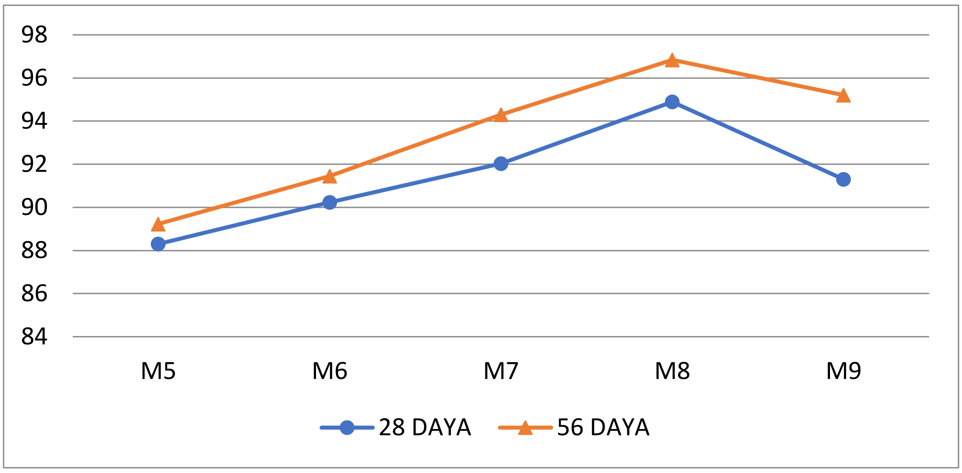

Fig 2:- Relation between compressive strength of gbs and concrete mixes

Table 5 Compressive strength of tio$_2$ testing results

Concrete mixes	% of Ggbs	% of Gbs	% of Tio$_2$	Compressive strength	
				28 days	56 days
M10	20%	70%	1%	95.98	97.62
M11	20%	70%	2%	97.67	99.82
M12	20%	70%	3%	99.03	102.2
M13	20%	70%	4%	97.51	100.31

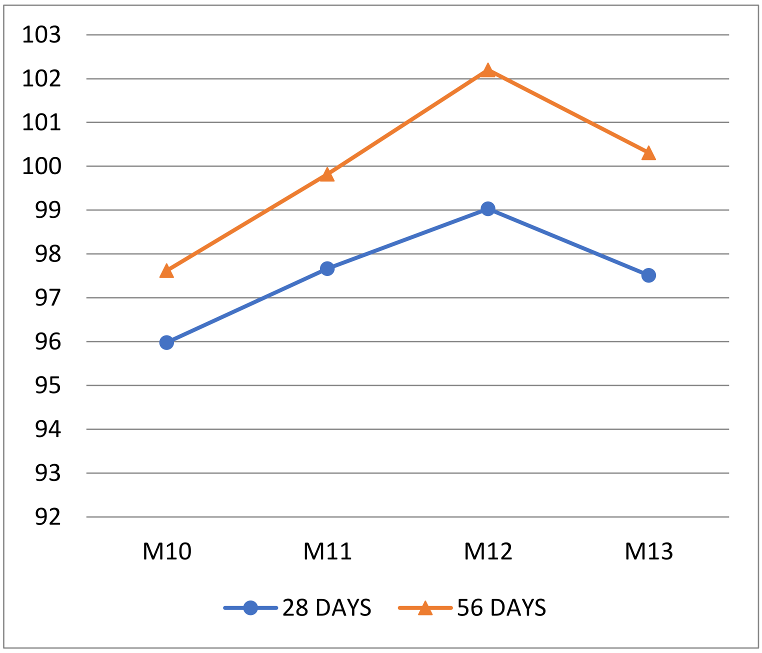

Fig 3:- Relation between compressive strength of Tio$_2$ and concrete mixes

3.2 Split Tensile strength

Split Tensile strength ofM80Gradeconcrete .Split Tensile strength results of all concrete mixtures determined at 28 and 56 days of curing are listed in Table 6 Split Tensile strength was increased with increase of ggbs up to 20% and then decreased as compared with the control mixture. Maximum Split Tensile strength obtained by M3 is 7.2 N/mm^2 with is more than 14.46% at 28days and Maximum Split Tensile strength obtained by M3 is 8.1 N/mm^2 with is more than 16.54% at 56 days compared to control mix. Figure 4 show Variation of compressive strength for ggbs.

