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Study on the Application of New Chemical Anti-corrosion Material in the Protection of Concrete Surface Building

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In this paper, the concept of material corrosion and the importance of corrosion are introduced. The engineering application and problems of anti - abrasive materials are discussed briefly, and the influence of corrosion on building materials is briefly discussed. The concrete protective building has been widely used in many fields such as marine engineering, chemical industry and electric power with its outstanding adaptability to complex environmental performance. The types and modes of action of concrete protective building are described in detail. The application of this technology in domestic and foreign applications is reviewed, and its application prospect in concrete protection engineering is prospected.

1. Introduction

Due to the dangers of cement concrete durability, it is imperative to explore various methods, techniques and measures to improve the durability of concrete. Building technology is a simple and effective anti-corrosion measures (Deshpande et al., 2014).

Metal and its environmental medium between the chemical, electrochemical or physical effects, causing metal deterioration and destruction, is known as metal corrosion. With the development of non-metallic materials, its failure phenomenon has attracted more and more attention. Corrosion scientists therefore advocate extending the definition of corrosion to all materials, and corrosion is the material due to the role of the environment caused by damage and deterioration. Corrosion phenomenon in the social production and use of various materials are common, resulting in a variety of different types of building materials, corrosion, increased costs, and the use of safety (Climent et al., 2016).

Therefore, the study of corrosion and protection of building products has obvious economic and social benefits (Su et al., 2014). The concrete protective building forms a layer of concrete on the surface of the concrete which can prevent the infiltration of water and other water-soluble media into the concrete by brushing, scraper, roller building, spraying. Its advantages are prominent, rapid development, engineering application prospects. As the traditional protective building performance and application of a certain degree of limitations, such as epoxy building wear resistance, gloss, good chemical resistance, but weather ability, high temperature resistance, and scratch resistance are poor.

There are two main ways to work with concrete protective buildings which are physical and chemical. The physical way is to use concrete building itself to mask the corrosive media into the interior of the concrete. The effect of the concrete building in this way is closely related to the performance of the building. The performance of the building will directly affect the durability of the concrete (Boinovich et al., 2015).

The other way is chemical means that the concrete protective agent infiltrates into the concrete, and the cement hydration products in the cement pore are complicated by the physical and chemical changes to generate new substances. The newly generated material blocks the corrosive medium from penetrating into the concrete internal channels, thereby effectively preventing the infiltration of corrosive media.

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2. Related theories and methods

2.1 Corrosion types and corrosion principles of materials

There are many methods of classification of corrosion of materials, and commonly used classification method is in accordance with the corrosion mechanism, corrosion patterns and corrosion of the natural environment to be classified in three areas.

2.1.1 Classification according to corrosion mechanism

The specific metal material is the mechanism by which corrosion mainly depends on the metal surface contact with the type of media which includes non-electrolyte solution, electrolyte solution and liquid metal. Chemical corrosion in the course of the reaction process does not produce the current. Such as iron and steel materials heated in the air, aluminum in carbon tetrachloride, chloroform or ethanol corrosion, aircraft engine combustion chamber parts in high temperature gas corrosion, iron and oxygen in the air chemical reaction to produce loose iron Oxide, corrosion of magnesium or titanium in methanol and so on which are chemical corrosion. It is characterized by the fact that under certain conditions, the oxidant in the non-electrolyte reacts directly with the atoms on the metal surface to form the corrosion product (Eduok et al., 2016). The electron transfer in the etching process is carried out directly between the metal and the oxidant, so no current is generated (Wang et al., 2015). High temperature oxidation of metals is generally considered to be chemical oxidation, but the high temperature can make the metal surface to form a dense semiconductor oxide film, so some scholars believe that the high temperature oxidation of metal belongs to the electrochemical mechanism. Electrochemical corrosion is current generated corrosion. Such as metal in the sea, the atmosphere, the soil corrosion. The most common and common corrosion involves at least one anode reaction (oxidation process) and a cathode reaction (reduction process). These two reactions are independent and simultaneous, called a pair of conjugate reactions (Figueira et al., 2015). Electrochemical corrosion is due to the formation of numerous tiny batteries caused by, but also and mechanical, mechanical, biological effects together lead to metal damage. The electrochemical corrosion principle of the metal is essentially the same as the well-known copper-zinc primary cell. Metal or alloy is often a chemical composition is not uniform, containing a variety of impurities and alloying elements, the structure and physical state are not uniform, and the surface oxidation (protection) film is not complete. Physical corrosion includes the dissolution of the molten steel by molten metal, resulting in thinning of the steel container wall (Lutz et al., 2014). Melting alkali can occur in the physical solution. Physical corrosion is due to material migration caused by corrosion of metal called solute, liquid metal called solvent, solid solute dissolved in liquid solvent and transferred to the liquid, making the solid metal material damage. The corrosion process without chemical reaction, no current generated, is a purely physical process. Of the three kinds of corrosion, electrochemical corrosion is the most common, the most serious harm to metal materials.

