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Compressive Strength and Microstructure of Activated Carbon-fly Ash Cement Composites

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In this work, carbon of 2% and 4% by weight were added for the first time in a fly ash cement system to produce Activated carbon–fly ash composites in the form of pastes and mortars. Compressive strengths of the composites were then investigated. It was found that the use of Activated carbon resulted in higher strength of fly ash mortars. The highest strength obtained for 20% fly ash cement mortars was found at 4% Activated carbon where the compressive strength at 28 days was 22.39 MPa. This benefit can clearly be seen in fly ash cement with fly ash of 20% where the importance of the addition of Activated carbon means that the relative strength to that of cement became almost 100% at 28 days. In addition, scanning electron micrographs also showed that good interaction between Activated carbon and the fly ash cement matrix is seen with Activated carbon acting as a filler resulting in a denser microstructure and higher strength when compared to the reference fly ash mix without Activated carbon.

1. Introduction

Fly Ash Cement (PF) because of its environmental benefits (product of coal-fired power plants) and engineering benefits (hydration in less heat, increase the ability to work on and improve the material and curing reaction, such as chlorination, etc. the durability of the chemical action) is considered to be an important building material (Langan et al., 2002; Saraswathy and Song, 2007; Yen et al., 2007; Miranda et al., 2005; Yazici, 2008). However, fly ash cement because of its setting and hardening for a long time, its strength increases than ordinary portland cement (PC) to slow, so fly ash cement than Portland cement mortar to 28d compressive strength low. In recent years, the focus of research is adding fly ash cement other materials to improve the compressive strength (Solano et al., 2017). Many foreign researcher's nanomaterials, such as nano-CaCO3, nano-TiO2 semiconductors and metals such as nanoclays, nanotubes and other materials incorporated into the cement group, the researchers found that of nanomaterials in cement-based materials to improve the microstructure has a significant effect, and can improve its durability (Sato and Diallo, 2010; Chang et al., 2007).

Domestic study, Jayapalan et al (Jayapalan et al., 2010) studied the different slag and fly ash - Slag - Cement composite strength. The results show that the addition of fly ash slag cement-based material in well to improve strength and fineness finer, increasing the strength, the better. Shekari (Shekari and Razzaghi, 2011) Adding to the fly ash slag cement base, the same results can improve the strength of the results, while the study also found that with the increase of surface area of the slag cement based performance better. In addition, the researchers found other cement-based materials will be incorporated on the compressive strength of the cement group has been effectively improved. Abdoli et al (Abdoli et al., 2011) studies have yielded so fly - fluoro - Cement Composite Cementitious Material achieve a better ratio between the amount of fluorine greater value gypsum, fly ash and cement between. Nazari and other groups (Nazari and Riahi, 2011) research rubber compound modifier concrete reinforcing mechanism. The results show that the incorporation of a certain amount in cement-based rubber particles, can improve the compressive strength of 17.2%, but the effect will be modified with the extension of storage time and gradually disappear, valid to 28d appropriate. Konsta-Gdoutos et al (2010) studied the mechanical properties of polyvinyl alcohol fiber reinforced cement-

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based composite materials, considering the practical application of the material toughness and compressive strength requirements, determine the optimum mix for domestic PVA fibers. Ye et al [13] made of different particle content of rice husk rice husk particleboard - cement composites, results showed that adding rice husk particleboard can greatly improve the compressive strength of cement composites.

Activated carbon due to its structure developed, large surface area, strong adsorption capacity, high mechanical strength, low bed resistance, good chemical stability, easy regeneration, durability and other advantages, it received great attention and extensive research, known as 21 centuries one of the most advanced materials. This article activated carbon fly ash cement formed activated carbon - fly ash cement composites, to determine the effect on the activated carbon composites by observing the compressive strength and microstructure of cement mortar.

