International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 5, Issue 04, April-2019

REVIEW OF SELF-COMPACTING CONCRETE USING CORROSION INHIBITORS

Surya Pratap Singh[1], Nishant Kumar[2]

[1]*M. Tech Scholar, Department of Civil Engineering, Sharda University, Greater Noida,*
[2]*Assistant Professor, Department Civil Engineering, Sharda University, Greater Noida,*

Abstract*— Self-compacting concrete is a flowing concrete mix that is able to consolidate under its own weight and due to this fluid nature of SCC it is considered to be suitable for placing in congested reinforcement. By using SCC, it is possible to minimize hearing-related damages on the worksite that usually occurs due to vibration of concrete. Corrosion which is one of the biggest problems that causes deterioration of concrete structures and has bigger impact in coastal areas. The corrosion causes the formation of rust which is four times the volume of original steel and does not have any of its good mechanical qualities, it also causes the loss of bond between concrete and steel which results in delamination, cracking and spalling. Corrosion inhibitor can be used to reduce the rate of corrosion when used in proper proportion by applying on the surface of steel or by adding during the preparation of concrete mix. Corrosion inhibitors are classified such as Organic and Inorganic and can also be classified on the basis of electrode reaction they possess such as anodic, cathodic or mixed inhibitors. The objective of this work is to study the behaviour of Organic and Inorganic corrosion inhibitors for steel in self-compacting concrete. The effectiveness of the inhibitors will be compared and analysed.

Keywords*— Self-Compacting concrete, Corrosion, Corrosion inhibitors, Half-cell Potentiometer.

I. INTRODUCTION

Concrete is the heterogeneous material consists of cement, water, fine and coarse aggregate and is used widely in the whole world. Self-compacting concrete (SCC) was first developed in the year of 1986. The fluidity and segregation resistance of self-compacting concrete ensures minimal concrete voids and uniform concrete strength. Self-compacting concrete also provides a superior level of finish and durability. This improved performance safety benefits, makes self-compacting concrete a very attractive solution for civil engineering construction.
In RCC structures after some time the reinforcing steel starts getting corroded due to many factors which reduces the stability of the structure and may results in collapse of the whole structure. Corrosion in the reinforcement steel is termed as 'cancer' globally across the world for concrete structures. Corrosion is basically caused by the destructive attack of chloride ions penetrating by different mechanism from the outside and the reinforcing steel in concrete structures are in passive condition and that is why they are protected by a thin layer of oxide having alkalinity pH 12-13, when this protective layer is breached due to chloride attack or carbonation, the corrosion takes place. This mechanism results in the formation of rust which is four times the volume of original steel and does not have any of its good mechanical qualities.
The corrosion inhibitors is economical and easy to apply, they can be applied on the surface of reinforcing steel or can be mixed during the preparation of concrete mix.
Corrosion inhibitors are the chemical substances that have capability to prevent corrosion or reduce the rate of corrosion when they are used in proportion by applying on the surface of steel or can be add during the preparation of concrete mix. Corrosion inhibitors can be classified on the basis of their composition such as Organic and Inorganic, they can also be classified on the basis of electrode reaction they have such as anodic, cathodic or mixed inhibitors. In India and many countries in the world the use of some inhibitors is banned due to their toxicity. Hence there is worldwide need to make use of environmentally friendly and non-toxic corrosion inhibitors which are extracted from naturally occurring plants materials which are commonly known as green corrosion inhibitors.

II. LITERATURE REVIEW

Boukhelkhal Djamila1 (2018), developed a relationship between the compressive strength and ultrasonic pulse velocity for all SCC. He also concluded that SCC with pozzolana have the lowest correlation coefficient. The Ultra sonic pulse velocity values also increased with increasing curing period for all. For the Experiment he studied the effect of mineral admixture available such as limestone powder, granulated slag and natural pozzolana on the correlation between compressive strength and corresponding ultrasonic pulse velocity for self-compacting concrete (SCC). Compressive strength and ultrasonic pulse velocity (UPV) were determined for four different SCC at the 3, 7, 28- and 90-day curing period.

J. Abdul Bari (2017), Compared the performance of the cathodic calcium nitrite, Ca(NO2)2, with anodic inhibitor calcium nitrite, Ca(NO3)2. The methods used to obtain corrosion resistance values were half-cell potential measurements,

polarization curves of reinforced rebars and mass loss of the reinforcement. He also concluded that the use of corrosion inhibitors reduced costs and inconvenience of repairs. The overall performance of the surface applied organic and inorganic corrosion inhibitors reduce the chloride induced corrosion. It was also observed by him that the half-cell measurements give accurate readings to a very extent and the readings observed were also stable.

