Experimental research on building material - ceramsite concrete

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Abstract: In order to study the strength and crack resistance of lightweight concrete, this paper made the concrete using lytag as coarse aggregate block, and join in the block of polypropylene fiber in order to improve its strength and crack resistance. Use control variable law for reference block, the following conclusions: through the experiment, when the standard test block ceramsite dosage is 1000 g, dosage of fiber types 6 mm for 70 g can achieve optimal crack resistance and maximum compressive strength, and with continued increase in the amount of ceramsite concrete compressive strength of block is on the decline.

Introduction

Ceramsite concrete is a lightweight concrete material, which is mainly used for non load-bearing structural components. However, its strength is low, and its crack resistance is poor, which restricts its development and application, and can not completely replace ordinary concrete[1]. In order to improve its anti cracking performance and strength, in this paper, the author set the fly ash ceramsite as coarse aggregate, polypropylene fiber as special addition materials, to study the effect of dosages of ceramsite and fiber in a standard block for the concrete strength; at the same time to improve the degree of evaluation of fiber on crack resistance, and finally to find out the optimal mix ratio.

Experiment

experimental materials

(1) cement

The cement is a powdery water hard inorganic cementitious material. The specific surface area of P.O42.5 cement is 342m2/kg, and the 28 day compressive strength is 45.3MPa, which meets the standard requirements[2].

(2) ceramsite

The particle size is 5mm-15mm, the compressive strength of the cylinder is 1.3-3.5MPa, the water absorption rate is less than 10%, and the refractoriness is more than 500[3].

(3) polypropylene fiber

Its main performance is shown in the table 1[3].

Table 1: the main properties of polypropylene fiber

Density (t/m^3)	Modulus of elasticity (MPa)	Tensile strength (MPa)	Limit expansion rate	Heat resistance ($°C$)	Melting point ($°C$)	Colour
0.9-0.91	(3~7)$\times 10^3$	300~600	18 %	121~160	165~170	white

The dry mixing method is used to mix the aggregate and fiber to disperse the fibers so as to ensure good adhesion with mortar and improve adhesion. After mixing 2min, mix cement and water and continue stirring 2~3min.

(4) air entrained agent

The air entrained agent can greatly improve cement workability, pumping and improve durability such as anti seepage and frost resistance of concrete, it can effectively prevent the twice adsorption of commercial concrete and reduce the time loss of concrete slump[4].

Determination of the mixture ratio

(1) calculation of the initial mix ratio

$$f_{cu,0} = f_{cu,k} + 1.645s \tag{1}$$

(2) Calculation of aggregate

In this experiment, the amount of cement is 500kg/m^3 and the amount of water is 225kg/ m^3.

$$V_s = \left[1 - \left(\frac{m_s}{r_c} + \frac{m_{wn}}{r_w}\right)\right] \times S_p \tag{2}$$

$$m_s = V_s \times r_s \tag{3}$$

$$V_a = \left[1 - \left(\frac{m_c}{r_c} + \frac{m_{wn}}{r_w} + \frac{m_s}{r_s}\right)\right] \tag{4}$$

$$m_a = V_a \times r_{ap} \tag{5}$$

$$r_{cd} = 1.15m_c + m_a + m_s \tag{6}$$

(3) Determination of air entraining agent

When the dosage of air entraining agent is generally at 0~0.5%, the compressive strength and flexural strength of concrete are the highest[5], so 0.1% of the dosage in the experiment is adopted. And by calculation, the dosage of air entraining agent is 3g .

experiment process

In this experiment, a total of 54 test blocks were made. In the first number 1~18 blocks, ceramisite dosage is 700g, and the fiber with the length of 3mm, 6mm, 9mm and the weight of 40g, 70g, 100g is respectively divided into 3 groups, and in each group there are 6 blocks ; The number 19~36 blocks with 1000g ceramic, and the number 37~54 blocks with 1300g ceramic particles, the content of the fiber is the same as that of the first group.

2.4. Test block pressurization

Fig.1compression-testing machine

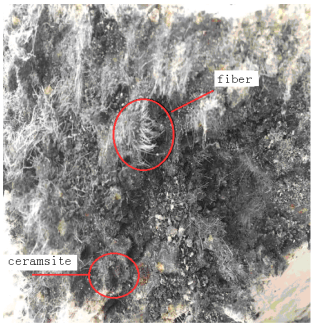

Fig.2 block damage chart

The test block is pressurized by NYL 2000D type pressure testing machine (shown in figure 1)and should pay attention that the contact side of the block must be the smooth surface. As the pressure goes on, the crack will appear and slowly grow until it is destroyed (shown in figure 2).