2. Experimental Study

Activated carbon was purchased from Zhejiang Jiangshan; fly ash cement by 20% and 80% of ordinary portland cement ratio was obtained, and in a comparative study with ordinary Portland cement mortar performance. While stirring, first using an ultrasonic activated carbon is added to a portion of cement mortar for 10 minutes, then mix by adding the remaining material, made of 40mm×40mcm×160mm test block of cement mortar. Cement mortar water, cement, sand ratio of 0.5: 1: 3. Title prepared cement composites named herein as (FM-C).

After form removal, cement mortar test block at room temperature water conservation respectively 7d, 14d and 28d, measuring its compressive strength. For comparison of activated carbon in which the role, configures the number of ordinary portland cement mortar, with their SEM microstructure research. Table 1 shows the proportion of experimental study of cement - based composites.

Table 1: Mix proportions of activated carbon-fly ash cement composites.

Cement composite material	Cement (%)	Fly-ash (%)	Activated Carbon (%)	Water-Cement ratio W/c
Cement	100	–	–	0.50
FM20	80	20	–	0.50
FM20-C2	80	20	2	0.50
FM20-C4	80	20	4	0.50

3. Results and discussion

3.1 Density

Each sample shown in Figure 1 at different ages density test results.

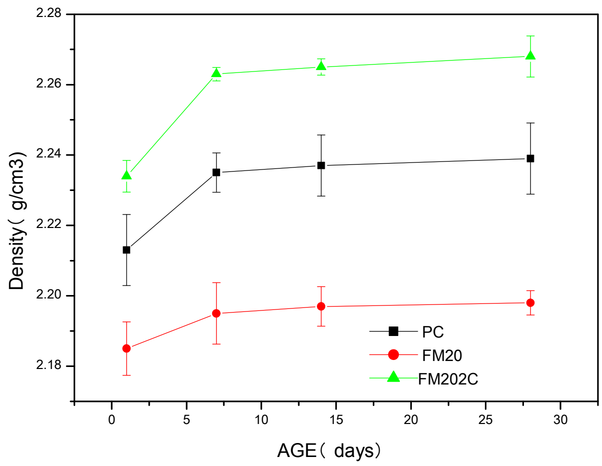


Figure 1: Density results of activated carbon–fly ash cement composites.

As shown in Figure 1, all are within the mortar density 2.185-2.268g/cm^3 range. We found that at any given time, not by adding activated carbon fly ash cement mortar should be less than the density of ordinary portland cement mortar in the same period, while adding activated carbon fly ash cement mortar (28d density of 2.268g/cm^3) significantly better than the same period is not added activated carbon fly ash cement mortar (28d density of 2.198g/cm^3) is much more compact, but also more ordinary portland cement (28d density of 2.239g/cm^3) denser. Increase was mainly due to the density of the activated carbon in the fly ash acts as a filler in cement mortar caused.

3.2 Comparison of compressive strength

The impacts of activated carbon fly ash cement compressive strength shown in Figure 2. The compressive strength of fly ash cement mortar shown in Figure 4. The test results show that fly ash cement mortar strength increase with the incorporation of activated carbon content increases. 4% activated carbon incorporated into its 28d strength is 22.39 MPa, the value is significantly larger than the corresponding values of compressive strength without adding fly ash cement activated carbon 18.97MPa much higher. While the incorporation of 4% activated carbon fly ash cement 28d compressive strength value close to ordinary portland cement (23.45 MPa). At the same time, we calculate the ash - activated carbon cement mortar and the relative strength of Portland cement mortar, and the results are expressed as a percentage - age representation form in Figure 3. When 28d, incorporated FM20 relative intensity of 4% activated carbon cement (95.48%), and the strength of Portland cement is substantially the same (100%). At the same time, then the same period of unincorporated strength of activated carbon fly ash cement material is higher, relative intensity of fly ash cement activated carbon was not added as shown in Figure 5

