Preliminary Study on the Functionality and Durability of Adhesive Powder in Mortar

In recent years, various kinds of special dry powder mortar products have gradually been accepted and widely used. As one of the main additives of dry powder mortar, redispersible latex powder has also been increasingly concerned. Then the adhesive powders preceded by all kinds of attributives have also gradually appeared, including polymer powder, resin powder, and water-based resin powder. Many years of propaganda by several adhesive powder manufacturers abroad with Wacker as the representative enables the technician personnel of mortar manufacturers to have a certain understanding of the functions of redispersible latex powder in mortar. But the performance in the aspects such as the property and durability of other types of adhesive powder still has not had a clear concept. The author will synthesize the microscopic properties and macroscopic performance regarding redispersible latex powder in mortar in the literature and show some of his own test results to everyone.

Action Mechanism of Redispersible Latex Powder

The redispersible latex powder is obtained by adding various additives to make the polymer emulsion formulated into mixture that can be used for spray dying, and then by adding protective colloids and anti-caking agents to make the polymer form free-flowing powder that can be redispersed in water after spray drying. Redispersible latex powder is distributed in the evenly stirred dry mortar, and after mortar is stirred by adding water, polymer powder will be redispersed inside the freshly mixed mortar and emulsified again. Due to the hydration of cement, surface evaporation and/or absorption of substrate causing the continuous consumption of free water of pores inside the mortar, as well as the strongly alkaline environment provided by cement, the latex particles are made to form a water-insoluble continuous film in the mortar after drying. This continuous film is formed by the single dispersed particles in the emulsion fused into a homogeneous body. It is the presence of these latex films distributed in the polymer-modified mortar that makes the polymer-modified mortar obtain the characteristics that rigid cement mortar cannot have:

Since the latex film has self-stretching mechanism, and can apply tensile force to the joint of it with substrate or mortar, at the interface between polymer modified mortar and substrate, this effect can can improve the bonding properties of mortar with different substrates, such as the adhesive force to the special base surfaces like high density tiles and polystyrene board;

Inside the mortar, this effect can keep it as a whole. In other words, the cohesive strength of mortar has been increased. With the increase in the dosage of redispersible latex powder, the bond strength of mortar and concrete base gets significantly improved;

It can be proved from the test results in Figure 1 and Figure 2 that the presence of highly flexible and elastic polymer regions has improved the bonding properties and flexibility of mortar, and the elastic modulus of the mortar itself is significantly decreased, indicating that its flexibility has got improved.

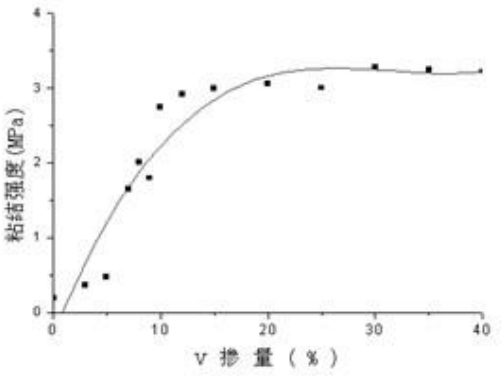

图 1 拉伸结度与可再分散乳胶粉添加量的关系曲线

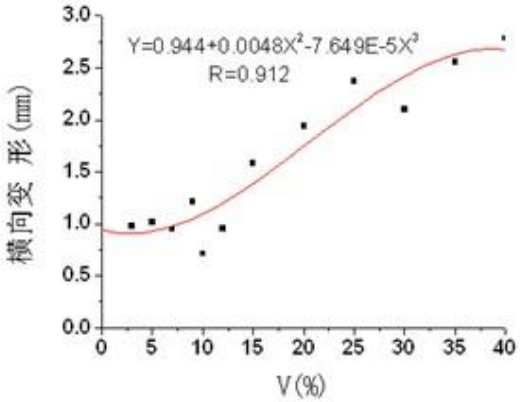

图 2 柔韧性与可再分散乳胶粉添加量关系曲线

In Figure 3 are the latex films observed inside the the polymer modified cement mortar in different ages under a scanning electron microscope. It can be found from these microstructure photographs that the thin films formed by latex are distributed in different locations of mortar, including the base-mortar interface, between the pores, around the pore wall, between the hydration products of cement, around the

cement particles, around the aggregates, and aggregate-mortar interface.

