

Experimental Study on Early Crack-resistance Property of Waste Fiber Recycled Concrete

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Abstract. In this paper, for four groups of recycled concrete specimen in early shrinkage and restraint cracking experiment, which the recycled aggregate replacement ratio of 100% and the waste fiber volume content of 0, 0.08%, 0.12%, 0.16%. Experimental results show that: when the volume content of waste fiber is 0.08%, the effect of reducing shrinkage is more obvious, while the volume content of waste fiber is 0.12%, the performance of anti-cracking is the best.

Introduction

As the city continued expansion, the construction waste which excreted as the old building demolition generated rapidly, the construction waste expand urban space. According to statistics, in the future of our country's construction waste production will break through 600 million tons per year^[1]. Early shrinkage ratio of recycled concrete was obviously higher than natural aggregate concrete is one of the most significant defects that recycled concrete exists, while polypropylene fiber on solving the early cracking of concrete, reducing shrinkage deformation of concrete has its unique role. Polypropylene fiber is the main material of waste fiber, recycling waste fibers will both protect the environment and conserve resources.

This article has carried on the early shrinkage and crack test under constraint conditions of the waste fiber recycled concrete, the recycled aggregate replacement rate of 100%, and the length of waste fiber mixed in the concrete is 19mm, in order to study the effect of the early shrinkage and crack resistance of the different waste fiber volume content which mixed in recycled concrete. Analyze the concrete cracking theoretically.

Test Method

Mix Proportion of Waste Fiber Recycled Concrete

Tab.1 Waste Fiber Recycled Concrete Mix Proportion

specimen number	Volume content of waste fiber [%]	Unit volume of material usage[Kg]				
		cement	sand	gravel	recycled concrete	water
RC0	0	390	709	0	1156	215
FRC08	0.08	390	709	0	1156	215
FRC12	0.12	390	709	0	1156	215
FRC16	0.16	390	709	0	1156	215

Recycled aggregates used in this experiment are made of recycled concrete, the waste concrete was on the age of 2 years and the strength grade of C40 ,by artificial crushing, screening, washing and

other treatment, recycled concrete can be the formation of particle regenerated thick bone material which size is 5 ~ 25mm finally. Fine aggregate for the river sand and fineness modulus was 2.7.

Waste fiber used in this paper was collected from the waste carpets, its chemical composition is polypropylene, through artificial splitting, finally cutting into a certain length. Design strength grade of the waste polypropylene fiber recycled concrete is C40 and the label source of cement used in this test is P.O42.5R ordinary Portland cement, water cement ratio of 0.5, sand at a rate of 38%. Due to the large water absorption of recycled aggregate, when pouring concrete need to configure additional water, the water absorption of recycled aggregate used in this experiment was 2.125%. The detailed data of the waste fiber recycled concrete's mixture ratio are shown in table 1.

Experimental Design

In this paper, the device used to measure the early shrinkage of waste fiber recycled concrete is homemade device. The size of steel is 100 mm×100 mm×500 mm. At both ends of the device, dial gauge is fixed in the shelf of dial gauge, contacting the probe buried inside the concrete through the surveying rod which is outside the device. The 3mm thick PTFE with a small amount of Vaseline to paste on tryout wall and floor. After forming the specimen covered with plastic film to keep it moisture immediately, conservation it into the environment which temperature of 20 ± 2 °C, humidity of $60 \pm 5\%$. To be close to the initial setting time of concrete, the specimen drawn around the PTFE sheet and fixed the dial gauge. Test apparatus shown in Fig.1.

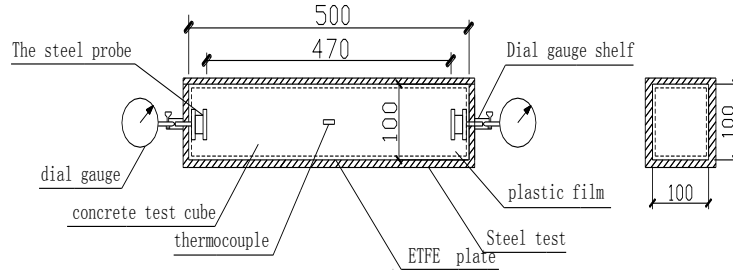


Fig.1 Installation Drawing of Early Shrinkage Test

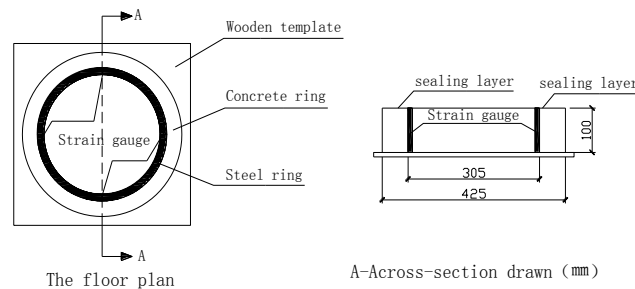


Fig.2 Apparatus of Ring Contraction Test

In this paper, ring constrained test is used to study crack resistance of the waste fiber recycled concrete. Test device consists of inner, outer steel ring and the base plate, pouring the concrete between the inner and outer steel ring. Keeping specimen one day after conversing in the nature environment, the specimen is placed in temperature of 20 ± 2 °C, humidity of $60 \pm 5\%$ of the environment, then remove the outer steel floor and the base plate. When close to crack in the concrete surface, use a magnifying glass observe whether concrete surface cracking or not, record the initial cracking time of each specimen (calculate from time of pouring concrete). After cracking of the concrete ring, adopt comprehensive cracking instrument to measure cracks' width. Test device shown in Fig.2.

