IIBCC 2024 International Inorganic-Bonded Fiber Composite Conference

STUDY ON THE INFLUENCE OF HIGH TENACITY FIBER ON THE PROPERTIES OF FIBER CEMENT BOARD

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ABSTRACT

High tenacity and high modulus PVA fiber has the characteristics of high tenacity, large modulus, acid and alkali resistance and good bonding ability, and can be widely used in cement-based reinforcement materials, plastic reinforcement materials and other fields. Fiber cement board (FCB) has been widely used due to its excellent performance. In this paper, fiber cement board was prepared by using polyvinyl alcohol fiber of different tenacity, and are compared and measured by the bend test, dry density, wet density, water absorption rate, dry shrinkage rate, wet shrinkage rate and other indicators, the following experimental conclusions are drawn: When the content of fiber was 1.0% - 1.5%, the three-point bending strength of fiber cement board prepared by adding high tenacity fiber is higher than that prepared by adding conventional fiber. The bending strength of fiber cement board reaches the maximum when the fiber content is 1.5%. It is further indicated that adding fiber can effectively improve the bending strength of fiber cement board.

KEYWORDS

PVA Fiber with different tenacity; Normal temperature cure; bending strength; dry and wet density; water absorption rate; dry shrinkage rate.

INTRODUCTION

High strength PVA fiber has good hydrophilicity, adhesion, impact resistance and easy to disperse during processing, so as a reinforcement material in cement, asbestos sheet, ceramic building materials and polymer matrix composite materials have a lot of applications (ChangFa Xiao, 2005). The high strength PVA fiber and cement matrix have good interfacial bonding force, and the hydroxyl group in PVA fiber can form a strong hydrogen bridge with the -OH group in cement hydrate (Xue FuLian, 2004). The high-strength fiber used in concrete and building materials has good mechanical properties, which can improve the toughness and impact strength of building materials, and its elastic fatigue resistance is also improved to a certain extent, which can prevent cracking; Good acid and alkali resistance, good dispersion, bending temperature and cold resistance of cement board and cement brick (Xue FuLian, 2004).

Reinforced concrete and building materials with high strength PVA fiber can effectively improve the impact resistance, elastic fatigue resistance and anti-cracking properties of the material. Geotextile made of high-strength PVA fiber has high tensile strength, good creep resistance, wear resistance, chemical corrosion resistance, microbial resistance and excellent water conductivity, which can play a role in reinforcing, isolating, protecting, draining and leakproof in engineering construction. Used for all kinds of DAMS and highways, railways, Bridges, tunnels, silt, sand and other projects, sand compression water separation, reinforcement, bedding, stable foundation and waterproof isolation, can significantly improve the construction quality, reduce project costs (ChangFa Xiao, 2005). However, there is insufficient research on the effect of different tenacity of PVA fibers on the properties of fiber cement boards (Rui Jiang, et al., 2014). In this paper, fiber cement board was prepared by using polyvinyl alcohol fiber of different tenacity, and are compared and measured by the bending strength, dry density, wet density, water absorption rate, dry shrinkage rate, moisture movement and other indicators.

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 - The properties of PVA fiber.

Type	Linear density (dtex)	Tenacity (CN/dtex)	E-Modulus (CN/dtex)	Elongation (%)
2dtex Fiber	2.02	12.94	322.18	6.20
high strength 2dtex fiber	2.16	13.89	310.53	6.21

Equipment

Electronic balance, mixer, microcomputer-controlled pressure testing machine, digital micrometer, polarizing microscope, dry and wet shrinkage meter, vacuum pump, filtration tanks, blast drying oven, warming oven.

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 natural 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 rat e, dry shrinkage rate and moisture movement of fiber cement boards were tested.

Table 2 - Experimental Formulations of Fiber Cement Boards with Different Tenacity 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 Tenacity was observed with a polarizing microscope, as shown in Figure 1.