Split Tensile strength were study with 10,30,50,70 and 90% with 20% of ggbs are shown table 7 .it was observed Maximum Split Tensile strength obtained by M8 is 7.6 N/mm^2 with is more than 19.9% at 28days and Maximum Split Tensile strength obtained by M8 is 8.35 N/mm^2 with is more than 15.32% at 56 days compared to control mix. . Figure 5 show Variation of Split Tensile strength for gbs.

Split Tensile strength of M80 Gradeconcretewere study with 1, 2, 3 and 4% of tio$_2$ and70 % with 20% of ggbs are shown table 8. .it was observed Maximum Split Tensile strength obtained by M12 is 7.8 N/mm^2 with is more than 22.62% at 28days and Maximum Split Tensile strength obtained by M12 is 8.62 N/mm^2 with is more than 24.028% at 56 days compared to control mix. Figure 6 show Variation of Split Tensile strength for Tio$_2$.

Table 6 Split Tensile strength of Ggbs testing results

Concrete mixes	% of Ggbs	Split Tensile strength	
		28 days	56 days
M1	0%	6.36	6.95
M2	10%	6.99	7.8
M3	20%	7.28	8.1
M4	30%	7.02	7.8

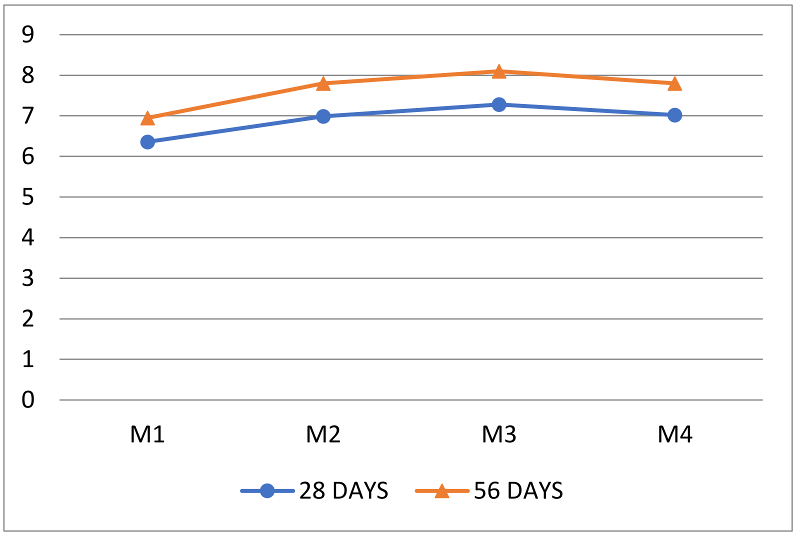

Fig 4 :-Relation between Split Tensile strength of ggsb and concrete mixes

Table 7 Split Tensile strength of Gbs testing results

Concrete mixes	% of Ggbs	% of Gbs	Split Tensile strength	
			28 days	56 days
M5	20%	10%	7.15	7.98
M6	20%	30%	7.3	8.1
M7	20%	50%	7.45	8.25
M8	20%	70%	7.6	8.35
M9	20%	90%	7.4	8.2

