ISSN: 2414-1895 DOI: 10.6919/ICJE.202112_7(12).0048

Effect of basalt fiber on moisture content and compressive strength of rubber ceramsite concrete

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Abstract

With the rapid development of China's social economy, various industries have made certain progress, among which the development of the construction industry is more prominent. In addition to being affected by the outside world, concrete itself also exists many factors that affect its performance. This experiment is to explore the effect of moisture content on the compressive strength of concrete. The water absorption rate of concrete will seriously affect the mechanical properties of specimens, and the test results show that the compressive strength of the composite with higher water absorption rate is weaker, showing an obvious negative correlation. Considering the relation between the porosity and water absorption of concrete, it is considered that the cavity volume can be characterized by the change curve of water absorption.

Keywords

Rubber ceramsite concrete, Basalt fiber, The compressive strength, Bibulous rate.

1. Introduction

With the rapid growth of car ownership in China in recent years, according to statistics, the number of motor vehicles reached 310 million by the end of 2017. Among them, the national car PARC reached 217 million, an increase of 23.04 million or 11.85 percent over the previous year. With the growth of China's car ownership, China's tire industry has also developed rapidly in recent years, China's tire industry to achieve rapid growth since 2006 has steadily ranked the world's largest tire producer and rubber consumer, tire output accounts for about a quarter of the world's total output[1-3]. According to statistics in 2020, China's monthly average output of rubber tires has reached 68,206,000, but with the significant increase in car ownership in China, the production of waste tires is bound to grow rapidly, according to statistics at the end of 2017, the number of waste tires more than 300 million, ranking first in the world. Under the influence of objective factors such as the annual increase in car ownership, scrapping of cars, and replacement of models, the scrapping rate of tires will remain between 6% and 8% each year [2,4,5].

Waste tires are harmful solid wastes, which take hundreds of years to decompose naturally. If we don't take effective measures to recycle, we will not only waste resources but also cause serious environmental pollution[6]. Recycling is around the corner, now the development of new type concrete research is underway, if the waste rubber applied to the development of the new type of concrete, after crushing waste rubber tire in mixed into concrete, not only can increase the toughness of concrete, improve its impact resistance and seismic performance, and can solve the problem of a large amount of waste rubber recycling[7].

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The compressive strength of concrete, as a performance index of the normal use of concrete, is the most priority in the preparation of concrete, which involves a lot of influencing factors, because many foreign researchers found that the concrete working in the water environment is low compressive strength, elastic modulus increases. Therefore, this paper will focus on the basalt fiber mixed with rubber ceramsite concrete, concrete internal factors (namely moisture content) on its compressive performance of the role of research[8].

Water content is the actual water content of the rock index, in civil engineering refers to the mass of water in the soil mass and soil particle mass ratio, expressed by percentage. In soil mechanics, we can recognize that water content is an important index to judge the porosity of the soil, but its influence on the compressive strength of concrete remains to be further studied. The following is our research on the influence of moisture content on concrete strength[9-10].

2. Test

2.1 Raw material parameters

Cement: The cement is made from Chongqing Huanxin Yanjing Cement Co., LTD. The production of composite Portland cement P.C42.5R, in line with the national "general Portland cement" (GB175-2007) in Portland cement requirements.

Ceramsite: clay ceramsite produced by Chongqing Caiyunshan Ceramsite Factory is adopted. See Table 1 for specific properties

Rubber: 16 mesh rubber produced by Sitong Rubber and Plastic Co., LTD., see Table 2 for specific parameters

Basalt fiber: the basalt fiber produced by Haining Anjie Material Co., Ltd. is used, and its specific performance indicators are shown in Table 3.