Table 1: Corrosion resistance of materials in contact with media

Item	Concentration (%)	T	Carbon steel	316 steel	C	Ta	Ni
35%HCL+ 0.5%HNO3		RT				●	
90%HSO4+ 10%HNO3		RT				●	
		RT				●	
70%HSO4+ 30%HNO3 50%HSO4+ 50%HNO3		RT				●	
Chrome	20	RT BP			●	● ●	○ ○
	HCL3 HNO31	RT BP		○ ○	● ○	● ●	

Marking: ● good corrosion resistance ○ poor corrosion resistance
Symbol: RT at room temperature BP boiling point

2.1.2 Classification in accordance with the form of corrosion

(1) Throughout the metal cross-section, comprehensive corrosion distribution gives the results of the metal structure to reduce the size of the cross until completely destroyed. Corrosion results in reduced material quality and thinner thickness. It can be uniform, and it can be uneven, uniform corrosion less harmful. Such as: metal corrosion in the atmosphere, carbon steel in strong acid, alkali corrosion. As long as you know the

corrosion rate of the material, you can calculate the material life. In most cases, the metal surface will produce protective corrosion product film, so that corrosion becomes slow.
(2) Local corrosion mainly occurs in the metal surface of the local area, while most of the other surface is almost no corrosion or corrosion is very slight. Its harm is much more serious than the average corrosion, which accounts for about 70% of the total mechanical corrosion damage. Local corrosion mainly has eight different types which include whole corrosion, crevice corrosion, galvanic corrosion, inter-granular corrosion, stress corrosion cracking, hydrogen embrittlement, corrosion fatigue, selective corrosion.

2.2 Mixed building

The mixture of polymer and cement is a new type of concrete cladding material developed in recent years. Most of the polymer is mixed into cement mortar in the form of emulsion, which greatly improves the compactness and cohesive force of mortar layer (Pour-Ali et al., 2015). Can be built on the wet base surface, its durability can be consistent with the matrix (concrete). At home and abroad for the mortar layer in the more and more varieties of polymers, such as acrylic emulsion, vinyl resin emulsion, epoxy resin emulsion, more applications are used in conjunction with a variety of polymers to further improve the protection performance. Foreign has been a large number of industrial buildings, bridges, marine buildings and other new projects and old works of repair. China has acrylic cement, neoprene latex mortar and other varieties, in recent years there have been some new varieties. Polymer modified cement mortar is not acid, and it is not suitable for use in a strong acidic environment.

3. New concrete protective building

In the strong corrosive environment, the general protective building cannot achieve the purpose of protection of reinforced concrete. At present, there are two ways to improve the effect of building protection. The first one is a single anti-corrosion materials modified, and the second is the development of new materials. Protective building developed constantly toward the comprehensive and environmentally friendly direction. The following describes the recent years of new concrete protective building research progress.

3.1 Glass flake protective building

A very thin glass flake is incorporated into the resinous material, coated on a concrete surface with a few millimeters of thick film building to achieve a long-term full isolation of the environment. Painting method can be used brush, high pressure airless spray or roller building. As the glass flake building with corrosion resistance, good permeability, poor building shrinkage, and thermal expansion coefficient is small, less curing residual stress, wear resistance, construction is simple and easy to repair. Construction and other industries have a large number of applications.
Especially in a variety of engineering equipment, Jia Fangqiu et al., used the AC impedance method to evaluate the corrosion resistance of the glass flake vinyl ester resin building and studied the corrosion resistance of the glass flake. The results showed that the building of the glass flake was better than that of the glass flake. The layer has better resistance to penetration and corrosion resistance. At the same time, the incorporation of glass flake building can effectively inhibit the building cracking and peeling, so that the building has excellent adhesion and impact resistance, which can be used to corrode the environment in the sea and the splash area of the structure (Ou et al., 2013). When in low temperature conditions, the building curing speed is difficult to meet the construction requirements, and curing carbon monoxide release, so anti-ultraviolet atmospheric aging performance is poor.

