

Test on mechanical capability of steel fiber reinforced cement-base composites

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Abstract. In order to enhance the mechanics capability of RPC, the tests on the cement steel fiber reinforced cement-base composites with different steel fiber bulk ratio were carried out. Many kinds of strengths of the cement with different steel fiber bulk ratios are obtained. The results show that the enhanced ratio of bending strength is more than that of cleavage strength with the same steel fiber bulk ratio, but the strength is less enhanced when the ratio reaches a certain percentage. The compressive strength becomes also higher with the increase of steel fiber bulk ratio, which is not apparent. The causations worked out through analysis are that the distances between fibers have the important influence on the strength.

1. Introduction

In national defense engineering, in order to improve the project's own resistance, there are two main ways: one is to seek the advanced structure system; The second is to develop new protective materials. Using new composite materials and reasonable structure form of study is important topic in today's protective engineering research at home and abroad.

The high performance of RPC material has great application potential in defense engineering. Steel fiber is an essential component in the current RPC, while the volume rate of steel fiber has a great influence on the mechanical properties of cement-based composite materials, thus determining the volume rate of steel fiber in ultra-high strength RPC is one of the key problems to solve first. From the point of the relevant papers published at home and abroad, when the fiber volume fraction is small, with the increase of volume rate, tensile strength is roughly linearly, and the compressive strength change small [1-3]. But with a big dose of it, there are few data that can be obtained right now/ there are few data available right now/ few data are available right now right now. The main reason is that with the increase of fiber volume rate, it is difficult to mix the steel fiber concrete with coarse aggregate. Therefore, the relationship between the mechanical properties and the fiber volume ratio of steel fiber cement based materials is not clearly reported at home and abroad in the case of large dosage. According to the study of steel fiber cement based composites in foreign countries, the volume ratio of steel fiber in ultra high strength RPC is relatively large. Therefore, in order to determine the suitable steel fiber volume rate in the ultra-high power RPC, the mechanical properties of the cement matrix composites must be studied when the volume rate of the steel fiber changes greatly. In order to eliminate the influence of aggregate on the mechanical properties of steel fiber reinforced concrete and to make the steel fiber volume rate change in a larger range, we measured the steel fiber with a large change in the fiber volume rate in the cement slurry, measured its cleavage strength, bending strength and compressive



strength, analyzed the influence of the steel fiber volume ratio on the net pulp cleavage strength, bending strength and compressive strength of steel fiber cement, and discussed the influence of the steel fiber volume ratio on the mechanical properties of steel fiber concrete with coarse aggregate.

2. Test and analysis

Raw materials used in the test.: Jinningyang 525# ordinary Portland cement, 1# steel fiber, coarse sand. Test method: Test according to CECS13:89 "steel fiber concrete test method", Specimen size: 100 x 100 x 100mm for compressive strength, 100 x 100 x 100mm for cleavage strength and 100 x 100 x 400mm for bending strength.

In the test, the water cement ratio was 0.30, the amount of water reducing agent was 1%, and the measured intensity was 28 days, and the results were shown in table 1 (V_f is the volume rate of steel fiber).

Table 1 the strength of steel fiber cement slurry at different steel fiber volume ratio

Number	V_f (%)	Cleavage strength (MPa)	Rate of improvement (%)	Bending strength (MPa)	Rate of improvement (%)	The compressive strength (MPa)	Rate of improvement (%)
BH-1	0	4.87	0	9.66	0	55.7	0
BH-2	1.0	5.32	9.2	12.22	26.5	57.35	3.0
BH-3	2.0	5.86	20.3	13.83	43.2	60.2	8.1
BH-4	3.0	6.22	27.7	14.94	54.7	62.25	11.8
BH-5	4.0	6.83	40.2	16.89	74.9	64.56	15.9
BH-6	5.0	7.15	46.8	18.59	92.4	67.11	20.5
BH-7	6.0	7.64	56.5	20.23	109.4	69.63	25.0
BH-8	7.0	8.12	67.6	22.95	137.6	71.22	27.9
BH-9	9.0	9.22	89.3	26.43	173.6	75.45	35.5
BH-10	11.0	9.86	102.5	30.55	216.3	81.34	46.0
BH-11	13.0	10.20	109.4	35.67	269.3	84.23	51.2
BH-12	15.0	10.52	116.0	37.02	283.2	85.22	53.0
BH-13	17.0	10.81	122.0	37.55	288.7	88.12	58.2
BH-14	19.0	11.05	126.90	38.03	293.7	91.04	63.4

2.1 The influence of steel fiber volume rate on the cleavage strength

According to table 1, respectively, we make the steel fiber volume ratio of steel fiber cement slurry net cleavage strength and cleavage strength increase rate curve (figure 1.a and figure 1.b).

