STUDY ON PREPARATION AND PROPERTIES OF PVA FIBER CEMENT BAORDS WITH DIFFERENT TITER

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ABSTRACT

PVA fiber is recognized as an ideal material to replace asbestos, and is known as "green and environmental protection material". At the same time, PVA fiber is widely used in natural curing cement products. In this paper, fiber cement boards are prepared by using different Titer (2dtex, 7dtex, 9dtex) of polyvinyl alcohol fiber produced by Shuangxin, and are compared and measured by bending strength, dry density, wet density, water absorption rate, dry shrinkage rate, moisture movement and other indicators, the following experimental conclusions are drawn: when the fiber content is ≤1.5%, fiber with 2dtex could significantly improve the comprehensive properties of fiber cement products; when the fiber content is ≥1.5%, the bending strength of fiber cement products does not change significantly with the increase of fiber content of the fiber with 2dtex. The bending strength of fiber cement boards prepared by fiber with 7dtex and 9dtex increases with the increase of fiber content, and the bending strength reaches the maximum when the fiber content is 2.2%.

KEYWORDS:

Fiber with different Titer; normal temperature cured; bending strength; fiber cement board

INTRODUCTION

As a new type of synthetic fiber with high tensile strength and elastic modulus, high-tenacity and high-modulus PVA fiber has excellent physical and mechanical properties, with high tensile strength and elastic modulus[1], good hydrophilicity and dispersibility, high bond strength with cement matrix; excellent alkaline resistance, which can maintain high stability in the alkaline environment of cement matrix. Therefore, high-tenacity and high-modulus PVA fiber has the characteristics of high strength, high elastic modulus and acid and alkali resistance[2]. At the same time, the fiber has a unique cross-sectional character, good adhesion with cement, its physical and chemical properties are stable, which can significantly improve the toughness or ductility of concrete; uniformly dispersed and lapped to form a three-dimensional network structure, which plays a role in improving the crack resistance and toughness of concrete, thus improving the overall quality and durability of concrete.

EXPERIMENT

Materials

High-tenacity and high-modulus polyvinyl alcohol (PVA) fiber (6 mm, from Inner Mongolia Shuangxin Environment-Friendly Material Co., Ltd.), Portland cement (P·O 42.5), tap water, microsilica powder, limestone powder, pulp and flocculants.

The properties of PVA fiber are listed in the following table 1:

Table 1 Properties of PVA fiber with different Titer

Type	Linear density (dtex)	Tenacity (CN/dtex)	E-Modulus (CN/dtex)	Elongation (%)
2dtex	2.29	13.16	324.07	6.16
7dtex	7.48	10.63	269.29	7.83
9dtex	9.44	9.32	250.59	7.82

Equipment

Electronic balance, mixer, microcomputer controlled pressure testing machine, digital micrometer, polarizing microscope,etc.

Experimental procedures and formulations

Samples were prepared according to Shuangxin laboratory standards of PVA fiber cement and the quality of all raw materials was based on their dry weight. The formulations of fiber cement are listed in Table 2. After the samples were prepared, they were placed in a curing box at 60 □ for 8 hours after being packaged in plastic bags. Then the samples with plastic bags were taken out and were cured in the room environment. After curing for 14 days, the samples were ready for measurement.

According to the Chinese national standard GB/T 7019-2014 “Test methods for fiber cement products”, the bending strength, dry and wet density, water absorption rate, dry shrinkage rate and moisture movement of fiber cement boards were tested.