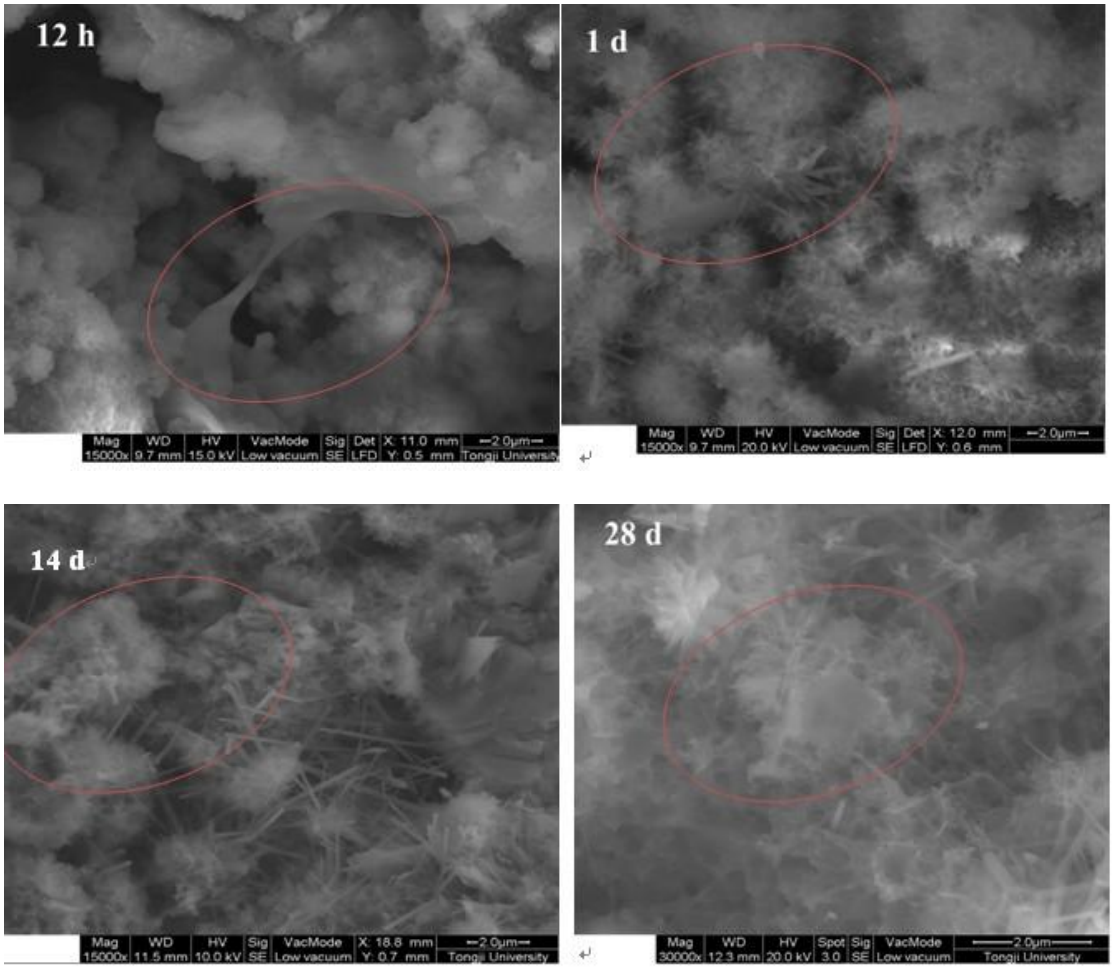

Figure 3 SEM Images of Redispersible Latex Powder Modified Mortar in Different Ages

It is these latex films distributed in the redispersible latex powder modified mortar that makes it obtain the characteristics rigid cement mortar cannot have:

Latex films can make shrinkage cracks on the base-mortar interface bridged and then healed.

