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IMPROVEMENTS IN OR RELATING TO CORROSION PREVENTION IN REINFORCED CONCRETE AND BRICK-WORK CONSTRUCTIONS.

PROVISIONAL SPECIFICATION.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Rafi Marg, New Delhi-1, India, an Indian registered body incorporated under the Registration of Societies Act (Act XXI of 1860).

The following specification describes the nature of this invention.

This is an invention by KUMMATTITHIDAL SANTHANAM RAJAGOPALAN, Scientist, CENTRAL ELECTRO-CHEMICAL RESEARCH INSTITUTE, Karaikudi-3 (Madras State), NERUR SANKARANARAYANA RENGASWAMY, Senior Scientific Assistant, CENTRAL ELECTROCHEMICAL RESEARCH INSTITUTE, Karaikudi-3 (Madras State) and THIRUPATHISARAM MUTHUKRISHNA BALASUBRAMANYAN, Senior Scientific Assistant, CENTRAL ELECTROCHEMICAL RESEARCH INSTITUTE, Karaikudi-3 (Madras State).

This invention relates to improvements in or relating to corrosion prevention in reinforced concrete and brick work constructions.

Hitherto it has been proposed that : (a) Materials such as sodium and potassium silicates, sodium, potassium and ammonium soaps, vegetable oils and resins make concrete less permeable to water thereby preventing reinforcement corrosion ;

(b) Inorganic coatings, coatings of drying oils and resins on reinforcement protect it from corrosion ;

(c) Coatings of cement slurry to which corrosion inhibitors are added prevent reinforcement corrosion ; and

(d) Addition of sodium nitrite to concrete mix inhibits corrosion.

These are open to the objection that :

(a) Substances added to render concrete impermeable are not completely effective since very small amounts of water vapour and air are only required to cause reinforcement corrosion ;

(b) Coatings on reinforcement interfere with the bonding of steel to concrete ; and

(c) Any one corrosion inhibitor like sodium nitrite or sodium chromate cannot be dependent upon to prevent reinforcement corrosion under the variable conditions that can be obtained in concrete constructions.

The invention broadly consists in the development of an inhibitive mixture to be added to the water used for laying concrete which ensures protection of reinforcement from corrosion under a wide variety of conditions that are met with in concrete constructions. Reinforcement corrosion takes place when corrosive salts such as the chlorides and sulphates increase and sufficient alkalinity is not obtained within the concrete. The inhibitive mixture has been so developed that the required alkalinity as well as sufficient concentration of inhibitive ions are always obtained. Examples of effective inhibitor systems are :

Sodium carbonate+Sodium nitrite
Trisodium phosphate+Sodium nitrite
Sodium hydroxide+Sodium nitrite
Sodium silicate+Sodium nitrite
Sodium hydroxide+Sodium silicate
Sodium carbonate+Ammonium stearate
Sodium carbonate+Sodium nitrite+Trisodium phosphate.

TABLE

Performance of the Inhibitor Systems developed

Description of test	System	Visual observation
Polished mild steel is centrally embedded in 1 :2 :4 concrete. After seven days curing in distilled water, concrete specimen is broken and steel specimen visually observed for rust spots (0.25% NaCl by weight of cement is added through mixing water to the concrete during preparation of specimens)	No inhibitor	10 rust spots
	Only sodium carbonate	4 big rust spots
	Only trisodium phosphate	3 to 4 big rust spots
	Only sodium hydroxide	5 rust spots
	Mixture I	Good
	Mixture II	Good
	Mixture III	Good

Good : Completely free from rust spots, pits etc.

TABLE

Cost of Treatment by the Inhibitor Mix

	Cost by weight of cement
1. Proprietory additives to the concrete mix	25-50%
2. Inhibitor system developed	Less than 20%

The following are among the main advantages of the invention :

1. It is easy to incorporate the inhibitive mixture in building constructions ;
2. It does not interfere with the bonding of steel to concrete ;
3. The chemicals to be used are available indigenously ;
4. The treatment cost is less than 20% unlike several proprietory additives which cost around 50%.

R. BHASKAR PAI,
Patents Officer,
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

Dated this 15th day of March 1967.

COMPLETE SPECIFICATION.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Rafi Marg, New Delhi-1, India, an Indian registered body incorporated under the Registration of Societies Act (Act XXI of 1860).

