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Influence of Natural Forest Covered Quarry Stone Powder on the Performance of Recycled Concrete with Manufactured Sand Based on Matrix Analysis Method

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Abstract:

The local climate of the jungle covered area is special. Compared with the climate of bare areas outside the forest, it has obvious marine climate characteristics, such as small daily and annual temperature range, high humidity, more precipitation and small wind speed. Therefore, the collected quarry stone powder also has different characteristics. In order to study the influence of stone powder content in manufactured sand and replacement rate of recycled coarse aggregate on tensile and compressive properties of concrete. The recycled concrete blocks with different stone powder content (0,5%, 10%, 15%) and different replacement ratio of recycled coarse aggregate (0,33.3%, 66.6%, 100%) were made. A total of 96 standard cubes were used for compressive and splitting tensile strength tests, and 48 standard prism blocks were used for compressive strength tests. In this paper, the influence of single factor and double factor coupling on the tension and pressure is analyzed. The test results show that a certain amount of stone powder in manufactured sand can promote the improvement of cube compressive strength, prism compressive strength and splitting tensile strength. With the increase of replacement rate of recycled coarse aggregate, the compressive strength and splitting tensile strength first decrease and then increase. In this paper, the relationship between cube compressive strength and splitting tensile strength as well as the relationship between cube compressive strength and prism compressive strength are obtained by fitting analysis.

***Keywords**: Natural Forest, Stone Powder Content, Compressive Strength, Recycled Coarse Aggregate.*

I. INTRODUCTION

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Fine aggregate for ordinary concrete mainly includes natural sand and machine-made sand. Among them, natural sand is naturally generated, and the mechanism sand particles which are mined and screened by artificial means are less than 4.75mm, including mountain sand, Lake sand, desalinated sea sand and river sand [1-2]. Remove weathered and soft particles. The mechanism sand is first removed from the soil, and then obtained by mechanical crushing and screening. The particle size of the particles is less than 4.75mm (square hole sieve), rock particles, tailings or industrial waste slag particles, and the weathered and soft particles are also removed. It is commonly known as machine-made sand [3]. On the one hand, with the rapid development of the construction industry, the amount of concrete is more and more large, and the natural sand resources are more and more tense. Many places have caused serious environmental pollution problems due to indiscriminate mining and excavation. On the other hand, China's current standards have strict restrictions on the content of stone powder in machine-made sand [4-5]. In 2002, the state promulgated "sand for building" (GB / T14684-2001) for the first time explicitly regulated the application of machine-made sand in concrete, which has played a promoting role in the promotion and application of machine-made sand in concrete [6].

Concrete industry is a serious resource consumption and resource dependent industry [7-9]. In today's sustainable development, concrete industry must also take the road of sustainable development, saving resources, reducing energy consumption and reducing environmental pollution. On the one hand, the sustainable development of concrete is to improve its performance and service life; On the other hand, more industrial wastes and less natural resources are used in concrete production. Therefore, it has both social and economic benefits to study the characteristics of manufactured sand and the performance of manufactured sand concrete.

II. BASIC PROPERTIES AND TEST METHODS OF RAW MATERIALS

2.1 Basic properties of raw materials

(1) Cement

P.O.42.5R cement produced by Chongqing Xincai Company (used to study the influence of MB value of manufactured sand on concrete performance and concrete mix ratio optimization) and Lafarge was adopted [10].

(2) Limestone powder

The fineness, density and MB value of the stone powder obtained by machine-made sand with 75um square hole sieve are 280m^2/kg, 2.71g/cm^3,MB and 1.2 respectively.

(3) Machine-made sand

Machine-made sand used to study the influence of characteristics in machine-made sand on concrete performance is manually screened by 75um square hole sieve, and the stone powder content is 1.8%.

(4) Water reducing agent

The experimental dosage of naphthalene water reducer is 1.5%~2.4% of the total amount of cementitious materials, and the dosage of polycarboxylate water reducer is 1.4%~1.8%.

(5) Tap water is used for concrete mixing and distilled water is used for chloride ion penetration test of concrete.

(6) Soil

Clay from mount mount, Geleshan rock and soil and three kinds of clay near the process laboratory in high-tech zone were respectively ground for 10min and 20min with a small vibration mill.

