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Research paper

Study on cracking resistance of polyvinyl alcohol fiber-reinforced low-dose cement-stabilized crushed stone

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Abstract: In this paper, the effects of polyvinyl alcohol fiber incorporation on the crack resistance of low-dose cement-stabilized crushed stone have been investigated. The resulting change in the compressive strength, compressive rebound modulus, splitting strength, dry shrinkage factor, and impact toughness with fiber incorporation was evaluated through the unconfined compressive strength test, compressive rebound modulus test, crack strength test, dry shrinkage test, and impact toughness test. The results showed the positive influence of PVA fibers on the crack resistance of low-dose cement-stabilized crushed stone. PVA fibers have been shown to improve the compressive strength, splitting strength, and impact toughness of low-dose cement-stabilized crushed stone while reducing the compressive rebound modulus and dry shrinkage factor. With the increase of fiber incorporation, the compressive strength, splitting strength, and impact toughness tend to increase first and then decrease. The compressive resilience modulus and dry shrinkage coefficient showed a tendency to decrease first and then increase. When the fiber dosage is 0.9 kg/m^3, the maximum energy consumed in the fracture of the specimen, the strongest impact resistance and impact ductility of the material, the indexes reach the optimal value, indicating that the crack resistance of PVA fiber low-dose cement-stabilized crushed stone is optimal at this dosage. This study provides a theoretical basis for promoting and applying PVA fiber in low-dose cement-stabilized gravel.

Keywords: compressive rebound modulus test, dry shrinkage test, low-dose cement-stabilized gravel, impact toughness test, pva fibers, splitting test, unconfined compressive strength test

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1. Introduction

Building a green, resilient and sustainable transportation integration system is an important future development path for the road engineering sector [1]. Semi-rigid pavements have become China's main road surface structure because of their high strength, good structure, stability, and frost resistance, and they can fully use local materials [2]. However, there are also some inherent defects in the semi-rigid base layer. It is very sensitive to temperature and humidity, producing temperature and dry shrinkage cracks due to temperature and humidity variations. Also, under the action of load, the base layer cracks will expand to the surface layer to form reflective cracks to damage the overall pavement structure, thus affecting the use and serviceability of the semi-rigid base asphalt pavements [3].

In order to reduce the reflective crack defects of semi-rigid asphalt pavement, much research has been conducted in recent years [4]. For example, using graded gravel as a transition layer between the semi-rigid base layer and the asphalt surface layer can functionally prevent and reduce the reflective cracking in the semi-rigid base layer and improve the internal drainage conditions of the road surface [5]. However, there are certain limitations to this method. First, since the bearing capacity of graded crushed stone is weak and the plastic deformation is large, its strength cannot meet the standard required by the code, the asphalt road is more prone to rutting and fatigue damage. Also, the water stability is relatively poor. Second, as there is no cemented material in the graded crushed stone, it is difficult to crush and form in construction, and the ease of change is poor [6]. In order to solve the defect of the intermediate layer of graded gravel. B. Yu et al. proposed using a small amount of asphalt as a binder of graded gravel for the transition layer of the pavement [7]. Although this method improves the load-carrying capacity of graded gravel to a certain degree, the asphalt gravel transition layer greatly increases the cost, and its applicability and effectiveness remain to be investigated. B. Li et al. studied adding a small amount of cement material to the graded crushed stone [8]. This approach improves the bearing capacity of the graded crushed stone to a certain extent and can reduce the drying and thermal shrinkage problems caused by the high cement content. However, there are also some shortcomings of this method. The engineering practice shows that low-dose cement-stabilized crushed stone is prone to load-type cracks under external action. Hence, the improvement of crack resistance of low-dose cement-stabilized crushed stone materials needs to be further studied.

PVA fiber offers the advantages of high strength, cement affinity, alkali resistance, and good durability with green environmental protection and low cost [9]. C.C. Thong et al. studied the effect of PVA fiber on the stable gravel properties of cement and showed that PVA fiber could significantly enhance the crack resistance and fatigue performance of cement-stabilized crushed stone [10]. K. Dhasindrakrishna et al. investigated the influence of PVA fiber on the mechanical properties of cement concrete and found that the concrete compressive strength could be improved by up to 40% and the splitting strength could reach 30%, while the bending toughness could also be improved [11]. Currently, there are more studies on such composite materials, mainly concentrating on cement mortar and cement concrete. There are fewer studies on the PVA fiber-reinforced low-dose cement-stabilized crushed stone. However, from the perspective of impact toughness, there are fewer studies to evaluate the crack resistance of PVA fiber reinforced low-dose cement-stabilized crushed stone. Therefore, whether PVA fiber can enhance the crack resistance of low-dose cement-stabilized crushed stone needs to be studied in-depth [12–14].

