Corrosion Inhibition in Reinforced Concrete

Tech ID: 23453 / UC Case 2012-702-0

SUMMARY

Professor Gaurav Sant and colleagues in UCLA's Department of Civil and Environmental Engineering have developed a new method of inhibiting corrosion in steel-reinforced concrete.

BACKGROUND

Modern and efficient infrastructure is a critical driver for economic growth. Aging and premature failure of US infrastructure limits the country's potential for economic recovery, to the extent that the restoration and improvement of urban infrastructure is identified by the NAE as a "grand challenge" facing society today. A substantial cause of such premature degradation is the electrochemical corrosion of reinforcing steel embedded in concrete infrastructure. In fact, the World Corrosion Organization estimates the cost of corrosion at $2.2 trillion across the globe which is around 3% of global GDP.

Corrosion mitigation in concrete bridge decks is particularly challenging, due to the combined effects of loading and environment. These typically include the application of Cl- containing de-icing chemicals, making Cl- induced corrosion common even in bridges remote from marine environments. At the same time, the potential for early age cracking in high surface-area elements is amplified, increasing the rate at which aggressive chlorides may penetrate to the steel rebar. In a time of limited financial resources and environmental constraints, there is a need for the emergence of technologies which can address environmental/structural conservation related to engineering infrastructure.

INNOVATION

Professor Gaurav Sant and colleagues in UCLA's Department of Civil and Environmental Engineering have developed a new method of inhibiting corrosion in steel-reinforced concrete. The approach uses calcium aluminate cement mixture (CAC) and NO^{3-} anion exchange coatings to simultaneously bind large quantities of Cl^- ions and release corrosion inhibiting NO^{3-} species. The coating is expected to increase service life by a factor of 10. It is readily applied as a topical coating and can be used with existing corrosion inhibition practices. The formulations are also effective over a wider range of surface Cl^- concentrations, spanning conditions from seawater, to exposure to deicing salts, or standing seawater that is concentrated by evaporation. Moreover, the coating is expected to exert beneficial effects even when the concrete is cracked.

The corrosion inhibition technology can also use anatase (TiO^2) to provide the anion exchange species. The anions are formed by TiO^2 oxidizing atmospheric NO_x pollutants under UV excitation. Therefore, NO^{3-} species capable of corrosion inhibition are always available as long as NO_x pollutants and UV-light are in the vicinity. This technology can delay steel corrosion inhibition by a factor of 10, in comparison to Portland-based cement systems. Moreover, this technique reduces NO_x levels in the atmosphere. The anatase can be applied either topically or integrally and is compatible with existing practices. Both formulations provide a convenient, cost-effective route for corrosion inhibition in high-value structural elements exposed to moisture and salt.

APPLICATIONS

Prevent corrosion in structures that contain steel-reinforced concrete

- Bridge decks
- Highways
- Skyscrapers

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INVENTORS

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OTHER INFORMATION

KEYWORDS

Concrete, corrosion inhibition, calcium aluminate cement mixture (CAC), anion capture exchange (ACE), anion exchange coatings, photoactivity, ion-exchange, anatase

CATEGORIZED AS

- **Engineering**
  - Engineering
- **Materials & Chemicals**
  - Other
- **Transportation**
  - Other

RELATED CASES

2012-702-0

- Homes
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ADVANTAGES

- Extends bridge-deck service lifetime by one order of magnitude
- Readily applied onto concrete surface
- Compatible with existing corrosion inhibition practices
- Remains effective even when exposed to concentrated seawater
- Formulation expected to remain effective for cracked concrete
- Regenerative: As long as UV-excitation and moisture are available

RELATED MATERIALS

- Falzone, Gabriel, Magdalena Balonis, Dale Bentz, Scott Jones, and Gaurav Sant. "Anion capture and exchange by functional coatings: New routes to mitigate steel corrosion in concrete infrastructure." Cement and concrete research 101 (2017): 82-92.
- Falzone, Gabriel, Magdalena Balonis, and Gaurav Sant. "X-AFm stabilization as a mechanism of bypassing conversion phenomena in calcium aluminate cements." Cement and Concrete Research 72 (2015): 54-68.
- Balonis, Magdalena, and Fredrik P. Glasser. "Calcium nitrite corrosion inhibitor in portland cement: influence of nitrite on chloride binding and mineralogy." Journal of the American Ceramic Society 94, no. 7 (2011): 2230-2241.

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	9598314	03/21/2017	2012-702

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Method For Mitigation Of Alkali-Silica Reaction In Concrete Using Chemical Additives
- Inorganic Admixtures for Preventing Conversion Phenomena in High-Alumina Cements
- Buffer-Free Process Cycle For Co2 Sequestration And Carbonate Production From Brine Waste Streams With High Salinity
- Facile, Low-Energy Routes for the Production of Hydrated Calcium and Magnesium Salts from Alkaline Industrial Wastes
- Controlled And Efficient Synthesis Of Inorganic-Organic Composite Cementation Agents With Enhanced Strain Capacity

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