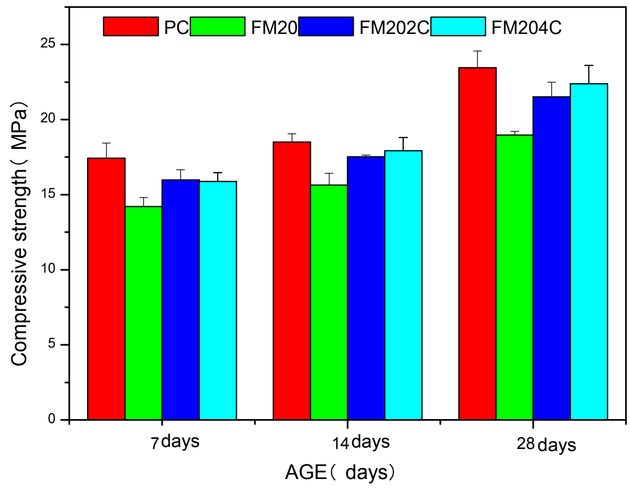


Figure 2: Compressive strength of activated carbon–fly ash cement composites at 7,14 and 28 days.

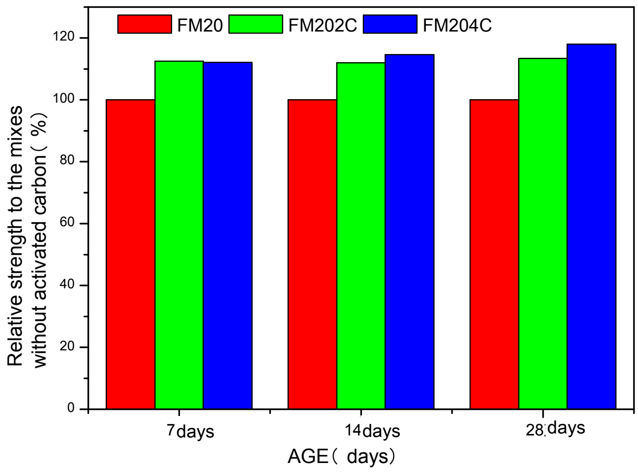


Figure 3: Relative compressive strength activated Carbon–fly ash cement composites to normal Portland cement.

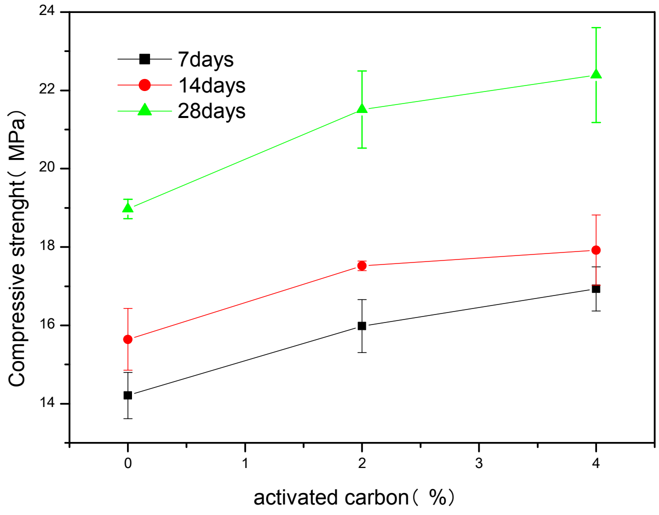


Figure 4: Effect of activated carbon on the compressive strength of Activated carbon–fly ash cement composites.