Table 1. Performance parameters of ceramsite

Particle diameter	Density grade	bulk density	water content	apparent density	water absorption
(mm)		(kg/m^3)	(%)	(kg/m^3)	(%)
0-10	500	476	16.63	758.97	5.53

Table 2. Performance parameters of rubber

Particle diameter	mean grain size	bulk density	ash content	apparent density	water absorption
(mm)	(mm)	(kg/m^3)	(%)	(kg/m^3)	(%)
0-1.18	1	1120	1<	1052	3<

Table 3. Performance parameters of basalt fiber

Operating Temp	sintering temperature	Linear Density	elasticity modulus	Density	tensile strength
(℃)	(℃)	(μm)	(GPa)	(kg/m^3)	(MPa)
-269-650	1050	7-15	91-110	2630-2650	3000-4800

2.2 The experimental method

Six standard test blocks were randomly selected and compared in pairs. After 24 hours of air drying under natural conditions, the compressive strength of the two test blocks was measured after there was no obvious clear water on the surface. Then carry on the moisture content determination experiment, the experimental test block is dry weigh the dry weight of the test block, and then put the

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test block into the water to soak to saturated state, weigh its wet weight, through the measured data to calculate the moisture content of the test block.

According to the applicable technical standards of lightweight aggregate concrete and the preliminary test, the optimal ratio is selected for the next qualification test, and the results are shown in the following table. Samples are numbered in the form of X-X-Y-Y-Z-Z, where X represents the content of basalt fiber, Y represents the length of basalt fiber, Y represents the specific number of basalt fiber length and Z represents the ratio of rubber content. Result analysis simplified the grouping into x-Y-Z form. Basalt fiber as admixture, by volume percentage directly added. Replace rubber particles, equal volume in proportion to replace river sand.

2.3 Sample preparation

Ordinary ceramsite concrete is prepared according to the Technical Standard for Application of Lightweight Aggregate Concrete (JGJ/T 12-2019).

Table 4. Mix proportion (kg / m3)

Materials / ID	ceramsite	cement	water	rubber	fly ash	dosage	length
X-0.2-Y-9-Z-10	792.15	379	180	22.3	85	0.2%	9
X-0.4-Y-9-Z-10	792.15	379	180	22.3	85	0.4%	9
X-0.6-Y-9-Z-10	792.15	379	180	22.3	85	0.6%	9
X-0.2-Y-9-Z-20	792.15	379	180	39.8	85	0.2%	9
X-0.2-Y-12-Z-30	792.15	379	180	59.9	85	0.2%	12
X-0.2-Y-18-Z-30	792.15	379	180	59.9	85	0.2%	18
X-0.2-Y-9-Z-30	792.15	379	180	59.9	85	0.2%	9
X-0-Y-0-Z-10	792.15	379	180	22.3	85	0	0
X-0-Y-0-Z-0	792.15	379	180	0	85	0	0

2.4 Experimental data and analysis

Samples are numbered in the form of A-A-B-B-C-C, where A represents the content of basalt fiber, B is the length of basalt fiber, C is the specific number of basalt fiber length and Z is the ratio of rubber content. Result analysis simplified the grouping into A-B-C form. Basalt fiber as admixture, by volume percentage directly added. Replace rubber particles, equal volume in proportion to replace river sand.

2.4.1Data

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DOI: 10.6919/ICJE.202112_7(12).0048

Table 5. Data record sheet

ID / IDMaterials	Dry eight g	Wet weightg	The moisture content %	The compressive strength MPa	
				3d	28d
0.2A-9B-10C	1213	1351	11.33	5.27	6.88
0.4A-9B-10C	1193	1321	10.67	6.27	8.92
0.6A-9B-10C	1230	1345	9.32	8.12	10.97
0.2A-9B-20C	1175	1312	11.59	5.23	7.02
0.2A-9B-30C	1208	1356	12.18	4.98	6.02
0.2A-12B-30C	1187	1329	11.88	5.99	8.42
0.2A-18B-30C	1177	1323	12.37	5.67	6.98
0A-0B-10C	1198	1345	12.19	5.24	5.98

2.4.2 The data analysis

The water mass in the test block can be calculated by the dry weight and wet weight of the test block, so as to get the moisture content of the test block, and the moisture content of the test block can be obtained by the ratio of moisture content and dry weight of the test block.