The following specification particularly describes and ascertains the nature of this invention and the manner in which it is to be performed.

This is an invention by KUMMATTITHIDAL SANTHANAM RAJAGOPALAN, Scientist, NERUR SANKARA-NARAYANA RENGASWAMY, Senior Scientific Assistant, and THIRUPATHISARAM MUTHUKRISHNA BALA-SUBRAMANYAN, Senior Scientific Assistant, all of the CENTRAL ELECTROCHEMICAL RESEARCH INSTITUTE, Karaikudi-3, India, all Indian citizens.

The annotated title of the invention :
This invention relates to prevention of corrosion of mild steel reinforcement in reinforced concrete and brickwork constructions.

Price : TWO RUPEES.

Prior knowledge :

Hitherto it has been proposed that—

(a) materials such as sodium and potassium silicates, sodium, potassium and ammonium soaps, vegetable oils and resins make concrete less permeable to water thereby preventing reinforcement corrosion ;

(b) Inorganic coatings, coatings of drying oils and resins on reinforcement protect it from corrosion ;

(c) Coatings of cement slurry to which corrosion inhibitors are added to prevent reinforcement corrosion.

Drawbacks connected with hitherto known processes :

These are open to the objections that—

(a) Substances added to render concrete impermeable are not completely effective since very small amounts of water vapour and air are only required to cause reinforcement corrosion ;

(b) Coatings on reinforcement may interfere with the bonding of steel to concrete.

The main object of the invention :

The object of invention is to prevent iron or steel reinforcement corrosion in reinforced concrete and reinforced brickwork constructions by introduing along with water used for mixing concrete, an inhibitive mixture which would prevent corrosion.

The main finding :

By the addition of the inhibitive mixture to the water used for mixing concrete, steel embedded in cement concrete or mortar does not corrode at the concentrations of chloride and sulphate normally present in cement concrete or mortar.

The new result flowing from the new finding :

The likelihood of reinforcement corrosion taking place because of the presence of more than average amounts of chloride and sulphate in concrete will be prevented.

Statement of invention :

According to the present invention, the composition which on addition to water used in mixing of concrete can inhibit corrosion of steel reinforcements embedded in concrete constructions consists of a mixture of sodium hydroxide and sodium nitrite or a mixture of sodium carbonate and sodium nitrite or a mixture of tri-sodium phosphate and sodium nitrite in the ratio of alkaline ingredient, namely sodium hydroxide, sodium carbonate, tri-sodium phophate to the passivating ingredient, namely, sodium nitrite in the range of 0.25 to 1 to 0.25 to 2, 0.25 to 2 being the preferred ratio.

The process for obtaining the composition consists in dissolving the two types of ingredients in water to obtain a liquid concentrate.

As stated, the alkaline ingredient to passivating inhibitor ingredient ratio is 0.25 :1 to 0.25 :2 respectively. The ingredients are dissolved in the specified proportion range with water to make a liquid concentrate.

Thus, 5 grams of the alkaline ingredient and 20 grams of the passivating type inhibitor are dissolved in 50 ccs. of water.

The composition may be added in the ratio of 50 ccs. of composition (liquid concentrate) to 1 kg. of cement during mixing of concrete in the case of concrete exposed to rural and urban conditions and 100 ccs. of composition (liquid concentrate) to 1 kg. of cement during mixing of concrete to be exposed to marine and industrial conditions.

The inhibitor systems are :

Sodium carbonate+Sodium nitrite
Trisodium phosphate+Sodium nitrite
Sodium hydroxide+Sodium nitrite
Sodium silicate+Sodium nitrite
Sodium hydroxide+Sodium silicate
Sodium carbonate+Ammonium stearate
Sodium carbonate+Sodium nitrite+Trisodium phosphate.