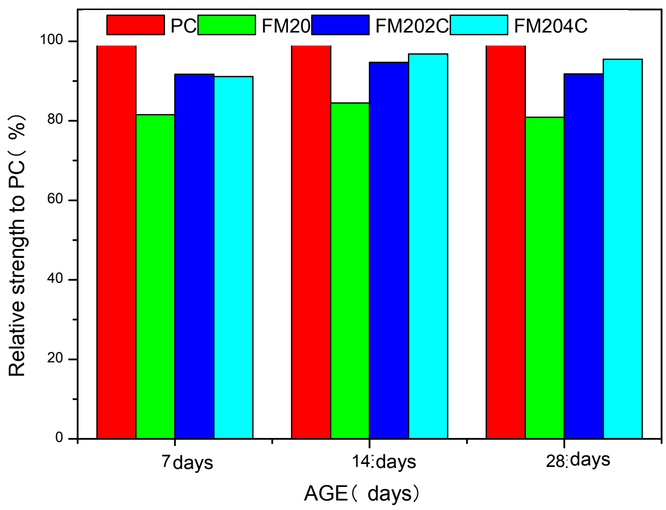
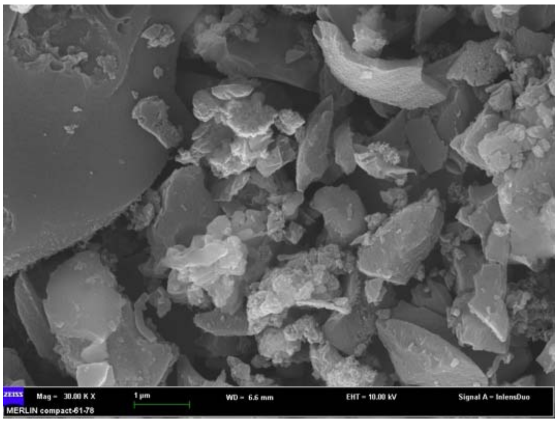


Figure 5: Relative compressive strength activated Carbon–fly ash cement composites to reference fly ash paste without activated carbon.

3.3 Enhanced activated carbon mechanism

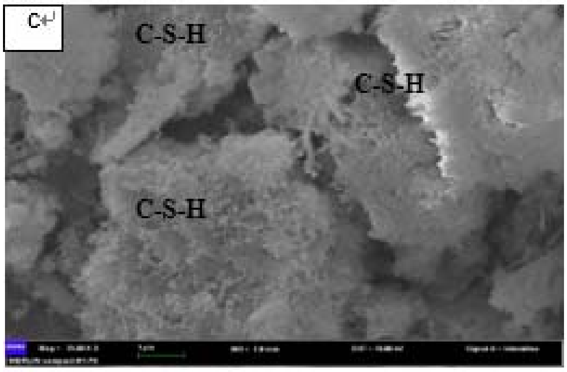
Fly - activated carbon cement mortar strength increased, activated carbon is thought to be due to further populating such as calcium silicate hydrate (CSH) and ettringite like hydration gap between the products caused. Figure 6 is activated carbon (a), of fly ash cement mortar (b) and activated carbon fly ash cement mortar (c) SEM image. From (c) is apparent in the structure of the activated carbon in the fly ash can be seen between a significant twist, indicating CSH some extent, so that the overall structure has been strengthened. In addition, activated carbon can be mixed with fly ash density test results (Figure 1) to give an explanation. In the compressive strength reaches the maximum density of cement-based composite material of Figure 1 although the ratio is not added activated carbon fly ash cement is even higher, but is slightly lower than that of ordinary Portland cement, which is mainly due to the activated carbon can making the material denser structure, but it does not continue to form the oxidation reaction product of such an impact strength such as C-

S-H (Pacheco-Torgal and Jalali, 2011). Therefore, it can be seen from the above results, the impact on the compressive strength of the activated carbon is to enhance the physical, chemical and fly ash is no mutual reaction between the cement and the activated carbon.



(a) activated carbon

(b) fly ash cement mortar



(c) activated carbon fly ash cement mortar

Figure 6: SEM image

4. Conclusion

The test results show that the addition of activated carbon in the fly ash cement mortar can improve the fly ash cement mortar compressive strength, increase its strength increases with activated carbon content increases; ash mixed with 20% + 4% activated carbon mortar highest, 28d compressive strength value 22.39MPa. In addition, activated carbon mixed with fly ash cement mortar compressive strength are significant; incorporation of 4% activated carbon, its fly ash cement matrix composites 28d compressive strength and resistance to ordinary portland cement material compressive strength considerably.

SEM showed that the activated carbon in the fly ash cement system can fill the gap hydration products calcium silicate hydrate (CSH) and ettringite such as between, so that the composite material than not adding activated carbon fly ash there cement microstructure and higher strength is more dense.

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