Research on the Influence of Replacing Cement with Granite powder-based Adglutinate on the Concrete Strength

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Abstract. Make concrete with the granite powder-based adglutinate to take place cement. Discuss the effect of substitution amount on concrete performance. With the increase of the substitution amount to cement, the compressive strength of concrete continues to decline; When it completely replaces cement and the amount of fly ash in agglutinate reaches to 20%, the 28 days compressive strength of concrete can reach 20Mpa. Moreover, the granite powder-based adglutinate with the content of 20% fly ash is used to replace cement entirely for making concrete.

Introduction

China has a wide geographical area and a wide distribution of granite minerals. Due to its hard strength and high strength, granite has always been a common building material widely used in construction projects. Due to the limited mining technology in China, the granite mass will lose about 30% in the form of fine dust when it is processed into the required shape and size. In 2016, the export volume of granite stone and products in China is 7.17 million tons, and the output of granite cutting waste is about 15%, which is about 1.07 million tons per year [1].

Research significance

Foreign scholars on the granite stone powder used in concrete to make a series of [2-7], and Chinese scholars also to a series of studies, granite and other stone powder is with granite stone with single or double mixing mixing in the form of a small amount of replacing cement to make concrete, the general dosage is 5% ~ 15% [8-12]. To solve above problems, this paper put forward for the first time use is given priority to with granite stone cement does not affect the compressive strength of concrete under the condition of completely replace cement, aims to improve the utilization rate of granite stone powder and lay a foundation for later research, to solve the resource waste and environmental pollution problems provide some guidance.

Experimental work

Materials

The granite powder-based adglutinate taken by the experiment is composed of two kinds of proportioning. The first proportioning is uniform mixed by granite powder, activator and ordinary coarse and fine aggregate; The second proportioning is uniform mixed by granite powder, fly ash, activator and ordinary coarse and fine aggregate. Granite powder is produced by a stone factory in Shanghai. The adapted cement is the conch brand ordinary portland cement of PO42.5 grade, the density is 3 200kg/m^3, and the Blain specific surface area is 410m^2/kg.

Test parameters

As shown in table 1 mixture made of concrete specimens, 70 * 70 * 70 placed under the standard curing condition maintenance, after forming of specimen in 3 d, 7 d and 28 d compressive strength test and sampling for microscopic scanning electron microscopy (sem) analysis.

Table 1.Granite stone powder cement instead of cement content test mix[%]

Sample number	Granite powder	Fly ash	Activator	Cement
F-1	15	13	20	52
F-2	31	13	20	36
F-3	67	13	20	0
FS-1	88	0	12	0
FS-2	84	4	12	0
FS-3	80	8	12	0
FS-4	76	12	12	0
FS-5	68	20	12	0

Testing

Specimen compression test

Place the well maintained specimen on the electro hydraulic pressure testing machine to conduct the compressive test, the loading speed is 0.1KN/s, and starte unloade when the loading pressure is no longer rising. Recorde the compressive strength of specimens respectively, and del with the data simply, analyze the change rules. Compare the results with the afterward microscopic test.

Sample Electron Microscope Scanning and Micro Data Processing

The specimens made in advance are cut into several 2cm×2cm×2cm cuboid, and dry the sample in the drying box for one day before the test, so as to prevent the water in the specimens from affecting the scanning. Micro scanning of different samples was carried out by scanning instrument after spraying gold. Handle the SEM images which have been scanned by image processing software.[13,14,15].

Test results and discussions

Effect of Different Content of Granite Rockfill Cements on Mechanical Properties of Concrete

FIG. 3 shows the relationship between the amount of cement content and the compressive strength of different granite. As shown in FIG. 3, the compressive strength of the concrete gradually decreases with the gradual increase of the substitution quantity, but the decrease is slow. Because the fineness of granite powder is smaller than that of cement, it has low activity. With the decrease of cement content, the hydration products decrease and the strength decreases. In addition, the effect is more significant with the increase of the substitutional amount of the granites.

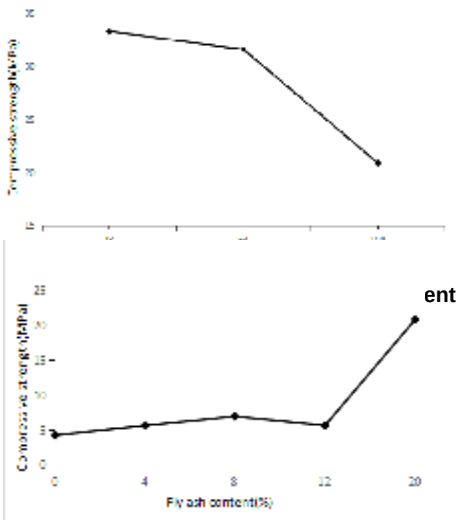

Fig.1.Relationship between different fly ash content and compressive strength

Fig.4 is the relationship between the different proportion and the compressive strength. It can be seen from figure 4 that with the increasing of the proportion of fly ash, the compressive strength of concrete shows an increasing trend. When the proportion of fly ash is from 12% to 20%, the compressive strength increases significantly. However, when the proportion of fly ash is more than 20%, due to the limited hydration of the material, it would loose the internal structure of concrete, so the strength will decrease.