It can be seen from figure 1 that, with the increase of fiber volume rate, the cleavage strength is basically linear, but when the steel fiber body rate is lower than 13%, the slope of the line is large, which is the growth rate of the cleavage strength. Steel fiber volume rate was 13%, the cleavage strength of steel fiber cement slurry net increase rate of 109.4%, and the fiber volume rate of 19%, net steel fiber cement slurry, cleavage strength increase rate is only 126.9% in fiber volume rate is higher than 13%, the cleavage strength of steel fiber cement slurry net increase is not obvious.

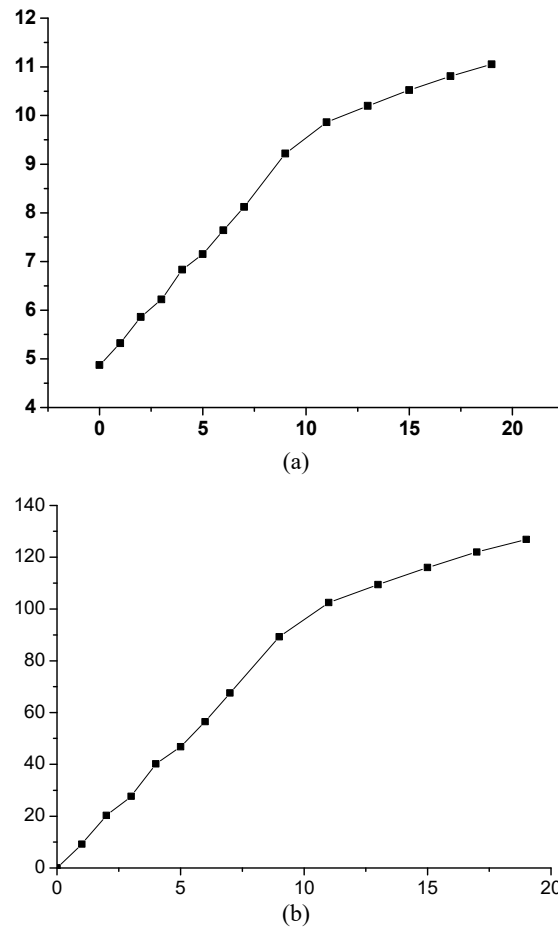
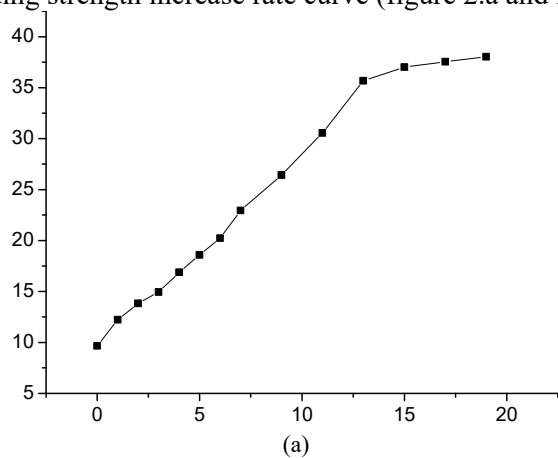


Figure 1 the relationship between the volume rate of steel fiber and the cleavage strength of steel fiber cement.

2.2 The effect of steel fiber volume ratio on bending strength

According to table 1, respectively, we make the steel fiber volume ratio of steel fiber cement net pulp bending strength and bending strength increase rate curve (figure 2.a and figure 2.b).



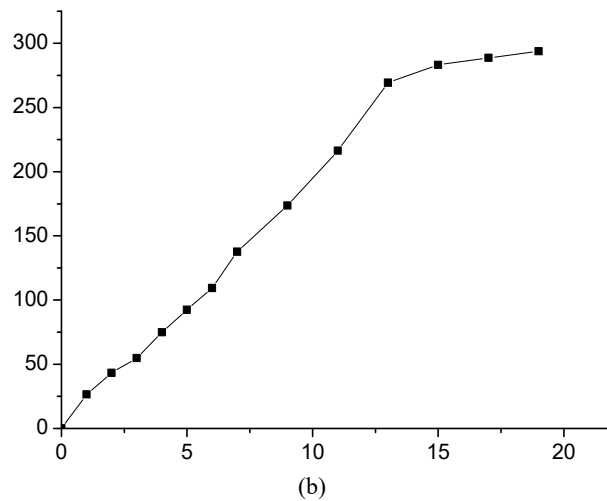


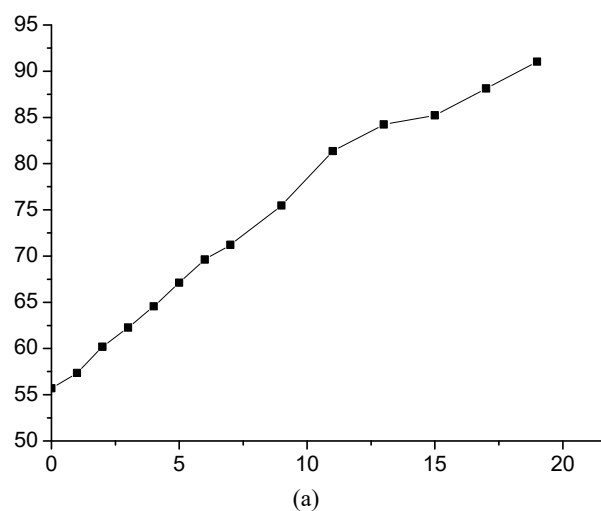
Figure 2 the relationship between the volume ratio of steel fiber and the shear strength of steel fiber cement

It can be seen from figure 2 that the influence of steel fiber volume ratio on the impact strength is basically the same as the effect on the cleavage strength. However, in the case that the steel fiber volume ratio is the same, the improvement rate of the bending strength should be greater than the increase rate of the cleavage strength, and the increase rate of the bending strength is 269.3% when the steel fiber volume rate is 13%.

