ASSESSMENT OF INHIBITING EFFICIENCY OF ORGANIC AND INORGANIC CORROSION INHIBITORS IN CONCRETE

Dr N V N PRABATH[1], A SAITEJA[2], G MADHULATHA[3], E DEEPIKA[4], A ALEKHYA[5]
[1]*Associate Professor, Department of Civil Engineering, AnuBose Institute of TechnologyFor Women's, KSP Road, New Paloncha, Bhadradri Kothagudem District, Telangana (TS), 507115*
[2,3,4,5]*Assistant Professor, Department of Civil Engineering, AnuBose Institute of TechnologyFor Women's, KSP Road, New Paloncha, Bhadradri Kothagudem District, Telangana (TS), 507115*

Submitted: 10-10-2024 Accepted: 18-11-2024 Published: 25-11-2024

Abstract In the current study, the M25 grade concrete mixes are admixed with various locally available organic and non-organic corrosion inhibitors such as Calcium Nitrite, Sodium Nitrite, Hexamine and Di-ethanolamine to understand the influence of these organic and non-organic corrosion inhibitors on the strength and corrosion resistance properties of concrete. The percentage dosage of admixed inhibitors vary from 1 to 5% by the weight of cement. For M25 grade concrete the optimum percentages of corrosion inhibitor admixture was found to be 4% for Calcium Nitrite, 3% for Sodium Nitrite, 2% for Hexamine and 3% for Di-ethanolamine. Calcium Nitrite corrosion inhibitor admixture imparts increased compressive, split- tensile and flexural strength than other corrosion inhibitors at 28 days.

All the corrosion inhibitors used in the study have enhanced the compressive strength, split tensile strength, and flexural strength of concrete. The initial gain of early strength decreased due to anodic process of inhibitors. Measured electrical resistivity and half-cell potential values of all corrosion inhibitors admixed M25 grade concrete mixes directs that calcium nitrate and Di-ethanolamine have shown high electrical resistance indicating their superior corrosion inhibition ability than sodium nitrite and hexamine. Accelerated corrosion test on reinforced concrete beams admixed with corrosion inhibitors confirmed that possible inception of corrosion in calcium nitrate admixed reinforced concrete beams is very low when compared to other corrosion inhibitors used for the study.

1. INTRODUCTION

In particular, because of its relatively low cost, flexibility and adaptability, the chosen and commonly used building materials. The key limit, also of excellent quality, of concrete is that it enters and induces the corrosion of reinforcements bars through microscopic cracks, holes and capillary pores through which chlorides, co_2, humidity etc (rebars). Recent experience shows that reinforced concrete structures (RC) do not withstand the hostile climate adequately. Rebar corrosion is a significant cause of damage to the structures of the RC.

Corrosion is "the chemical or electrochemical reaction between usually a metal, and its environment that produces a deterioration of the metal and its properties." Corrosion contributes to the development of rust for steel embedded in concrete, which has an amount two to fourfold and no strong mechanical properties. Corrosion also creates pits or troughs inside the reinforced steel surface which reduces strength as a result of reduced sectional area. This reduces strength. In order to have the properties required for structural concrete, reinforced concrete is used with steel. It prevents the failure of concrete structures subject to traffic, wind, dead loads and thermal cycles, which cause tensile and flexural stresses. However, the formation of rust leads to a weakening of the link between steel and concrete and eventual delamination and spilling as reinforcement corrodes.

The credibility of the system is often affected when left unchecked. Decreased steel's strength within the intersectional range.

2. LITERATURE REVIEW

Arpit Goyal1[1],HomayoonSadeghi Pouya[2] , Eshmaiel Ganjian[3] , Peter Claisse[4](2018): it explores the process and thermodynamic and kinetic behavior of ferroconcrete corrosion. It also introduces and compares various corrosional prevention strategies, including the use of corrosion inhibitors, alternative insulation, coating steel and concrete and electrochemical techniques, available, and recommended by BS 1504-9:2008. It has been concluded that electrochemical methods are more effective than traditional ones.

R. Dharmaraj and R. Malathy(2015): The paper introduces sodium nitrate as a corrosion inhumanizing admixture for self-compacting cement, the strength and corrosion resistant properties of 0%, 1%, 3%, 4% and 5%, by the weight of cement were examined. The findings show that self-compacting concrete increases the strength of the concrete with an inhibitor accretion (sodium nitrite). In the end, the compressive strength of cubes at 3 percent of nitrite was 8.8 percent higher than with the regular self-compacting concrete mix.