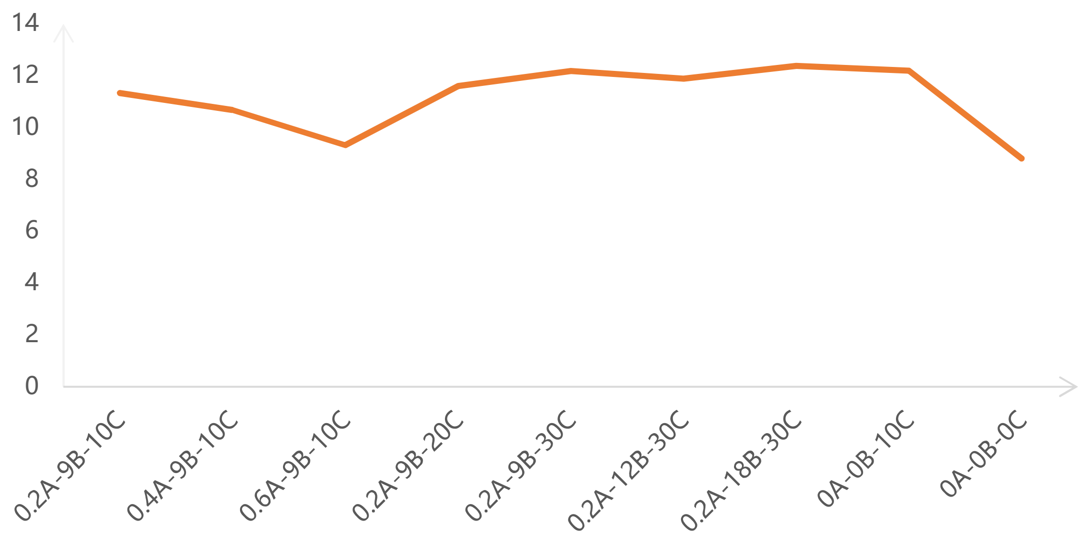

Figure 1. Diagram of water absorption variation

It can be concluded from the figure 1 that the water content of 0.2-9B-10C is 11.33%, 0.4-9B-10C is 10.67%, 0.6-9B-10C is 9.32%, 0.2-9B-20C is 11.59%, and 0.2-9B-30C is 12.18%. The water content of 0.2A-12B-30C, 0.2A-18B-30C, 0A-0B-10C and 0A-0B-0C is 11.88%, 12.37%, 12.19% and 8.8% respectively. The compressive strength of the 0.2A-9B-10C block was 5.27mpa after curing for 3 days, and 6.88mpa after curing for 28 days. The compressive strength of the 0.4A-9B-10C test block is 6.27mpa after curing for 3 days and 6.235mpa after curing for 28 days. It can be seen from the data comparison between the no. 1 test block and No. 2 test block that the moisture content of the No. 2 test block is higher than that of the No. 1 test block, but the compressive strength of the No. 1 test block is higher than that of No. 2 test block regardless of curing for three days or 28 days. The specific comparison diagram is as follows:

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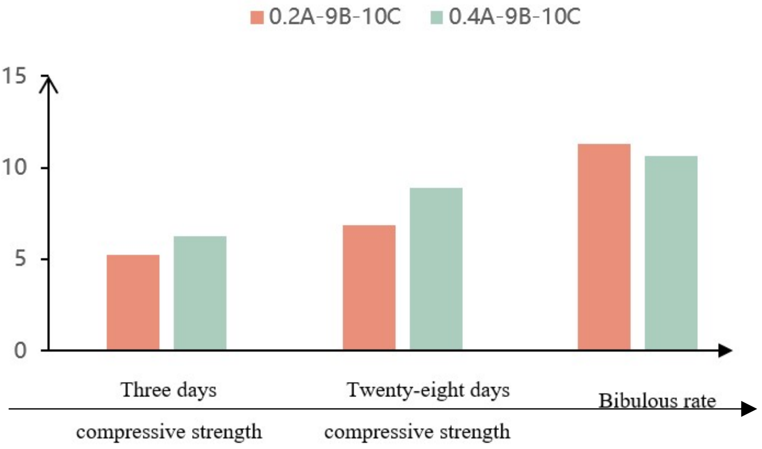