Based on the above problems, according to some shortcomings of low-dose cement-stabilized crushed materials, a new PVA fiber-reinforced low-dose cement-stabilized crushed material is designed and the new material is used as the research object, compressive strength, compressive rebound modulus, splitting strength, dry shrinkage test, and impact toughness at various age were systematically studied for the low-dose cement-stabilized crushed stone incorporating PVA fiber. The crack resistance with the change in fiber content and age was also analyzed, and the optimal fiber dosage was recommended. The aim is to solve the problem of reflection cracks on asphalt pavements with semi-rigid base due to early cracking of the semi-rigid base. This study provides a reference for the engineering application of PVA fiber-reinforced low-dose cement-stabilized gravel materials.

2. Materials and mix design

2.1. Raw materials

2.1.1. Cement material

Ordinary portland cement p·o.42.5, manufactured by Changsha zhonglian (Changsha industrial park, Hunan province), China, was used as the primary binder. Its properties are given in Table 1.

Table 1. Cement technical indicators

Description	**Stability (mm)**	**Fineness (%)**	**Compressive strength (MPa)**		**Flexural strength (MPa)**		**Setting time (min)**	
			3 days	**28 days**	**3 days**	**28 days**	**Initial condensation**	**Final condensation**
Test value	1.0	2.5	25.3	51.4	7.8	8.3	280	400
Standard value	≤ 5.0	≤ 10.0	≥ 17.0	≥ 42.5	≥ 3.5	≥ 6.5	≥ 240	≥ 360

2.1.2. PVA fibers

In this study, the PVA fibers produced by Shanghai jieyuan chemical were selected. The fibers were slit after adding a modifier under special production processing conditions. These PVA fibers are bundled and are not conducive to dispersion. Therefore, the 5 mm diameter fiber bundles were dispersed artificially into finer filaments before use in experimental research. Van der Waals forces existed among the individual fibers (Fig. 1). The fibers were arranged in bundles by the van der Waals forces because of the small diameter of the individual fibers (15 μm). The mechanical properties of the fibers are given in Table 2.

Fig. 1. PVA fibers

Table 2. Mechanical properties of PVA fibers

Splitting strength		**Young's modulus**		**Fiber length (mm)**	**Fiber diameter (μm)**
cN/dtex	**MPa**	**cN/dtex**	**GPa**		
13	1500	250	34	12-30	15

Note: cN = 0.01 N; and dtex = grams of 10,000-m-long bundles.

2.1.3. Aggregates materials

The aggregate of this study is limestone aggregate, and its technical indicators meet the requirements of the JTG/E42-2005, the technical indicators are shown in Table 3 and Table 4.

Table 3. Technical indexes of coarse aggregate

Performance metrics	**Measured data**				**Design requirements**
	1	**2**	**3**	**4**	
Crush Value (%)	20.4	21.1	20.6	21.2	≤ 26
Apparent relative density (g/cm^3)	2.658	2.636	2.662	2.666	≥ 25
Needle flake particle content (%)	7.6	8.1	7.9	8.2	≤ 15

Table 4. Technical indicators of fine aggregates

Test items	**Test results**	**Design requirements**
Apparent relative density	2.682	≥ 2.5
Sand equivalent (%)	75	≥ 60
Mud content	< 1.5	–
Fineness modulus	2.8	–
Angularity (s)	36.2	≥ 30

2.2. Mix design

2.2.1. Graded design

According to the requirements of the JTG E42-2005, and combined with the analysis and calculation of the screening results of the actual coarse and fine aggregates, the best mix ratio is obtained by adjusting the mixing ratio, as shown in Fig. 2.