3.2 Self-repair building

Self-healing building is the 20th century, and we put forward the name of the intelligent building, that is damaged after the building has a self-repair function, or under certain conditions with self-repair function of the organic polymer building. Self-repair building with appearance repair function - gap fill. From the repair mechanism and building components can be divided into additive repair and intrinsic repair building. The repair of concrete gap type damage mainly relies on the release and flow of repair reagents in the building, which can be repaired by re-leveling, filling the gap and forming a reversible polymer network to achieve the original building appearance (Boinovich et al., 2015; Coldrick et al., 2016). The results show that CCSM can significantly improve the impermeability and compressive strength of cement-based materials on the basis of the analysis of the fracture repair. The CCSM is mainly through the diffusion of chemical substances which penetrate into the concrete, with the help of chemical conversion to improve the impermeability of concrete, we give concrete self-repair function. The study also shows that CCSM can significantly improve the chemical resistance of concrete and freeze-thaw resistance.

4. Experimental methods and principles

4.1 The properties of concrete and reinforced concrete

Concrete is usually made of cementations materials (such as cement), water and aggregate in a certain proportion of mixed preparation, if it is necessary, we can add some admixtures or admixtures. It has high compressive strength (generally 30~40MPa), good durability, wide range of strength characteristics. Reinforced concrete is added in the concrete reinforced by a combination of materials. Use the wire will be bound to the application of steel bars into the structure of the shape, with the template covered in the steel skeleton outside, and then pouring concrete. Reinforcement helps to improve the mechanical properties of concrete, which concrete to withstand the pressure. It has a strong and good performance, tensile strength is generally 200MPa.

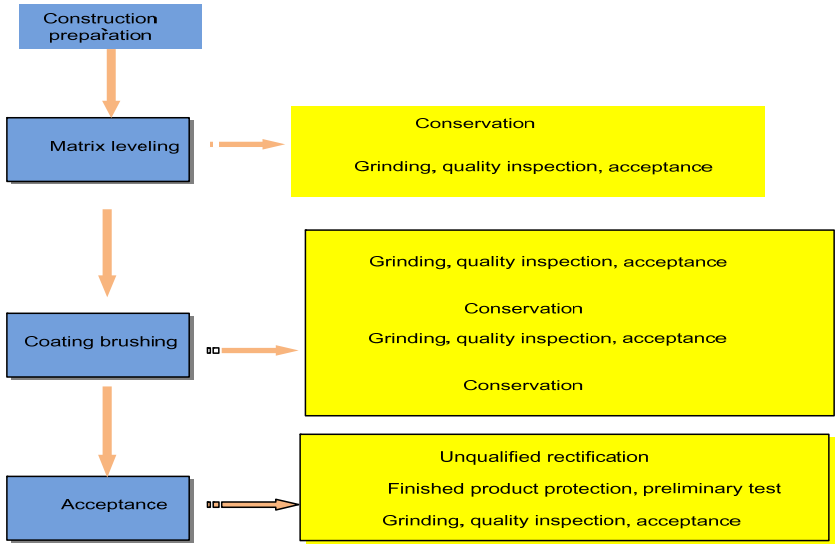

Figure 1: The paint construction process flow chart

4.2 Selection

Cement is the key which is the proportion of the appropriate water-cement ratio, concrete can have a good compressive strength, the general theory of the best water-cement ratio 0.4 ~ 0.5, and then adjust the value according to different circumstances. If the choice of volcanic ash, the concrete obtained a small number of coarse pores, pore size is also small.

Steel bars are often used in the diameter of 8,12,16,20,25,32,40 mm and steel for the 20MnSi, 20MnV, 25MnSi, BS20MnSi. Reinforcement in the concrete according to the role of points can be divided into force tendons, stirrups which are part of the cable-stayed stress, fixed force tendon position, frame tendons, distributed tendons with the plate of the tendons which are arranged vertically.

4.3 Anti-corrosion methods

Acid and alkali, salt and erosive solvents, atmospheric, groundwater, ground water, and corrosive media contained in the process of industrial production can cause corrosion of the building. In addition, the building will be subject to biological corrosion.1xassw

(1) Basic protection. We can improve the quality of concrete and construction quality, appropriate low water-cement ratio, enough concrete protective layer thickness. Concrete surface building, adding corrosion inhibitor, electrochemical cathode protection, high corrosion resistance steel or a variety of coated steel bars which are commonly used means of protection.

