A Review on the Properties of Biomass Active Mixed Materials for Concrete

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Abstract. Experiment shows that wheat straw ash has rich biomass activity. Many scholars have shown that the strength, durability, freezing and thawing resistance of concrete have changed greatly after the wheat straw ash material is mixed into concrete as an active mixed material. This paper reviews and looks forward to the future development direction.

1 Overview of Wheat Straw Ash

Wheat straw is one of oligomers derived from advanced aliphatic derivatives, SiO_2 Natural organic polymer materials[1,2].All kinds of academic achievements published with straw and straw ash as research objects have increased year by year in recent ten years, and academic attention has been continuously raised. In view of the large yield of wheat straw, how to use it efficiently has become an important subject in the field of agriculture and ecological environment protection. The results show that wheat straw ash produced by ashing treatment has potential advantages and good prospects in ecological environment protection and treatment, development and research of green ecological building materials, etc.

2 Main Properties of Wheat Straw Ash

In one of study on the Characters of Biomass Straw Ash by Li Ye et al[3],The straw ash sample was obtained by heating the wheat straw to 815℃ at a rate of 6℃/ min. The structure and morphology of wheat straw ash were characterized by SEM, and the composition elements of wheat straw ash were analyzed by energy spectrometer. The microcrystalline structure of wheat straw ash was analyzed by XRD. As a result, the volatile matter ratio of wheat straw was more than 70%, and the highest chemical content of wheat straw ash was SiO_2, followed by K_2O, this proportion is consistent with the content of chemical composition in rice husk ash. But SiO_2 Content in wheat straw ash is only half of rice husk ash. The SEM results showed that the surface of wheat straw ash showed a smooth flake structure. The results of energy spectrometer showed that the content Si elements in wheat straw ash was the highest, followed by the content of K,Cl elements. XRD analysis results show that there are the following crystalline phases in wheat straw ash, mainly composed of quartz, square quartz, dolomite and kaolinite.

By XRD study, Xu Peng[4] found that wheat straw ash had a small hump, which indicates that the main structure of wheat straw ash after combustion is crystal and contains some amorphous compounds. The results of thermogravimetric analysis showed that the DTG of wheat straw ash appeared peak at 663℃,990℃ and 1180℃, and the weight loss began to accelerate at 910℃.

The results by Liu Ruizhi in Tianjin Cement Industry Design and Research Institute Co., Ltd[5] show that there are exothermic stages between 255℃~307℃, 403℃~443℃ in the combustion of straw, while the exothermic stage is concentrated in the lower temperature stage, and both stages have partial CO_2, CO release, in which alkanes and olefins are also released in the low temperature stage. By comparison, it is considered that the gas released by wheat straw under high temperature combustion has little effect on the environment and can be used in cement kiln.

The results by Xu Peng show that the active components of wheat straw ash have exceeded the composition requirements of C grade pozzolanic materials specified in the ASTM. Experimental results show that more than 50% content of SiO_2+Al_2O_3 in wheat straw ash, as well as 17.75% of the active ingredients, has better activity.

In one of research by Fucheng Wang[6] inHeilongjiang Bayi Agricultural Reclamation University ,the rice husk was naturally dried and calcined in a muffle furnace at 500℃ for 6 h, and the ash samples were determined. The results showed that the ash formation rate of rice husk was determined by burning 4 h and 2 h, at 500℃,600℃ and 815℃ temperature respectively. The results showed that the ash formation rate of rice husk was 11.87%, at 600℃. The relationship between the ash formation rate of straw and calcination time and calcination temperature is inversely proportional. That is, at the same calcination temperature,

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the ash formation rate of straw decreases with the increase of calcination time, and at the same calcination time, the ash formation rate decreases with the increase of calcination temperature.

The results show that the composite system of wheat straw-cement has a great contribution to the strength of concrete. Zhang Qiang[7] showed By adding silica fume and straw ash into concrete, the optimum content of silica fume was 10% when the compressive strength of concrete increased by 24%, while the proper proportion of straw ash could play an effective activity. The reason is that the effective component of straw ash is SiO_2.It plays a full role in the hydration reaction of cement and improves the strength of cementitious system. When the proportion increases, the cement in concrete slows down, which affects the strength of concrete.