Figure 2: Comparison of test block 1 and test block

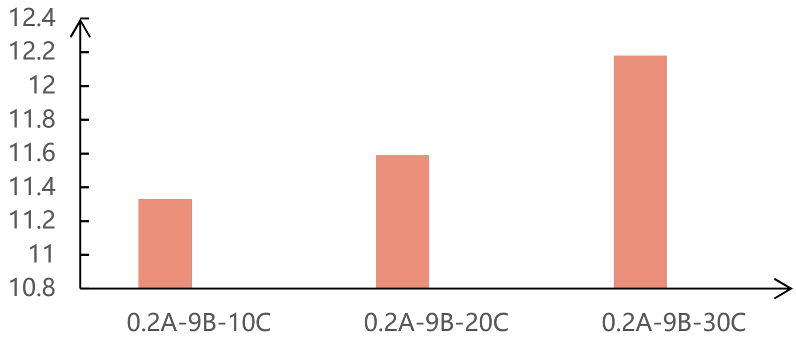

Figure 3: Contrast diagram of water absorption

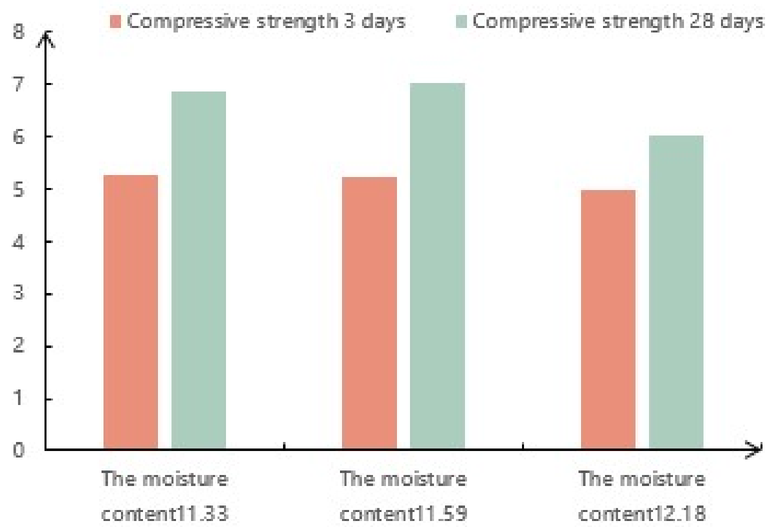

Figure 4:Diagram of moisture content and compressive strength

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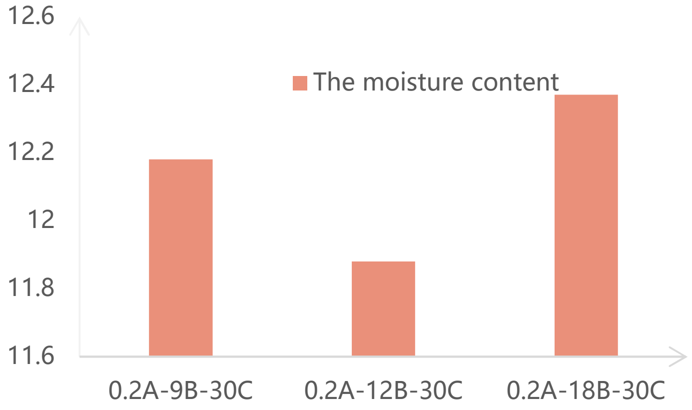