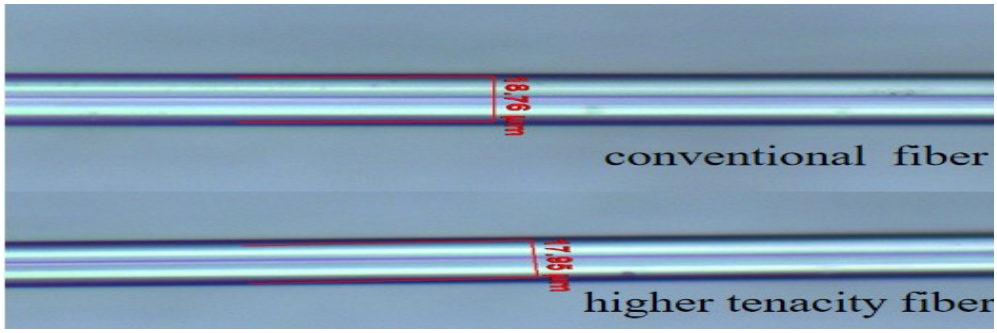

Figure 1 - Microstructure observation of fibers with different tenacity.

According to the above microstructure, the fiber surface is smooth, and there is no attachment on the surface. The diameter of fibers with different tenacity is no 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 Tenacity and cement boards without fiber. It can be seen from Figure 2 that the bending strength of different tenacity fiber cement boards increases with the increase of fiber addition amount, and the bending strength of higher tenacity fiber cement boards reaches the maximum when the fiber addition amount is 1.5%, 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 main factor affecting this experiment is that under the same quality, higher tenacity fiber has a higher tenacity, thus the bending strength is also increased. Considering bending performance, economy, environment, technology and other factors, PVA fiber with higher tenacity fiber and 1.0 wt% content is selected as the optimal addition amount of fiber cement board.

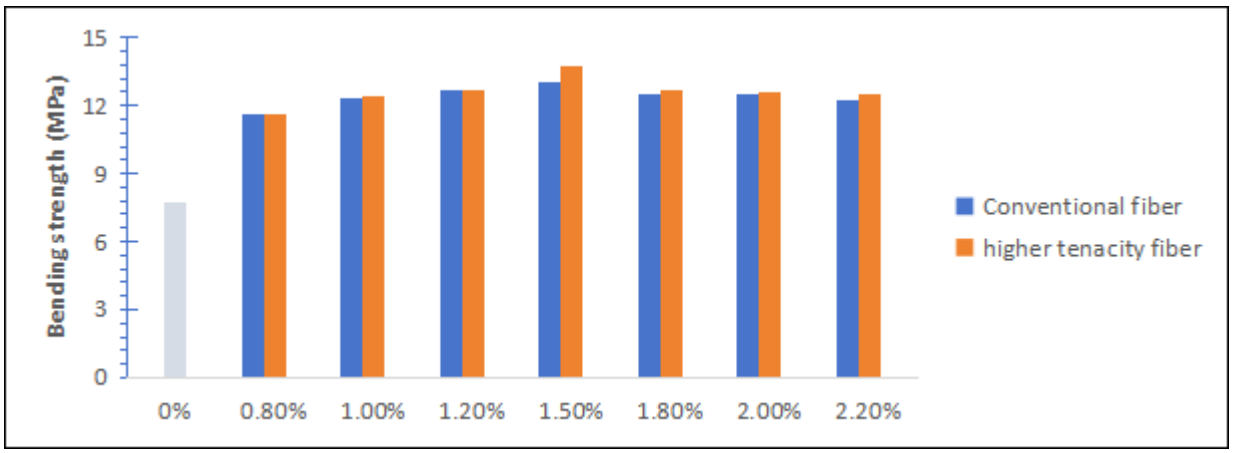

Figure 2 - Bending strength of fiber cement boards prepared by different tenacity fiber.

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 Tenacity 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 conventional and higher tenacity fibers are reduced, but the overall dry density is more than 1.72 g/cm^3, and the wet density is more than 1.76 g/cm^3. The dry and wet density of fiber cement boards prepared by conventional and higher tenacity fibers had no significant difference.