In another study[8]According to the experimental study on the mechanical properties of straw ash concrete, the results show that when the content of straw ash increases from 10% to 20%, the ratio of 28d tensile strength reduction of concrete decreases from 25% to 45%. However, when the proportion of straw ash incorporation is between 0~10%, the influence on the compressive strength of concrete is small, and when the proportion of straw ashincorporation exceeds 25%, the compressive strength decreases significantly. By comparing the predicted value with the experimental value, the author thinks that the prediction of wavelet neural network can be used to predict the tensile strength and compressive strength of straw gray concrete. In the study, the suitable water-cement ratio under the optimum content is compared and the results show that the small or large water-cement is not conducive to the increase of concrete strength, while the suitable water-cement ratio is suggested to be controlled at about 0.5.

One study by Nabil M. in School of Engineering, Daman University, Saudi Arabia[9]show the effect of wheat straw ash on concrete resistance to freeze-thaw damage was studied. In the study, the durability of wheat straw ash concrete increased with the increase of 5%,10% and 15% cement content under the water-binder ratio of 0.5 and 0.7. Different aggregate types also show different states for freeze-thaw resistance of wheat straw ash concrete. The concrete containing pumice aggregate has higher freeze-thaw deterioration durability compared with concrete containing basalt aggregate. The aggregate type effect of wheat straw ash concrete is more obvious than that of ordinary concrete. wheat straw concrete showed higher durability under the water-binder ratio of 0.5 than 0.7. The results also show that the water-binder ratio, aggregate type and aggregate size have more obvious influence on durability than ordinary concrete. Nabil M. believe that when the water-to-cement ratio is 0.5 and the maximum aggregate size is 9.5mm, the aggregate is pumice aggregate, the concrete of wheat straw ash has the best resistance to freeze-thaw failure.

The results by Xu Peng[10] show that when the porosity is 20% and the content of straw ash is 10%, straw ash concrete also shows better performance in purifying water. This study is relatively bad for environmental conditions, or the design and manufacture of functional concrete for purifying water, such as the study of the water purification performance of permeable concrete under straw ash-cement composite cementitious system, in the construction of permeable storage and net discharge permeable system, It has good reference significance.

Some scholars[11] have shown that the amount of straw ash and the types and sources of straw ash have great influence on the performance of straw ash concrete. The analysis shows that when the content of straw ash in concrete is less, straw ash can enhance the compressive resistance of concrete. At the same water / binder ratio, the compressive strength of high strength concrete can be increased by more than 10 MPa when the substitution amount is 10% to 20% in the study of rice husk ash as admixture instead of some cement.

The experiment also shows that when the content of straw ash is too high, it will be unfavorable to the later durability of straw ash concrete.

With the increase of rice husk ash content in concrete, the compressive, flexural and flexural strength of concrete is reduced. It is considered that the content of rice husk ash is about 10%.

The results show that when the content of wheat straw ash is within 5%, the early strength of concrete can be improved, but the influence of wheat straw ash on the later strength of concrete is small.

The metal elements and unburned fixed carbon in wheat straw ash will accelerate the slump loss of straw ash concrete. The ease of concrete is reduced, which makes the construction and pouring difficult. With the increase of wheat straw ash content, the slump loss of concrete will be more and more large, and the existence of a large number of metal ions will lead to salting out in the later process of straw ash concrete, which will affect the durability of concrete.

By adding a certain amount of straw ash, it is found that the sulfate ion can be reduced into the concrete and the compactness of the concrete can be increased.

Because straw ash can be added into concrete to cause adverse effects on concrete, scholars believe that some other admixtures can be considered to reduce the adverse effects of straw ash, such as silica powder, which can improve the apparent density of concrete. Improve the ease of concrete.

