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EFFECT OF MINERAL ADMIXTURE (GGBS) AND POLYPROPYLENE FIBER ON SELF COMPACTING CONCRETE

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ABSTRACT

This paper focuses on effect of mineral admixture ground granulated blast furnace slag (GGBFS) and polypropylene fiber on self-compacting concrete. The properties of self-compacting concrete are filling ability, passing ability, viscosity etc, which is measured by slump flow test, L box test, and V funnel test. A by-product of iron industries is a hot molten iron slag which is obtained from rapid cooled from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder which is later known as ground granulated blast furnace slag which have similar properties to cement and can be used to replace cement by some proportion in concrete. Use of GGBS reduces the industrial waste which is also important for environmental aspects. Also use of CGBS, reduction in the temperature rise and to help in avoiding early age thermal cracking, improved workability, as well as light weight replacement of cement in large structures as bridges and retaining walls, GGBS can be very perfect replacement to the cement.

This study focuses on the effect of GGBS and polypropylene fiber on the properties of self-compacting concrete. In this research work, a series of experiments have been done in a row to detect the optimum percentage of replacement of cement by GGBS. The grade of concrete taken was M40 and grade of cement was 43 OPC. The experimental works carried out to find the feasible percentage replacements of constituent materials by supplementary materials. Specially, the replacements percentage in the castings of samples was varied only for the GGBS and 1% of polypropylene fiber is constant, where the replacement percentages for the GGBS by 5%, 10% 15%, and 20% respectively. In conventional concrete there is some limitation like self-compaction, surface finishes, maintains strength at congested area. Due to these limitations here we are trying to make self-compacting concrete with the use of mineral admixture and fiber. This paper mainly focus on the mix proportions by replacement of cement by GGBS and fiber to critically check the fresh, mechanical and durability properties of self-compacting concrete.

KEYWORDS: *Scc Strength, Durability, Ggbs, Fiber.*

1. INTRODUCTION

In today's world, the increase of sustainability in construction practices has been given a significant emphasis. Because of Increasing in the uses of industrial materials as partial replacement for supplementary cementitious material (SCM) in cement, a primary material used in the construction industry is one way to achieve sustainability. In recent the partial substitute of binder with the SCMs like ground granulated blast furnace slag, silica fume etc. The positive aspects of self-compacting concrete are reduction in labour, safety due to decrease in human risk, less construction time, refined filling capacity, better interfacial transitional zone, decreased permeability, improved durability, more freedom in designing, superior quality production and good structural implementation etc. One of the major drawbacks of SCC was its cost due to the utilization of high amounts of cement, mineral admixtures and chemical admixtures. The uses of mineral admixture materials improve the rheological and durability property of concrete which in turn reduces the usage of cement. This will result into strong structures which requires fewer repair during its life span.As we compared the ordinary concrete with SCC has a lower viscosity therefore, a more significant flow rate when pumped. To achieve a high workability, there is limitation on the nominal maximum size, amount and grading of the aggregate. So to maintain consistency of fresh mixture of SCC, and to reduce settlement effects, the practice was to utilize high range water reducing admixture, to restrict the maximum size of coarse aggregate and fine content, and to utilize low water powder proportions or polycarboxylic ether to modify the flow properties and rheology of SCC. The properties of fresh SCC are influenced by water to content or some mineral admixtures, or by polycarboxylic ether.

There are various ways to making a self-compacting concrete by using different types of mineral and chemical admixture and using different types of fiber. Incorporating fibers into concrete mixes is recognized as an efficient way to resolve the brittle texture and dramatically improve the material properties of concrete.

The composition of self-compacting concrete is analogous to that of traditional concrete. The notable distinction between SCC and ancient concrete is that the SCC incorporates a heap of fineness content of water agent high range(super plasticizer) and viscosity modifying agent that is cement, fine mixture ,water mineral and chemical admixture. SSC mixture develop higher shrinkage deformation and gift larger cracking tendency significantly at early stage(called motor vehicle genius and plastics Ardra Mohan And K.M.Mini [2018] studied the effect of silica fume and ultrafine ground granulated blast furnace slag on self-compacting concrete. He performed the series of experiment by using 5%, 10%, 15% of silica fume and ultra-fine GGBFS as the replacement of cement and he concluded that 5% of silica fume and 10% of ultra-fine GGBFS gives the high workability.

