Hydraulic and Civil Engineering Technology VIII
M. Yang et al. (Eds.)

doi:10.3233/ATDE230765

Influence of Regenerated Powder on Properties of Dry Powder Mortar

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Abstract. In order to reduce the environmental pressure of regenerated powderin construction waste, regenerated powder was used as a mineral admixture to replace part of cement to prepare dry powder masonry mortar. The effects of regenerated powder content on the workability, basic properties (layering degree, apparent density and gas content) and mechanical properties of dry powder masonry mortar were studied. The results show that the water consumption, stratification degree and apparent density of dry powder masonry mortar increase with the increase of regenerated powder content, while the gas content of dry powder masonry mortar decreases with the increase of regenerated powder content. The change of curing time does not affect the law that the compressive strength of dry powder masonry mortar decreases with the increase of regenerated powder content. According to the Technical Regulations for the Production and Application of Dry Powder Mortar (DG/TJ08-205A-2000, Shanghai), mortar of M10 ~ M20 grade can be configured.

Keywords. Regenerated powder, dry powder mortar, basic properties, compressive strength

1. Introduction

With the development of the construction industry in our country, construction wastes are increasingly produced every year [1]. Therefore, the reuse of construction waste has become a key research topic [2-3]. In the process of reuse of construction waste, a large number of fine particles will be produced, and we usually refer to the fine particles with a particle size of less than 0.16mm as regenerated powder [4]. The amount of regenerated powder is large and easily dispersed in the air [5]. In order to reduce the pressure of regenerated powder in construction waste on the environment, regenerated powder can be used as a mineral admixture to replace part of cement to prepare dry powder masonry mortar [6]. On this basis, it is considered to apply the regenerated powder from construction waste into dry powder mortar, which can solve the two major problems of the shortage of construction resources [7] and increasing production of construction waste year by year to a certain extent.

Different from fly ash, slag and other mineral admixtures, the composition of regenerated powder more complex because of its diversity and complexity. The regenerated powder of construction waste mainly consists of calcium oxide, silicon dioxide, alumina and other chemical components [8-9], among which the content of

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calcium oxide is generally high. However, the content of silica in there generated powder produced by bricks is higher, while the content of silica in the regenerated powder produced by waste concrete is lower. Therefore, the type of raw materials has a great influence on the chemical composition of the powder.

2. Experimental Programs

2.1. Experimental Materials

Ordinary Portland cement (P.O42.5); Fine aggregate is natural river sand, which is screened, washed and dried before use; Tap water; Naphthalene is a water-reducing agent, and its main chemical components are shown in table 1. Waste concrete from a local construction site in Jining was selected and treated by particle shaping technology to produce a large amount of regenerated powder with particle size less than 0.16mm. The main chemical composition is shown in table 1.

Table 1. Chemical Composition of regenerated powder and water reducing agent (%).

Composition	CaO	CO_2	Al_2O_3	SO_3	SiO_2	Fe_2O_3	MgO	K_2O	Na_2O
Water reducing agent	2.94	65.19	0.17	24.71	0.32	0.05	0.13	0.03	6.44
Regenerated powder	13.31	14.87	14.57	0.52	45.24	4.30	1.66	3.74	1.50

2.2. Mix Proportions Design

The water-binder ratio was 1:3, 1:4, 1:5 and 1:6. The content of regenerated powder was 0%, 10%, 20% and 30%, respectively. The amount of admixture is 0.6% of the total amount of cementing material, and the consistency of mortar is controlled within the range of 70~80mm by adjusting the water consumption.

3. Results and Discussions

3.1. Effect of Regenerated Powder Content on Physical Properties of Dry Powder Masonry Mortar

According to the change analysis in figure 1, when the cementity-sand ratio of dry powder masonry mortar is the same, the water requirement of dry powder mortar increases linearly with the increase of the content of regenerated powder. When the cementity-sand ratio is 1:6, the water requirement of the mortar with 30% regenerated powder is 11.4% higher than that of the pure cement control group. Due to the irregular particle shape of the regenerated powder, the surface is covered with cracks and V-notch. The irregular morphology increases the external surface area ratio of the regenerated powder larger.

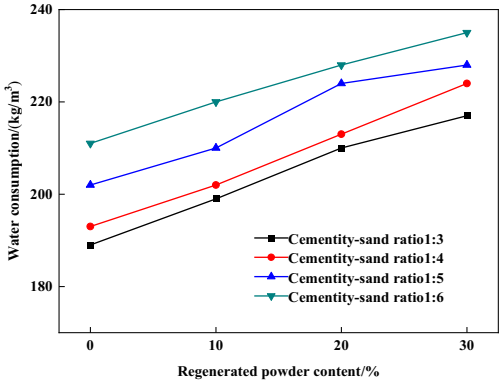


Figure 1. Influence analysis diagram of water consumption of dry mortar.

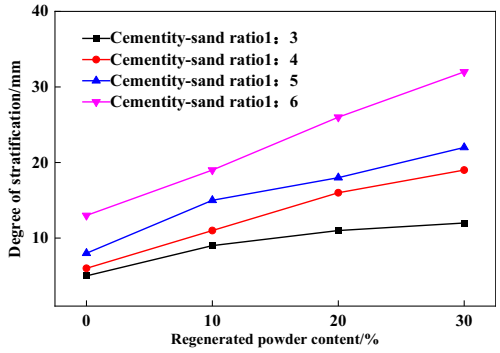


Figure 2. Influence analysis diagram of layering degree of dry mortar.