Analysis of experimental results

When the ceramsite content is 700g, fibre size increased from 3mm to 6mm, with the increase of the amount of fiber the compressive strength of specimens increases; The fiber size increased from 6mm to 9mm, the compressive strength decreased; Experiments show that, the maximum test block strength is when the fiber length is 6mm. The result is shown as Fig 3.

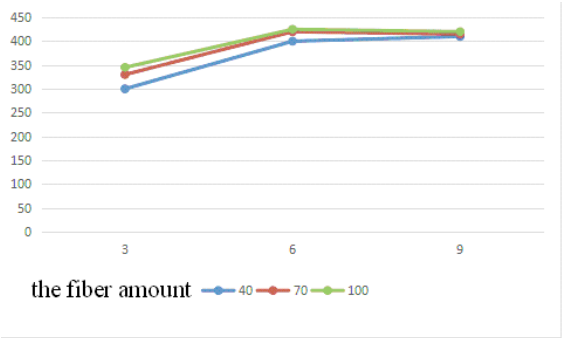

Fig.3 Ceramic concrete strength when ceramsite content is 700g (Mpa)

When ceramsite dosage is 1000g, as shown in Figure 4, when the fiber specification increases from 3mm to 6mm, the compressive strength of ceramsite concrete blocks generally increases, and the strength decreases with 6mm increasing to 9mm.

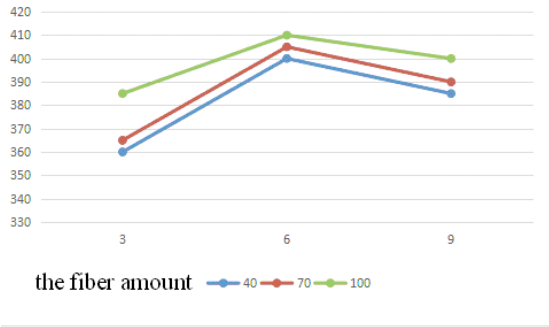

Fig.4 Ceramic concrete strength when ceramsite content is 1000g (Mpa)

When ceramsite dosage is 1300g ,as shown in Figure 5, with the change of fiber specification from 3mm to 9mm, the compressive strength of ceramsite concrete block decreases. In general, when the fiber dosage is 70g, the strength is the largest, 40g time is the second and 100g is the smallest.

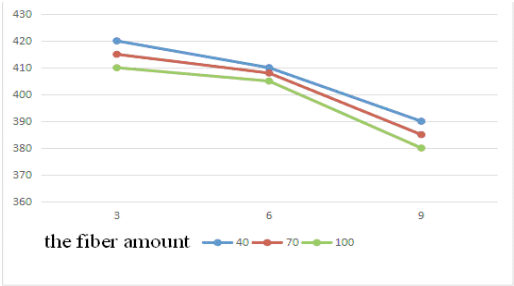

Fig.5 Ceramic concrete strength when ceramsite content is 1300g (Mpa)

In the course of the experiment, the time of the crack development is shown as table 2.

Table 2 crack width and cracking time

Type / amount of ceramsite (g)	crack width (mm)	cracking time (s)
700	3	8
1000	4	17
1300	4	15

It can be seen from the table that when the amount of ceramsite is 1000g, the cracking time is the latest, and the width of the cracking is the smallest.
By Formula 1 to formula 6, the optimal mix ratio is obtained as follows:

$$\text{sand: ceramsite: water: cement} = 33:30:12:25 \tag{8}$$

Conclusion

Through the above analysis, we can draw the following conclusions:
(1) With the increase of the amount of ceramsite, the strength of the initial test block increased obviously. However, when the ceramsite dosage is over 1000g, the compressive strength decreases with the increase of ceramsite dosage. The experiment shows that the ideal strength can be achieved when the content of the ceramsite in the standard test block is 1000g.
(2) The increase of fiber dosage can increase the compressive strength of the test block in a certain range. The experiment shows that when the fiber specification is 6mm and the fiber dosage is 70g, the compressive strength of the test block is the best.
(3) By considering the strength and cracking resistance comprehensively, the best proportion is put forward in this paper: fiber specification is 6mm, and sand: ceramsite: water: cement =33:30:12:25.

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