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An Investigation on Slump Loss and Its Prevention

Mahesh S M*, Shreyas B V, Vanishree B

Dept. of Civil Engineering

*DayanandaSagar Academy of Technology and Management, Bangalore**

Corresponding author's email id: *maheshsmmahi54@gmail.com*[*]

Abstract

Concrete is an important and successful material in the construction industry for a long time. It has so many applications and utilization in the construction field. Due to advancement in technology and constantly increasing economy, construction industry develops in everlasting leaps and bound day by day. This boom in construction, demands massive amount of concrete to be produce to satisfy the current need. This enormous quantity of concrete requires a deal of quality raw material which produce concrete. As raw material is the second largest consumed material by human kind, the natural raw material which produced concrete is day by day become scare. This paper presents that it is important for developing the concrete with high filling capacity. The optimum mix proportion of super plasticizer and viscosity agent was clarified for the concrete with high filling capacity. It was found that there exists the suitable viscosity of paste for improving not only the deformability but also the segregation resistance, which is highly dependent on the volume of free water in fresh concrete. This creates a technological challenge to work out certain materials which fulfill this task.

Key Words: *Slump loss, workability, fly ash, GGBFS*

INTRODUCTION

Concrete can act as an effective repository for large quantities of waste materials, if their combination with Ordinary Portland Cement (OPC) based products has no adverse effect. Air cooled blast furnace slag aggregate is strong enough to be used as lightweight aggregate. Flyash and Ground granulated blast furnace slag are a by-product material which has the

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properties of cement and can be used as replacements of cement. There are ecological advantages to use this in construction.

A new approach for restoring the slump of concrete mixes using admixtures was examined. A number of admixtures (i.e. a water reducer, a water reducer and retarder, a super plasticizer and a self compacting admixture) were individually added to OPC, 10% silica fume and 30% fly ash concrete batches after 1 or 2 hours from being originally mixed. The original mixes did not contain any admixtures. As a result of this process a slump increase usually occurs, but then disappears within an hour giving enough time for casting the concrete. The compressive strength, initial surface absorption and porosity of the concrete treated in this manner were evaluated and compared to the control concrete, which did not have any slump restoration, or to concrete in which water was used to restore its slump. It was found that the use of water to restore slump had an adverse effect on the properties of concrete especially the mixes with pozzolanic materials. The application of the new approach (i.e. slump restoration by admixtures) did not adversely affect, or in some cases improved the properties of the different concrete mixes. The admixture, which gave the best results in that respect, was the self compacting admixture. The recommendation to the ready mixed concrete industry is to add this admixture to the concrete on arrival at the site in order to restore the lost slump.

Now-a-days the most suitable and widely used construction material is concrete. This building material, until these days, went through lots of developments. the most important part of concrete is cement. The production process of this raw material produces a lot of CO2. The most effective way to decrease the CO2 emission of cement industry, is to substitute a proportion of cement with other materials. These materials called supplementary cementing materials (SCM's). Usually used supplementary cementing materials are Ground Granulated Blast Furnace Slag (GGBS), Fly Ash (FA), Silica Fume (SF), Metakaolin (MK). The aim of this study is to get acquainted with these SCM's and to examine some features. The most interesting feature is to increase chemical resistance of concrete. In this study, an attempt has been made to study the durability of concrete using the mineral admixtures like Fly Ash & Ground Granulated Blast Furnace Slag (GGBS) for M30 grade concrete. Workability of

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concrete generally implies the ease with which mix can be handled from the mixer to its finally compacted shape. The measurements of the workability Of fresh concrete is of importance in assisting the practicability of compacting the mix and also in maintaining consistency throughout the job. In addition, workability testes are often used as an indirect check on the water content and therefore on the water/cement ratio of concrete. Workability should be distinguished from consistency which term as used in concrete practice, relates to the degree of wetness of concrete. On the other hand, consistency has to do with the force flow relationship alone. A job starts with the mix just right cement and aggregate are measured, the right amount of water is add, and mixing is then carried out for the given time. A batch of concrete wetter than the rest will mean the batch of concrete that is weaker and less durable in the finished job. A job batch that is too dry will lead to difficulties in placing, compacting and finishing.