The study[12] suggested that straw ash contained a lot of SiO_2 and Al_2O_3,. The results showed that But there's a certain amount of unburned carbon, The specific surface area of particles is large. As a concrete admixture, The large content of unburned carbon leads to the increase of water demand. Select the concrete admixture "flow ratio" and activity index as the reference value, The feasibility of straw ash as concrete admixture was investigated. Considering the large particle size of straw ash, At the same time, the feasibility of grinding straw ash as admixture was investigated. By analyzing the phase composition of hydration products of cement-straw ash system, Then the reaction mechanism was studied. The results showed that the biomass straw ash particles were irregular, mainly composed of SiO_2,Al_2O_3,CaO,K_2O and unburned carbon. Straw grays are irregular, Particle structure with high unburned carbon content is loose and porous, The particle structure

with large silicon and aluminum content is dense. XRD results show that the content of Ca $(OH)_2$ in cement hydration products can be significantly reduced by introducing straw ash into cement system, indicating that active components such as active SiO_2, Al_2O_3 in straw ash were involved in the reaction.

It is considered that the compressive strength of straw ash concrete is the decisive index to ensure that it meets the requirements of design and construction standards. At present, research is mainly based on the parameters of biomass ash. High strength concrete was prepared by harvesting and burning wheat straw ash and adding concrete in a certain proportion. The experimental results show that proper amount of straw ash can improve the early strength of concrete. When the content of straw ash is 5, the compressive strength of high strength concrete can reach 79.1 MPa. However, scholars especially mentioned that straw ash should be pretreated to reduce the content of alkali metal elements in ash. There are many ways of pretreatment, such as pickling. But at present, the strength test is rarely carried out at home and abroad, which is based on the perfect and optimal straw ash content. Therefore, it is considered that the preparation technology, mix ratio design method and constitutive relation model of straw ash concrete must be studied systematically and deeply, so as to further optimize the preparation process of crop straw ash, at the same time, to control the ash and to strengthen the innovation of practical and technical mix ratio design method and preparation technology of straw ash concrete[13].

Public data at home and abroad show that thermal conductivity is the main index of thermal physical properties of building materials, and also the control index of thermal insulation, heat insulation and energy saving of building enclosure structure system. At present, there are few researches on the thermal physical properties of biomass ash concrete. The preliminary results show that the biggest advantage of using biomass ash instead of some cement to make concrete is that it can improve the thermal resistance of concrete, which points out a new way to make green concrete. Some scholars have used rice husk ash to replace cement, and found that the thermal resistance rate of rice husk ash concrete is obviously higher than that of ordinary concrete, but there is still a lack of systematic and in-depth conclusion. In fact, the strength and thermal conductivity of concrete and the apparent density of materials show a complex contradiction. It is considered that reducing the thermal conductivity of straw ash concrete is the key to study the thermal physical energy of straw ash concrete.

3 Conclusions

The research home and abroad shows that wheat straw ash, as one of the important admixture materials in concrete, shows good green environmental protection, environmental friendliness and ecological cyclability, which will play a great role in the construction of ecological civilization, and can also be transformed into economic benefits in the process of promoting ecological civilization. For the study of wheat straw ash adaptability in concrete, at the macro level, in the future, focusing on the benefits of ecological civilization and economic benefits, starting with the LCA analysis method, fully consider the cost of wheat straw ash concrete production, use, operation and maintenance, management, etc. Provide green building materials for sponge city construction.

At the micro level, we can focus on cracking the heat of wheat straw concrete in improving concrete Bottlenecks in terms of industrial, mechanical and durability properties, such as K^+.The effect on straw ash concrete, effectively avoiding alkali aggregate reaction and solving the problem of poor rheological properties of straw ash concrete can also be studied in the second generation new cement production line.To explore the production of a new type of cement under extreme climatic and environmental conditions such as hypoxia, alpine, high altitude, weathering and erosion.

At the same time, the mechanism of the composite cementitious system can be further analyzed by comparing the microstructure and morphology, properties and manifestation of the cement single cementitious material in the process of hydration and condensation hardening.

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