T. A. Ostnor and H.Justnes(2015): The experiments demonstrated that the capacity of half cells was more negative than visual inspections by using anodic inhibitors. It is determined that the 3–4% cement-weight inhibitor dose seems enough to protect the bar against corrosion. The effects of corrosion inhibitors on concrete porosity have been demonstrated by capillary absorption studies. The chloride, nitrite and nitrate concentration profiles for leaching have been investigated. However, due to potential chemical change, it was difficult to seek the noise level of nitrite.

3. MATERIALS USED IN USED IN THE STUDY

Cement

53 grade OPC [IS: 12269-1987, OPC Grade]. They are collected from a single source and stored during the investigation and are vigilant to ensure that the cement of the same standard and business is used.

Fig 1: Cement

Fine aggregates

Sand helps in filling the voids created in between CA in concrete. Fine Aggregate as River sand is used for this Experimental work and its properties like fineness modulus, Specific gravity and Bulk density are tested as per IS: 2386(Part3)-1963.

ISSN: 3049-0952
www.jsetms.com

Fig 2: Fine aggregate

Coarse aggregates

The Coarse aggregates selected for the investigation are 10mm. These 10mm aggregates can easily pass through the small openings mainly used for congested reinforced areas. These aggregate are collected from the locally available crusher.

Fig 3: Coarse aggregates

Proportions of mix

The materials used to manufacture the M25 grade concrete mix for present study are detailed in this section. Ordinary cement of Portland 53 grades in accordance with IS: 8112-1989, and physical testing in accordance with IS: 4031 were carried out. A fine aggregate with its properties that comply with IS 383-1970 shall be clean locally accessible Zone II river sand. Well-qualified granite aggregates with a maximum size of 20 mm and 12 mm are available locally and are used as rough aggregates. In the current study the effect of the corrosion inhibitors is reduced by the use of no chemical admixtures in the form of super-plastizers.

Concrete grade M25 was chosen to test the effect on concrete properties of the corrosion inhibitors. The proportions of the mix were determined using the BIS design process. The requisite materials are per 1m3 of concrete.

Table 1: materials required for 1m3 of concrete.