2.2 Experimental method

According to "Standard for Test Methods of Ordinary Concrete Mixtures" (GB/T 50081-2002), "Standard for Test Methods of Mechanical Properties of Ordinary Concrete" (GB/T 50081-2002) and "Standard for Test of Long-term Performance and Durability of Ordinary Concrete" (GB/T50082-2009).

(1) Early crack resistance test method

The early crack resistance test of concrete should be carried out with reference to the Standard for Long-term Performance and Durability Test of Ordinary Concrete GB/T-50082. However, in this experiment, the mold used is not the standard size, but a steel mold of 600mm×400mm×100mm with three crack inducers. Among them, the middle one is the easiest to induce. In this experiment, a steel plate with a thickness of 10mm is placed under the mold, so as to make concrete cracks appear more easily. In this test, the water loss rate of concrete was measured at the same time, and the whole induced cracking process lasted for 6 hours.

(2) Sulfate corrosion resistance test of concrete

The sulfate attack resistance test of manufactured sand concrete is carried out according to Standard for Test Methods of Long-term Performance and Durability of Ordinary Concrete (GB/T50082-2009), and cube specimens with dimensions of 100mm×100mm×100mm are adopted. There are 3 blocks in each group, and 3 groups are formed, which are also formed by using 100mm×100mm×100mm plastic 3 continuous molds, and then moved into the standard curing room for curing after removing the molds. The specimens were taken out of the standard curing room 2 days before the age of 28 days, dried at (80 5)℃ for 48 hours, and then cooled to room temperature. One group was taken to measure the compressive strength to verify the 28-day strength of concrete, one group was taken to carry out dry-wet cycle, with the total time of each cycle being 24 hours, and the remaining group was put into the curing room to keep the original curing conditions and continue curing. Due to the limited time, the compressive strength loss of concrete can only be tested after 15 cycles, which is expressed by the compressive strength corrosion resistance coefficient (Kt), and the influence of stone powder

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content in manufactured sand on the sulfate attack resistance of concrete can be judged. Compressive strength and corrosion resistance coefficient of concrete are calculated according to the following formula:

$$K_t = \frac{f_{cn}}{f_{cC}} \times 100 \quad (1)$$

In which Kt is the compressive strength corrosion resistance coefficient, and f_{cn} is the compressive strength measured value (MPa) of a group of concrete specimens eroded by sulfate after n cycles, which is accurate to 0.1MPa . f_{cC} is a set of compressive strength measured values (MPa) of comparative concrete specimens with standard curing at the same age as those corroded by sulfate, which is accurate to 0.1 MPa.

III. INFLUENCE OF STONE POWDER CONTENT IN MANUFACTURED SAND ON CONCRETE PERFORMANCE

3.1 Influence of stone powder content in manufactured sand on concrete performance

The workability of concrete includes fluidity, cohesiveness and water retention. It is not only an important index for construction, but also restricts the performance of hardened concrete to a great extent. Therefore, the research group has tested the influence of the content of stone powder in the sand of 3%, 7%, 10%, 15% and 20% on the slump, cohesion and water retention of C30 concrete. The test results are shown in table 4.2 and figure 4.1. The influence of the content of stone powder in the sand of 3%, 7%, 10%, 15% and 20% on the slump, cohesion and water retention of C30 concrete is shown in Figure 1.

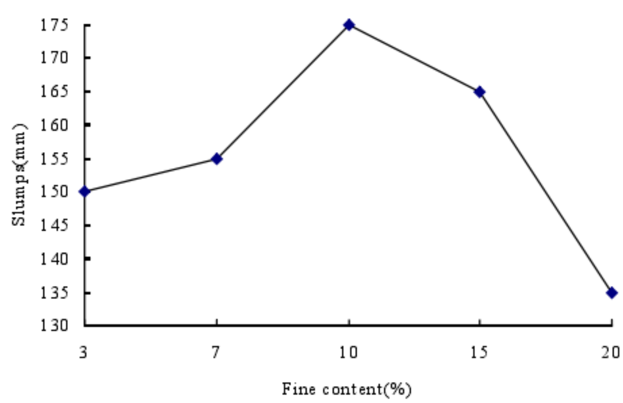

Fig 1: Influence of stone powder content on slump of C30 concrete

It can be seen from Figure 1 that the slump of ordinary silicate concrete with strength grade of C30 increases with the increase of stone powder content when the stone powder content is

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less than 10%, and decreases with the increase of stone powder content when the stone powder content is more than 10%. The reason for this phenomenon may be that the fineness of stone powder is close to the fineness of cement. Adding a certain amount of stone powder into machine-made sand concrete can make up for the deficiency of paste material in sand concrete and increase the total amount of paste, especially in the low strength concrete with less cementitious materials.