Table 2 Experimental Formulations of Fiber Cement Boards with Different Titer and Content

Sample	PVA fiber(%)	Cement (%)	Pulp(%)	Microsilica powder(%)	Limestone powder	Remark
1	0	81.5	3.5	5.0	10.0	The board preparation experiment was carried out according to the 8 different addition amounts, and three parallel experiments were conducted for each formulation.
2	0.8	80.7	3.5	5.0	10.0	
3	1	80.5	3.5	5.0	10.0	
4	1.2	80.3	3.5	5.0	10.0	
5	1.5	80	3.5	5.0	10.0	
6	1.8	79.7	3.5	5.0	10.0	
7	2	79.5	3.5	5.0	10.0	
8	2.2	79.3	3.5	5.0	10.0	

RESULTS AND DISCUSSIONS

Microstructure of High-tenacity and high-modulus polyvinyl alcohol (PVA) fiber

The microstructure of high-tenacity and high-modulus polyvinyl alcohol fibers with different Titer was observed with a polarizing microscope, as shown in Figure 1:

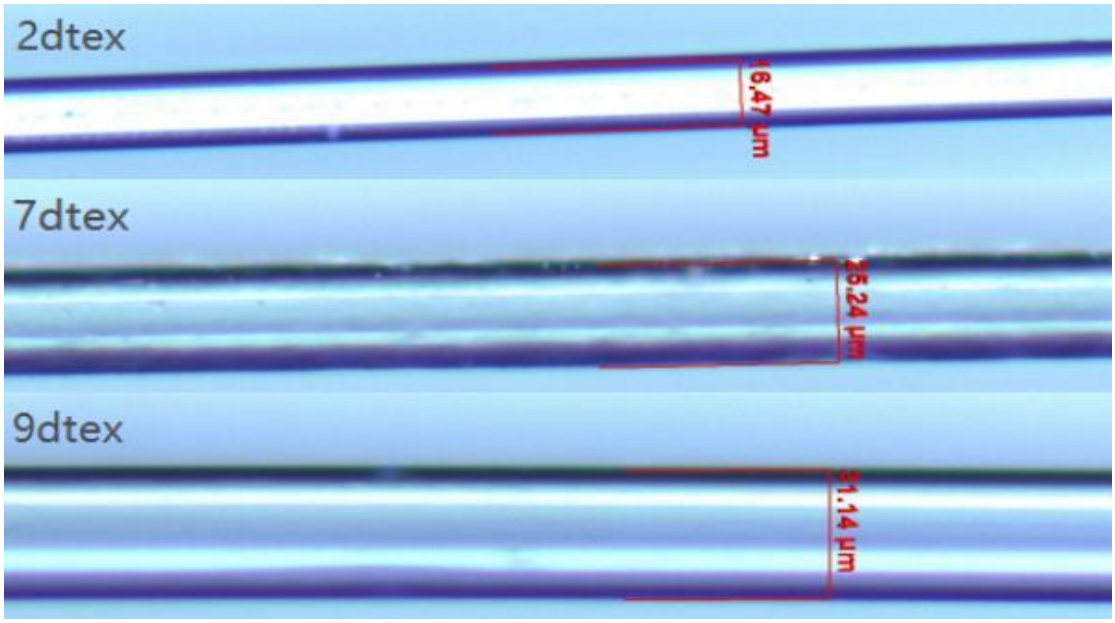

Fig. 1 Microstructure observation of fibers with 2dtex, 7dtex and 9dtex

According to the above microstructure, the fiber surface is smooth, and there is no attachment on the surface. The diameter of fibers with different Titer is obviously different.

Determination of the bending strength of fiber cement boards

Figure 2 shows the change trend of the bending strength of fiber cement boards after adding fiber in different proportions and with fiber of different Titer and cement boards without fiber. It can be seen from Figure 2 that the bending strength of 2dtex fiber cement boards increases with the increase of fiber addition amount, but when the fiber addition amount is more than 1.5%, the bending strength of the boards does not change significantly with the increase of fiber addition amount; the bending strength of fiber cement boards prepared with 7dtex and 9dtex fibers increases with the increase of fiber addition amount, and reaches the maximum when the fiber addition amount is 2.2%. The main factor affecting this experiment is that under the same quality, 2dtex fiber has a smaller size, so more fibers combine with cement slurry to produce a strong grip, thus the bending strength is also increased. When the fiber content is more than 1.5%, the dispersion of 2dtex fiber in the cement slurry becomes worse and agglomeration occurs, while the dispersibility of 7dtex and 9dtex fiber in the cement slurry is higher than that of 2dtex fiber, so the bending strength of fiber cement boards prepared with 7dtex and 9dtex fiber is higher than that of fiber cement board prepared with 2dtex fiber. Considering bending performance, economy, environment, technology and other factors, PVA fiber with 2dtex and 1.5 wt% content is selected as the optimal addition amount of fiber cement board.

