International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE) Volume 1, Issue 2 , June 2016

Effect of Chlorides on Physical Properties of Concrete

[1] Tushar D. Bhise, [2] Shilpa V. Patil,
[1] PG Student,[2] Associate Professor,
[1][2]Department of Civil Engineering, Vishwakarma Institute of Information Technology, Pune, India

Abstract: **— concrete is the major product used in the construction industry. Concrete has to constantly face challenges of aggressive environment either from within or from external sources during its service life. Hence, durability of concrete with respect to exterior aggressions is one of the current priorities in civil engineering. As it has indirect effect on economy, serviceability and maintenance. Damage to concrete structures in continuous contact with saline environment is of utmost importance in all other types of damages. Upon exposure to saline water, Cl^- ions penetrate into the structures and subsequently lead to corrosion of reinforcement. The penetrated chloride also reacts with components of cement and leads to a rehydration of residual cement. Some smart materials i.e. admixtures like silica fume, fly ash, metakaolin, rice husk etc. are also being used within the concrete to increase its durability and strength. It is necessary to identify the penetration and reaction of chloride ions with these Pozzolanic materials which may alter the physical Properties of concrete either in fresh or in hardened state of concrete. In present research work, the effect of chloride ions on fresh and hardened properties of concrete is studied.**

***Index Terms*— Chloride penetration, Chloride - concrete interaction, Pozzolanic materials, and Physical properties**

I. INTRODUCTION

Concrete is a heterogeneous mix of cement. Aggregates and water. Concrete is major product used in the construction industry. Concrete has to constantly face aggressive environment either internal or from external sources during its service life and durability and strength of concrete get reduced. Concrete can be damaged by fire, aggregate expansion, sea water effects, bacterial corrosion, calcium leaching, physical damage and chemical damage. It is never possible to prevent deterioration of concrete completely. So prediction of long-term behaviour of concrete structures is very important. Corrosion of steel reinforcement is the major problem and chloride is the most aggressive and most widespread corrosive ion. It is therefore essential to understand the interactions between chloride and concrete in order to identify and predict behaviour of concrete structures. Ground granulated blast slag (GGBS), fly ash, silica fume are industrial by-products used as partial replacement for cement in concrete.

There are few works carried out by researchers S. Gadpalliwar et.al (2010) worked on Partial Replacement of Cement by GGBS, RHA and Natural Sand by Quarry Sand in Concrete, which gives strength variation with different replacement proportion of Pozzolanic material, natural sand and quarry sand [1]. Fabien Barberon et.al (2005) worked on Interactions between chloride and cement-paste materials, which gives results of multinuclear nuclear magnetic resonance study on fixation of chloride in hydration products and characterization new phases potentially appearing due to chloride ingress [2]. D.M. Roy et.al (2001) worked on Effect of silica fume, metakaolin and low-calcium fly ash on chemical resistance of concrete gives results of effects of aggressive chemical environment on mortar prepared with OPC and silica fume / metakaolin / low – calcium fly ash at different replacement levels [3]. Wei Sun et.al (2002) which results shows that concrete specimen subjected to freeze – thaw cycling scale more severely in chloride salt solution than those in water and weight loss of specimen in chloride salt solution is more than in water [5].

II. EXPERMENTAL PROGRAM

A. Materials

Concrete mix of M35 grade made with ordinary Portland cement of 53 grade having Sp. gravity is 3.14. Good quality river sand was used as a fine aggregate conforming to Zone-II of IS: 383- 1970 have fineness modulus of 2.735, specific gravity of 2.5 and water absorption 0.98%. The coarse aggregate passing through 20 mm and retained on 10 mm sieve was used. Its specific gravity was 2.85 and water absorption 0.8%. Potable water free from organic substance was used for mixing as well as curing of concrete [6]. Salt (NaCl) was used as chlorides. Ground granulated blast-furnace slag is the granular material formed when molten iron blast furnace slag is rapidly chilled by immersion in water. It is a granular product with very limited crystal formation, is highly cementitious in nature and, ground to cement fineness, and hydrates like port land cement. The specific gravity of GGBS was 2.85. The compressive strength of concrete after 7 Days and 28 Days was 25.6 Mpa and 36 Mpa respectively.