There are four tests widely used for the determination of the fresh concrete workability :

1. Slump test.
2. Compacting factor test.
3. Vee bee consistometer test.
4. Flow test.

MATERIALS AND METODOLOGY

The different pozzolonas used in the experimentation are fly ash (FA), ground granulated blast furnace slag (GGBFS) and OPC cement of 43 grade. Chemical admixtures are air entraining agent, super plasticizer, and plasticizer. The detailed description about the materials used is given below,

Cement: In this experimental work, ordinary Portland cement (OPC) 43 grade conforming to IS: 8112 – 1989 was used. The cement used was zuari cement from the local distributors. The properties of cement are as follows:

Table 1: Properties of cement (OPC 43)

Sl. No.	Material Property	Results obtained
1	Specific gravity	3.15
2	Fineness	4%
3	Normal consistency	34%
4	Initial setting time	30 minutes
5	Final setting time	5 hrs 45 minutes

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2.2 Fly ash

In this experimental work, low calcium, class F dry fly ash from the silos of Bellary thermal power plant conforming to IS: 3812 (Part 1) – 2003 was used. The chemical composition of fly ash is given as follows.

Table 2: Chemical composition of fly ash

Sl. No.	Constituent	Composition (%)
1	SiO_2	52
2	Al_2O_3	23
3	Fe_2O_3	11
4	CaO	5.0
5	SO_3	0.8
6	Na_2O	1.0
7	K_2O	2.0
8	Total Na eq. alkali	2.2
9	Loss on ignition	2.8
10	Blaine fineness m^2/kg	420
11	Relative density	2.37



Fig.1 Fly ash

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Ground granulated blast furnace slag

In this experimental work, ground granulated blast furnace slag received from Hubballi distributor, conforming to IS: 3812 (Part 1) – 2003 was used. The chemical composition of ground granulated blast furnace slag is given as follows.



Fig.2 GGBFS

Table 3: Chemical composition of GGBFS

Sl. No.	**Constituent**	**Composition (%)**
1	SiO_2	35
2	Al_2O_3	12
3	Fe_2O_3	1.0
4	CaO	40
5	SO_3	9.0
6	Na_2O	0.3
7	K_2O	0.4
8	Total Na eq. alkali	0.6
9	Loss on ignition	1.0
10	Blaine fineness m^2/kg	400
11	Relative density	2.57

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Fine aggregates

Locally available river sand belonging to zone II of IS: 383-1970 was used for the project work. The physical properties of fine aggregates used are shown in below

Table 4: Physical properties of fine aggregates

Specific gravity	2.60
Bulk density	1752 kg/m^3
Water absorption	1.0%



Fig.3 Fine aggregate

Coarse aggregates

Locally available crushed aggregates confirming to IS 383-1970 are used in this experimentation. The sieve analysis data and physical properties of coarse aggregates are show in table 5.

Table 5: Physical properties of Coarse aggregates

Specific gravity	2.63
Bulk density	1782 Kg/m^3
Water absorption	0.6%

Super plasticizer

The optimum dosage of Master Glenium SKY 8644 to meet specific requirement should always be determined by trail mixes using the materials and conditions that will be experienced in use.In the experimentation suitable dosage of 8% is added to achieve high workability and slump value for flowability.



Fig.4 Master glenium sky 8644

Plasticizer

The optimum dosage of Master Pozzolith 6865 to meet specific requirement should always be determined by trail mixes using the materials and conditions that will be experienced in use. In the experimentation suitable dosage of 8% is added to achieve high workability and slump value for flowability.

Air-entraining

The optimum dosage of Master Air 721 to meet specific requirement should always be determined by trail mixes using the

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materials and conditions that will be experienced in use.

In the experimentation suitable dosage of 4% is added to achieve high workability and slump value for flowability.



Fig. 5 Master Air 721

TRIAL MIX:

Mix proportion = 1:1.53:2.43 for W/C ratio 0.45

The material required for 20kg of nominal concrete mix using the mix proportion by mass,

Cement	– 4kg
Fine aggregate	– 6.12kg
Coarse aggregate	– 9.72kg
W/C (0.45)	– 1.8 ltr

Table 6: Mix proportion

W/C ratio	Cement	Fine aggregate	Coarse aggregate
0.45	437.78kg	672.28 kg/m^3	1063.65 kg/m^3
0.45	1	1.53	2.43

MIXING

Calculate the material required for 20kg of concrete using the mix proportion by volume as discussed above and W/C of 0.45. Cement was replaced by blends of fly ash and GGBFS as per desired percentages. Blending of flyash and GGBFS is done in equal proportions for the particular percentage of replacement cement. Mixing was done by hand. Cement is mixed with blends and then fine aggregate shall be mixed dry to a uniform color and then the coarse aggregate with L.W.A is added and mixed until the coarse aggregate is uniformly distributed. Now water and chemical admixtures is added and the whole mix is mixed until the resulting concrete is uniform in colour.