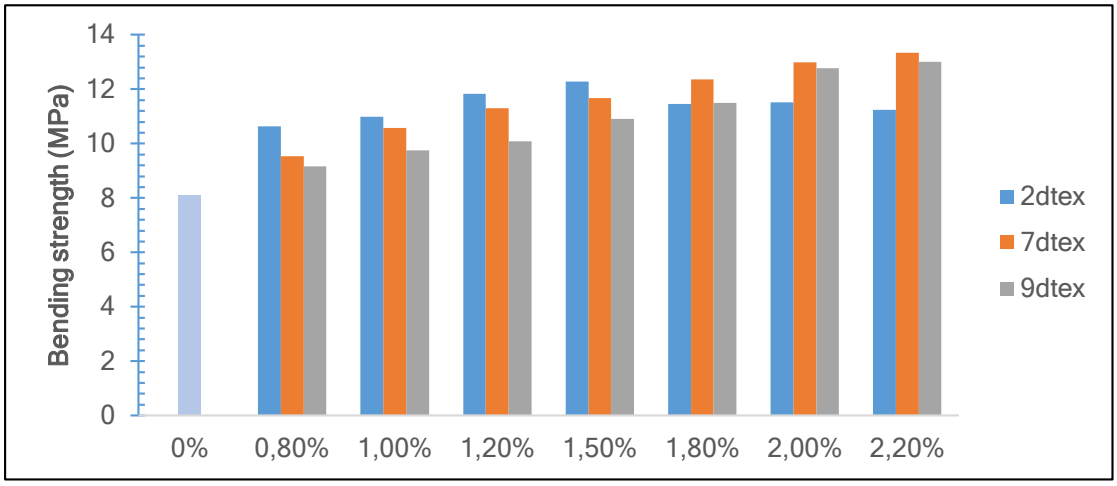

Fig. 2 Bending strength of fiber cement boards prepared by 2dtex, 7dtex and 9dtex fibers

Determination of the dry and wet densities of fiber cement boards

Figure 3 and Figure 4 show the change trend of the dry and wet densities of fiber cement boards after adding fiber in different proportions and with fiber of different Titer and cement boards without fiber. It can be seen from Figures 3 and 4 that with the increase of fiber addition amount, the dry and wet density of the fiber cement boards prepared by 2dtex, 7dtex and 9dtex fibers are reduced, but the overall dry density is more than 1.68g/cm^3, and the wet density is more than 1.76g/cm^3. On the whole, the dry and wet density of the fiber cement boards prepared by 7dtex and 9dtex fiber is slightly higher than that of the fiber cement boards prepared with 2dtex fiber; The dry and wet density of fiber cement boards prepared by 7dtex and 9dtex fibers had no significant difference.

