Studies of Composition and performance of mountain sand concrete powders

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Abstract: We designed experiment to study the effect of gravel and sand proportional change of different design label concrete. The result showed, it was useful to improve its compressive strength when we increased the proportion of mortar in low-grade and increased the proportion of stone in high-grade concrete in designing composition. Contrast test of powder concrete showed that the powder can significantly improve the mixing performance of concrete. The correlation of performance indicators with its strength of fresh concrete was also analyzed finally. The research results had important guiding significance for the design of concrete mix ratio and the application of powder in concrete.

1 Introduction

Concrete material was usually wasted and its compressive strength was not high when it was damaged in the potential state. Compressive destructive test of concrete found, C15-C30 low grade concrete block was crushed when the surface mortar layer and the interfacial transition zone appearing cracks, with some stone crushed, fracture occurred mostly in the mortar layer and interfacial transition zone, few occurred in the crushing gravel; C35-C60 high grade concrete block was crushed when stones were crushed, with some mortar layer and the interfacial transition zone appearing, fracture occurred mostly in crushing stone, few in layer and interfacial transition zone. We tried to change the proportion of gravel and sand in different grades of concrete composition to increase the compressive strength\cite{1-5}.

2 Test

2.1 Raw materials used in the test
Cement: P·O52.5 manufactured by Guizhou Hailuo Pangjiang Cement Factory.
Sand1, Sand2: Manufactured sand locally produced.
Stone: Limestone gravel, continuously graded in 5-25mm
powder: Produced by Ultrafine Powder company
Coal ash: Grade II coal ash in Guizhou Mingchuan, Active index of 28d 76%
Stone powder: Made in Guizhou;
Admixture: Polycarboxylate-type high performance water-reducing admixture

2.2 Test procedure

We tried to increase the compressive strength by changing the proportion of gravel and sand composition in different grades concrete. Each test for 30L material, designing of six modules and seven modules installed powder concrete two sets for each one, six modules and seven modules installed concrete three sets for each one (each set from C15-C60). To verify the effect of change of gravel and sand ratio on strength of different grades concrete, we formed six modules for more gravel and seven modules for more sand. The effect of powder on the performance of concrete was also tested by the contrast test of powder concrete. A total of 100 sets of concrete test was tested.

2.3 Concrete composition

The composition of powder concrete is as follows: (with powder instead of just 20% of cement for the other composition)

| Concrete grade | 52.5 Cement (kg) | Stone powder (kg) | Coal ash (kg) | Sand1 (kg) | Sand2 (kg) | Gravel1~25 (kg) | Water (kg) | Admixture (kg) |
|----------------|------------------|------------------|--------------|------------|------------|----------------|------------|--------------|
| C15            | 70.80~           | 150.100~         | 100.120~     | 310.54~    | 490.51~    | 860.87~        | 167.169~   | 4.6~         |
| C20            | 100.110~         | 130.140~         | 160.120~     | 520.53~    | 490.51~    | 870.88~        | 167.169~   | 4.6~         |
| C25            | 130.140~         | 110.120~         | 90.110~      | 510.52~    | 490.51~    | 810.89~        | 168.170~   | 4.6~         |
| C30            | 180.190~         | 90.100~          | 80.100~      | 590.51~    | 490.51~    | 890.91~        | 168.170~   | 4.6~         |
| C35            | 200.210~         | 80.90~           | 70.90~       | 690.70~    | 290.31~    | 900.91~        | 169.171~   | 4.6~         |
| C40            | 230.250~         | 60.80~           | 60.80~       | 570.58~    | 390.41~    | 990.91~        | 169.171~   | 4.6~         |
| C45            | 270.280~         | 60.70~           | 50.70~       | 460.47~    | 490.51~    | 910.92~        | 170.172~   | 4.6~         |
| C50            | 300.320~         | 50.60~           | 40.60~       | 350.36~    | 590.61~    | 920.93~        | 170.172~   | 4.6~         |
| C55            | 340.350~         | 40.50~           | 30.50~       | 240.25~    | 690.71~    | 930.94~        | 171.173~   | 4.6~         |
| C60            | 370.390~         | 30.40~           | 20.40~       | 130.14~    | 790.81~    | 940.95~        | 171.173~   | 4.6~         |

2.4 Test data: Data was summarized as follows which reflected the various properties of concrete:
3 Test result analysis

(1) The influence of stone ratio and mortar on the strength of different grades concretes

