Research on Application Technology of Iron Tailings in Artificial Sand

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Abstract. Iron tailings are the solid waste discharged by the concentration plant after useful components is selected from the ore, which is an important source of environmental pollution in mining development. Iron tailings not only needs to occupy a lot of land and cause great harm to the surrounding ecological environment, but also needs to treatment and maintenance costs. The comprehensive recovery and utilization of iron tailings resources can not only make full use of mineral resources, expand the utilization scope of mineral resources, as well as extending the service life of the mine, it is also an important means of pollution control and ecological protection, can also save a lot of land and capital, solve the employment problem, benefit the human society, and realize the effective unification of resource benefit, economic benefit, social benefit and environmental benefit, after many years of research, iron tailings can be used in artificial sand making. This paper analyses the current status condition of iron tailings and attempts to provide some useful suggestions and countermeasures for the utilization of iron tailings.

1. Introduction
The large amount of iron tailings discharged by iron ore mine not only occupies a large amount of land, causes land to be deserted, consumes lots of construction and maintenance funds, but also has potential geological disasters. The staple use of iron tailings can significantly reduce the discharge of industrial solid waste, which is the most important direction for the comprehensive utilization of tailings. The iron tailings are used to produce artificial sand is one of the application directions. After proper sorting and processing, iron tailings can be made into artificial sand, which not only solves the shortage of construction sand and environmental pollution, but also improves resource utilization ratio and forms comprehensive benefits. Based on the previous studies, this paper prepares an EVA-modified Cement Mortar with iron tailings, which combines low cost and high functionality, and meets environmental protection requirements. In this research, Neoprene latex, polyacrylate emulsion and ethylene-vinyl acetate copolymer (EVA) were used as modifiers for general research.

2. Component Part of Polymer Modified Cement Mortar
In the 1990s, polymer modified cement mortar began to rise, they have been widely used in engineering field such as maintenance and reinforcement, waterproofing, and anti-corrosion engineering, and have gradually become a very important building material. Polymer modified cement mortar adopts the reasonable compounding of inorganic and organic materials, adjusts the internal structure of the
hydrated hardened body, thereby improving the mechanical properties and bonding properties of the mortar, so it gains more and more attention. Polymer component is also called as cement modifier, which are mainly divided into four categories according to their physical properties and synthetic processes: ethylene-vinyl acetate copolymer (EVA), polyacrylate emulsion (PAE), styrene butadiene latex (SBR), neoprene latex CR).

Aggregate plays an important role in the mortar and has an impact on the properties and costs of the mortar. Natural river sand is a common aggregate, however, with the rapid development of the construction industry, a large amount of mortar concrete is consumed, which makes the reserves of river sand in China drop sharply. In addition, the annual discharge of solid waste such as steel slag, ore, fly ash, etc. produced by industrial and mining is high, and the long-term accumulation pollutes ecological environment, the realization of the resource utilization of these industrial and mining solid waste has become an urgent problem to be solved. The iron tailings are used to replace river sand as a building material has become a new option.

3. Experimental Contents

3.1. Experimental Program
A modified cement mortar with low water absorption, resist compression and high bending resistance, good workability and simple construction was prepared in this experiment. Different content of neoprene latex, polyvinyl alcohol (PVA) and ethylene ethylene-vinyl acetate copolymer (EVA) were added into standard mortar to prepare samples, its compressive strength is tested, the reasonable process parameters and technological process are obtained, and the analysis data and theoretical discussion are summarized. The experimental process is arranged as follows: polymer modified cement mortar experimental scheme: design mix ratio, mixing mortar, room temperature forming (24h), room temperature maintenance(28d), testing bending resistance, compressive strength, data analysis and scanning analysis.

3.2. Experimental materials and instruments
Material: Ordinary Portland cement (P.O. 42.5), Standard sand (particle size d0.20mm) neoprene latex, polyvinyl alcohol (45% solid content), PVA (40% solid content), EVA (40% solid content).

Instrument: standard triple test mold (40mm×40mm×160mm); NYL-600 universal hydraulic testing machine; ACS-15S electronic scale; DKZ--5000 electric bending machine; scanning electron microscope (SEM); HGY-40A cement concrete standard maintenance box with constant temperature and humidity; slice; measuring cylinder; beaker and so on.

3.3. Sample preparation
According to the national standard, strength experiment of cement mortar determines the mixing ratio: cement: sand: water 1: 1:3: 0.5; (2) the amount of high polymer is set to 5%, 10% 12%, 15%, 17%, 20% of the cement quality.
Sample preparation was carried out according to the test process of cement mortar strength.