R.Dharmaraj (2016), concluded that corrosion inhibitors used as admixture does not show any negative effects on the compressive strength. The inhibitors were added in different proportions such as 1%, 2%, 3%, 4% and 5%.
He concluded that in 3% of sodium nitrite there was maximum increase in the compressive and flexural strength when they are compared with the other specimens without inhibitors.
He also concluded that the over dose of inhibitors increases the setting time which decreases the strength of concrete. He also concluded that the better strength and durability were obtained the in 3% sodium nitrate. For this experiment he studied the strength and corrosion resisting properties of self-compacting concrete with sodium nitrite as corrosion inhibiting used in different percentages such as 1%, 2%, 3%, 4% and 5% by weight of cementitious material. The tests that he performed were Strength tests and the results were compared with conventional self-compacting concrete. The corrosion resistance performance tests that were performed was impressed voltage method, rapid chloride permeability test and gravimetric weight loss method.

Anil Kumar H. S (2016), concluded that Compressive strength among all the specimens that were made in this experiment was better in steel fibre concentration of 1% and 1.5% as compared to 0%. The ultrasonic pulse velocity values that were obtained in the research was less at 400 °C compared to 600°C and 800°C in one-hour duration. He also concluded that the effect of weight loss reinforced self-compacting concrete having steel fibre is found very less at 1% of fibre content at 400°C in one-hour duration. He concluded that the loss of weight variation is marginal as compare with self-compacting concrete with 0% steel fibre. For the Experiment he performed various non-destructive tests such as rebound hammer and ultrasonic pulse velocity. The elevated temperature effects that were recorded on weight loss, rebound number and ultrasonic pulse velocity for self-compacting concrete reinforced having steel fibres of aspect ratio 50 at 0 to 1.5% at an interval of 0.5% in volume fraction. The temperature was 4000°C, 6000°C and 8000°C for one-hour duration during the research work.

Dr. M. Devi (2012), concluded that on replacing sand by quarry dust increases the strength of the concrete and on addition of inhibitor it offers very good resistance against chemical attack it also increases corrosion resistance. He concluded that addition replacement of sand by quarry dust improved overall properties of concrete. He used percentages such as 1%, 2%, 3% and 4% of Triethylamine and on replacing quarry dust with 2% addition of inhibitor shows maximum improvement in the compressive strength and split tensile strength also in flexural strength when compared to the control specimen. He also concluded that Bond strength also increases when compared to control specimens. He concluded that on adding corrosion inhibitor permeability & water absorption properties were reduced. He concluded that on adding organic inhibitors to quarry dust replaced concrete offered very good resistance against chemical attack and also increases corrosion resistance and this takes place when it forms a thin oxide layer to prevent outside agents and shields the anodic sites. For the experimental study he investigated the use of quarry dust as fine aggregate in concrete along with an organic inhibitor named Triethylamine. He used different percentages of inhibitors such as 1%, 2%, 3% and 4% by weight of cement. He performed many tests such as Strength tests, water absorption test and the durability tests and on obtaining results they are compared with the natural sand concrete. For corrosion resistance he evaluated on the basis of the performance of the concrete. For the penetration of chloride ions results were obtained by impressed voltage method and weight loss measurement.

Mohammad Ismail (2011), concluded that Bambusa Arundinacea used as a inhibitor showed better compressive strength compared to calcium nitrite and ethanolamine. He concluded that Bambusa Arundinacea can be considered a better for substituting nitrite and amine- based corrosion inhibiting admixtures because of its geometric pore blocking effects. For the Experiment he used Green plant extracts inhibitor Bambusa Arundinacea and compares its effectiveness with calcium nitrite and ethanolamine inhibitors. He prepared Concrete mix that was designed to 30MPa with 0.45 W/C ratio and he performed the tests at 7, 28 and 90 days. He also added 1.5% and 4.5% weight of cement content of chloride and sulphate for an analytical grade of magnesium chloride and magnesium sulphate. He also concluded that most stability were obtained on 2% and 4% dosage of inhibitors.

L. Arun Raja (2010), concluded that the compressive strength and split tensile strength shows better results on using fibres in various percentages. He also concluded that the results of Non -destructive tests also improves on using fibres in different percentages. He observed that compressive strength and tensile strength and increases up to 0.25% and on addition above 0.25% of fibre it was very difficult to attain attaining workability. He also observed that non-destructive test on self-compacting concrete mixes having 0.25% of fiber and 1% dosage of super plasticizer melamine increases the tensile strength in concrete. The workability was assessed using various according to the specification of EFNARC code on self-compacted concrete such as slump flow, L- box differential height and V-funnel tests. He found that all the mixes that were made in the course of research work of self-compacting concrete obtained the designed characteristic strength of M30.

Sanjay Kumar Sharma (2009), Concluded that on different concentrations of the AZI extract inhibit zinc corrosion and that inhibition efficiency of the extract usually varies with concentration and temperature. He concluded that AZI leaves extract can be used as an inhibitor for zinc corrosion in H2SO4 medium. He also concluded that the green inhibitor molecule acts by being adsorbed on zinc surface and the overall inhibition is provided by a synergistic effect. He also concluded that the inhibitive action of AZI leaves extract is controlled by temperature and the concentration of the inhibitor that were being used during the course of the research work. He performed gravimetric method to study corrosion inhibition of Neem leaves extract as a green inhibitor.