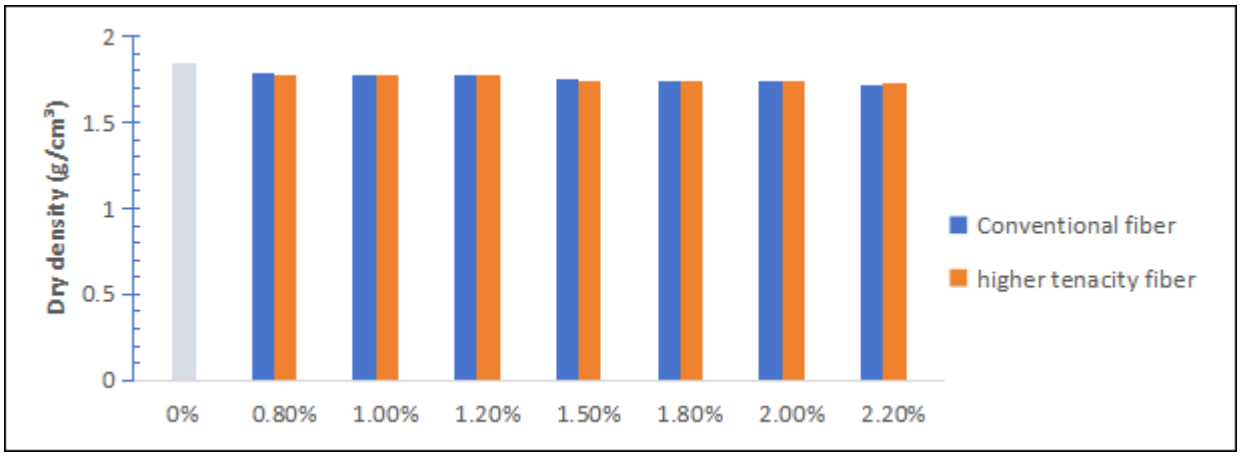

Figure 3 - Dry density of fiber cement boards prepared by conventional and higher tenacity fibers.

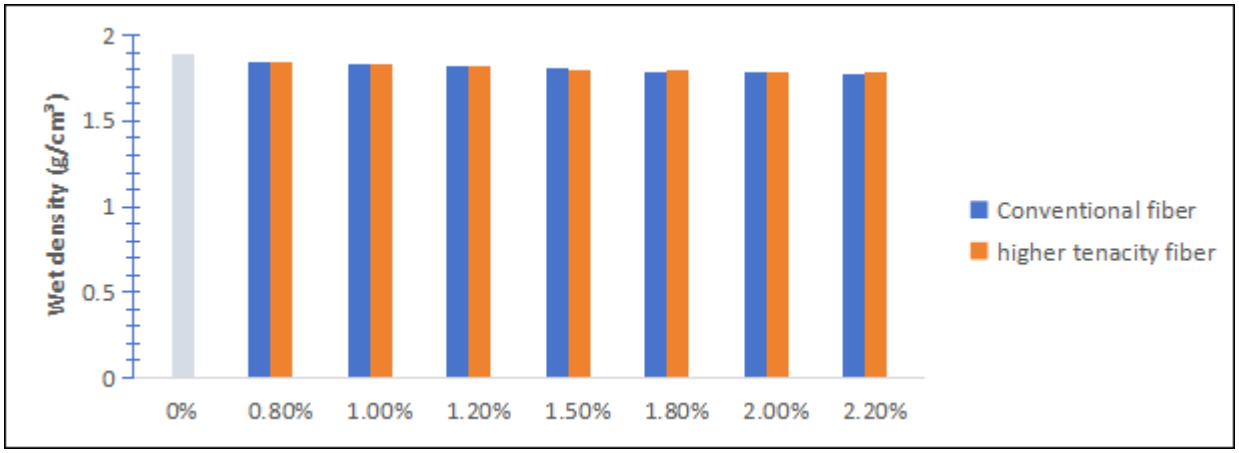

Figure 4 - Wet density of fiber cement boards prepared by conventional and higher tenacity fibers.

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 fiber cement boards prepared by conventional and higher tenacity fibers had no significant difference.