B. Preparation of specimen

For the experimental study, 3 sets of 4 types of specimens of cubes for compressive strength, beams for flexural strength and cylinders for split tensile strength of M35 grade concrete. 1st specimen is only plain concrete of M35 grade. In 2nd specimen, 5% NaCl were added in plain concrete of M35 grade by the weight of cement. In 3rd specimen, cement were replaced by 20% GGBS but without addition of NaCl. And in 4th specimen, 5% NaCl added and cement were with 20% GGBS by the weight of cement ref. table no. I. The samples were cured for 28 days. The destructive tests like compressive strength test as per IS 516-1959, flexural strength as per IS 516-1959 and split tensile strength as per IS 5816-1999 on specimen [7].

Table I: Details of different types of mix

Sr. No.	Identification of Mix	Description of Identification of Mix
1.	M	M35 concrete without NaCl, without GGBS i.e. plain concrete.
2.	MS	M35 concrete with NaCl, without GGBS.
3.	MG	M35 concrete without NaCl, with GGBS.
4.	MSG	M35 concrete with NaCl, with GGBS.

The M35 mix proportioning is designed as per guidelines, according to the Indian Standard Recommended Method IS 10262- 2009. The total content was 400 kg/m³, fine aggregate is taken 640kg/m³, coarse aggregate is taken 1163kg/m³. In this research, 4 types of concrete mix with M35 grade were used as explained in table 1. Cubes, beams and cylinder moulds were used for casting. The total mixing time was 5 minutes. Compaction of concrete was done in three layers with 25 strokes of 16mm tamping rod for each layer. The concrete was left in the mould and allowed to set for 24 hours before the moulds were demoulded and placed in curing tank until the day of testing. The three specimens of each set was prepared and left for curing in the curing tank for 28 days. Water cement ratio was maintained as 0.5 for every mix.

C. Tests performed

In fresh state, workability test were conducted. The workability and water cement ratio of concrete for each mix was as follow. Water cement ratio maintained as 0.5 for all mixes.

Table II: Workability and w/c for diff. types mix

Sr. No.	Type of mix	Workability
1.	M	105mm
2.	MS	110mm
3.	MG	107mm
4.	MSG	115mm

The testing is carried out in hardened state of concrete for compressive strength on cubes as per IS: 516 – 1959, split tensile strength on cylinder as per IS: 5816 – 1999, flexural strength on beam of as per IS: 516 – 1959.

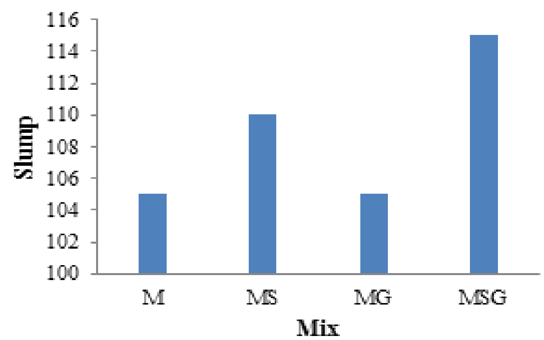

Fig 1: Workability Result

III. RESULTS AND DISCUSSION

The workability of concrete is increased by addition of salt and GGBS in concrete. Results are mentioned in Table II. Pouring and compaction of concrete were done properly. After 28 days, weight of each block were checked and it comes as per permissible. Weight results are mentioned in table III. So it is clear that the density of each block were properly maintained.

Table III: Average weight after 28 days`

Sr.No	Mix	Cubes	Beams	Cylinders
1.	M	8.54kg	38.26kg	13.01kg
2.	MS	8.73kg	38.27kg	12.95kg
3.	MG	8.71kg	38.23kg	12.80kg
4.	MSG	8.38kg	38.32kg	12.66kg

Table IV: Average strength after 28 days

Sr. No	Mix	Compressive strength tests Mpa	Flexural Strength Mpa	Split tensile strength

				Mpa
1.	M	35.01	3.80	2.88
2.	MS	33.25	3.76	2.76
3.	MG	25.50	2.57	2.45
4.	MSG	26.80	3.014	2.48

After 28 days of curing, all blocks were tested for compressive strength test, flexural strength and split tensile strength for all types of mix. Results are mentioned in table IV. From the results it is clear Strength of concrete is not affected by addition of salts. But by the replacement of GGBS with cement, strength of the concrete gets reduced.
All results like Workability, Compressive Strength, Flexural Strength and Split Tensile Strength are shown graphically in fig 1 to fig 4 respectively.