Figure 5:effect of basalt fiber length on moisture content

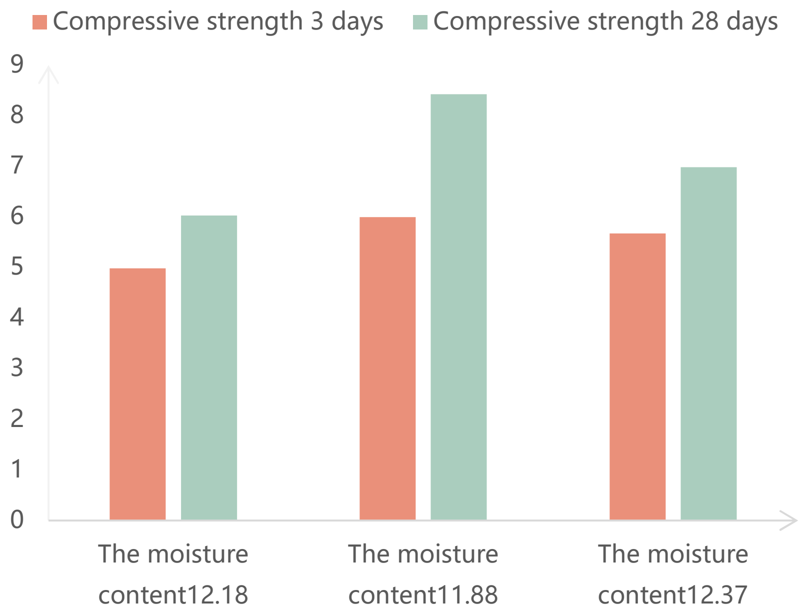

Figure 6:Diagram of moisture content and content and compressive strength

According to the comparison of the first group (0.2A-9B-10C), the fourth group (0.2A-9B-20C), and the fifth group (0.2A-9B-30C), when the content of basalt is the same and the fiber length of basalt is the same, the compressive strength of rubber-ceramsite concrete is affected by changing the rubber content of the text block. It can be concluded that: After curing for 28 days, with the increase of rubber content, the moisture content in concrete will increase, and the compressive strength will increase first and then decrease. In the three groups of experiments, when rubber content reaches 20%, the compressive strength of concrete reaches the peak of 7.02mpa, and the compressive strength has a small downward trend after curing for 3 days. Compared with concrete with a rubber replacement rate of 10%, the strength of rubber-ceramsite concrete with a replacement rate of 30% mixed with basalt fiber decreased by 5.5%.

According to the comparison of the five groups (0.2A-9B-30C), the six groups (0.2A-12B-30C) and the seven groups (0.2A-18B-30C), when the basalt incorporation amount and rubber substitution rate are controlled at the same time (namely, the basalt incorporation amount is 0.2%, and the rubber substitution rate is 30%), The influence of the length of the modified basalt fiber on the water absorption of concrete is analyzed, and the compressive strength trend of concrete is as follows: As the growth of the length of the basalt, concrete block moisture content will increase after lower first, in the three groups of experiments 12 mm length of fiber, makes the moisture content of specimens to a minimum, at 11.88%, the effects of moisture content on the compressive strength is increased after the first cut, so can get 12 mm, while the moisture content is the lowest in three groups of

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DOI: 10.6919/ICJE.202112_7(12).0048

experiments, However, the compressive strength of the 12mm test block was the highest after curing for 3 and 28 days respectively.