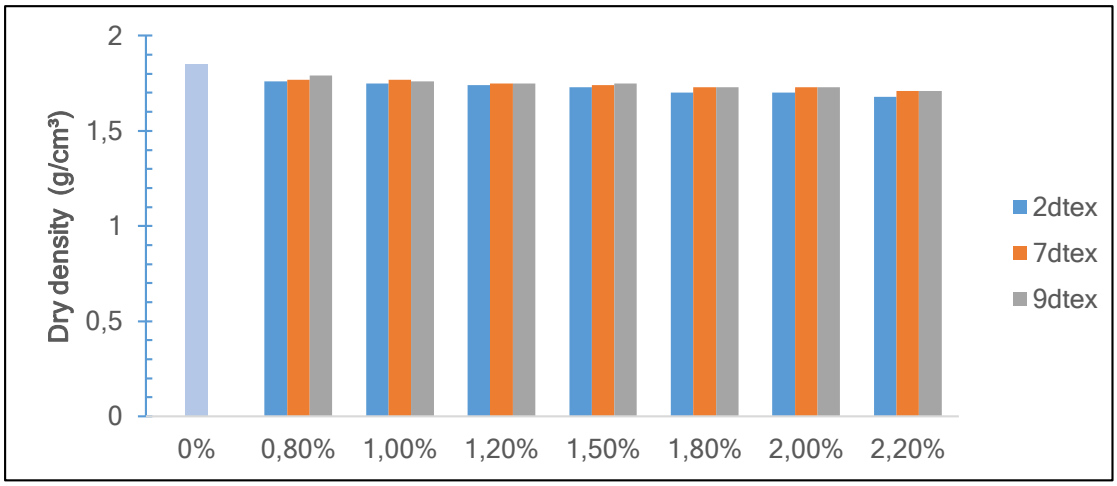

Fig. 3 Dry density of fiber cement boards prepared by 2dtex, 7dtex and 9dtex fibers

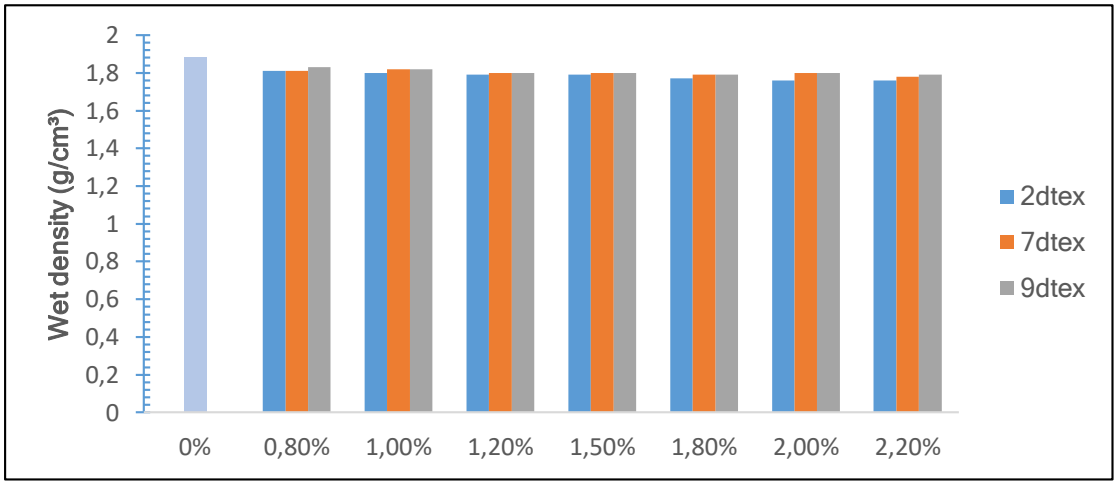

Fig. 4 Wet density of fiber cement boards prepared by 2dtex, 7dtex and 9dtex fibers

Determination of the water absorption rate of fiber cement boards

Figure 5 shows the change trend of the water absorption rate of fiber cement boards after adding fiber in different proportions and with fiber of different Titer and cement boards without fiber. It can be seen from Figure 5 that the water absorption rate of the fiber cement boards prepared by adding 2dtex fiber is slightly higher than that of the fiber cement boards prepared by adding 7dtex and 9dtex fiber; The water absorption rate of fiber cement boards with 7dtex fiber is slightly higher than that with 9dtex fiber.

