Performance of MCI 2005, MCI 2007 and DCI in Concrete Prepared using Water Containing Chlorides

Background: The supply of fresh water is limited in some areas and concrete is produced with water containing chlorides. It is known, that presence of chlorides in concrete causes corrosion of embedded metal reinforcement. To prevent this, corrosion inhibitors should be added to the concrete mix.

Purpose: To evaluate the performance of MCI 2005, MCI 2007 and DCI in concrete prepared using water containing chlorides.

Method: Electrochemical Impedance Spectroscopy (EIS)

Materials: MCI 2005

MCI 2007

DCI, manufactured by 'Grace Construction Products'

Concrete sample preparation kit ('Quick Set' - sand and Portland cement mortar mix; steel rebars, 'Hobart' mixer)

Artificial 'sea water', prepared from the synthetic sea salt, manufactured by 'Aquarium Systems'.

Electrochemistry Impedance Spectroscopy test kit (Potentiostate 'Fermostat' with

EIS 900 software, manufactured by 'Gamry Instruments Inc.', Calomel Saturated reference and High Density Graphite Counter Electrodes

Procedure: The samples for Electrochemical Impedance Spectroscopy were prepared according to standard procedure.

Rebars were cleaned with a wire brush and rinsed with methanol.

The following mix designs were used:

- 2 kg mortar + 224.3 gr. sea water (CONTROL)

- 2 kg mortar + 224.3 gr. sea water + 0.61 gr. MCI 2005 (MCI 2005)

- 2 kg mortar + 157.0 gr. sea water + 1.90 gr. MCI 2007 (MCI 2007)

- 2 kg mortar +216.3 ml sea water + 25.0 g DCI (DCI)

This mix design correspond to the dosages:

- MCI 2005 -0.6 l/m^3 (1 $pint/yd^3$)
- MCI 2007 - 2.0 l/m^3 (3 $pints/yd^3$)
- DCI - 25l/m^3.

Mortar were mixed for 3 min., and then molded in a 400ml plastic beaker with a rebar embedded in the center. After curing for 28 days in plastic bags samples were kept for 1 year at ambient conditions

Results:

Material	**Rp, polarization resistance, Ohm x 10^6**	**I cor, corrosion current, nA/cm^2 x 10^{-3}***	**Corrosion rate, nky/mpy x 10^{-3}***	**Protective power, Z, % ****
MCI 2007	27.8	0.15	5.8/0.23	95.5
MCI 2005	6.4	0.67	25.9/1.03	79.9
DCI	4.7	0.92	10.7/0.42	72.4
'Control' (no corrosion inhibitor in mix design)	1.3	3.33	38.6/1.52	-

*Calculations were carried out using formulas:

Icorr.=26mV/(Rp x Surface area);

1nA/cm^2=11.6nm/year

**Z=100%x(Icorr.Cont. -Icorr.MCI)/Icorr.Cont.

Conclusion:

1. MCI-2005, and especially MCI-2007 work better than DCI to reduce reinforcement corrosion in concrete made with water containing chlorides.
2. MCI 2007 and MCI 2005 added to the mix design at a dosage rate of 0.6l/m^3 and 2.0l/m^3 respectively provide better corrosion protection to the rebars in concrete made with water containing chlorides than DCI added at a dosage of 25l/m^3.
3. The significant water reduction MCI-2007 allows is what enabled its additional corrosion protection to the embedded reinforcement, i.e. less water, so less chloride contamination.

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SODIUM NITRITE, 5.1, UN1500, PGIII, OXIDIZER/TOXIC **98%-120 MESH** Lot No: **NANI-03-171** **RQ: 100(45.4)** Net Wt. **50 LBS.**	

CAS#: 7632-00-0 RTECS#: RA 1225000
FW: 69.00 MERK INDEX: 9,8407

Emergency Contact: CHEMTREC:1-800-424-9300
CHEMTREC INTERNATIONAL: (703) 527-3887

HEALTH HAZARADS & FIRST AID:
MATERIAL IS DANGEROUS IF INHALED! IMMEDIATELY FLUSH EYES OR SKIN WITH COPIOUS AMOUNT OF WATER, FOR AT LEAST 15 MINUTES IN CASE OF CONTACT EXPOSURE. MATERIAL IS IRRITATING TO THE MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT. EXPOSURE SYMPTOMS MAY INCLUDE - BURNING SENSATION, COUGHING, WHEEZING, SHORTNESS OF BREATH, HEADACHES, LARYNGITIS, NAUSEA AND VOMITING, DIURESIS, ANEMIA, METHEMOGLOBINEMIA, NEPHRITIS, GASTROENTERITIS AND VASODILATION. IF MATERIAL HAS BEEN INHALED, REMOVE SUBJECT TO FRESH AIR. IF SUBJECT IS NOT BREATHING GIVE ARTIFICIAL RESPIRATION - PREFERABLY MOUTH-TO-MOUTH. IF BREATHING IS DIFFICULT OXYGEN SHOULD BE SUPPLIED. CONTAMINATED CLOTHING SHOULD BE REMOVED AND THOROUGHLY CLEANED BEFORE REUSE. CALL A PHYSICIAN! WASH THOROUGHLY AFTER HANDLING.

INCOMPATIBILITIES: ACIDS, ACID ANHYDRIDES, FUELS, (REDUCING AGENTS). EXPLOSIVE MIXTURES MAY RESULT FROM IMPROPER HANDLING!

PRODUCTS OF DECOMPOSITION: OXIDES OF SODIUM AND NITROGEN.

HANDLING & STORAGE: APPROPRIATE OSHA/MSHA APPROVED RESPIRATOR, CHEMICALLY RESISTANT GLOVES, CHEMICAL GOGGLES AND OTHER APPROPRIATE PROTECTIVE CLOTHING (RUBBER APRON OR OVERWEAR)SHOULD BE WORN. MECHANICAL EXHAUST IS REQUIRED. AVOID CONTACT WITH EYES, SKIN AND CLOTHING. DO NOT BREATHE DUST. AVOID PROLONGED AND REPEATED EXPOSURE. HYGROSCOPIC. KEEP CONTAINERS SEALED. STORE IN COOL DRY PLACE. OBSERVE PROPER PERSONAL HYGIENE. SAFETY SHOWER SHOULD BE AVAILABLE. THE PREFERRED FIRE EXTINGUISHING MEDIA IS WATER, DRY CHEMICAL POWDER, CARBON DIOXIDE OR POLYMER FOAM. MATERIAL IS NONCOMBUSTIBLE. PROTECTADJACENT AREA!

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