Lhami et al.(2108)studied the effect of shrinkage reducing admixture on self-compacting concrete. The results showed that there is an improvement in a fresh property of self-compacting concrete by using the different percentage of shrinkage reducing admixtures. The workability of fresh properties as compared to 0%, 0.8, 1% and 1.2% of admixtures, among these the best workability result is obtained by the 1% of shrinkage reducing admixture.

2. LITERATURE REVIEW

Xi Liu et al.(2019) studied the effect on self compacting lightweight concrete by incorporating steel and polypropylene fibers. They concluded that the workability properties are slightly influenced by using fiber. The result showed that by using 0.5% of steel fiber and 1% of polypropylene fiber slump values is decreased by 5% and also increases in flow time as compared to without fiber.

Mucteba et al.(2011)have studied the effect of different mineral admixture on self compacting concrete. Cement was replaced with different percentage of fly ash, granulated blast furnace slag, limestone powder, basalt powder (BP) and marble powder. They concluded that all these admixture showed the good workability(like slump flow in the range of 690-750mm) but among these admixture fly ash and GGBS shows the best performance as compared to other mineral admixture.

Dinakar et al.[2018] studied the design of self-compacting concrete with ground granulated blast furnace slag. The results show that from the proper experimental investigation and the self-compacting slag concretes were evaluated for their self-compact ability and strength characteristics. The results indicate that the using of GGBS as a partial replacement of cement can be capable of producing high quality self-compacting concrete.

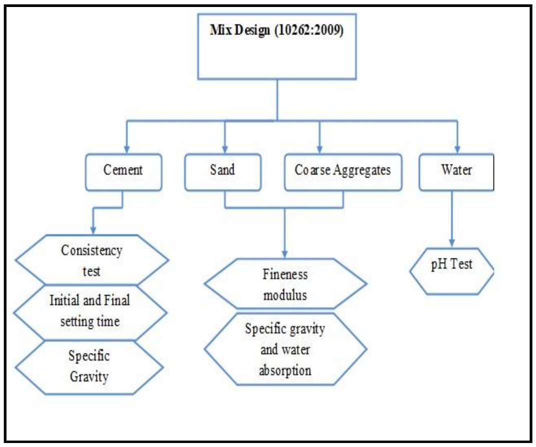
Syamak et al.(2018) studied the effect of GGBS on the frost resistance of self-compacting concrete. The result shows that with increasing the percentage of replacement of cement with ggbs there is also increase in workability. The slump flow of 0%, 30%, 50%, 65%, 80% of ggbs is 680, 720,810,690,760 respectively.

Shrinkage) compared to plain concrete mixture.

Gidion et al.(2015)have studied the behavior of self compacting concrete under the different curing temperature. The results showed that the compressive strength of self-compacting concrete greatly affected by curing temperature as compared to conventional or normal concrete. They concluded that the strength development of concrete specimens cured at higher temperature is faster than the specimens cured at the lower temperature. In low temperature, the strength of concrete specimens have higher strength at later.

3. METHODOLOGY

The methodology which is adopted in this study is given the flow chart below.



- Mix proportion has been performed as per IS 10262:2019. The test performed on the fresh concrete are
- Slump Flow.
- V Funnel
- L box
- U box
- Stability
- Test on fresh properties
- The test performed on the hardened concrete are
- Compressive strength test
- Split strength test
- Flexural strength test

TESTING OF MATERIALS

Test on coarse aggregate

Sieve analysis of coarse aggregate is done to know the particle size distribution of the sample as per IS 2386(part 1)-1963.

The specific gravity test, water absorption test, impact value test, impact value test, crushing test, flakiness index, elongation index was conducted for the coarse aggregate and the test results obtained are given in table below:

S.N	Properties	Result
1	Types Of Aggregate	Crushed
2	Specific Gravity	2.76
3	Water Absorption	0.5%
4	Impact Value	29.5%

	Test	
5	Crushing Test	21.28%
6	Flakiness Index	8.7%
7	Elongation Index	22.07%

Test on fine aggregates

The test result of the fine aggregates are listed on the table blow.