Improving the closure property of mortar.

Improving the cohesive strength of mortar: the presence of highly flexible and elastic polymer regions has improved the flexibility and elasticity of mortar, provided cohesion and dynamic behavior for the rigid matrix. When a force is applied, since the improvement of flexibility and elasticity may make the microcracks postponed and formed until reaching a higher stress.

The intertwined polymer region also has a blocking effect on microcracks consolidated into throughgoing cracks. Therefore, the redispersible latex powder has enhanced the failure stress and failure strain of material.

The modification of polymer on the cement mortar makes the two obtain complementary effects so that polymer-modified mortar can be used for many

special occasions. In addition, due to the advantages of dry mixed mortar in such aspects as quality control, construction operation, storage and environmental protection, the redispersible latex powder has provided effective technical means for the production of special dry mortar products.

Based on the action mechanism of redispersible latex powder in the mortar, we have made some comparative tests to verify the performance in the mortar of another material also known as adhesive powder on the current market.

1. Raw Materials and Test Results

1.1 Raw Materials

Cement: ordinary Portland cement of Conch grade and 42.5 grade

Sand: river sand, with a silicon content of 86%, fineness of 50-100 mesh

Cellulose ether: using SidleyCel®Cellulose Ether products with viscosity of 30000-35000mpas (Brookfield viscometer, spindle 6, speed 20)

Heavy calcium powder: heavy calcium carbonate powder with fineness of 325 mesh

Latex powder: VAE-based redispersible latex powder, with a Tg value of -7 ℃, here called: redispersible latex powder

Wood fiber: ZZC500 from JS Company

Commercially available adhesive powder: a commercially available adhesive powder, referred to herein as: commercially available adhesive powder 97

The Mechanical test formulation is:

Table 1 Mechanical Test Formulation

Cement	28%
Sand	60%
Heavy calcium powder	8%
Cellulose ether	0.19%
Latex powder	2.5%
Wood fiber	0.25%

The Formulation Based on the Redispersible Laten Powder

Cement	35%
Sand (20-50 mesh)	20%
Sand (50-100 mesh)	45%
Cellulose ether	0.2%
Commercially available adhesive powder	0.2%

Laboratory standard test conditions: temperature (23 ± 2) ℃, relative humidity (50 ± 5)%, circulation wind velocity of lest area less than 0.2m/s.

Molded expanded polystyrene board: bulk density of 18 kg/cubic meter, cut into 400 × 400 × 5mm.

2. Test Results

2.1 Tensile Strength under Different Curing Time

The sample preparation can be conducted according to the test methods in JG149-2003 for the tensile bond strength of mortar. The curing system here is: cured for one day after forming of sample under laboratory standard conditions and then placed in the oven of 50 °C. The test for the first week is: placed in the oven of 50 °C until the 6th day, taking out, sticking the pull-out test head, and testing a set of pull-out strength on the 7th day. The test for the second week is: placed in the oven of 50 °C until the 13th day, taking out, sticking the pull-out test head, and testing a set of pull-out strength on the 14th day. The third week, the forth week... ...and so on.