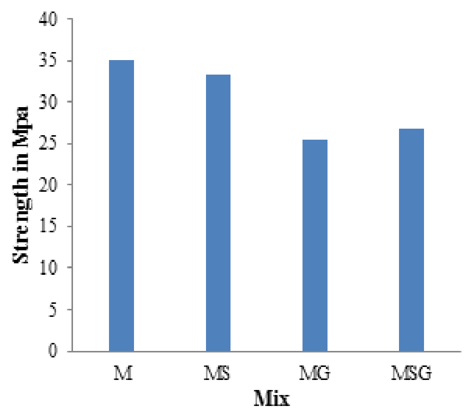

Fig 2: Compressive strength after 28 days.

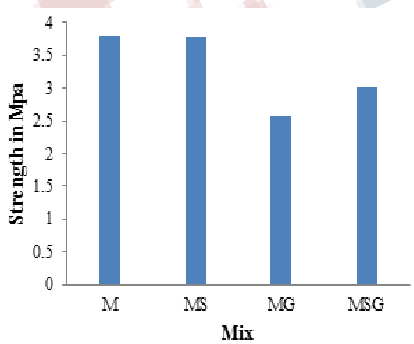

Fig 3: Flexural strength after 28 days

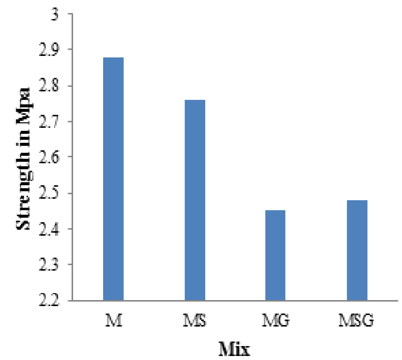

Fig 4: Split Tensile strength after 28 days.

IV. CONCLUSION

Based on the experimental study the following conclusion is drawn:

- Strength does not affected by addition of NaCl in concrete.
- Workability of concrete is increased by addition of NaCl and GGBS in concrete.
- Compressive Strength, Flexural strength, Split tensile strength of all type of mix of concrete get reduced by replacement of GGBS with cement.

REFERENCES

[1] Sonali K. Gadpalliwar, R. S. Deotale, Abhijeet R. Narde, "To Study the Partial Replacement of Cement by GGBS, RHA and Natural Sand by Quarry Sand In Concrete", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 2 Ver. II (Mar- Apr. 2014), PP 69-77, 2014.

[2] Fabien Barberon, Ve´ronique Baroghel-Bouny, He´le`ne Zanni, Bruno Bresson, Jean - Baptiste d'Espinose de la Caillerie, Lucie Malosse, Zehong Gan, "Interactions between chloride and cement-paste materials", Magnetic Resonance Imaging 23 (2005) 267–272, 2005.

[3] D.M. Roy, P. Arjunan, M.R. Silsbee, "Effect of silica fume, metakaolin, and low-calcium fly ash on chemical resistance of concrete", Cement and Concrete Research 31 (2001) 1809–1813, 2001.

[4] Dr. Herald Justnes, "A review chloride binding in Cementitious systems" SINTEF civil and environmental engineering, cement and concrete.

[5] Wei Sun, Ru Mu, Xin Luo, Changwen Miao, "Effect of chloride salts, freeze – thaw cycling, and extremely applied load on performance of concrete", cement and concrete research 32(2002) 1859-1864.

[6] IS 10262 -2009 "IS Method of Mix Design", Bureau of Indian Standards, New Delhi.

[7] IS 516 -1959 "Methods of Tests for strength of concrete", Bureau of Indian Standards, New Delhi.

[8] IS 456 -2000 "Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standards, New Delhi.