EXAMPLE 1

One gram of inhibitor mixture (equal quantities of sodium carbonate and sodium nitrite) is dissolved in 35 cc. of distilled water. 50 gm., of portland cement is taken and corresponding quantities of sand and jelly are also taken and a 1 :2 :4 concrete mix is thus prepared using the inhibited water for mixing. 0.5 gm. of sodium chloride is also introduced to the mixing solution, during preparation of concrete. A 2.8 cm. ×2.8 cm. size polished cylindrical mild steel specimen is centrally embedded in the above concrete and a cylindrical concrete specimen of 5 cm.×5 cm. size is thus made. The concrete specimen is immersed in distilled water and at the end of 7 days, specimen removed, broken and the steel specimen is visually observed for rust spots. The observation is as given below :

S. No.	System	Visual observation
1.	Control system containing only NaCl and not inhibitor	5 to 10 rust spots
2	New inhibitor system + NaCl	no rust spots

EXAMPLE 2

One gram of inhibitor mixture (equal quantities of sodium hydroxide and sodium nitrite) is dissolved in 35 cc. of distilled water. 50 gm., of portland cement is taken and corresponding quantities of sand and jelly are also taken and a 1:2:4 concrete mix is thus prepared using the inhibited water for mixing. A 2.8 cm.×2.8 cm. size polished cylindrical mild steel specimen is centrally embedded in the above concrete and a cylindrical concrete specimen of 5 cm.×5 cm. size is thus made. The concrete specimen is immersed in synthetic sea water and at the end of 30 days, specimen removed, broken and the steel specimen is visually observed for rust spots. The observation is as given below :

S. No.	System	Visual observation
1.	Control system without inhibitive mixture	Innumerable rust spots
2.	New inhibitor system	no rust spots

EXAMPLE 3

5 cm.×5 cm. size concrete specimen is prepared similar to that explained in Example 2 and the specimen is exposed in salt fog chamber and at the end of 500 hours exposure, specimen removed, broken and the steel specimen is visually observed for rust spots. The observation is as given below :

S. No.	System	Visual observation
1.	Control system without inhibitive mixture	4 to 5 big rust spots
2.	New inhibitor system	no rust spots

Main advantages :

(a) It is easy to incorporate the inhibitor mixture in building constructions.

(b) It does not interfere with the bonding of steel to concrete.

(c) The chemicals to be used are available indigenously.

(d) The treatmtnt cost is less than 20% unlike several proprietory additives which cost around 50% of the cost of cement.

Summary :

In the case of several instances of premature failure of roofings of RCC and RCBW constructions, it has been noticed

that the reinforcement in these roofings have undergone extensive corrosion. It has also been noticed that concrete and mortar surrounding the reinforcement has appreciable amounts of chloride and sulphate. The inhibitive mixture developed can prevent corrosion of reinforcement in the presence of the maximum amount of chlorides and sulphates that can be naturally present in RCC and RCBW constructions.

Noteworthy features :

(a) An inhibitive mixture consisting of a constituent which helps in maintaining a high PH and a passivating or adsorption inhibitor which when added to water used for laying concrete ensures protection from corrosion of iron and steel reinforcements in RCC and RCBW constructions.

(b) The inhibitive mixture is introduced by adding to the water used for mixing concrete.

(c) The inhibitive mixture can be made available in the form of a liquid concentrate.

We claim :

1. A composition which on addition to water used in mixing concrete inhibits corrosion of steel reinforcements embedded in concrete constructions which consists of a mixture of sodium hydroxide and sodium nitrite or a mixture of sodium carbonate and sodium nitrite or a mixture of tri-sodium phosphate and sodium nitrite in the ratio of alkaline ingredient namely, sodium hydroxide, sodium carbonate, tri-sodium phosphate to the passivating ingredient namely sodium nitrite in the range of 0.25:1 to 0.25:2, 0.25:2 being the preferred ratio.

2. A process for obtaining the composition claimed in Claim 1 which consists in dissolving the two types of ingredients in water to obtain a liquid concentrate, namely, 2.5 gms. of the alkaline ingredient and 20 gm. of the passivating type of inhibitor dissolved in 100 ccs. of water.

3. A process as claimed in Claim 2 wherein the composition is added in the ratio of 50 ccs. of composition (liquid concentrate) to one kg. of cement during mixing of concrete in the case of concrete to be exposed to rural and urban conditions.

4. A process as claimed in Claim 2 wherein the composition is added in the ratio of 100 ccs. of composition (liquid concentrate) to one kg. of cement during mixing of concrete in the case of concrete to be exposed to marine and industrial conditions.

5. A composition as claimed in any of the preceding claims for preventing steel reinforcement corrosion in concrete constructions such as RCBW and RCC constructions substantially as hereinbefore described.

R. BHASKAR PAI,

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COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH.

Dated this 27th day of December 1967.

MGIP Sant.—SL—4 Patent/74—7-7-76—100.