Electron microscopy (SEM) analysis

The image analysis and processing software was used to analyze and process the SEM image of above granite powder concrete to abstract related data of grains and pores in SEM image of concrete, which were then calculated via formula to figure out

microstructural parameters such as average equivalent grain size(D_p), average equivalent pore diameter(D_b), and average void ratio(E), etc.

Table 2 was obtained after processing and integrating the data in Matlab via formulas.

Table2.The microscopic parameter values of samples at different ages.

	D_p/um	D_b/um	E
7d	3.81	2.21	0.14
14d	8.23	2.08	0.10
28d	19.75	1.83	0.03

Fig.2 is the curve for change of average equivalent grain size D_p of granite powder concrete with the curing age change. It is observed from the figure below that: with increase of age, the average equivalent grain size D_p gradually increases. Furthermore, the uptrend of curve shows that after curing age of 28d, the average equivalent grain size still has a growth trend, indicating the strength of new concrete still increases after curing age of 28d.Fig.3 is the curve for change of average equivalent pore diameter D_b of granite powder concrete with curing age change. It is clearly seen from the figure that the average equivalent pore diameter falls gradually with increase of curing age. Compared with Fig.1, the change amplitude of average equivalent pore diameter is significantly smaller than that of the average equivalent grain size.Fig.4 is the curve for change of average void ratio e of granite powder concrete with curing age change. It is obvious that the average equivalent void ratio gradually falls with increase of curing age, and falling amplitude is significant. The reason for dramatic fall is the same with that as analyzed for Fig.2. This also proves that the internal structure of new concrete is increasingly compact.Besides, the linearly dependent coefficients for the change curves in above three figures were respectively 0.938, 0.9678 and 0.9758, which implies good linear relationship, and the average equivalent grain size is inversely proportional to average equivalent pore diameter and average void ratio.

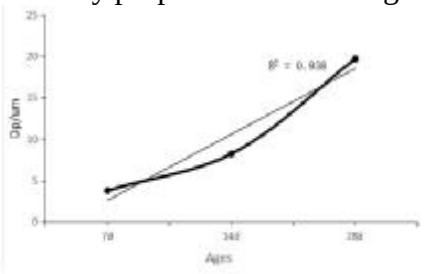

Fig.2 .Relationship between D_p and curing age

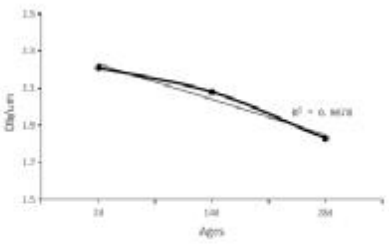

Fig.3 .Relationship between D_b and curing age

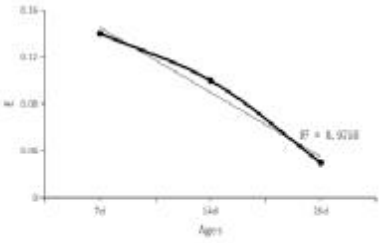

Fig.4 .Relationship between E and curing age

Conclusions

Based on this experimental study, the following conclusions can be drawn:

1) As the quantity of replacement of cement with granite power-based adglutinate increased, the compressive strength of concrete continuously fell yet with slow downtrend, and stabilized at 20MPa when the cement was completely replaced to fabricate concrete, In the meanwhile, due to slow hydration reaction of fly ash in adglutinate, the strength of new concrete still rose after curing age of 28d. Thus it is feasible to completely replace cement with Granite powder-based adglutinate to fabricate cement.
2) When the granite powder-based adglutinate completely replaced cement to fabricate concrete, the strength increased with the increase in added amount of fly ash. When the added amount of fly ash was 12% to 20%, the compressive strength of concrete was increasing significantly. When the added amount reached 20%, the strength of concrete was the best. This indicates that secondary hydration reaction of fly ash is vital to strength of concrete.
3) When the granite powder-based adglutinate completely replaced cement to fabricate concrete, the strength increased with the increase in added amount of fly ash. When the added amount of fly ash was 12% to 20%, the compressive strength of concrete was increasing significantly. When the added amount reached 20%, the strength of concrete was the best. This indicates that secondary hydration reaction of fly ash is vital to strength of concrete.

Thus, as subsequent research went deep, it was found that granite powder-based adglutinate can

completely replace cement to fabricate concrete, thereby more efficiently utilizing granite powder and solving wasting of resources and environmental pollution.

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