Experimental research on high-temperature properties of concrete coarse aggregate

Author: 1, Wang Li, 2, Fu Libin, 3, Li Chenliang

Huanghe Science and Technology College

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Abstract: The ratio of the thickness of the aggregate accounted for roughly 70%, and it's performance is good or bad has a direct impact on the strength of concrete. In this paper, the heating device with coarse aggregate of concrete by varying degrees of high temperature treatment, study the change of its physical and mechanical properties, for the study of aggregate on concrete degree of preparing high temperature mechanics performance influence.

First, the test object

By common coarse aggregate concrete with different degrees of heat insulation treatment, the determination of its physical and mechanical properties observed mass loss, color changes, and changes in surface morphology crushing indicators, study its performance in high-temperature study of concrete prepare.

Second, the test equipment

1, HZCS-01IPC automatic fire simulation test system and automatic temperature control heating system: Class 1 equipment as shown in Figure 2.

Figure 1: HZCS-01IPC automatic fire simulation test system of FIG.

Figure 2: Automatic temperature control heating system control cabinet

2, crushing value tester, standard square hole sieve sand and weighing instruments, standard sandsieve, sieve shaking blast oven and electric machines.
Third, test procedure

1. Sample preparation: In this experiment, all from Xinhai gravel concrete mixing station, select the nominal size class 5 -20mm concrete with calcareous gravel, gravel batch in line with national standards GB / T14685-2011 "construction with gravel, pebbles, "the technical requirements of concrete with coarse aggregate. According to standard methods gravel placed blast oven dried to constant weight, random samples drawn from 5 parts and each 5 kg be numbered A, B, C, D, E and make a mark.

2. The high temperature treatment of the sample: the number of B, C, D, E, respectively, through the grave IHZCS-01IP automatic fire simulation test system 300°C, 400°C, high temperature of 500 °C and 600 °C. To ensure comparability of the sample, the heat treatment heating rate are controlled by 10°C / min.

3. According to the current national standard GB / T14685-2011 "construction with gravel, pebbles, " the sample was measured at different temperatures coarse aggregate crushing value, while measuring the mass loss temperature of each number gravel and observe its color and surface features change, make records.

Fourth, experimental data analysis and conclusions

1. Coarse aggregate quality

Table 1 calculation processing results for mass loss at different temperatures stones situation. From the test results, in the gravel after the different treatments, there will be varying degrees of quality loss, mass loss overall modest, but with the heating temperature, mass loss increased significantly, the mass loss rate showed an increasing trend. Analysis stones after being subjected to high temperature mass reduction is mainly caused by three aspects: on the one hand stones contained high-temperature combustion of organic matter in the face will lose some quality; additional internal chemical composition stones occur under high temperature decomposition in gas may also lead to loss of quality; coupled at high temperature, the water inside the concrete containing crystalline mineral crystal water and decomposition of the components in the form of water vapor out of the volatile and so may result in loss of quality aggregates.
Table 1- Stone mass loss rate

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>temperature</th>
<th>High temperature before quality</th>
<th>After the mass temperature</th>
<th>Mass loss</th>
<th>Mass loss Percentage(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Room temperature</td>
<td>5000</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>B</td>
<td>300 °C</td>
<td>5000</td>
<td>4998</td>
<td>2</td>
<td>0.04</td>
</tr>
<tr>
<td>C</td>
<td>400 °C</td>
<td>5000</td>
<td>4994</td>
<td>6</td>
<td>0.12</td>
</tr>
<tr>
<td>D</td>
<td>500 °C</td>
<td>5000</td>
<td>4991</td>
<td>9</td>
<td>0.18</td>
</tr>
<tr>
<td>E</td>
<td>600 °C</td>
<td>5000</td>
<td>4986</td>
<td>14</td>
<td>0.28</td>
</tr>
</tbody>
</table>

2, index and crushed gravel surface features

Measured within the coarse aggregate crushing value of certain quality air-dry state is about 9.5 -13.2 mm stones loaded with a standard cylinder, the press machine loading, after unloading weighed sample mass \( m_0 \), with a pore size of 2.36 mm sieve screening crushed fines weighed sample screen margin \( m_1 \), crushing index using the formula:

\[
\delta=\frac{m_1-m_0}{m_0}\times 100\%
\]

Calculations. Crushing index is smaller, the ability to resist crushing stones stronger.