3.4. Performance test
Test of flexural and compressive properties of polymer modified mortar refer to GB177-85 "Test Method of Cement Mortar Strength", the test piece size is 40mm×40mm×160mm. Compressive strength refers to JGJ70-90 "Testing Methods of Basic Properties for Building Mortars" [1], test piece specifications: 40mm×40mm. The flexural and compressive strength of the standard samples are shown in Tables.1, Table.2, Table.3 below, and Figure.1 and Figure.2.

| Table 1. 28d flexural and compressive strength of neoprene latex modified cement mortar |
|---------------------------------|-------------------|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| project                         | polymer-cement ratio of neoprene latex modified cement mortar | poly-ash ratio |
| 0                               | 5                 | 8               | 10             | 12             | 15             | 17             | 20             |
| 28d flexural strength (MPa)     | 6.25              | 6.30            | 6.33           | 6.38           | 6.42           | 6.75           | 6.55           | 6.5            |
| 28d compressive strength (MPa)  | 41.75             | 39.55           | 37.65          | 36.8           | 33.75          | 31.3           | 28.5           | 25.3           |
Table 2. 28d flexural and compressive strength of PVA modified cement mortar

| Project                      | Polymer-cement ratio of PVA modified cement mortar poly-ash ratio | Poly-ash ratio |
|-----------------------------|------------------------------------------------------------------|----------------|
|                             | 0       | 5       | 8       | 10      | 12      | 15      | 17      | 20      |
| 28d flexural strength (MPa) | 6.25    | 6.37    | 6.5     | 6.65    | 6.76    | 6.85    | 6.55    | 6.5     |
| 28d compressive strength (MPa) | 41.75   | 39.05   | 36.42   | 33.7    | 31.0    | 28.2    | 25.5    | 22.6    |

Table 3. 28d flexural and compressive strength of EVA modified cement mortar

| Project                      | Polymer-cement ratio of EVA modified cement mortar poly-ash ratio | Poly-ash ratio |
|-----------------------------|------------------------------------------------------------------|----------------|
|                             | 0       | 5       | 8       | 10      | 12      | 15      | 17      | 20      |
| 28d flexural strength (MPa) | 6.25    | 6.04    | 5.95    | 6.61    | 6.35    | 5.95    | 5.54    | 4.84    |
| 28d compressive strength (MPa) | 41.75   | 36.65   | 33.37   | 30.9    | 27.23   | 23.23   | 20.4    | 16.5    |

Figure 1. Flexural strength curve of polymer modified cement mortar (28d)

Figure 2. Compressive strength curve of polymer modified cement mortar (28d)

Bonding property test of polymer modified mortar: prepare ordinary mortar test block (40mmX40mmX80mm), put it into the testing mold, (40mm=>40mmX160n-m) and then pour the polymer modified mortar, vibrate and compact, 28d curing molding, and form a new and old mortar interface binging. Then, the binding strength value is obtained according to testing method of its flexural strength, as shown in Figure.3.
3.5. Data Analysis

It can be seen from Fig.1, Fig.2 and Tables 1-3 that the compressive strength of the polymer modified cement mortar decreases with the increase of the polymer-cement ratio, and the flexural strength increases slowly, the flexural strength of neoprene latex and PVA modified cement mortar reaches a large value when its content is 12%-15%, and increase about 10%. The flexural strength of EVA modified cement mortar increases by about 2% in its 12% content. The polymer-cement ratio increased, the flexural strength of the three polymer modified cement mortars all decreased, and the EVA modified cement mortar decreased more. The bonding strength of the three polymer modified cement mortars was effectively improved, The neoprene latex and PVA modified cement mortar were obviously improved, which was close to the standard flexural strength of the original cement mortar, the bonding strength value EVA of modified cement mortar is 17% lower than the standard flexural strength of the original cement mortar.

EVA can be evenly distributed in the cement matrix, which is better to bond cement particles, inhibit the volume shrinkage of cement materials in the solidification process, reduce the number of micro-cracks or micro-defects in the cement matrix, reduce the size of micro-cracks or micro-defects, and improve the microstructure of cement matrix. The interaction of hydroxyl with positive ion in cement improves the structure of cement mortar and improves its performance. Polyvinyl alcohol is added to the cement mortar, other hydroxyl groups due to water molecules through hydrogen bond association, the surface of cement particles formed a layer of stable solvation water film, inhibit the cement hydration process, slow down the hydration speed, cement hydration is more complete, the formation of the structure of the cement stone is more dense, thereby improving the flexural strength.

4. Conclusion

A portion of the iron tailings can be made into a qualified artificial sand product by appropriate technology. The sand making process is simple and the investment is small. The sand making process of iron tailings can be used for making iron tailings bricks or producing concrete, so that iron mines can achieve production targets without iron tailings. As China's urbanization process continues, iron tailings sand and other artificial sands will become the mainstream of construction sand. The development of iron tailings sand not only reduces the damage to the environment caused by the exploitation of natural sand, but also reduces the load brought by the iron tailings to the environment, change waste material into things of value, it conform to the basic national policy of sustainable development in China, and has broad application prospects, and can achieve significant economic, social and environmental benefits.
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