(2) For the steel surface the building is a layer of thick epoxy paint, which has a strong corrosion resistance, significantly improve the mechanical properties of reinforced concrete, especially in the environment with more advantages. Physicochemical properties of polyurea is shown in Table 2, elastomer materials is shown in Table 3, and this sprayed polyurea elastomer material has a very superior physical and mechanical properties which is shown in Table 4. UVB-313 lamp with anti-ultraviolet anti-aging test, the test temperature is 50 °C, and the test time is 3871h.

Table 2: Polyphase elastomer integrated physical and mechanical properties

Physical properties	P pointer	Physical properties	P pointer
Tensile Strength(MPa)	10—27.5	Bonding with	
S- hardness	30A-65D	AL	>13.7
T-strength (KN/m)	43.9-105.4	Bonding with al MPa	>13.7
Elongation (%)	420—1000	Wear resistance	< 45
Bonding with		Impact performance	> 50
concrete (MPa)	>2.8		

Table 3: Polyurea elastomer low temperature physical and mechanical properties (minus 20 degrees)

Physical properties	P pointer
Tensile Strength(MPa)	>10
T-strength (KN/m)	43.9--105.4
Elongation (%)	100--500

Table 4: Polyurea elastomer coating aging resistance

Physical properties	Before aging	Mechanical properties
Tensile Strength(MPa)	13.5	13,5
T-strength (KN/m)	76.4	84.4
Elongation (%)	134	110

4.4 Results and discussion

With the development of science and technology and social progress, concrete protective building presents the following trends.

(1) High performance, wide area. Now the application of high-performance building system mainly includes epoxy seal, epoxy cloud iron intermediate paint and chlorinated rubber finish. For the sun cannot use the location of the epoxy seal and resistant paint. And the sea water cooling tower and other corrosive environment worse parts can be used epoxy glass flake paint, phenol modified epoxy paint, to enhance the resistance to media corrosion and building shielding effect. Waterborne fluorocarbon buildings have been recognized by the industry and have been used in the field of bridge towers. The structure of the concrete in the tidal zone is improved by the structural modification of the epoxy building to improve its adaptability to the wet concrete base, that is, the moisture resistance, permeability, alkali resistance and excellent adhesion to the wet concrete base The Hangzhou Bay Bridge, Qingdao Bay Bridge piers are used wet curing epoxy primer for wet base surface of the back cover (Abdullayev et al., 2013; Klomfass et al., 2016). In the face of the wide concrete building, the future requirements will be higher and higher.

(2) Construction period is short. Large tonnage of deepwater harbour wharf, large water conservancy and hydropower project construction, the paint put forward higher requirements, requiring it without affecting the operation of the case, a large area of spraying and construction, which requires the construction of concrete building cycle Short, quick, as soon as possible to improve the durability of concrete, so that these terminals and other projects play its role more quickly. Figure 2 shows the concrete plus coating and no coating relative anti-corrosion ability of the comparison results, the abscissa for the year, we can see, add paint more anti-corrosion ability.

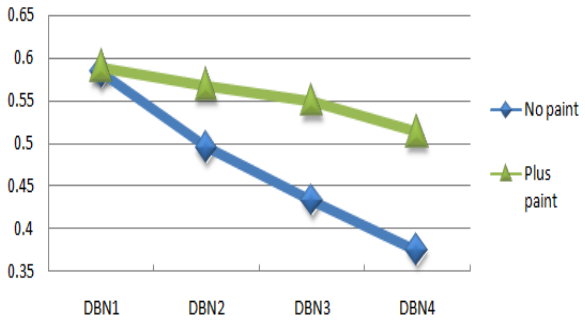

Figure 2: The concrete plus coating and no coating relative anti-corrosion ability of the comparison results

5. Conclusion

Concrete protective building is great significance to improve the durability of concrete structure. The development and marketing of concrete structure anticorrosive building technology are needed to adapt to the rapid development of concrete structure in China and improve the technical level and guarantee of concrete structure engineering in China. The operational safety of infrastructure has important practical significance and has positive effect on enterprise technological innovation.