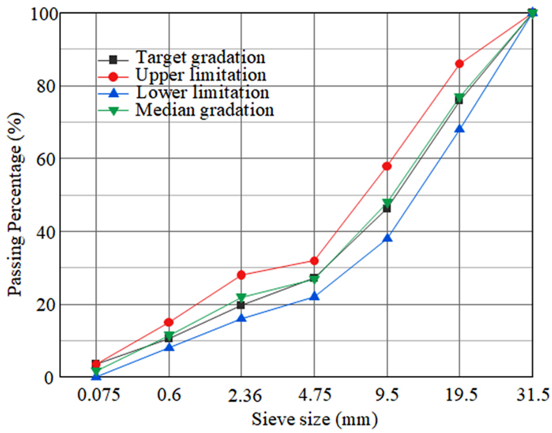

Fig. 2. Synthetic gradation curve of mixture

2.2.2. Determination of water content and maximum dry density

In this paper, the optimal water content and maximum dry density of low-dose cement-stabilized gravel were determined by standard compaction test method. The mixture with a cement dosage of 2.5% was subjected to a standard compaction test under different pre-added water contents (3%, 4%, 5%, 6%, 7%), and the test results are shown in Fig. 3.

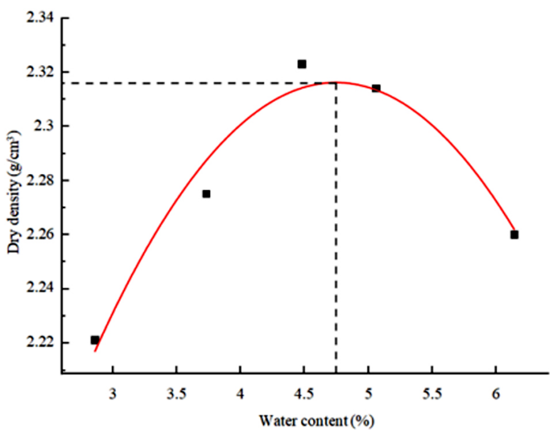

Fig. 3. Cement content 2.5% moisture-dry density curve

3. Specimen preparation and test methods

3.1. Specimen preparation

It is known from the previous findings that when the cement dosage in low-dose cement-stabilized crushed stone is 2.5%, the drying shrinkage is small, according to the minimum standard requirements for CBR at 7 and 14 d of age, the minimum unconfined compressive strength at 14 d of age is 1.3 MPa and the minimum value of compressive resilience modulus is 260 MPa, better road performance than at 2% and 1.5% cement content [15]. Thus, the cement dose studied in this paper is 2.5%. The amount of PVA fiber incorporation is selected as 0, 0.6 kg/m^3, 0.9 kg/m^3, and 1.2 kg/m^3. Two types of specimens (cylindrical specimens and beam specimens) were selected in this study according to the JTG-E51-2009. Cylindrical specimens were used for compressive strength, compressive rebound modulus, and splitting strength tests, whereas beam specimens were used for dry shrinkage test and impact toughness test. The diameter and height of the cylindrical specimen were 150 mm. The beam specimens were 400 mm ×100 mm ×100 mm in dimensions. Vibration compaction was adopted for specimen fabrication. The specimens were cured at 20 ± 2°C temperature and 95% relative humidity. Three specimens were cast for each mix proportion for each test. The specimen preparation is shown in Fig. 4.

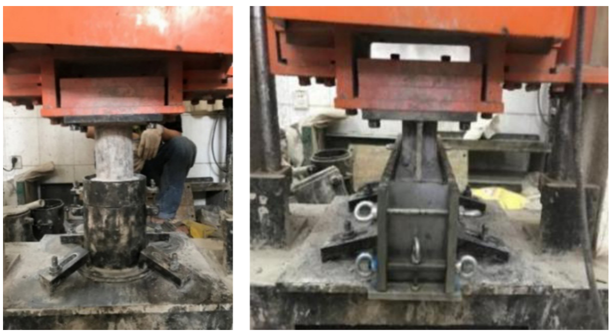

Fig. 4. The specimen is formed

3.2. Test methods

PVA fiber low-dose cement-stabilized crushed stone as an intermediate layer must have sufficient strength, modulus, and good crack resistance. Therefore, it is necessary to verify its road performance and propose its evaluation method.

3.2.1. Unconfined compressive strength test

Unconfined compressive strength tests were performed on the cylindrical specimens after 7 days, 28 days, and 90 days, using universal testing machine according to the JTG-E51-2009. The test was performed at room temperature (20 ± 5°C) and 50–70% relative humidity at a 1mm/min loading rate. The result was obtained using Eq. (3.1).

$$R_C = \frac{P_C}{A} \tag{3.1}$$

where: R_c – compressive strength of the specimen (MPa), P_c – ultimate load in case of specimen failure (N), A – cross-sectional area of the specimen (mm^2).