Concrete Grade	C	FA	CA	W
M25	390.12 kg	917.08 kg	703.28 kg	224.47 liters

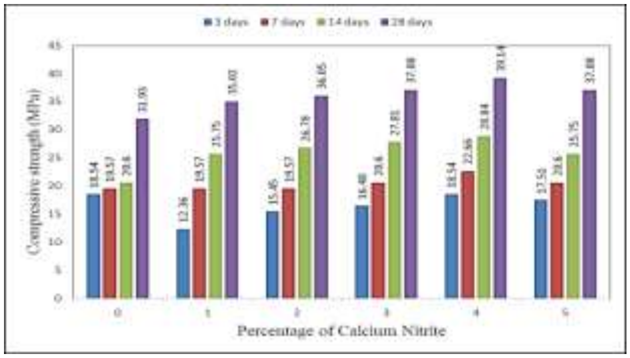
Tests to be conducted on the concrete

1. Compressive strength
2. Split tensile strength
3. Flexural strength
4. Electric resistivity

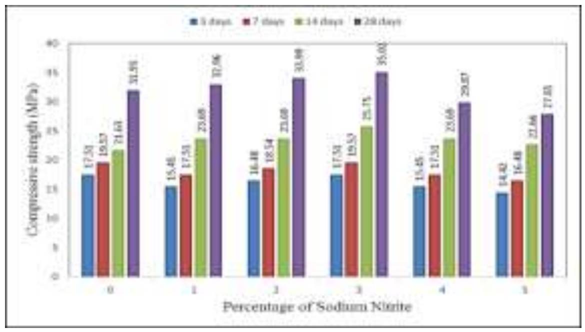
4. RESULTS AND ANALYSIS

ISSN: 3049-0952
www.jsetms.com

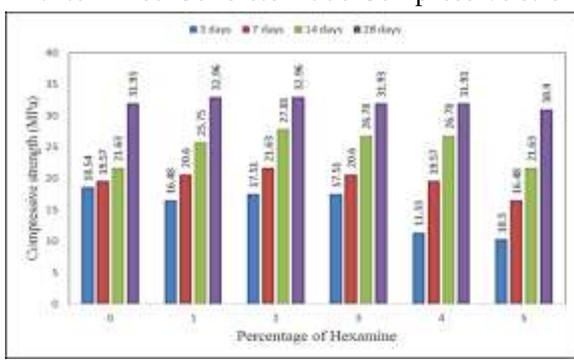
Compressive strength



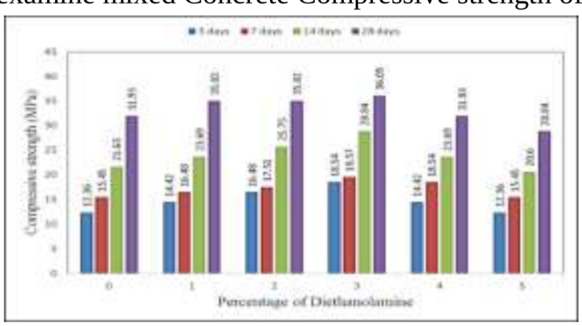
Graph 1: Calcium nitrite mixed concrete compressive strength of M25 grade



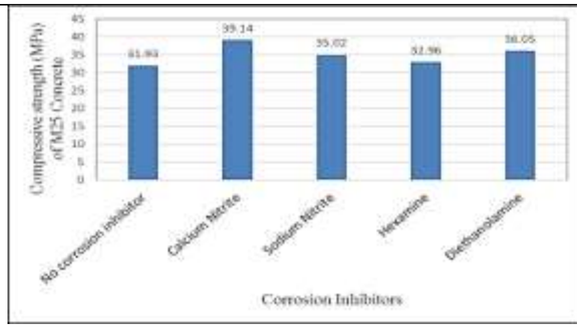
Graph 2: Sodium nitrite mixed Concrete made Compressive strength of M25 grade



Graph 3: Hexamine mixed Concrete Compressive strength of M25 grade

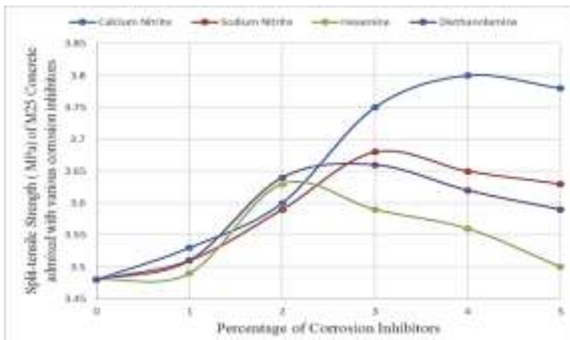


Graph 4: Di-ethanolamine mixed M25 Concrete Compressive strength



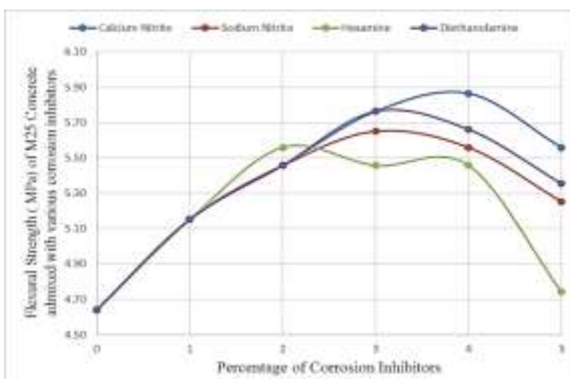
Graph 5: Compressive strength variation of M25 concrete admixed in 28 days with different corrosion inhibitors

Split Tensile Strength



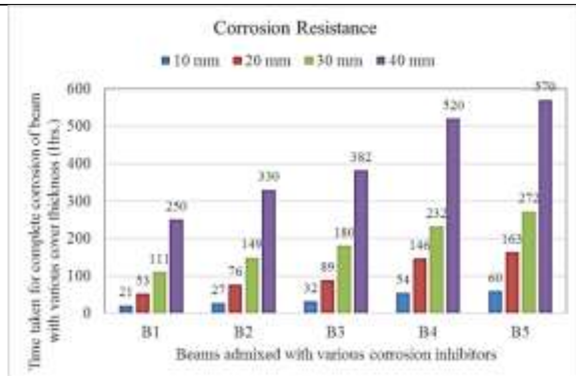
Graph 6:M25 concrete mixes with different corrosion inhibitors at 28 days, combination of split-tensile strength (MPa)