It can be seen from the change in figure 2 that when the cementity-sand ratio of dry powder masonry mortar is the same, the layering degree of dry powder mortar increases with the increase of the content of regenerated powder. The reason can be attributed to the particle characteristics of regenerated powder. When the stratification is too small or close to zero, mortar is easy to produce dry shrinkage cracking after construction hardening, which will aggravate cracks, affecting the durability of the masonry structure. According to the provisions of "Design Specification for Masonry Mortar Mix Ratio" (JGJ/T98), when the layering degree of masonry mortar is ≤30mm, the cementity-sand ratio is 1:6, and the content of regenerated powder is 30%, the layering degree of mortar is 32mm, which exceeds the regulations. This mix ratio does not meet the basic performance requirements of the mortar.

It can be seen from the change analysis in figure 3 that, when the mortar cementity-sand ratio is the same, the gas content of dry mortar decreases gradually with the increase of the content of recycled micro-powder. The addition of recycled micro-powder will increase the density of the mortar. The reasons are as follow as the space for bubbles is reduced and the gas content of the slurry is gradually reduced. A certain amount of gas content is conducive to the growth of mortar strength, but if the gas content is too small, it will affect the frost resistance and water resistance of the mortar. When the gas content is too large, the compressive strength of the dry mortar decreases with the increase in gas content.

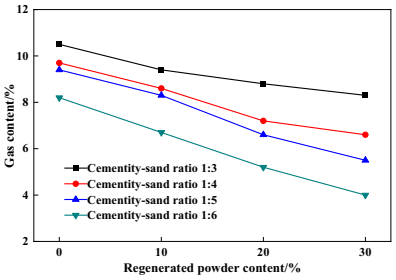


Figure 3. Influence analysis diagram of dry mortar gas content.

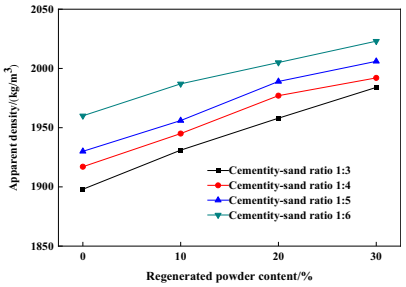
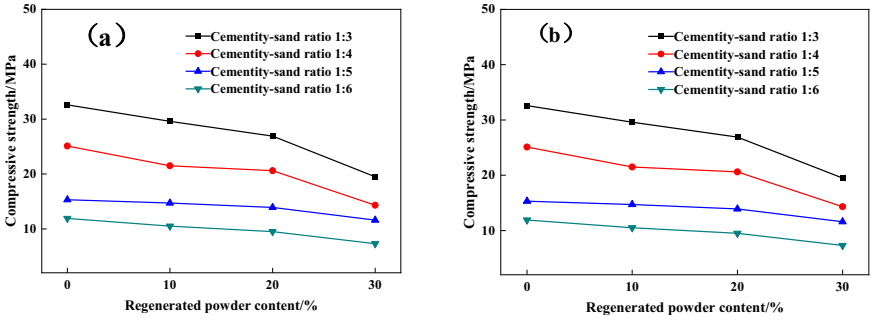


Figure 4. Influence analysis diagram of dry mortar apparent density.

It can be seen from the analysis of the changes in figure 4 that when the mortar cementity-sand ratio is the same, the apparent density of dry mortar increases with the increase of the content of recycled micro-powder. When the cementity-sand ratio is 1:6, the apparent density of the mortar with 30% regenerated micro-powder is 3.2% higher than that of the pure cement control group. This is due to the small fineness, large specific surface area and good bonding with cement of the reclaimed fine powder. Therefore, with the increase of the mixing amount, the pore space in the slurry decreases, making the slurry more dense, and thus the apparent density of dry powder mortar increases.

3.2. Influence Analysis of Compressive Strength of Dry Powder Masonry Mortar

As can be seen from figure 5, regardless of the curing period of dry mortar, the compressive strength of mortar decreases with the increase of the content of regenerated powder. Due to the large surface area and fine particles of the regenerated powder, although it has certain activity, the activity is very low and much lower than that of cement. The regenerated powder also has a water absorption effect, resulting in the reduction of water in cement hydration. Therefore, the strength of mortar decreases with the increase of the dosage of regenerated powder in construction waste. According to the division of compressive strength in "Technical Specification for Production and Application of Dry powder Mortar" (DG/TJ08-205A-2000, Shanghai), it can be seen that dry powder mortar with different mixtures of regenerated powder can prepare M10 ~ M20 dry powder masonry mortar with different strength levels.



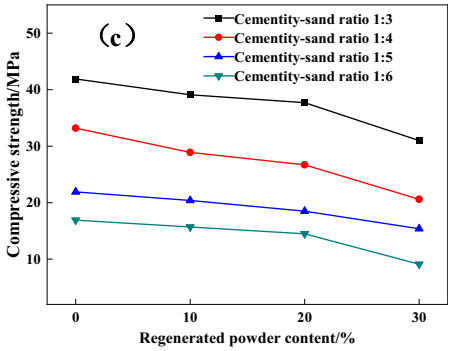


Figure 5. Influence of regenerated powder on compressive strength of dry powder mortar: (a) 7d; (b) 14d; (c) 28d.

4. Conclusions

(1) The change of regenerated powder content change the workability and basic properties of dry powder mortar. The water consumption, stratification degree and apparent density increase with the increase inregenerated powder content, while the change trend of gas content is opposite, and the gas content of mortar decreases with the increase inregenerated powder content. When the cementity-sand ratio is 1:6 and the content of regenerated powder is 30%, the stratification degree of mortar is 32mm, which exceeds the regulations.

(2) Regardless of the curing period of mortar, the compressive strength of dry mortar decreases with the increase of regenerated powder content. According to the "Technical Specification for Production and Application of Dry powder Mortar" (DG/TJ08-205A-2000, Shanghai), the strength grade of masonry mortar can be divided, and the mortar of grade M10 ~ M20 can be prepared.

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