3.2.2. Compressive resilient modulus test

According to the requirements of the JTG- E51-2009, after 7 days, 28 days, and 90 days, the test was carried out using the universal testing machine. The results were obtained from Eq. (3.2).

$$E_C = \frac{Ph}{l} \tag{3.2}$$

where: E_c – compressive resilience modulus (MPa), P – unit pressure (MPa), h – specimen height(mm), l – rebound deformation (mm).

3.2.3. Splitting strength test

According to the requirements of the JTG-E51-2009, after 7 days, 28 days, and 90 days, the test was carried out in the general testing machine at a 1 mm/min loading rate. The results were obtained using Eq. (3.3).

$$R_f = 0.04178\frac{P_f}{h} \tag{3.3}$$

where: P_f – the maximum load at which the specimen is broken (N), h – the height of the specimen after immersion in water (mm).

3.2.4. Impact toughness test

According to the requirements of the JTG-E51-2009, after 7 days of curing, the length L and initial mass m0 of the specimen were determined. The specimen was moved to a shrinking chamber with a controlled temperature of 20 ± 1°C, a relative humidity of 60% ±5%, and a desiccant for dehumidification. From the time the specimen is moved into the dry shrinking box, the dial gauge reading is recorded once a day for 7 days, and the quality of the specimen is weighed, and every 2 days after 7 days, and after one month, the dial gauge readings are recorded on 45 days and 60 days respectively, and after the end, the specimen is dried to a constant amount of MP in the drying box. The results were obtained using Eq. (3.4), Eq. (3.5), Eq. (3.6), Eq. (3.7), Eq. (3.8).

$$\omega_i = \frac{m_0 - m_i}{m_P} \tag{3.4}$$

$$\delta_i = X_{i,1} + X_{i,2} \tag{3.5}$$

$$\varepsilon_i = \frac{\delta_i}{l} \tag{3.6}$$

$$\alpha_{di} = \frac{\varepsilon_i}{\omega_i} \tag{3.7}$$

$$\alpha_d = \frac{\sum \varepsilon_i}{\sum \omega_i} \tag{3.8}$$

where: ω_i – i th water loss rate (%), m_0 – initial mass of the specimen (g), m_i – weight of the i th weighing of the standard specimen (g), m_p – mass of the standard specimen after drying (g), δ_i – Shrinkage observed for the i th time (mm), $X_{i,1}$, $X_{i,2}$ – readings of two dial indicators at the i th observation (mm), ε_i – i th dry shrinkage strain (%), l – Length of the specimen (mm), α_{di} – dry shrinkage coefficient of the specimen (%), α_d – dereschlingkag, kofi sint, bents, speymen (%).

3.2.5. Impact toughness test

According to the JTG-E51-2009, the impact toughness tests on the specimens were conducted after 7 days and 28 days curing ages. The JB30B pendulum impact testing machine was used for testing whose energy can reach 0–300 J. The impact toughness was determined from Eq. (3.9).

$$E_{\text{impact}} = N \cdot m \cdot g \cdot h \tag{3.9}$$

where: E_{impact} – energy Joule (J), N – number of hits, g – 9.81 m/s; m – drop hammer quality 4.54 kg, h – drop hammer height 400 mm.

4. Results and discussions

4.1. Unconfined compressive strength

In order to analyze the effect of age and fiber content on compressive strength, the test results are shown in Fig. 5.

As shown in Fig. 5, the compressive strength gradually increases with age. The increase in the compressive strength of PVA fiber low-dose cement-stabilized crushed stone is higher than that of ordinary low-dose cement-stabilized crushed stone. Because, with the growth of age, the adhesion and fixation effect of cement on fibers is enhanced, so that PVA fiber low-dose cement stabilizes gravel to form a strong whole, PVA fiber plays a reinforcing role in the matrix. With the increase of age, the fiber strengthening effect is more obvious. According to the relevant literature, the compressive strength of cement-stabilized crushed stone has been developed at 60 d [16]. Therefore, with the increase in age, the compressive strength of the later specimen increases gradually.