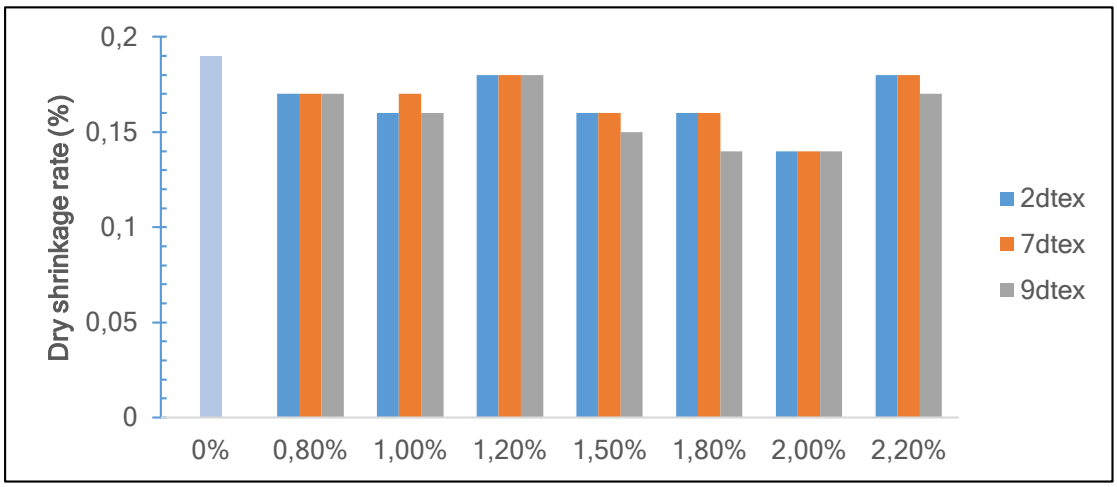

Fig. 5 Water absorption rate of fiber cement boards prepared by 2dtex, 7dtex and 9dtex fibers

Determination of the dry shrinkage rate and moisture movement of fiber cement boards

Figure 6 and Figure 7 show the change trend of the dry shrinkage rate and moisture movement of fiber cement boards after adding fiber in different proportions and with fiber of different Titer and cement boards without fiber. It can be seen from Figure 6 and Figure 7 that with the increase of fiber addition, the dry shrinkage rate and moisture movement of the fiber cement boards prepared with the same fiber has little change. On the whole, the dry shrinkage rate of the fiber cement boards prepared with 2dtex and 7dtex fibers has no significant difference, which is slightly higher than that of the fiber cement boards prepared with 9dtex fibers. The fiber cement boards prepared with the three fibers have no significant difference in the moisture movement.

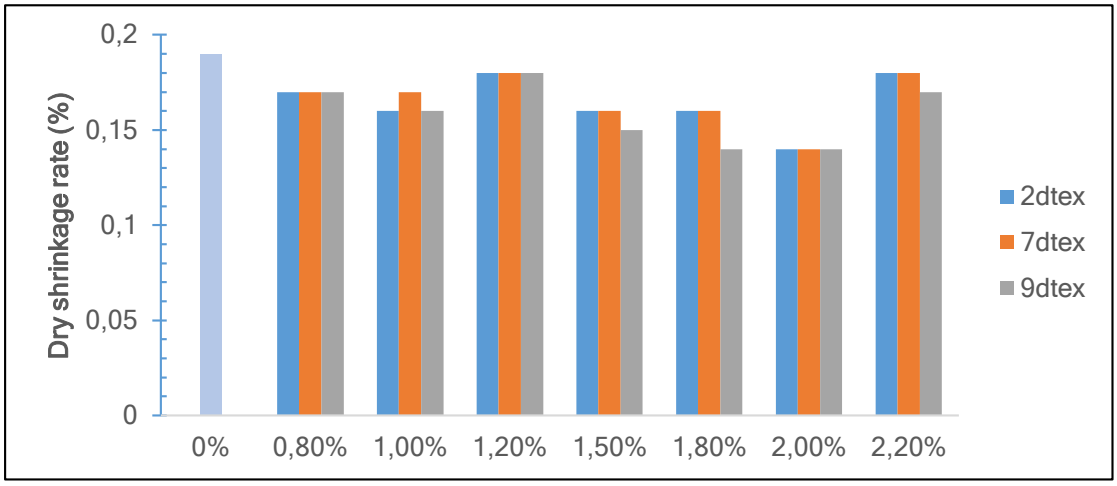

Fig. 6 Dry shrinkage rate of fiber cement boards prepared by 2dtex, 7dtex and 9dtex fibers