At the same time, the addition of stone powder can make up for the disadvantages of machine-made sand, such as angular and rough surface, and reduce the friction between machine-made sand and machine-made sand. It is found from the figure that C30 concrete has the largest slump when the stone powder content is 10%. When the content of stone powder exceeds 15%, the slump of concrete decreases, which may be because the stone powder increases the slurry of the mixture and reduces the friction between sand and sand. However, when the content of stone powder is too high, the total powder volume in the mixture system increases, which leads to the increase of water demand, the consistency of the slurry formed by the powder and water, the increase of the cohesion of concrete and the decrease of slump.

3.2 The influence of the content of stone powder in the mechanism sand on the shrinkage performance of concrete

Shrinkage of concrete is one of the most important deformation properties of concrete, and dry shrinkage is the most important shrinkage in concrete, accounting for 80% - 90% of the total shrinkage of concrete. As for the mechanical sand concrete, the stone powder in the mechanism sand has two effects on the drying shrinkage of concrete: first, the stone powder increases the total amount of concrete slurry, increases the shrinkage of concrete, and has adverse effect on the shrinkage of concrete. On the other hand, the stone powder in sand can fill the concrete pores, which can play the filling effect, increase the density of concrete structure, restrain the dry shrinkage of concrete, which is beneficial to the shrinkage of concrete.

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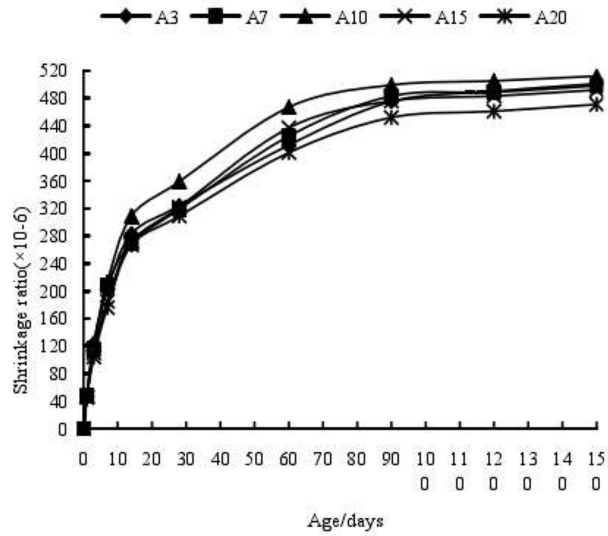

Fig 2: Influence of stone powder content on drying shrinkage of C30 concrete

(1) Effect of stone powder content in manufactured sand on drying shrinkage of C30 manufactured sand concrete

Figure 2 shows the dry shrinkage rate of C30 machine-made sand concrete with different stone powder content at different ages. It can be seen from the figure that the dry shrinkage rate of concrete with different stone powder content in one day is roughly the same, and the later the dry shrinkage rate is, the greater the difference is. The dry shrinkage rate of machine-made sand concrete with stone powder content of about 10% is the largest among all the stone powder content. When the stone powder content is less than 10%, the dry shrinkage rate of C30 concrete increases with the increase of stone powder content; When it is higher than 10%, the dry shrinkage of C30 concrete increases with the increase of stone powder content.

(2) Effect of stone powder content in manufactured sand on drying shrinkage of C40 manufactured sand concrete

Figure 3 shows the dry shrinkage of C40 concrete with different stone powder content. Compared with C30 concrete, generally speaking, the drying shrinkage rate of C40 concrete is larger, because the amount of slurry in C40 concrete is more than that of C30 concrete. In the figure, the stone powder content of C40 concrete with the maximum dry shrinkage rate is about 7%, but the stone powder content of 10% concrete has little difference with that of 7%, so it can be inferred that the stone powder content of C40 concrete with the maximum dry shrinkage rate should be between 7% and 10%. When the stone powder content exceeds 10%, the dry shrinkage rate of C40 machine-made sand concrete decreases with the increase of stone powder content, and the one-day dry shrinkage rate of machine-made sand concrete increases with the increase of stone powder content.

