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The overview for the development of sea-sand concrete and recycled concrete

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Abstract. With the continuous development, the demand for concrete has increased. But the supply of raw materials is insufficient. So, the research should be conducted on new types of concrete. There are new types of concrete with materials such as seawater sea-sand concrete and recycled concrete. This paper summarizes the latest progress about mechanical properties of these two materials and summarizes the results of a large number of scholars on the mechanical properties of seawater sea sand concrete and recycled concrete. Their relevant research is in line with the requirements of carbonaceous peaking and carbon neutral strategy.

Keywords: seawater sea-sand concrete; recycled concrete; mechanical properties.

1. Introduction

With the development of the construction industry, the amount of sand used for concrete is growing. Especially for China's marine areas, the lack of fresh water, gravel, river sand and other conventional construction raw materials terrestrial raw material supply scarcity. In order to achieve sustainable development, it is very practical and economical to research new types of concrete.

Among them, seawater sea sand concrete is used in concrete with sea sand instead of river sand. Recycled concrete is new concrete prepared by recycling some waste concrete blocks, crushing them, then cleaning and grading them, and then mixing them with cement, sand and water in the corresponding proportions. Its key role is to be able to fully recycle as a construction material. So limited resources can be reused, solving part of the environmental problem.

2. Research progress of seawater sea-sand concrete

Marine engineering is a field that China and the world are trying to develop and build.

Sea sand concrete is sea sand used in place of river sand in concrete, and consists of sea sand and other raw materials. Sea sand concrete cannot be made with sea sand alone. It needs to be used in conjunction with artificial or natural sand, and ordinary silicate cement, and also needs to ensure that the chloride ion percentage of that cement is less than 0.025%. Several other admixtures, such as fly ash and silica fume, are also required. The content of chloride ions in the water body should be strictly controlled, i.e. low 250mg/L.

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2.1. Research progress of seawater sea-sand concrete material

In terms of research on sea sand concrete, domestic research in recent years has focused on high performance concrete and durability.

Qi reviewed the progress and results achieved in recent years in earlier domestic research on sea sand concrete and pointed out some urgent problems in the research on sea sand concrete: the treatment of sea sand the cost of sea sand desalination is relatively high [1].

Li et al. analyzed the hazards of using seawater, coral instead of inland river sand to reduce the durability of reinforced concrete structures. Preferably high efficiency rust inhibitor or new special steel bars such as new corrosion resistant steel bars, stainless steel bars and titanium bars [2].

Yang combined three green resources of recycled aggregate, sea-sand and seawater to form Recycled aggregate sea-sand concrete (RASC) to replace ordinary concrete. And introduced lightweight, high-strength and corrosion-resistant fiber reinforced polymer (FRP) materials to strengthen the structure, which can realize the regeneration of resources, and make the structure significantly improved in strength and ductility [3].

Zhou prepared basalt fiber reinforced seawater sea sand cement matrix composites. Ordinary basalt fibers are poorly reinforced by the greatest degree of strength deterioration [4].

2.2. Mechanical properties of seawater marine sand concrete members

Lu and others used seawater coral sand to make plain concrete, and through experiments found that the concrete has sufficient strength. If in the lack of fresh water and river sand conditions such as the island, as long as the appropriate increase in concrete grade, a little more than the amount of cement than the general concrete, reduce the water-cement ratio, you can get enough performance, so that the concrete in roads, flooring and anti-wave dams and other plain concrete project use [5].

Chen found that seawater mixed with coral sand can meet the various mechanical properties of sea sand concrete [6].

Limeira J et al. found that the basic mechanical properties are basically the same as those of river sand, and sea sand in its original state can be used as equivalent to river sand. If used together with steel reinforcement, the reinforcement must be treated with antirust treatment [7].

Yan et al studied the effect of admixtures on the strength of seawater marine sand concrete by experimental method. And the test results showed that different admixtures had different effects on the strength of concrete, among which slag had a strong effect on the late strength growth, and fly ash had the greatest effect on the amount of late strength growth of concrete [8].

Li et al. experimentally concluded that it has a relatively low modulus of elasticity compared to normal concrete. The mechanical properties can be improved after adding fly ash and slag [9].

Liu et al. test results show that the sea sand concrete has better mechanical properties compared with ordinary river sand concrete. Sea sand can be used instead of river sand without considering the corrosion of reinforcement. The chloride salts in the sea sand and a small number of shells have little effect on the mechanical properties of the concrete [10].

Chen et al. studied that the effect of sea sand substitution rates on the mechanical properties was not significant [11].

Li et al. found that the flexural and compressive strengths of concrete at 28 d were reduced compared to normal concrete, and found that the use of hot water curing improved the flexural and compressive strengths [12].

Xiao et al. designed and produced recycled concrete from seawater sea sand and found that the recycled aggregates had a greater effect on the mechanical properties of the concrete compared to seawater sea sand [13].

Guo Dong et al. results showed the strength of seawater mixed coral reef sand concrete developed faster in the early stage but grew slowly in the later stage, and the flexural and splitting tensile strengths were higher than those of ordinary. There is no significant difference compared with concrete. [14].