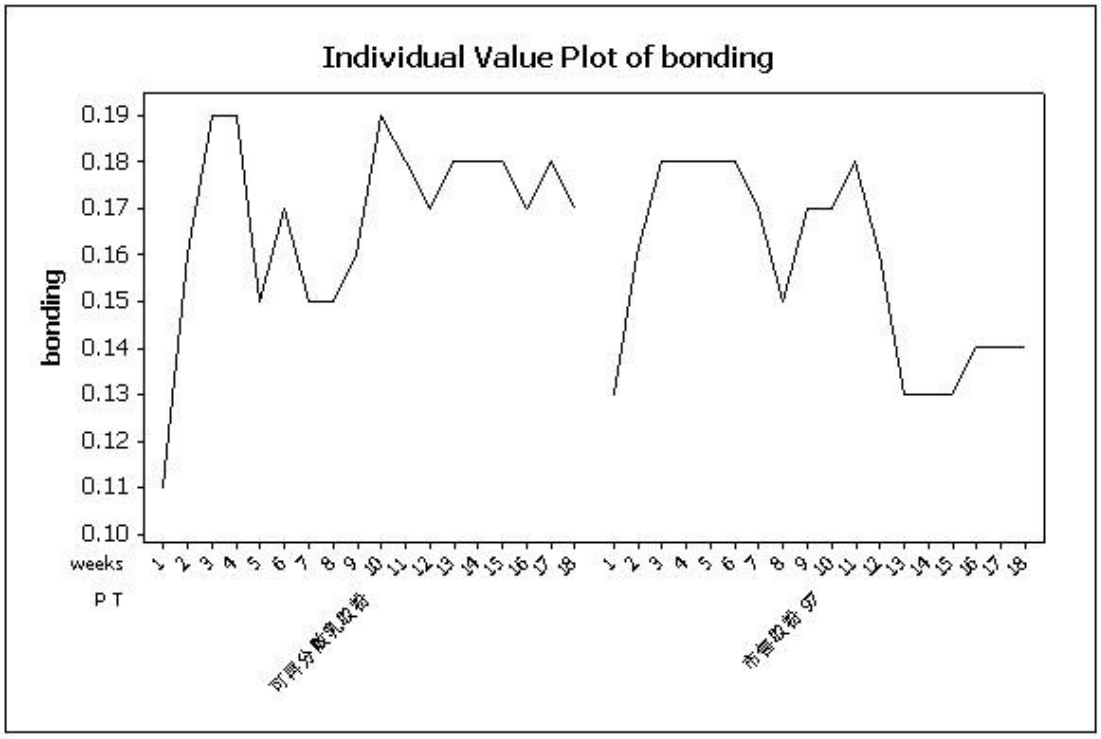

图 4、EPS 板基面上不同龄期时拉拔强度曲线

Bonding strength on EPS board, after different curing time

We can see from the results that with the increased time of the redispersible latex powder in the mortar in the high temperature environment, its strength is gradually increased and maintained, which is consistent with the theory that redispersible latex powder in the powder can form latex film. If the storage time is longer, the latex film of powder will reach a certain density, thus ensuring the adhesive force of mortar onto the special base surface, EPS board. While the commercially available adhesive powder 97 is the opposite. With the time stored in the high temperature environment stretched, its strength is declining.

It also shows from the test base surface that the destructive power of redispersible latex powder on the EPS board has been maintained, while the destructive force of commercially available adhesive powder 97 on the EPS board is getting worse.

Comprehensively speaking, the commercially available adhesive powder is different from the redispersible latex powder in mechanism of action, forms the film inside various parts of mortar with redispersible latex powder, and as the second cementitious material, the mechanism of action to improve various physical properties of mortar is inconsistent.

Conclusion

1) It shows through this simple test that the commercially available adhesive powder and redispersible latex powder have different mechanisms of action, improving the adhesion of mortar for the base surface not by improving improving the comprehensive properties of mortar.

2) The tests involved in the paper are based on the description of laboratory test results by the author, for mortar manufacturers' reference and validation. An important reason for our application of redispersible latex powder is that it can change the comprehensive properties of mortar: operability durability, flexibility and adhesion to the special base surface. And the improvement of flexibility is the most important and this may be the starting point to select the redispersible latex powder.

3). Many studies have shown that the redispersible latex powder will exist stably after dispersed to form the film in the mortar and has always played a role in improving the comprehensive properties of mortar. We should also make this system test as much as possible to ensure proper materials in order to improve the durability

of our buildings.

For more information, and product samples,

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