When the amount of fiber incorporation is less than 0.9 kg/m^3, the compressive strength of PVA fiber low-dose cement-stabilized crushed stone increases with the increase of fiber blending. When the fiber dosage is 0.9 kg/m^3, its compressive strength reaches the maximum. When the fiber dosage is greater than 0.9 kg/m^3, its compressive strength decreases as the fiber dosage increases. This is attributed to the excessive amount of fiber mixing. The specific surface area of the fiber increases, the hydration cement wrapped around each fiber decreases, and there

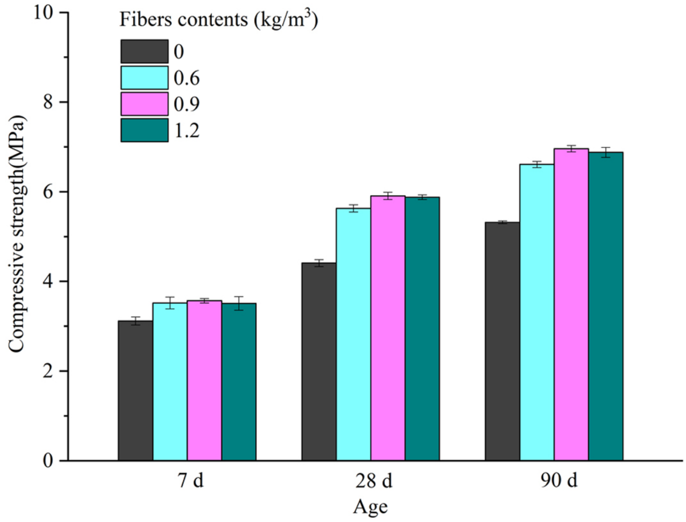

Fig. 5. Compressive strength test results under different fiber content (age of 7 days, 28 days, 90 days)

may be no cement around the fiber, resulting in defects and a decrease in material strength. Also, at high fiber amounts in the low-dose cement-stabilized crushed stone, the fiber dispersion is low and non-uniform. The fibers are agglomerated, reducing the compressive strength of PVA fiber low-dose cement-stabilized crushed stone. When the age of the regeneration is 90 days, the compressive strength of the specimens with fiber dosage of 0.6 kg/m^3, 0.9 kg/m^3 and 1.2 kg/m^3 is 6.61 MPa, 6.96 MPa and 6.88 MPa, respectively, which is 24.2%, 30.9% and 29.3% higher than that of the ordinary cement-stabilized gravel.

4.2. Compressive resilience modulus

In order to analyze the effects of age and fiber content on the compressive resilience modulus, the test results are shown in Fig. 6.

It can be seen from Fig. 6 that when the curing age is 7 days, the compressive rebound modulus of the specimens is primarily controlled by two factors, i.e., its modulus size and compositional structure. Due to the incomplete cement hydration and inadequate reaction products formed, there is a disparity between the compressive rebound modulus value of the ordinary low-dose cement-stabilized crushed stone and PVA fiber low-dose cement-stabilized crushed stone. With the continuous increase in curing age, greater cement hydration products are formed, and the coarse and fine aggregates in the ordinary low-dose cement-stabilized gravel are connected into one. Thus, the stiffness increases rapidly, and the compressive rebound modulus is significantly improved. After the fibers are incorporated into the mixture, they can absorb the impact energy of part of the load on the specimen due to their small modulus [17]. Therefore, the compressive rebound modulus of PVA fiber low-dose cement-stabilized crushed stone specimens is lower than that of ordinary cement-stabilized crushed stone.

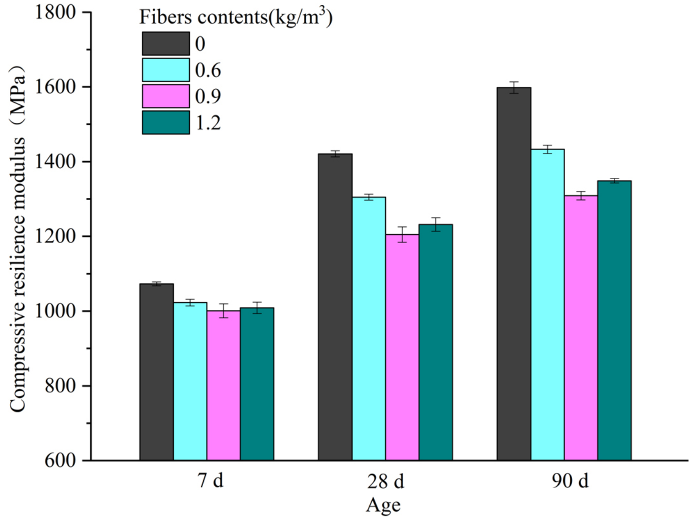

Fig. 6. Test results of compressive resilience modulus under different fiber content (age of 7 days, 28 days, 90 days)