Testing procedure:

Workability tests:

The following workability tests are conducted on fresh concrete.

- Slump cone test.
- Compaction factor test.
- Vee-Bee consisto meter test.
- Flow table test

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EXPERIMENTAL RESULTS:

Table.7 Reference mix

w/c ratio: 0.45	Temperature: 31 ^{0}C	WORKABILITY TEST			
Sl. NO.	Elapsed time in min	Slump (mm)	Vee-bee(sec)	CF	Flow Test (mm)
1	0	5	8	0.84	182.5
2	15	3	7	0.82	166.2
3	30	2	5	0.80	157.5
4	45	1	4	0.86	115.0
5	60	0	3	0.86	84.5
6	75	0	2	0.86	85.0
7	90	0	2	0.89	63.75

Table.8 With addition of plasticizer

w/c ratio: 0.45	Temperature: 31 ^{0}C	WORKABILITY TEST			
Sl. NO.	Elapsed time in min	Slump (mm)	Vee-bee(sec)	Compaction factor	Flow Test (mm)
1	0	5	11	0.90	273.75
2	15	4	10	0.89	259.0
3	30	3	10	0.87	262.5
4	45	2	8	0.85	242,5
5	60	0	6	0.85	237.5
6	75	0	5	0.85	236.5
7	90	0	4	0.84	235.5

Table.9 With addition of air entraining agent

w/c ratio: 0.45	Temperature: 31 ^{0}C	WORKABILITY TEST			
Sl. NO.	Elapsed time in min	Slump (mm)	Vee-bee(sec)	Compaction factor	Flow Test (mm)
1	0	6	8	0.88	298.25
2	15	5	7	0.87	316.25
3	30	0	6	0.86	291.25
4	45	0	5	0.83	315.00
5	60	0	4	0.87	378.75
6	75	0	3	0.87	408.75
7	90	0	3	0.88	458.75

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Table.10With addition of super plasticizer

w/c ratio: 0.45	Temperature: 31 ^{0}C	WORKABILITY TEST			
Sl. NO.	Elapsed time in min	Slump (mm)	Vee-bee(sec)	Compaction factor	Flow Test (mm)
1	0	4	6	0.98	332.50
2	15	0	10	0.86	312.50
3	30	0	7	0.87	303.75
4	45	0	5	0.84	390.00
5	60	0	5	0.88	428.75
6	75	0	4	0.875	432.25
7	90	0	3	0.87	442.50

Table.11with addition of 30%fly ash

w/c ratio: 0.45	Temperature: 31 ^{0}C	WORKABILITY TEST			
Sl. NO.	Elapsed time in min	Slump (mm)	Vee-bee(sec)	Compaction factor	Flow Test (mm)
1	0	4	17	0.82	169.0
2	15	3	13	0.79	176.3
3	30	2	12	0.78	180.05
4	45	1	11	0.79	180.0
5	60	1	8	0.80	171.3
6	75	0	7	0.84	165.0
7	90	0	5	0.90	135.0

Table.12With addition of 30%fly ash +plasticizer

w/c ratio: 0.45	Temperature: 31 ^{0}C	WORKABILITY TEST			
Sl.NO.	Elapsed time in min	Slump (mm)	Vee-bee(sec)	Compaction factor	Flow Test (mm)
1	0	160	6	0.877	389.25
2	15	7	6	0.889	281.25
3	30	5	13	0.863	267.0
4	45	3	10	0.842	276.3

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5	60	0	7	0.815	255.0
6	75	0	6	0.845	303.75
7	90	0	5	0.864	410.0

Table.13 With addition of 30% fly ash +air entraining agent

w/c ratio: 0.45	**Temperature: 31 ^{0}C**	**WORKABILITY TEST**			
Sl. NO.	**Elapsed time in min**	**Slump (mm)**	**Vee-bee(sec)**	**Compaction factor**	**Flow Test (mm)**
1	0	52	10	0.88	332.50
2	15	10	10	0.86	291.25
3	30	0	12	0.83	270.00
4	45	0	13	0.84	320.00
5	60	0	16	0.80	298.75
6	75	0	15	0.85	366.25
7	90	0	10	0.80	313.75