(3) Effect of stone powder content in manufactured sand on drying shrinkage of C60 manufactured sand concrete

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Figure 4 shows the dry shrinkage of C60 concrete with different stone powder content. It can be seen from the figure that the change of dry shrinkage rate with the content of stone powder is affected by the age. The change of dry shrinkage rate with the content of stone powder is different with the age. It can be seen from the figure that the 1-day and 3-day dry shrinkage of C60 machine-made sand concrete basically shows an upward trend with the increase of stone powder content, and the concrete with the highest stone powder content has the largest dry shrinkage. However, with the increase of age, the dry shrinkage rate of concrete changes. The concrete with 8% sand powder content has the largest dry shrinkage rate in the later age. When the stone powder content is higher than 8%, the dry shrinkage of concrete decreases with the increase of stone powder content. When the stone powder content is lower than 8%, the dry shrinkage of concrete increases with the increase of stone powder content.

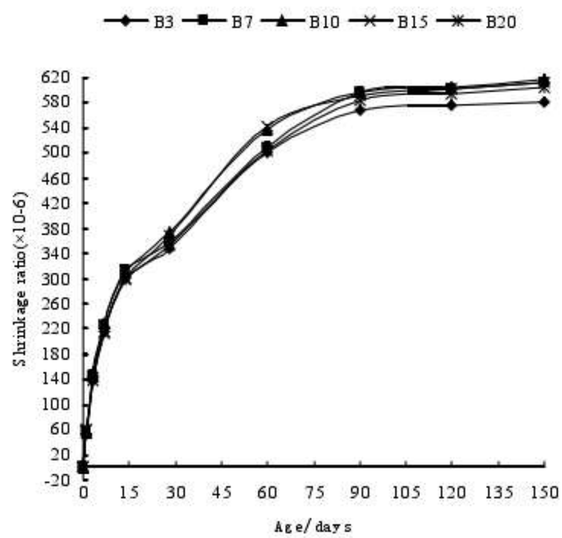

Fig 3: Influence of stone powder content on dry shrinkage of C40 concrete

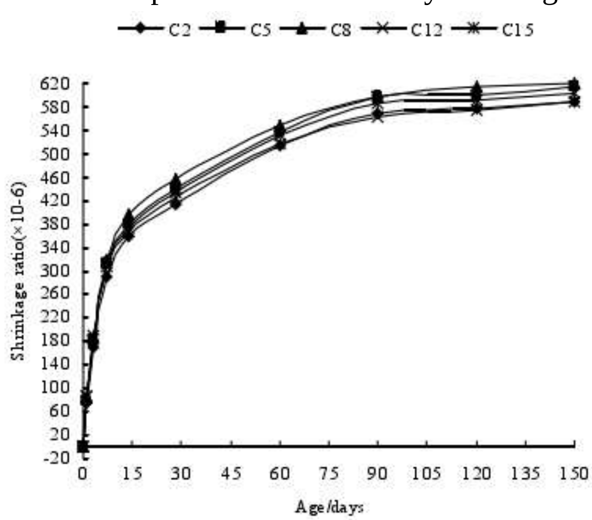

Fig 4: Influence of stone powder content on dry shrinkage of C60 concrete

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IV. CONCLUSION

The influence of stone powder content in machine-made sand on the drying shrinkage of concrete is studied. The stone powder content of machine-made sand with the maximum drying shrinkage of C30 and C40 concrete is 10%, and that of C60 concrete is 8%. There are two rules that affect the early crack resistance of machine-made sand concrete: first, with the increase of stone powder content in random sand, the early crack resistance of concrete shows a downward trend, and the higher the stone powder content is, the lower the early crack resistance of concrete is. Second, the higher the strength grade of machine-made sand concrete, the lower the early crack resistance of concrete. The increase of stone powder content in sand will reduce the chloride ion penetration resistance of concrete. However, the influence of stone powder content in manufactured sand on concrete is not obvious. The test results show that the stone powder in machine-made sand can improve the sulfate resistance of concrete. When the stone powder content of C30 and C60 reaches 20% and 15% respectively, there is no corrosion.

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