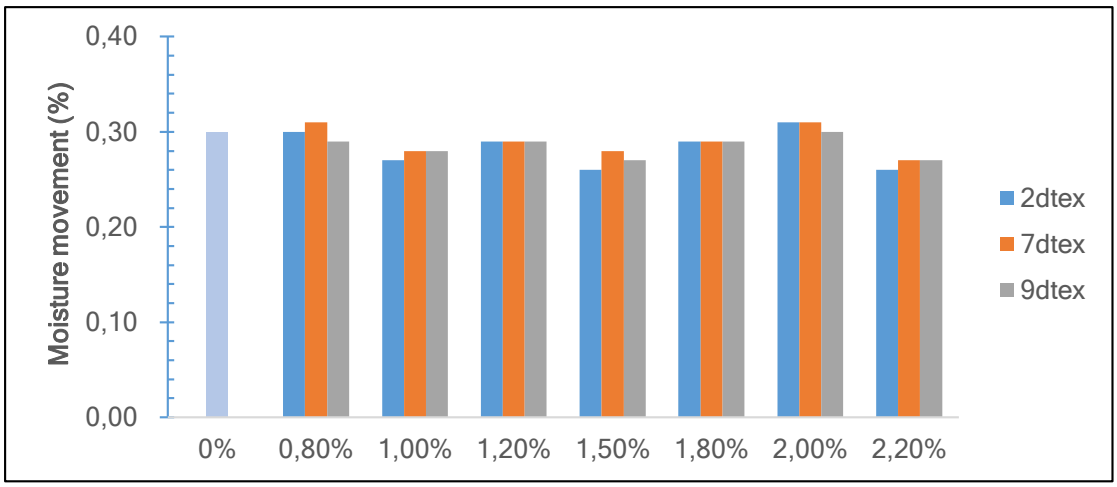

Fig. 7 Moisture movement of fiber cement boards prepared by 2dtex, 7dtex and 9dtex fibers

CONCLUSION

(1) The bending strength of fiber cement boards prepared with 2dtex fibers increased with the increase of fiber content, but when the fiber content was more than 1.5%, the bending strength of the boards did not change significantly with the increase of fiber content; the bending strength of fiber cement boards prepared with 7dtex and 9dtex fibers increases with the increase of fiber addition, and reaches the maximum when the fiber addition is 2.2%.

(2) With the increase of fiber addition amount, the dry and wet density of the fiber cement boards prepared with 2dtex, 7dtex and 9dtex fibers decreased, but the overall dry density was more than 1.68g/cm^3, and the wet density was more than 1.76g/cm^3. On the whole, the dry and wet density of the fiber cement boards prepared with 7dtex and 9dtex fiber is slightly higher than that of the fiber cement boards prepared with 2dtex fiber; the dry and wet density of fiber cement boards made of 7dtex and 9dtex fibers had no significant difference.

(3) The water absorption rate of fiber cement boards with 2dtex fiber is slightly higher than that with 7dtex and 9dtex fiber; the water absorption rate of fiber cement boards with 7dtex fiber is slightly higher than that with 9dtex fiber.

(4) With the increase of fiber addition amount, the dry shrinkage rate and moisture movement of

fiber cement boards prepared with the same fiber has little change; on the whole, the dry shrinkage rate of the fiber cement boards with 2dtex and 7dtex fiber was no significant difference, slightly higher than that with 9dtex fiber; there was no significant difference in the moisture movement of the fiber cement boards prepared with the three fibers.

Considering bending performance, economy, environment, technology and other factors, PVA fiber with 2dtex and 1.5 wt% content is selected as the optimal addition amount for fiber cement boards.

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