Table.14with addition of 30% fly ash + super plasticizer

w/c ratio: 0.45	**Temperature: 31 ^{0}C**	**WORKABILITY TEST**			
Sl. NO.	**Elapsed time in min**	**Slump (mm)**	**Vee-bee(sec)**	**Compaction factor**	**Flow Test (mm)**
1	0	150	3	0.88	398.75
2	15	140	4	0.93	385.00
3	30	13	10	0.94	270.00
4	45	12	8	0.95	373.75
5	60	1	7	0.93	393.25
6	75	0	6	0.91	435.00
7	90	0	5	0.89	416.25

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Table.15with addition of 30%ggbfs

w/c ratio: 0.45	**Temperature: 31 ^{0}C**	**WORKABILITY TEST**			
Sl. NO.	**Elapsed time in min**	**Slump (mm)**	**Vee-bee(sec)**	**Compaction factor**	**Flow Test (mm)**
1	0	2	12	0.82	203.0
2	15	0	10	0.84	191.25
3	30	0	6	0,83	190.25
4	45	0	5	0.83	178.75
5	60	0	4	0.87	141.25
6	75	0	3	0.89	86.25
7	90	0	2	0.88	81.25

Table.16With addition of 30%ggbs +plasticizer

w/c ratio: 0.45	**Temperature: 31 ^{0}C**	**WORKABILITY TEST**			
Sl. NO.	**Elapsed time in min**	**Slump (mm)**	**Vee-bee(sec)**	**Compaction factor**	**Flow Test (mm)**
1	0	145	12	0.91	301.25
2	15	22	11	0.887	283.75
3	30	0	9	0.885	270.0
4	45	0	8	0.885	276.25
5	60	0	5	0.864	351.25
6	75	0	5	0.868	383.75
7	90	0	8	0.872	428.75

Table.17with addition of30% ggbs +air entraining agent

w/c ratio: 0.45	**Temperature: 31 ^{0}C**	**WORKABILITY TEST**			
Sl. NO.	**Elapsed time in min**	**Slump (mm)**	**Vee-bee(sec)**	**Compaction factor**	**Flow Test (mm)**
1	0	4	10	0.85	315.00
2	15	3	8	0.83	340.00
3	30	0	7	0.85	305.00
4	45	0	7	0.83	362.50
5	60	0	6	0.86	397.50
6	75	0	5	0.87	427.50
7	90	0	4	0.86	422.50

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Table.18With addition of 30% ggbs + super plasticizer

w/c ratio: 0.45	**Temperature: 31 ^{0}C**	**WORKABILITY TEST**			
Sl. NO.	**Elapsed time in min**	**Slump (mm)**	**Vee-bee(sec)**	**Compaction factor**	**Flow Test (mm)**
1	0	160	5	0.90	370.00
2	15	15	6	0.91	343.75
3	30	4	9	0.93	286.25
4	45	1	6	0.89	413.75
5	60	0	4	0.83	448.75
6	75	0	3	0.85	450.00
7	90	0	2	0.87	440.00

CONCLUSIONS:

- By comparing all slump test results the stiffness of mix is better maintained using combination of 30% of fly ash and plasticizer upto 30min and slump value of 140mm is obtained.

- Also by comparing all flow test results combination of fly ash and plasticizer gives better workability or flow value.

- Compaction factor value better obtained using super plasticizer when compared to other admixtures.

- As Vee-bee value decreases workability increases.By comparing all test results of Vee-bee workability of mix is better maintained using combination of 30% GGBS and super plasticizer.

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AUTHORS' PROFILE

Mahesh S M, *Assistant Professor*
Department of Civil Engineering
College: Dayananda Sagar Academy of Technology and Management, Bangalore
E-mail:maheshsmmahi54@gmail.com

Shreyas B V*, Assistant Professor*
Department of Civil Engineering
College: DayanandaSagar Academy of Technology and Management, Bangalore
E-mail: shreyasbv2009@gmail.com

Vanishree B*, Lecturer*
Department of Civil Engineering
College: NitteMeenakshi Polytechnic, Yelahanka, Bangalore
E-mail: vanishreebennur55@gmail.com

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