Table 2-Stone crushing index and surface characteristic change table

<table>
<thead>
<tr>
<th>Sample</th>
<th>temperature</th>
<th>Crushing index(%)</th>
<th>Color and surface characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Room temperature</td>
<td>7.7</td>
<td>Gray, bright, clean surface</td>
</tr>
<tr>
<td>B</td>
<td>300 °C</td>
<td>8.8</td>
<td>Light gray, tends to dim individual red surface, surface Chu Chen</td>
</tr>
<tr>
<td>C</td>
<td>400 °C</td>
<td>9.2</td>
<td>Faded blue, the color tends to be dark, increase local red particles, surface Chu Chen</td>
</tr>
<tr>
<td>D</td>
<td>500 °C</td>
<td>12.0</td>
<td>Dark gray, touching the surface of dust sense</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12.2</td>
<td>Gray, touching the surface of a thin layer of dust particles</td>
</tr>
</tbody>
</table>

Figures 3 and 4, respectively, before and after the numbers before and after the high temperature and crushed stone electronic picture, can clearly be seen from the figure changes color and surface characteristics of the stones subjected to high temperatures after the change. Table 2 after the crushing value index recorded at different temperatures and surface characteristics of the stone changes, Figure 5 is a stone crushing index temperature curve analysis shows that both, gravel subjected to high temperature in different degrees, crushing index is rising, when the temperature
exceeds500 °C, reaches 600 °C, its intensity decreasing trend is slowing down, the strength of overall aggregate with the rise of temperature by gradually decreasing.

![Figure3: Coarse aggregate after high temperature](image3.png)

<table>
<thead>
<tr>
<th>Room temperature</th>
<th>300 °C</th>
<th>400 °C</th>
<th>500 °C</th>
<th>600 °C</th>
</tr>
</thead>
</table>

![Figure4: After crushing coarse aggregate](image4.png)

Document HOFF GC, BILODEAU A, MALHOTRA V M. Elevated temperature effects on HSC residual strength [J]. Concrete International, 2000, 22 (4): 41-47 the discussion of loss of strength: quality limestone is larger heat capacity aggregate ratio of high strength concrete with granite aggregate has better high temperature performance, calcined limestone aggregate, absorb heat, heat capacity and the quality is low, slowing the temperature rise inside the specimen, the strength loss reduction SLOW. Document "Experimental Thermal Analysis limestone calcination and sulphation performance," he also pointed out that, in order to CaCO3 as the main component of limestone at high temperature resistance furnace, high temperature environment will generate limestone quicklime and release carbon dioxide, the main chemical reaction formula:

\[
\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2 \uparrow
\]

limestone begins to decompose different temperatures of about 600 °C. Decomposition at About 780 °C fastest, to about 850 °C decomposition end. Integrated both concluded that due to the quality limestone aggregates larger heat capacity, when the temperature rises to 600 °C, started to decompose to absorb heat, resulting in aggregate own strength decreases.
slowing, and this just confirms the experimental data view. According to this inference, aggregated due after more than 800 °C decomposition is substantially complete, reducing its ability to absorb heat, whether its intensity decreasing trend change it again, since the heating temperature of the test is limited, the projections conducted research until later.

Let's analyze the color and surface characteristics are also significant changes: under normal temperature stone was gray, clean and bright, with the temperature rising by the fire, faded blue, turning gray, dust particle surfaces have a sense of touch, the more color increasingly bleak, local aggregate particles appear red. For the color of dark gray Jiancheng this change, the main reason is that this experiment is calcareous stone, mainly composed of \( \text{CaCO}_3 \). Therefore, as the temperature rises, calcareous aggregate gradually broken down, and its color has become a decomposition of calcium oxide that is an off-white color. The local surface is rendered in red may cause a small amount of iron contained in the aggregate under high temperature oxidized.

References

[1] Jianxun Dong, Yue Zhang, Zhaoxing Feng and so on. Experimental Study on Thermal Performance of Limestone High Temperature Calcination for Sulfur Fixation[J]. Thermal power generation, 2005(2)


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