Qin found that seawater sea-sand concrete had better basic mechanical properties compared with ordinary concrete. [15].

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It was found that the mechanical properties of seawater marine sand concrete containing steel fibers were low, but the difference gradually decreased as the strength level of concrete and the amount of steel fibers were increased [16].

Geng et al. studied marine sands from several regions and showed that the mineral fraction, fineness modulus and crushing value of marine sands were essentially the same as those of river sands. The chloride ion content varied in different regions. The pore structure development patterns of Seawater sea-sand concrete (SWSSC) and Ordinary concrete(OC)were found to be consistent with their mechanical property development patterns [17].

3. Renewable concrete research progress

Recycled concrete is a new concrete prepared by processing some discarded concrete blocks so that they partially or fully replace natural aggregates, and then mixing them with cement, sand and water in the appropriate proportions.

3.1. Research progress of renewable concrete materials

Zhang conducted a more comprehensive study and analysis of the material properties of recycled concrete such as workability, deformation performance, and durability performance through a series of indoor tests [18].

Xiao concluded that the basic properties of recycled concrete are closely related to the properties of recycled aggregates and the microstructure of recycled concrete. To improve the various properties, it should be studied from the optimization of the production process of recycled aggregates, pretreatment of aggregates, ratio design and microstructure, etc [19].

The results of Du and others showed that the slurry can fill the pores of the recycled aggregate to some extent and bond some micro-cracks generated inside it during the crushing process. [20].

Ke found that when the replacement rate of recycled aggregate is 0-60%. Its slump is not much different from the base concrete and the slump loss is not much [21].

Xiao et al investigated the effects of recycled coarse aggregate replacement rate, addition of polymer damping materials, boundary conditions [22].

Lu concluded that the incorporation of waste concrete less than 20% can give full play to the best performance of recycled concrete [23].

3.2. Progress of research on mechanical properties of renewable concrete members

A large amount of waste concrete is crushed and screened into Recycled Aggregate (RA), which replaces natural aggregates in the preparation of Recycled Aggregate Concrete (RAC).

3.2.1. Strength

3.2.1.1. Compressive strength. Wang et al found that increasing the RA substitution rate and sand rate instead decreased the compressive strength of RAC. Meanwhile, high efficiency water reducing agent can effectively improve the mechanical properties [24];

Ni et al showed that the mechanical strength increased with the increase of recycled coarse aggregate replacement rate. The porosity of RAC mixed with 70% RA was maximum [25].

Wang concluded that the water-cement ratio has the greatest effect on the compressive strength [26].

The analysis by Li et al found that it increases as the volume admixture of steel fiber increases at both 50% and 100% RA replacement rate [27].

3.2.1.2. Flexural strength. Lu found that the flexural strength of RAC was highest when the RA substitution rate was 20% [28].

The result of Zheng et al. showed that RAC in cold regions increased and then decreased with increasing RA replacement rate, with the highest flexural strength of RAC with 30% RA and the lowest with 100%. [29].

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Han et al found that single admixture of polyacrylonitrile fiber or polyacrylonitrile imitation steel fiber had an enhancement effect on it [30].

The results of Su et al showed that the overall effect of different fiber admixture on the cubic compressive strength showed an increase and then a slow decreasing trend. And the overall increase effect is: steel fiber is the biggest [31].

3.2.1.3. Splitting tensile strength. Zhang et al found that the best strengthening effect was achieved when the ratio of rice husk ash to kaolin was 3:1 [32].

Chen et al found that the amount of recycled coarse aggregate is increased, splitting tensile strength and axial compressive strength decrease [33].

Meanwhile, many researchers have improved the RAC strength by various ways. Wang et al used polypropylene fibers and steel fibers to improve the RAC so that its splitting tensile strength was improved [34].

Zhou et al found that the RAC showed a positive correlation with the amount of high-performance polypropylene fibers [35].

Go et al found that the addition of nano-SiO2 effectively improved the splitting tensile strength of RAC [36].

3.2.2. Deformation characteristics.

3.2.2.1. Modulus of elasticity. Xue et al found that the influence of unit water consumption was greater than that of sand rate [37]. Wang Ruijun et al found that the increase in RAC substitution rate decreases the modulus of elasticity [38]. Analysis by Hu et al. showed that the RAC is 15% to 25% lower than that of ordinary concrete [39]. Xiao et al, pointed out that the crushing process of waste concrete can also lead to the reduction of RA quality, which in turn affects the compactness and elastic modulus of RAC [40].

4. Conclusions

The following conclusion:

1. In terms of research on sea sand concrete, domestic research in recent years has focused on high performance concrete, composite materials and how to improve durability by reducing the water-cement ratio and incorporating fly ash to help improve mechanical properties.

2. To improve the various properties of recycled concrete should be studied from the optimization of the production process of recycled aggregates and microstructure of recycled concrete. The research mainly focuses on the effects of aggregate gradation, cement incorporation ratio, etc. on the mechanical properties such as tensile and flexural strength, and seeks the best performance of recycled concrete.

3. The results of the study show that the rational design of the material has met the basic requirements and is feasible in civil engineering. It needs to be more intelligent and establish relevant mathematical models for research and improvement.

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