At a certain age, with the increase of fiber doping, the compressive resilient modulus of the specimen firstly decreases and then increases, and the trend of increase is slow. The compressive resilient modulus of the specimen reaches the minimum value when the fiber dosage is 0.9 kg/m^3. The increase in compressive resilient modulus is mainly due to the decrease in the uniformity of fiber distribution, which makes it easy to form clusters. When the recuperation age was 90 d, the compressive resilient modulus of specimens with PVA fiber dosage of 0.6 kg/m^3, 0.9 kg/m^3, and 1.2 kg/m^3 were 1433 MPa, 1309 MPa, and 1349 MPa, respectively, which were 10.3%, 18.1%, and, 15.6% lower compared to the normal low-dose cement-stabilized aggregates specimens.

4.3. Splitting strength

In order to analyze the effects of age and fiber content on cleavage strength, the test results are shown in Fig. 7.

It can be seen from Fig. 7 that with the increase of the curing age, the splitting strength of ordinary low-dose cement-stabilized crushed stone and PVA fiber low-dose cement- stabilized crushed stone gradually increases. The amplitude of the splitting strength increases gradually decreases, and the reason for the decrease is the same as the reason for the decrease in the increase in compressive strength. At the 7 days curing age, the splitting strength of ordinary low-dose cement-stabilized crushed stone was 0.21 MPa, and the samples with PVA fiber dosage of 0.6 kg/m^3, 0.9 kg/m^3, 1.2 kg/m^3 had splitting strength of 0.25 MPa, 0.27 MPa, and 0.26 MPa, which increased by 0.04 MPa, 0.06 MPa, and 0.05 MPa, respectively. At 28 days, the splitting strength of ordinary low-dose cement-stabilized crushed stone was 0.29 MPa.

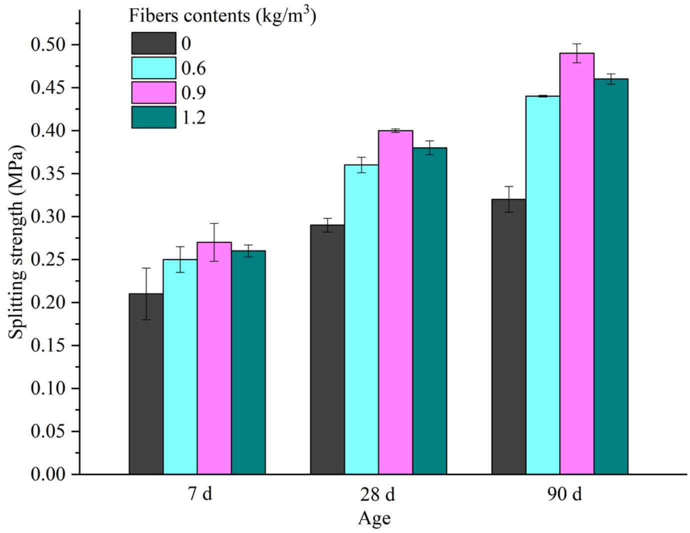

Fig. 7. The results of splitting strength test under different fiber content (age of 7 days, 28 days, 90 days)

When the PVA fiber dosage was 0.6 kg/m^3, 0.9 kg/m^3, and 1.2 kg/m^3, the corresponding splitting strength of the specimens was 0.36 MPa, 0.4 MPa, and 0.38 MPa, respectively. For the ordinary low-dose cement-stabilized crushed stone specimens, The splitting strength of the 28-day-old specimen is 38% higher than that of the 7 day old specimen. The cracking strength of the PVA fiber low-dose cement-stabilized crushed stone specimen with a fiber dosage of 0.6 kg/m^3, 0.9 kg/m^3, and 1.2 kg/m^3 increased by 44%, 48%, and 46%, respectively, compared with that of the 7 days of age specimen. It can be seen that the incorporation of PVA fiber has a good effect on rapidly improving the splitting strength of low-dose cement-stabilized crushed stone in the short term. The reason is that the early cement hydration reaction is rapid, resulting in more cement. The cement filling connects the fiber and the aggregate to play better the reinforcement role of the fibers [18].