Test on cement

The fineness test, consistency test, initial setting time, final setting time, soundness test, and specific gravity test were conducted and the test values obtained are given below.

S.N	**Properties**	**Result**	**Standard Values**
1	Consistency	28%	-
2	Initial Setting Time	41 minutes	<30 minutes
3	Final Setting Time	484.6 minutes	> 600 minutes
4	Fineness	8%	>10%
5	Specific Gravity	3	2.9-3.15

Test on fresh concrete

Test on fresh concrete

15%, 20% and 1% of polypropylene fiber:3 samples for every 7 days were tested. All the required equipment for casting and testing were available in the lab.

- **Compressive strength**

The compressive strength test is results are listed in the table below.

Replacement of cement with GGBS	Polypropylene Fiber	7 days strength (N/mm2)	28 days strength (N/mm2)
5%	1%	30.1	46.3
10%	1%	28.8	46.5
15%	1%	26.4	46.7
20%	1%	23.33	47.01

- **Flexural Strength Test**

The flexural strength test results are listed on the table below

Replacement of cement with GGBS	Polypropylene Fiber	7 days strength (N/mm2)	28 days strength (N/mm2)
5%	1%	4.56	6.94
10%	1%	4.14	6.97
15%	1%	3.6	7.01
20%	1%	2.89	6.71

Filling ability (Flow ability)

The ability of freshly mixed concrete to flow and fill all the spaces within formwork under its own weight is called filling ability of SCC. This test is one of the important test of self-compacting concrete. This test is performed to know the flow ability of freshly mixed concrete. This test is also known as slump flow test. The obtained slump flow test describes the flow ability of a freshly mix concrete in unconfined condition. There are different classes of slump flow which are given below:

- Slump flow class 1 (SF1):In this class the slump flow range lies in between 500mm - 650mm.This class of SSC is appropriate for unreinforced or lightly reinforced.

Fiber Content (Constant)	**% of Replacement of cement**	**Slump (mm)**	**L- box**
1%	0%	580	0.72
1%	5%	635	0.8
1%	10%	675	0.85
1%	15%	720	0.88
1%	20%	765	0.93

• Concrete structures, for examples tunnel lining and the section that are small enough to prevent long horizontal flow like piles and deep foundation.

• Slump flow class 2 (SF2):In this class slump flow range lies between 660-750mm. This class of concrete is appropriate for normal application like walls, columns etc.

• Slump flow class 3(SF3):In this class slump flow rang lies between 760mm-850mm.This class of self-compacting concrete is appropriate for heavily reinforced structure in vertical application likes complex structure. This class concrete gives better surface finishes as compared to SF1 and SF2 for normal vertical applications but segregation resistance is more difficult to control in congested areas.

4. CASTING AND TESTING ON HARDENEND PRPOERTIES

After the fixing of proportion of replacement of cement by polypropylene fiber and GGBS, I prepared for the casting of all the samples required to check the hardend properties of concrete i.e compressive strength, flexural strength, split strength. Total of 84 samples comprising 36 cubes, 24 beams and 24 cylinder were casted. The size of cubes is l*b*h=150*150*150 mm, cylinder is d=150 mm and h=300 mm, beam is l*b*h=500*100*100 mm. These samples were tested on the basis of 7 days of curing. For the each replacement of GGBS i.e. 5%, 10%, 15%, 20% and 1% of polypropylene fiber:3 samples for every 7 days were tested. All the required equipment for casting and testing were available in the lab.

5. CONCLUSION

In conclusion, self-compacting concrete (SCC) is greatly influenced by using the different types of fiber, mineral and chemical admixture. The following observations have been made from the study by using GGBS and Polypropylene fiber:

• For 20% replacement of cement with GGBS and polypropylene fiber , the fresh properties observed were better as compared to 5%,10%, 15% replacement. Hence, the result shows that if we increase the GGBS replacement, we can have a better workable concrete.

• Increasing the GGBFS content in concrete mix leads to increase the flow characteristic of self compacting concrete.

• The hardened properties like compressive strength, flexural strength of SCC increases with increasing the GGBS upto 20%.

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