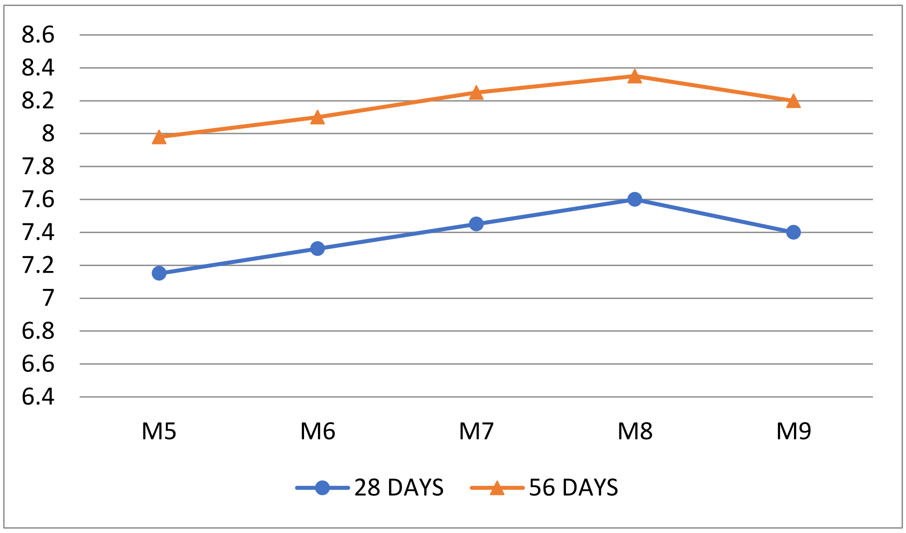

Fig 5 :-Relation between Split Tensile strength of gbs and concrete mixes

Table 8 Split Tensile strength of Tio_2 testing results

Concrete mixes	% of Ggbs	% of Gbs	% of Tio2	Split Tensile strength	
				28 days	56 days
M10	20%	70%	1%	7.52	8.35
M11	20%	70%	2%	7.65	8.48
M12	20%	70%	3%	7.8	8.62
M13	20%	70%	4%	7.72	8.51

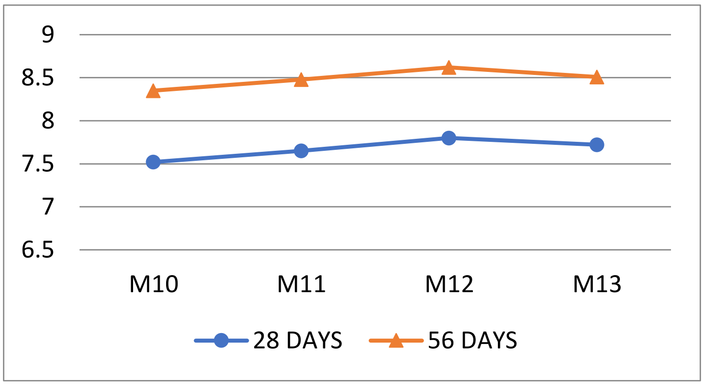

Fig 6 :-Relation between Split Tensile strength of tio_2nd concrete mixes

3.3 Flexural strength

Flexural strength ofM80Gradeconcrete .Flexural strength results of all concrete mixtures determined at 28 and 56 days of curing are listed in Table 9 Flexural strength was increased with increase of ggbs up to 20% and then decreased as compared with the control mixture. Maximum Flexural strength obtained by M3 is 5.42N/mm^2 with is more than 4.63% at 28days and Maximum Flexural strength obtained by M3 is 56.3 N/mm^2 with is more than 6.62% at 56 days compared to control mix. Figure 7 show Variation Flexural strength for GGbs.

Flexural strength were study with 10,30,50,70 and 90% with 20% of ggbs are shown table 10 .it was observed Maximum Flexural strength obtained by M8 is 5.82 N/mm^2 with is more than 12.35% at 28days and Maximum Flexural strength obtained by M8 is 6.09 N/mm^2 with is more than 15.34% at 56 days compared to control mix. Figure 8 show Variation of Flexural strength for Gbs.

Flexural strength of M80 Gradeconcretewere study with 1, 2, 3 and 4% of tio_2 and70 % with 20% of ggbs are shown table 11. it was observed Maximum Flexural strength obtained by M12 is 6.11 N/mm^2 with is more than 17.95% at 28days and Maximum Flexural strength obtained by M12 is 6.29 N/mm^2 with is more than 19.12% at 56 days compared to control mix. Figure 1 show Variation of Flexural strength at all concrete mixes. Figure 9 show Variation of Flexural strength for Tio_2.

Table 3 Flexural strength of Ggbs testing results

Concrete mixes	% of Ggbs	Flexural strength	
		28 days	56 days
M1	0%	5.18	5.28
M2	10%	5.2	5.49
M3	20%	5.42	5.63
M4	30%	5.3	5.48