For the shrinkage of concrete, it can be measured from the initial time of pouring concrete, the measuring method is artificial measurement readings. Within the first 12h of measuring interval time is 1 hours; from 24 hours to 48 hours, measurement interval time is 2 hours; from 48 hours to 72 hours, measurement interval time is 6 hours.

Experimental Results and Analysis

The Early Shrinkage

The shrinkage curve of waste fiber recycled concrete that conserve under constant temperature and humidity conditions for three days, as shown in Fig.3. Value of recycled concrete shrinkage which added waste fiber in recycled concrete is significantly lower than the recycled concrete, when waste fiber's volume content of waste fiber recycled concrete is 0.08% and 0.16%, value of shrinkage reduced by 33.1% and 16.7% respectively. Addition of the waste fiber can effectively reduce the early shrinkage of recycled concrete, and when waste fiber content is 0.08%.it has the most significant effect.

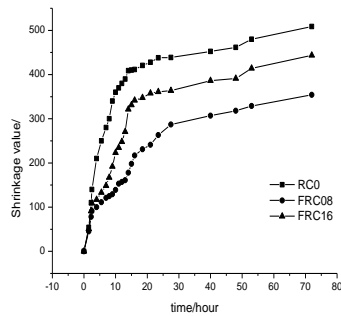


Fig.3 Early Shrinkage Curve of Waste Fiber Recycled Concrete

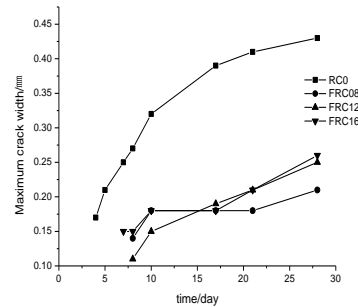


Fig.4 Curve of Maximum Crack Width

Restraint Cracking

Since the identical experimental conditions, we can see that: due to the incorporation of waste fiber, the initial cracking time of waste fiber recycled concrete can be postponed, compared with recycled concrete, when the volume content is 0.08%, 0.12% and 0.16%, the initial cracking time has been delayed by 3.8 days, 3.91 days and 2.89 days respectively.

Tab.2 Early Cracking Cases of Fiber Waste Recycled Concrete

Serial number	Cracks Time [d]	The Length of initial crack [mm]	The width of initial crack [cm]	The Length of final crack [cm]	The width of max crack [mm]	The number of final crack	The number of throughout Crack
RC0	4	21	0.17	100	0.43	5	2
FRC08	8	10	0.14	100	0.21	5	2
FRC12	8	10	0.11	56	0.27	5	0
FRC16	7	15	0.12	100	0.26	4	2

From the perspective of the finally throughout crack's quantity, if the waste fiber volume content is 0.12%, there was no throughout crack. In order to illustrate more clearly the cracking effect of adding waste fiber in recycled concrete, within the observation age, the change cases of crack width is given in Fig.4.

Within 28 days' age, as the maximum crack' width of the annular specimen, specimen which not adding fiber recycled concrete is the largest, and adding volume content of 0.08%, 0.12% and 0.16% waste fiber in recycled concrete were less than the reference specimen, reduced by 51.2%, 37.2% and 51.2% respectively. From the comprehensive performance perspective, crack resistance effect which the waste fiber volume content of 0.12% in recycled concrete is superior to the volume content of 0.08% and 0.16% of the waste fiber in recycled concrete.

Mechanism Analysis

In waste fiber recycled concrete, waste fibers is distributed as three-dimensional distribution system, on the one hand to exist in the concrete surface, so that waste fiber filtration area is reduced, moisture migration is difficult, so that the contraction of the capillary water loss decreased capillary tension in recycled aggregate concrete[2]. On the other hand, Due to the large number of fibers per unit volume evenly distributed within the concrete, large cracks were refined and scattered into the less harmful micro-cracks, these tiny, invisible cracks in the process of development of fiber block will inevitably encounter fiber barrier, waste fiber bear and homogenization many tiny shrinkage stress of crack, consume micro-crack propagation energy, prevent further expansion and extension of cracks, so that waste fiber played a significant role in cracking[3-5].

Conclusion

(1)The incorporation of waste fiber can significantly improve the shrinkage defects of the recycled concrete. It can enhance the capacity of cracking resistance of recycled concrete. Therefore, the incorporation of a certain amount of waste fibers in recycled aggregate concrete is one of the effective ways to overcome the cracking of the concrete.

(2)The incorporation of waste fiber can effectively reduce early shrinkage of the recycled concrete, when volume content of the waste fiber is 0.08 percent, the effect of reduction is more obvious, and reduction can be 33.1%, better than the waste fiber content of recycled concrete is 0.16%.

(3)Adding a variety content of waste fiber can reach the results of inhibiting the early shrinkage of concrete, from a comprehensive point of view, a 0.12% volume fraction of waste fiber in recycled concrete, the effect of crack resistance can be the best.

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