The incorporation of PVA fibers has a greater impact on the splitting strength of low-dose cement-stabilized crushed stone specimens. Overall, PVA fibers play a certain role in enhancing the splitting strength. When the fiber dosage is less than 0.9 kg/m^3, the splitting strength of PVA fiber low-dose cement-stabilized crushed stone increases with the fiber amount. When the fiber dosage is 0.9 kg/m^3, the splitting strength reaches the maximum. When the fiber dosage is greater than 0.9 kg/m^3, the splitting strength decreases as the fiber dosage increases. The reason is that the appropriate amount of fiber blending plays a bridging and reinforcing role in low-dose cement-stabilized crushed stone, which can disperse the load transfer in time and make the force of the specimen more uniform. When the fiber dosage exceeds 0.9 kg/m^3, the uniformity of fiber distribution gradually decreases. It is easy to agglomerate, eventually decreasing the splitting strength of PVA fiber low-dose cement-stabilized crushed stone. When the curing age is 90 days, the fiber dosage is 0.6 kg/m^3, 0.9 kg/m^3, 1.2 kg/m^3, the splitting strength is 0.44 MPa, 0.49 MPa, 0.46 MPa, respectively, compared with ordinary low-dose cement stable crushed stone, the splitting strength is increased by 37.5%, 53.1%, 43.8%, respectively.

4.4. Dry shrinkage test

Figure 8 shows the results of the dry shrinkage test for a cement dosage of 2.5% and a fiber content of 0.9 kg/m^3. As can be seen from the graph, the water loss rate gradually increases with the growth of the age of maintenance, but it basically remains stable after the age reaches 10 d. Therefore, attention must be paid to the setting of the maintenance conditions before this time. The water loss is mainly caused by the hydration of the mixture.

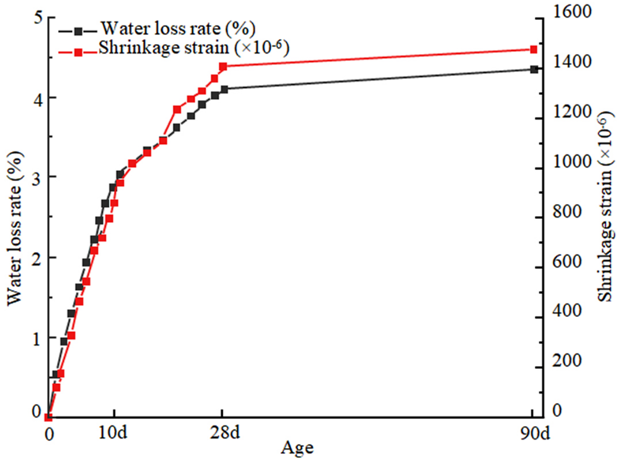

Fig. 8. Water loss rate, dry shrinkage strain with age change rule

As can be seen from Fig. 9, when the fiber dosage is certain, there is an obvious relationship between the coefficient of dry shrinkage and the age, after adding fiber, the coefficient of dry shrinkage of low-dose cement-stabilized crushed stone is obviously smaller, and the coefficient

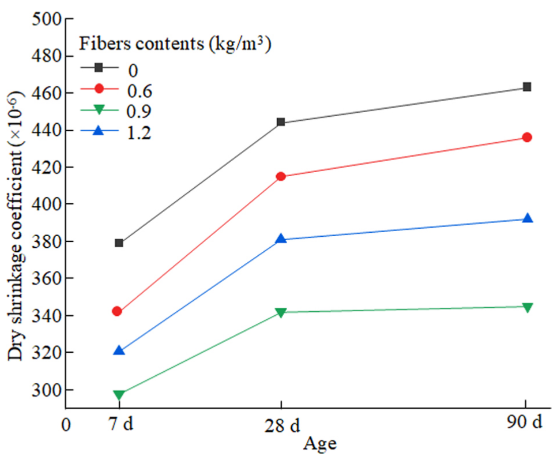

Fig. 9. Variation of drying coefficient with age

of dry shrinkage is the smallest when the fiber dosage is 0.9 kg/m^3. The growth rate of the coefficient of drying shrinkage is relatively large when the age is less than 28d, and the growth rate slows down in the following age. As the fibers can fill the interfacial voids between cement paste and aggregate, the free water loss channels are occupied by cement paste and fibers, the dry shrinkage coefficient of fiber cement stabilized aggregates is significantly lower than that of the cement stabilized aggregates without fibers, which effectively reduces the loss of bound water and the migration of free water in fiber cement stabilized aggregates. Therefore, fiber improves the cracking resistance of low-dose cement-stabilized crushed stone aggregates by a certain degree.

