Influence of Molding Methods on the Polymer Pervious Concrete

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Abstract. The influence of vibration molding method and manual poking molding method on strength and water permeability of polymer pervious cement concrete with water cement ratio of 0.27, 0.30 and 0.33 is studied. It is found that the compressive strength of vibration molding increases with the increasing of vibration time and the water permeability coefficient decreases. The strength of concrete with vibration molding is higher than that of manual poking molding, and the water permeability coefficient is lower. However, the water permeability coefficient with both molding methods is more than 0.5mm/s.

1. Introduction

Pervious concrete, also known as porous concrete, is composed of water, cement and coarse aggregate, without sand and other fine aggregates. The apparent density is between 1600kg/m³ ~ 2100kg/m³, the compressive strength is between C15 ~ C30, the water permeability coefficient is higher than 0.5mm/s, and the porosity is between 15% ~ 25%[1]. Polymer pervious cement concrete is a kind of pervious concrete, which adds polymer to enhance mechanical and physical properties of concrete. Compared with ordinary pervious concrete, the paste of polymer pervious cement concrete could enhance the bond ability between aggregate and cement paste, and prevent the generation and development of interior crack[2].

The molding method is very important to the concrete specimens. The performance indexes vary with different molding method. At present, there are various molding methods, such as vibration molding method, manual poking molding method, static pressure molding method, and there existed problems below among various molding methods:

- For manual poking molding method, due to the difference of laboratory personnel, the dispersion of test data is larger.
- For the same molding method, different scholars adopt different parameters in the research process, such as the vibration time of vibration molding method, it is not easy to compare with the test data.
- However, researchers are mostly concentrated in the study of the concrete molding method independently, lacking the contrast between studies, and most of the studies are concentrated in the molding methods of ordinary pervious concrete, few in that of polymer pervious cement concrete.
In this paper, the compressive strength and water permeability coefficient of polymer pervious cement concrete with 0.27, 0.30 and 0.33 water cement ratio are studied adopting the manual poking molding method and vibration molding method.

2. Test and analysis

2.1. Experiment design

2.1.1. Test materials. Cement: Jinyu P.O.42.5 ordinary portland cement, produced in Beijing. Coarse aggregate: gravel with size of 5mm ~ 10mm. Polymer: produced in Shandong Province, which is mainly composed of redispersible latex powder and high purity nanometer silica powder.

2.1.2. Concrete mix proportion. Concrete mix proportion is shown in Table 1 below.

| Water cement ratio | Cement (kg/m³) | Water (kg/m³) | Aggregate (kg/m³) | Polymer content (kg/m³) |
|--------------------|----------------|---------------|-------------------|------------------------|
| 0.27               | 370            | 99.9          | 1531              | 10                     |
| 0.30               | 370            | 111           | 1531              | 10                     |
| 0.33               | 370            | 122.1         | 1531              | 10                     |

2.2. Test results and analysis

2.2.1. Influence of molding methods on compressive strength of specimens. The compressive test results of polymer pervious cement concrete with vibration molding and manual poking molding are shown in Table 2 and Figure 1.

| Molding method | Water cement ratio | 0.27 | 0.30 | 0.33 |
|----------------|--------------------|------|------|------|
| Vibration      | 10s                | 27.55| 28.19| 35.66|
| Molding time   | 15s                | 30.88| 38.03| 38.61|
| manual vibration molding | According to reference[5] | 26.06| 30.08| 30.24|

Comparison of different molding methods: the strength with vibration time 15s and 20s is higher than 30MPa, and is higher than that of manual poking molding method. The reason is that with the vibration, the loose concrete mixture gradually becomes compacted, and the contact areas between aggregates increase. On the other hand, the gravel aggregate is relatively polygonal, and the aggregates are interlaced with each other to form an "interlocking structure"[3]. Therefore, the strength of the specimen could be improved. With the increasing of the vibration time, the effect is gradually obvious, and the strength of the specimen is also gradually improving. It could be found that the compressive strength reaches 43.6 MPa with vibration time 20, which is higher than that of manual poking molding (30.08Mpa).
2.2.2. **Influence of molding methods on water permeability coefficient of specimens.** The water permeability coefficient test results of polymer pervious cement concrete are shown in Table 3.

| Molding method          | Water cement ratio | 0.27 | 0.30 | 0.33 |
|-------------------------|--------------------|------|------|------|
| Vibration molding time  | 10s                | 4.88 | 4.33 | 4.19 |
|                         | 15s                | 3.73 | 3.54 | 3.28 |
|                         | 20s                | 2.75 | 1.63 | 2.35 |
| manual vibration molding| According to       | 4.54 | 4.86 | 4.06 |
|                         | reference[5]       |      |      |      |

Figure 1. Compressive strength with different molding methods

Figure 2. Water permeability coefficients
Influence of molding method: Figure 2 is the permeability coefficients with different molding methods and water cement ratio. With vibration molding method, the test data of vibration of 10s is close to that of manual poking molding method. The water permeability coefficient of vibration 15s and 20s is lower than the others. With the increase of vibration time, the inner part of the specimen becomes more and more dense, and it could enhance the strength. However, the increase of vibration time molding not only make the aggregate closer together, but also accelerate the movement of paste, and the mixture paste could fill the voids between aggregates, so the water permeability coefficient becomes smaller. From the test results, it is found that the water cement ratio also influences the water permeability coefficient of the concrete. With the increasing of water cement ratio, the water permeability coefficient decreases. Because the compactness of concrete more depends on the fluidity of the paste. Water cement ratio determines the fluidity of the mixture paste. When the water cement ratio decreases, the fluidity of the mixture paste is smaller, and the aggregates are not completely filled by the paste, resulting in larger internal pores and easier for the formation of, so the water permeability of the specimen is better and the water permeability coefficient is higher. With the increase of water-to-cement ratio, the fluidity of the mixture paste also increases, making the paste deposit at the bottom of specimen, blocking the pores, the number of pore passage decreases, resulting in the decrease of water permeability coefficient. Therefore, the water cement ratio is an important factor to the permeability of the specimens.

3. Conclusion
In this paper, through the experiment of polymer pervious cement concrete, the influence of vibration molding method and manual poking molding method on the compressive and water permeability properties of the concrete is studied, and the following conclusions are obtained:
- The compressive properties of polymer pervious concrete are influenced by the molding method. With the vibration molding, the compressive strength of the concrete increases with the vibration time, and the increasing rate is flattening out. Compared with the manual poking molding, the strength of concrete by the vibration molding method is generally higher.
- The water permeability coefficient of the specimens is also influenced by the molding method. With the increase of vibration time, the water permeability coefficient decreases, it is generally lower than that of manual poking molding method. However, using the two molding methods, the water permeability coefficient meets the requirement of reference [4], higher than 0.5mm/s.

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