2.3 The effect of steel fiber volume ratio on compressive strength

According to table 1, respectively, we make the steel fiber volume ratio of steel fiber cement net rate of compressive strength and compressive strength increase the influence of the curve (figure 3.a and figure 3.b).

It can be seen from figure 3 that although the compressive strength of steel fiber cement slurry increases with the increase of the steel fiber volume rate, it is not obvious that the increase of compressive strength is only 63.4% when the steel fiber volume ratio is 19%. The main reason for the increase of compressive strength is that the fiber restricts the transverse deformation of the specimen under pressure.



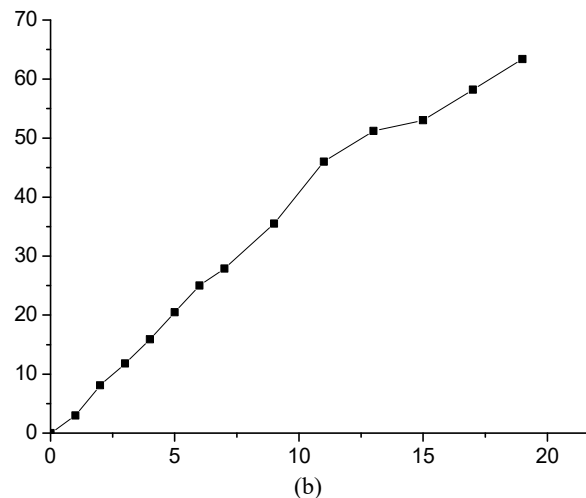


Figure 3 the relationship between the volume ratio of steel fiber and the compressive strength of steel fiber cement

From the perspective of literature, there have been no reported domestic steel fiber content reached more than 10% of the study, containing aggregate of concrete, steel fiber volume rate, generally only about 3%, the highest is only 6%. The reason is that, with the increase of the volume ratio of steel fiber, it is difficult to mix and form, and the steel fiber is formed and the layered image is serious. On the other hand, in the general construction structure, the steel fiber volume rate can meet the design and use requirements at around 3%.

For ordinary steel fiber concrete, the effect of tensile strength and other mechanical properties is not obvious when the steel fiber volume rate exceeds 6%. It is generally believed that due to the uneven distribution of steel fibers, it may be a major reason for the ordinary steel fiber concrete. But, in this article, because the net is the cement slurry, from the perspective of the fracture cross-section of net steel fiber cement slurry, even in the steel fiber volume rate of 19%, the distribution of steel fiber is still a relatively uniform. So the reason why the steel fiber is more than 13%, the reason why the steel fiber is so much more than 13%, the reason why it's not to increase in the proportion of the fibers is due to the uneven distribution of the fibers.

According to the theory of stress transfer of short fiber composites, when single fiber tension, through the interface between fiber and matrix around the fiber stress field, is formed in a range of substrate, the stress field of the range size mainly depends on the cohesion of matrix (cohesion is related to the strength of the matrix of matrix) [4]. A single fiber in the process of tension was uprooted, if the other fiber is just within the stress field of the fibre, this fiber can be drawn together and not have enough enhancement effect. Therefore, the spacing of fibers is not as small as possible, but there is an optimum fiber spacing, which is that the fibers must have sufficient thickness to transfer the stress. The fiber volume ratio of the optimum fiber spacing in this paper may be 13%. The optimum fiber spacing is related to the strength of the matrix and the bonding strength of the matrix. The higher the strength of the matrix, the smaller the optimum fiber spacing. Thus, to make the fiber have the enhancement effect of the ideal, the rate of increase in fiber volume at the same time should also increase the strength of the matrix, otherwise, when the fiber volume ratio increases to a certain extent, mechanical properties of steel fiber reinforced cement matrix composites does not have obvious improvement. In steel fiber reinforced concrete with aggregate, when the thickness of the fiber between aggregate and cement mortar is lower than a certain value, the mechanical properties of steel fiber reinforced concrete also won't have obvious improve, perhaps even lower.

3. Conclusions

It can be seen from the experiment in this paper that, with the increase of fiber volume rate, the cleavage strength and the bending strength basically present/show linear growth, but the slope of the line is large

when the steel fiber body rate is lower than 13%, and when the steel fiber volume rate exceeds 13%, the two strength growth slows down. And the compressive strength is smaller than the previous two.

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