4.5. Impact toughness test

As shown in Fig. 10, PVA fibers significantly influence the crack resistance of low-dose cement-stabilized crushed stone. When the fiber addition ranges from 0 to 0.9 kg/m^3, the energy consumed by the breakage of the specimen is positively correlated with the amount of fiber doping. When the fiber doping amount is 0.9 kg/m^3, the energy consumed by the fracture of the specimen at the age of 7 days and 28 days reached the peak of 61.2 J and 85.9 J, respectively, compared with the ordinary low-dose cement stable gravel increased by 30.2% and 37.2%, to a certain extent, the toughness of the specimen is enhanced, so the influence of external adverse impact can be reduced in practical applications. When the amount of fiber blending continues to increase, the energy consumed by the fracture of the specimen is reduced, but the decrease is not significantly noticeable. The reason is that the appropriate amount of fibers can be fully bonded with the surrounding cement paste, thereby improving the pull-out strength of the fiber. This phenomenon can effectively promote the blocking effect of the fiber on the

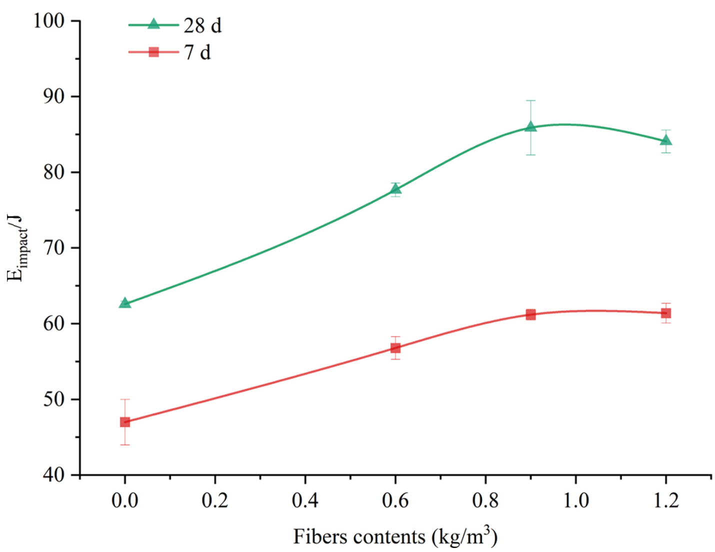

Fig. 10. Relationship between Eimpact and fiber content at different ages

crack and the splitting stress transmission on the crack surface so that the force of the specimen is more uniform. When the fiber dosage exceeds 0.9 kg/m^3, the uniformity of fiber distribution gradually decreases. It is easy to agglomerate, eventually decreasing the crack resistance of PVA fiber low-dose cement-stabilized crushed stone. The energy consumed by the fracture of the specimen at the age of 28 is increased by about 15~25 J compared with that at the age of 7 days. It signifies that the curing age greatly affects the specimen crack resistance. In summary, when the PVA fiber dosage is 0.9 kg/m^3, the crack resistance of the specimen is optimal.

5. Conclusions

In order to study the toughening effect of PVA fiber-reinforced low-dose cement-stabilized crushed stone, the effect of PVA fiber dosage and the curing age of the specimens on the mechanical properties of low-dose cement-stabilized crushed stone was studied through indoor experiments. The test results were analyzed, and the following conclusions were drawn.

1. The curing care age significantly affects the compressive strength, splitting strength, compressive rebound modulus, and crack resistance of low-dose cement-stabilized crushed stone specimens. With the increase of the curing age, the compressive strength, compressive rebound modulus, splitting strength, and crack resistance of the specimen gradually increase, but the rate of increase gradually decreases.
2. PVA fiber dosage also affects the compressive strength, compressive rebound modulus, splitting strength, and crack resistance of low-dose cement-stabilized crushed stone. With the increase of fiber doping, the compressive strength, splitting strength, and crack resistance increase, while the compressive rebound modulus decreases first and then increases. Its crack resistance is optimal when the fiber dosage is 0.9 kg/m^3.
3. In this paper, the influence of fiber doping, anti-compressive strength at the age of curing, compressive rebound modulus, crack strength and crack resistance is studied. However, the influence of mineral grading type and fiber diameter on crack resistance is not considered. In order to improve its crack resistance, the influence of fiber diameter and the optimization design of gradation are the next research directions.

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