Flexural Strength



Graph 7: Flexural strength of M25 mixes with different inhibitors of corrosion for 28 days

Studies of corrosion inhibition



Graph 8: Time to develop the maximum break along the beam length

5. CONCLUSIONS

The present research work 4 corrosion inhibitor admixes were mixed in M25 concrete and examined for their effect on the electricity and corrosion causing properties of concrete with calcium nitrite, sodium nitrite, hexamine, and diethanolamine. The following conclusions can be taken from the experimental findings.Best dosage of corrosion inhibitor admixture will beautify the integrity and uniformity of concrete.

1. Percentages for M25 has been estimated to be 4% for calcium nitrite, 3% for nitrite of sodium, 2% for hexamine and 3% for diethanolamine.
2. Calcium Nitrite corrosion inhibitor admixture imparts extended compressive, split- tensile and flexural strength improved by calcium nitriteat 28 days.
3. Calcium nitrate and Di-ethanolamine shows electric resistivity values than sodium nitrite and hexamine.
4. Almost all the optimally admixed corrosion inhibitors used for the observe exhibited very less probability (less than 5% possibility) for corrosion at 28 days. All the optimally admixed corrosion inhibitors in concrete displayed very low potentials virtually supplying the passivity of rebars due to corrosion inhibitors.
5. The accelerated corrosion testshows,calcium nitrite takes more time for generation of full crack than followed byDi-ethanolamine, Sodium nitrite and Hexamine.
6. calcium nitrate admixedconcrete beams has less charge deterioration elements.Followed by Di-ethanolamine, Sodium nitrite and Hexamine. So the probability of occurrence of corrosion is less compare to other corrosion inhibitors.

REFERENCES

[1]. Diagnosis and Assessment of Concrete Structures— State of the Art Report; CEB Bulletin d'information N. 192; International Federation for Structural Concrete (FIB): Lausanne, Switzerland, January 1989.

[2]. R Polder, C Andrade, B Elsener, J Gulikers, R Weidert, M Raupach, 'Recommendations of RILEM TC 154–EMC: Electrochemical techniques for measuring metallic corrosion. Test method for on-site measurement of resistivity of concrete. Mater. Struct. 2003, 36, 461–471.

[3]. Sateesh, N., Sampath Rao, P., Ravishanker, D.V., Satyanarayana, K (2015). 'Effect of Moisture on GFRP Composite Materials (2015) Materials Today: Proceedings, 2 (4-5), pp. 2902-2908.

[4]. V Srinivasa Reddy, M V Seshagiri Rao, S Shrihari," Appraisal of Processing Techniques for Recycled Aggregates in Concrete", International Journal of Engineering and Advanced Technology (IJEAT)

ISSN: 2249 – 8958, Volume-8 Issue-6, August 2019, Retrieval Number F8407088619/2019©BEIESP, DOI: 10.35940/ijeat.F8407.088619, pp.1661-1665

[5]. Devi, G.N., Saranya, J., Manjubaashini, N., Thangadurai, T.D., Roopan, S.M., Chitra, S (2017), 'Polyamidoaminoepichlorohydrin resin a novel synthetic anti-corrosive water soluble polymer for mild steel' , Progress in Organic Coatings, 109, pp. 117-125.

[6]. M Finsgar, J Jackson (2014), 'Application of corrosion inhibitors for steels in acidic media for the oil and gas industry: a review', Corrosion Science, vol. 86, pp. 17- 41.

[7]. M Hayyan, SA Sameh, A Hayyan, IM AlNashef (2012), 'Utilizing of sodium nitrite as inhibitor for protection of carbon steel in salt solution', International Journal of Electrochemical Science, vol. 7, no. 8, pp. 6941-6950.

[8]. Torres-Acosta, Martınez (2012), 'State of the Art on Cactus Additions in Alkaline Media as Corrosion Inhibitors' ,Hindawi Publishing Corporation ,international Journal of Corrosion, vol. 2, pp. 641- 650

[9]. Tummala Suresh Kumar, Kosaraju Satyanarayana, Materials Today: Proceeding, 26 (2), 3228-3233, (2020)