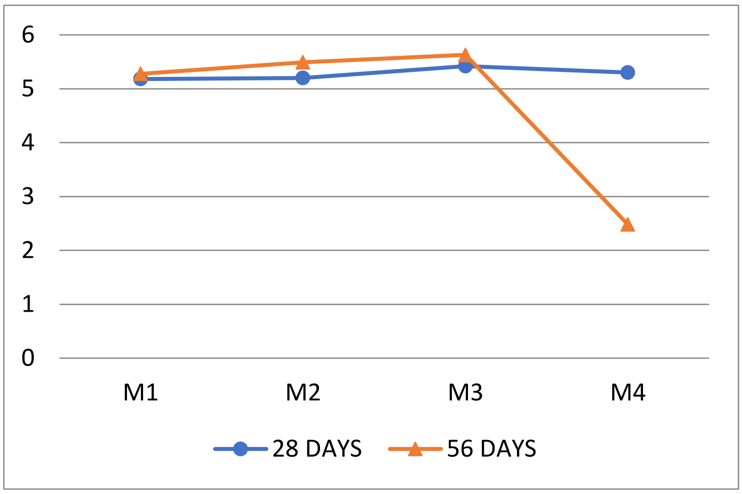

Fig 7 :-Relation between Flexural strength of GGbsand concrete mixes

Table 4 Flexural strength of Gbs testing results

Concrete mixes	% of Ggbs	% of Gbs	Flexural strength	
			28 days	56 days
M5	20%	10%	5.52	5.74
M6	20%	30%	5.63	5.82
M7	20%	50%	5.7	5.93
M8	20%	70%	5.82	6.09
M9	20%	90%	5.76	5.97

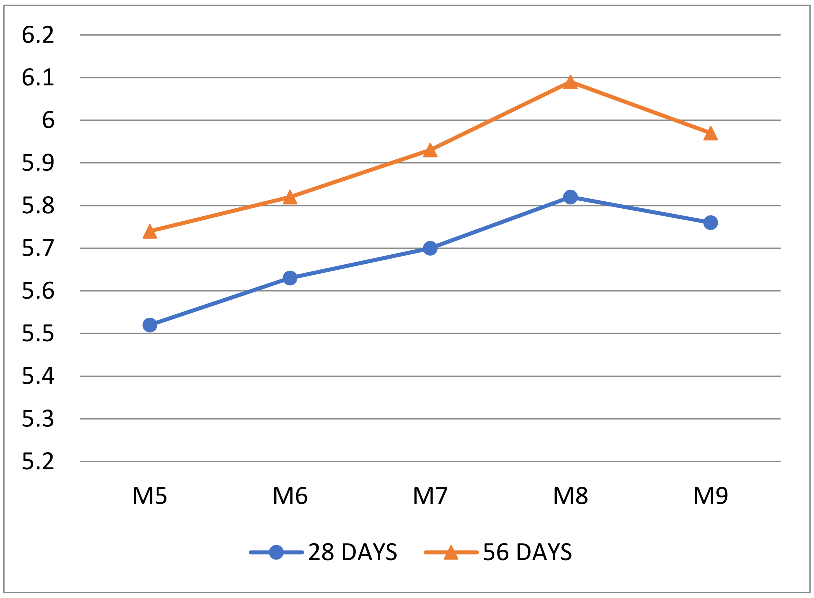

Fig 8 :-Relation between Flexural strength of Gbsand concrete mixes

Table 4 Flexural strength of Tio_2 testing results

Concrete mixes	% of Ggbs	% of Gbs	% of Tio_2	Flexural strength	
				28 days	56 days
M10	20%	70%	1%	5.89	6.12
M11	20%	70%	2%	6	6.21
M12	20%	70%	3%	6.21	6.29
M13	20%	70%	4%	6.13	6.21

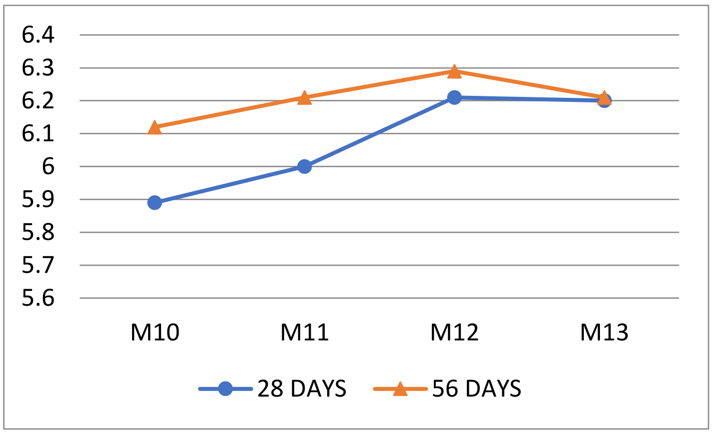

Fig 9 :-Relation between Flexural strength of Tio_2 and concrete mixes

4. Conclusion

1. Strength properties of concrete specimens increased, with increase in cement replacement by GGBS, providing maximum strength at 20 % replacement,
2. Combination of 20% of GGbs with 70% Gbs increase the strength properties compared to control mix
3. It is also observed that combination of 20%ggbs and 70% Gbs with 3% Tio_2 increases the strength properties compared to control mix
4. Results have indicated that concrete made with Tio_2 could suitable be used for making structural concretes, as well as for applications where abrasion is also important parameter.

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