Compression results show, the 56d strength of C15-C30 powder concrete of seven modules installed was higher than six molds', C35-C60 powder concrete of six modules installed was higher than seven molds'. For example, the 56d average strength of concrete which loaded by seven molds was 18.6, 24.3, 31.9, 39.5 MPa, loaded by six molds was 17.6, 23.5, 31.5, 33.9 MPa for C15-C30, other which loaded by seven molds was 44.2, 53.8, 57.7, 64.1, 68.7, 73.4 MPa, loaded by six molds was 44.7, 54.7, 59.5, 64.7, 69.8, 74.5 MPa for C35-C60.

Some cement was replaced by coal ash in low grade concrete. Strength of coal ash increased slower. So when it was subjected to external load, the weakest part of the mortar layer and the interface transition zone was easy to reach the limit load and cracked, with few gravel crushing. There was more mortar in concrete loaded by seven molds. So its mortar got higher compressive ability. A small cement was replaced by coal ash in high grade concrete. Its strength increased quicker. So when it was subjected to
external load, the mortar layer and the interface transition zone was more difficult to crack with large
gravel being crushed. There was more gravel in concrete loaded by six molds. So its gravel got higher
compressive ability[6-10].

When concrete composition was designed, we increased the proportion of sand in low grade concrete
to improve the strength of concrete. For high grade concrete, we increased the proportion of gravel to
increase its the strength.

(2) Effect of powder on concrete performance index: strength, gas content, rewinding time

On the whole, the strength of the concrete was slightly reduced after mixing with the powder, but the
mixing capacity was improved with the increase of the gas content, the decrease of the consistency, the
increase of the rewinding time and the slump.

1) Effect of powder on concrete strength

The strength of 56d concrete mixed with micro-powder was slightly lower than that of unconfined
concrete, but its long time strength growth rate was faster.

2) Effect of powder on concrete gas content

The air content of concrete mixed with powder was higher than that of unmixed concrete overall. For
example, the content of C30 unmixed concrete was 1.9% and the content of C30 mixed concrete was 2.6%.
The same phenomenon also existed in other grades concrete.

3) Effect of powder on concrete rewinding time

The experimental result showed that the rewinding time of concrete decreased with the addition of
powder. For example, the rewinding time of C25 unmixed powder concrete was 3.0s and the mixed
powder concrete was 2.4s.

(3) The relationship between air content, wet bulk density and strength of concrete

1) The relationship between air content and strength of concrete

When the gas content was high, the other strength may be high or low. The same phenomenon also
existed when the gas content was low. The effect of the content powder concrete on the strength was not
very obvious when it was under 3%. For example, the 56th day strength of C20 powder concrete filled
with seven molds was 28.1MPa, 26.5MPa when the gas content was 1.2%, 1.7%. For another one, the 56th
day strength of C20 powder concrete filled with six molds was 28.1MPa, 26.5MPa when the gas content
was 1.2%, 1.7%.

2) The relationship between wet bulk density and strength of concrete

The effect of the wet bulk density concrete on the strength was not very obvious when it was
between 2500~2560kg/m³. When the wet bulk density was high, the other strength may be high or low. The same phenomenon also
existed when the wet bulk density was low. For example, the 56th day strength of C20 powder concrete filled
with seven molds was 28.1MPa, 26.5MPa when the wet bulk density was 1.2%, 1.7%. For another one, the 56th
day strength of C20 powder concrete filled with six molds was 28.1MPa, 26.5MPa when the wet bulk density was 1.2%, 1.7%.

It proved that there was no interrelation between performance index of air content, bulk density and
concrete strength. We cannot predict the strength of concrete through the evaluation of these indicators.

4 Conclusion

To increase concrete’s strength, we can increase sand ratio in low grade concrete and increase gravel
ratio in high grade concrete in designing concrete composition.

After mixing powder into concrete, mixing performance of concrete got improved notably. So
powder is good admixture for concrete.

The gas content and strength of concrete had little interrelation with each other in the range of 3%.
The wet bulk density had no relevance to strength of concrete when the wet bulk density was between
2500~2560kg/m³.
As the test was purely completed in the laboratory artificial test, there was some error in the weighing, the precision of the instrument, environmental factors and manual operation and so on. To reduce the elimination of error to get more accurate data, more research need to be conducted in-depth.

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