Effect of concrete viscosity on apparent quality of fair faced concrete

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Abstract. In this paper, concrete with different viscosity was prepared by adjusting the water binder ratio of concrete. The floating time of table tennis was used to characterize the viscosity of concrete, and the effect of concrete viscosity on the apparent quality of fair faced concrete was studied. The test results show that with the increase of concrete viscosity, the apparent porosity of concrete decreases first and then increases. When the water binder ratio is 0.37 and the floating time of table tennis is 40s, the appearance quality of concrete components is the best.

1. Introduction
With the development and progress of China's construction industry, the requirements for concrete components are no longer limited to concrete strength, but also put forward higher requirements for the apparent quality of components. In recent years, the research and engineering application of fair faced concrete in China have developed rapidly [1]. The common appearance defects of fair faced concrete members refer to the "bubble hole defects" in the appearance of members [2]. At present, most of the evaluation methods for the appearance quality of concrete members in the industry are based on personal senses or manually counting the number of "bubble holes" in the unit area of concrete members. There is no specific quantifiable evaluation method and there is great subjective randomness.

Photoshop computer image processing technology is a digital way to analyze, recognize and process images, so as to display information more accurately and intuitively [3]. Through Photoshop Image processing technology, this paper accurately analyzes the apparent quality of concrete specimens made of concrete with different water binder ratio and different viscosity, and forms detailed basic data, which has certain reference value for the research of fair faced concrete engineering in the future.

2. Experimental
2.1. Materials
(1) Cement (C): the "Minfu" brand 42.5R ordinary portland cement of Fujian Minfu building materials, and its performance indexes are shown in Table 1.
Table 1. Cement properties

| Sieve residue /% | Setting time /min | Flexural strength /MPa | Compressive strength /MPa |
|------------------|-------------------|------------------------|--------------------------|
|                  | Initial setting   | Final setting          | 3d  | 28d    | 3d  | 28d    |
| 0.8              | 160               | 245                    | 4.7 | 8.8    | 28.5| 50.2   |

(2) Gravel: Granite gravel produced by a stone factory in Zhangzhou. See Table 2 for specific performance indexes of gravel.

Table 2. Gravel properties

| Particle size/mm | Apparent density / (kg/m³) | Bulk density / (kg/m³) | Sediment percentage /% | Needle and flake content /% |
|------------------|-----------------------------|------------------------|------------------------|-----------------------------|
| 5~25             | 2650                        | 1460                   | 0.7                    | 2                           |

(3) Sand (S): Granite manufactured sand produced by a building materials Co., Ltd. in Xiamen. See Table 3 for its performance indexes.

Table 3. Sand properties

| Type                | Mud block content /% | Powder content /% | MB value | Crushing value index /% | Chloride ion content /% | Fineness modulus |
|---------------------|----------------------|-------------------|----------|-------------------------|-------------------------|-----------------|
| Machine-made sand   | 0                    | 4.4               | 0.6      | 12.8                    | 0.00                    | 2.8             |

(4) Superplasticizer(A): KZJ point-QS special superplasticizer for fair faced concrete, which meets the requirements of GB 8076-2008 concrete admixtures.

(5) Water(W): Meet the requirements of JGJ 63-2006 water standard for concrete.

2.2. Performance test method

2.2.1. Test method for apparent porosity of concrete

When the quality defect of "bubble hole" appears in fair faced concrete components, take photos at an appropriate light angle. At this time, the defect part of "bubble hole" will show a shadow, which is very different from the color of surrounding normal concrete components [4]. After the image is preprocessed and cut, the area outside the concrete component is removed, and then imported into Photoshop software. Call out the histogram function in the software to display the pixel value of the whole image, and record the value as T1. Select the sampling color "shadow" through the color range function. At this time, the pixel value of the shadow area can be displayed on the square diagram, and record the value as T2. The calculation formula of concrete apparent porosity is shown in formula (1).

\[ \gamma = \frac{T2}{T1} \times 100\% \] (1)

2.2.2. Test method for viscosity of concrete

The concrete viscosity test method uses the method described in ZL 201620627378.9 patent and uses the scheme of table tennis floating time to evaluate the concrete viscosity.

3. Experimental scheme design

The concrete with different viscosity is prepared by adjusting the water binder ratio, and the concrete slump is controlled within 155 ± 5mm through adjusting the dosage of water reducing agent, so as to avoid the impact of different concrete slump on the experimental results. The concrete mix is shown in Table 4, and the specific conditions of concrete with different viscosity are shown in Table 5.
Place the prepared concrete in 150 mm × 150 mm × 150 mm test mold shall be vibrated for 50 s to form the test piece. The test piece shall be demoulded after curing in the laboratory for 24 h. The four sides of the test piece shall be photographed to form the appearance pictures of the test piece. The pictures shall be analyzed to obtain the apparent porosity of the concrete.

4. Experimental results and discussion

The effect of concrete with different viscosity (different table tennis floating time) on the apparent porosity of concrete is studied. The experimental results are shown in Fig. 1.

Fig. 1. Effect of different viscosity concrete (different table tennis floating time) on apparent porosity of concrete

The experimental results show that. With the increase of concrete viscosity (the increase of table tennis floating time), the apparent porosity of concrete decreases first and then increases. The water binder ratio is 0.37. When the table tennis floating time is 40s, the proportion of concrete apparent porosity is the lowest, which is 0.20%. The test group with water binder ratio of 0.60 and table tennis floating time of 12s has the highest proportion of concrete apparent porosity, reaching 0.92%. This may be because when the viscosity is too low, although the bubble discharge speed is fast, the concrete mixture is more likely to produce new bubbles during vibration, resulting in the high proportion of comprehensive concrete apparent porosity. The water binder ratio was 0.33, and the apparent porosity of the concrete in the test group with the table tennis floating time of 60s reached
0.56%, which may be caused by the excessive viscosity of the concrete and the difficulty of discharging bubbles from the concrete.

5. Conclusions

(1) Concrete viscosity or water binder ratio is one of the key factors affecting the appearance quality of concrete components. It is not blindly pursuing low viscosity to obtain better apparent quality. When the viscosity is too low, although the bubbles are discharged quickly during vibration, new bubbles are easy to be generated during vibration forming, resulting in the increase of the proportion of concrete apparent porosity and the deterioration of concrete apparent quality.

(2) When the water binder ratio is 0.37 and the table tennis floating time is 40s, the apparent quality of the concrete component is the best and the proportion of the apparent porosity of the concrete is the lowest.

(3) Through the research, it is found that the appearance quality of concrete components can be improved by controlling the concrete viscosity. Of course, factors such as concrete slump, concrete air content, the type of release agent and the type of formwork will affect the appearance quality of concrete components. Further research can be carried out in these directions.

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References:

[1] Cui X., Xia W. J., Wang L. Z., et al. (2017) Research on Key Technologies of fair faced concrete preparation and construction. New building materials, 5:67-71.

[2] Wang L. Z., Lu L. H., Cui X., et al. (2016) Study on preparation technology of fair faced concrete. Concrete and cement products, 12:27-31.

[3] Liu Y. J. (2018) Research and implementation of Photoshop automatic evaluation system based on image analysis. Taiyuan University of technology

[4] Wang R. (2015) Application of light and shadow in modern photography. Popular literature and art, 18:189-190.