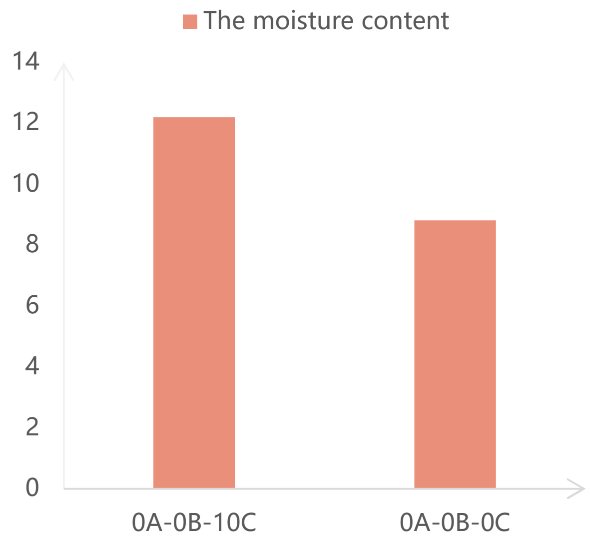

Figure 7: Influence of rubber content on water content

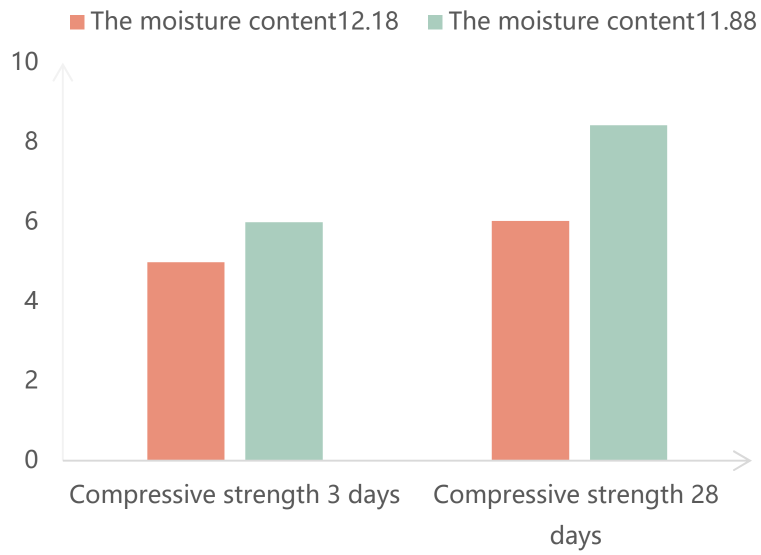

Figure 8: Diagram of moisture content and compressive strength

According to the comparison between the ninth group (0A-0B-0C) plain concrete and the eighth group (0A-0B-10C) rubber-ceramsite concrete with rubber replacement rate of 10%, the relationship between water content and rubber incorporation can be concluded by exploring: After adding a certain amount of rubber, the moisture content of plain concrete soil itself will increase, improve the elastic modulus of concrete at the same time, the compressive strength of concrete will also be greatly affected, especially the longer the curing time, the greater the impact on the compressive strength of concrete.

3. Conclusions and Suggestions

In summary, the moisture content of concrete is closely related to the porosity of concrete specimens. The concrete compressive strength of the test block is indirectly affected by the moisture content of concrete. The porosity can be obtained by measuring the moisture content, and the porosity can directly affect the compressive strength of concrete. It can be seen that the higher the moisture content is, the greater the adverse impact on the compressive strength of concrete. In the process of concrete

ISSN: 2414-1895 DOI: 10.6919/ICJE.202112_7(12).0048

construction, the moisture content of concrete should be strictly controlled to reduce porosity, so as to make concrete effectively play its compressive performance.

Through exploring the relationship between compressive strength and moisture content of rubber concrete, the following conclusions and suggestions can be drawn: From the overall trend, the compressive strength of plain concrete decreases significantly after adding rubber, and its moisture content increases. After curing for 3 days and 28 days, the compressive strength of concrete decreases significantly. Compared with plain concrete, its strength decreases by 16.16% and 49.66% respectively. Visible to maintenance the longer its compressive strength decline will be more obvious, comprehensive comparison at the same time to see the original plain concrete compressive strength in the case of a 28-day curing in 11.88 MPa, the compressive strength is larger, this also confirms mix you concrete has the compressive strength good advantage, with the rubber particles to replace river sand and join the basalt fiber after contrast, When only rubber particles were added to concrete without adding basalt, the compressive strength of concrete decreased significantly. However, after adding 0.6% and 9mm basalt, the overall compressive strength of concrete decreased only 7.66% compared with plain concrete. Therefore, it is advantageous to add rubber particles into concrete as fine aggregate instead of river sand to improve the elastic modulus and increase the toughness of concrete. But it will greatly reduce the strength, which is not good for the use of concrete in buildings.

Therefore, the use of rubber concrete, through the appropriate addition of basalt fiber and other ways to change the strength of concrete, in the use of concrete is should foster strengths and avoid weaknesses, make full use of its advantages, to avoid its shortcomings.

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