For different concrete structure, we can select the appropriate protective building by improving the durability of concrete which has an important role. The latest research results show that a variety of protective buildings in the material properties and applications are different, including pleurae anti-corrosion building both in the material itself, the overall performance, construction performance, environmental adaptability. Cost-effective and application prospects have a certain advantage. In the actual research work, we should consider the improvement method, carry out high performance, wide application field, short construction period and other materials research and development work. In particular, we should study the development of solvent-free, non-polluting materials, vigorously develop environmentally friendly buildings.

Reference

Abdullayev E., Abbasov V., Tursunbayeva A., Portnov V., Ibrahimov H., Mukhtarova G., Lvov Y. 2013, Self-healing buildings based on halloysite clay polymer composites for protection of copper alloys. ACS applied materials & interfaces, 5(10), 4464-4471. DOI: 10.1021/am400936m.

Boinovich L.B., Emelyanenko A.M., Modestov A.D., 2015, Synergistic effect of superhydrophobicity and oxidized layers on corrosion resistance of aluminum alloy surface textured by nanosecond laser treatment. ACS applied materials & interfaces, 7(34), 19500-19508. DOI: 10.1021/acsami.5b06217.

Boinovich L.B., Emelyanenko A.M., Modestov A.D., Domantovsky A.G., Emelyanenko K.A., 2015, Synergistic effect of superhydrophobicity and oxidized layers on corrosion resistance of aluminum alloy surface textured by nanosecond laser treatment. ACS applied materials & interfaces, 7(34), 19500-19508. DOI: 10.1021/acsami.5b06217.

Climent M.A., Jesús C., Pedro G., 2016, Graphite–Cement Paste: A New Building of Reinforced Concrete Structural Elements for the Application of Electrochemical Anti-Corrosion Treatments. Buildings, 6(3), 32. DOI: 10.3390/coatings6030032.

Coldrick S,, 2016, Modelling Small-scale Flashing Propane Jets, Chemical Engineering Transactions, 48, 73-78, DOI: 10.3303/CET1648013

Deshpande P.P., Jadhav N.G., Gelling V.J., Sazou D., 2014, Conducting polymers for corrosion protection: a review. Journal of Buildings Technology and Research, 11(4), 473-494. DOI: 10.1007/s11998-014-9586-7.

Eduok U., Suleiman R., Khaled M., Akid R., 2016, Enhancing water repellency and anticorrosion properties of a hybrid silica building on mild steel. Progress in Organic Buildings, 93, 97-108. DOI: 10.1016/j.porgcoat.2016.01.006.

Figueira R.B., Carlos J.R.S., Pereira E.V., 2015, Organic–inorganic hybrid sol–gel buildings for metal corrosion protection: a review of recent progress. Journal of Coatings Technology and Research 12(1), 1-35. DOI: 10.1007/s11998-014-9595-6.

Klomfass A., 2016, Improved Explosion Consequence Analysis with Combined CFD and Damage Models, Chemical Engineering Transactions, 48, 109-114, DOI: 10.3303/CET1648019

Lutz A., Van den B.O., Van D.J., Verheyen K., Bauters E., De G.I., 2014, A shape-recovery polymer building for the corrosion protection of metallic surfaces. ACS applied materials & interfaces, 7(1), 175-183. DOI: 10.1021/am505621x.

Ou J., Hu W., Xue M., Wang F., Li W., 2013, Superhydrophobic surfaces on light alloy substrates fabricated by a versatile process and their corrosion protection. ACS applied materials & interfaces, 5(8), 3101-3107. DOI: 10.1021/am4000134.

Pour-Ali S., Changiz D., Ali K., 2015, Corrosion protection of the reinforcing steels in chloride-laden concrete environment through epoxy/polyaniline–camphorsulfonate nanocomposite building. Corrosion Science 90, 239-247. DOI: 10.1016/j.corsci.2014.10.015.

Su F.H., Kai Y., 2014, Facile fabrication of superhydrophobic surface with excellent mechanical abrasion and corrosion resistance on copper substrate by a novel method. ACS applied materials & interfaces 6(11), 8762-8770. DOI: 10.1021/am501539b.

Wang N., Xiong, D., Deng, Y., Shi, Y., & Wang, K. 2015, Mechanically robust superhydrophobic steel surface with anti-icing, UV-durability, and corrosion resistance properties. ACS applied materials & interfaces, 7(11), 6260-6272. DOI: 10.1021/acsami.5b00558.