Shiyuan Qian et al (2008), studied effects of commercially available corrosion-inhibiting systems that were being used in concrete structures that are usually exposed to corrosive environments were evaluated on the electrochemical cells. The results of this study are presented in two companion papers that showed reports on a five-year field evaluation laboratory investigation. He used different concentrations of the corrosion-inhibiting admixtures used in the electrolytes such as 1.1%, 35%, 4.2%, 1.2%, and 7.8% for admixtures B, C, E, F, H. For the electrochemical values included half-cell potential, linear polarization and AC impedance and these tests were carried out using a computer-controlled electrochemical interface which was coupled with a frequency response analyser. He concluded that there was increase in chloride threshold and reduction in corrosion rate of the reinforcing bars when compared to the control coating with coatings A, D, and G and also it provided good performance in the saturated $CaOH_2$ solution.

A.N. Lashari et al (2003), used four types of corrosion inhibitors such as calcium nitrite of two dosages, calcium nitrate of three dosages and two organic inhibitors and were evaluated at five different contamination such as 0.8% chloride, 0.8% chloride and 1.5% SO3 seawater, brackish water and unwashed aggregates. For this experiment he prepared plain and reinforced concrete cylindrical specimens, having dimensions of 75 mm in diameter and 150 mm high using ASTM C 150 Type V Portland cement. After all the tests and results that he obtained he concluded that the compressive strength of the concrete specimens having all the inhibitors that were studied in the particular experiment was more than that of the control specimens.

III. **CONCLUSION**

The following conclusions can be drawn such as the organic inhibitors shows better efficiency as compared to the inorganic inhibitors as well as inhibitors additions shows no harmful effects to the compressive strength up to certain percentage. We can also conclude that self-compacting concrete having fly ash can be effectively used in construction industry with appropriate dose of super plasticizer-controlled mixing taking care of environmental pollution. Also, we can conclude that on addition of super plasticizer there is reduction in the water content without decreasing the workability. At 3% inhibitor dose of sodium nitrite it was observed that maximum improvement in the compressive and split tensile results as compared to the reference specimen without addition of inhibitor. It was also observed that the over dose of corrosion inhibitor accelerates the setting time which reduces the ultimate strength of concrete. It was observed that on adding inhibitors as admixture in self-compacting concrete shows lower permeability.
The compressive strength observed was better in steel fiber concentration of 1% and 1.5% as compared to 0%. We can also say that it is possible to manufacture self-compacting concrete using mineral admixtures and use of granulated slag shows improvement in the flow properties of self-compacting concrete. It was observed that on addition of corrosion inhibitor water absorption properties were reduced and on addition of the organic inhibitors with quarry dust replaced concrete shows increases in corrosion resistance properties by forming thin oxide layer and shielding of the anodic sites.

REFERENCES

[1] Boukhelkhal Djamila (2018). "Use of Non-destructive test to estimate the self-compacting concrete compressive strength." March 2018.
[2] J. Abdul Bari (2017). "An investigation on effects of Cement Concrete with an addition of Corrosion Inhibitors." International journal of Engineering Technology Science and Research, Volume 4, Issue 1, January 2017.
[3] R. Dharmaraj, R. Malathy (2016). "Mechanical and corrosion properties of Reinforcing steel for self-compacting concrete." International journal of Technology and Engineering System, Volume 8, March 2016.
[4] Anil Kumar H.S, V.D. Gundakalle (2016). "Destructive and Non-Destructive test on steel fiber reinforced self-compacting concrete exposed to elevated temperature." International Research Journal of engineering and Technology, Volume 3, Issue 9, September 2011.
[5] Abdulrahman, A.S. Mohammad Ismail (2011). "Ecofriendly green inhibitor to improve the strength of concrete contaminated by chloride and sulphate." International journal of Recent Research and Applied Studies, Volume 9, Issue 3, December 2011.
[6] L Arun Raja (2010). "Non-Destructive test on Fiber Reinforced Self-Compacting Concrete." International journal of Recent Research and Applied Studies, December 2010.
[7] Dr, M Devi (2012). "Effect of corrosion inhibitor on the strength and durability Properties of quarry Dust Concrete." International Conference on Advances in Civil Engineering, December 2012.
[8] Sanjay Kumar Sharma (2009). "Corrosion Inhibition of Neem leaves extract as a green inhibitor for Zinc." Green Chemistry Letters and Reviews, Volume 2, September 2009.

[9] Shiyuan Qian et al (2008). "Corrosion Inhibiting system for durable concrete bridges." (2008) ASCE, Vol 20, PP:29-36.
[10] A. N. Lashari et al (2003). "Effectiveness of Corrosion Inhibitors in the contaminated concrete." Volume 25, PP:439-449.