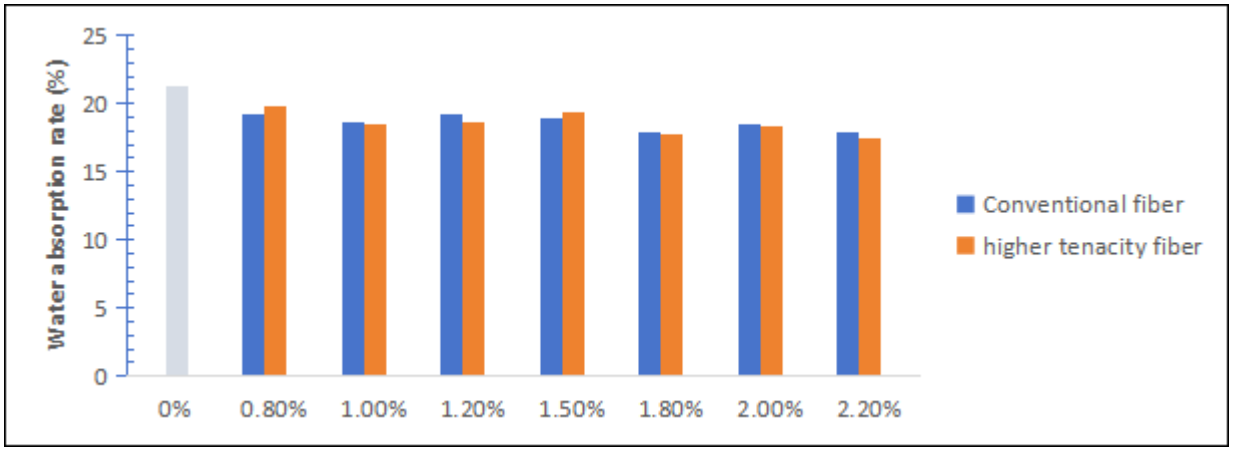

Figure 5 - Water absorption rate of fiber cement boards prepared by conventional and higher tenacity fibers

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 Tenacity 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 conventional and higher tenacity fibers has no significant difference.

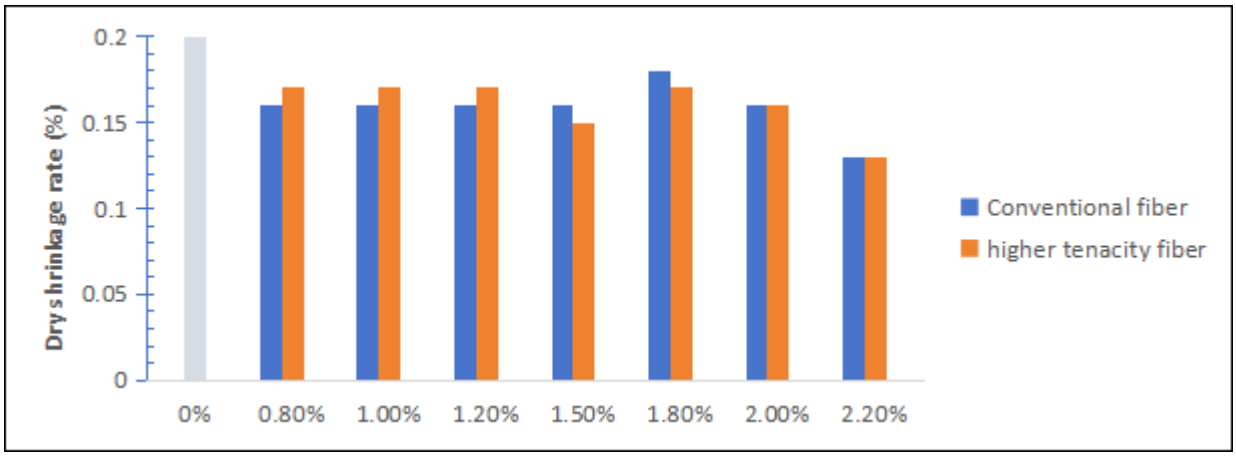

Figure 6 - Dry shrinkage rate of fiber cement boards prepared by conventional and higher tenacity fibers.

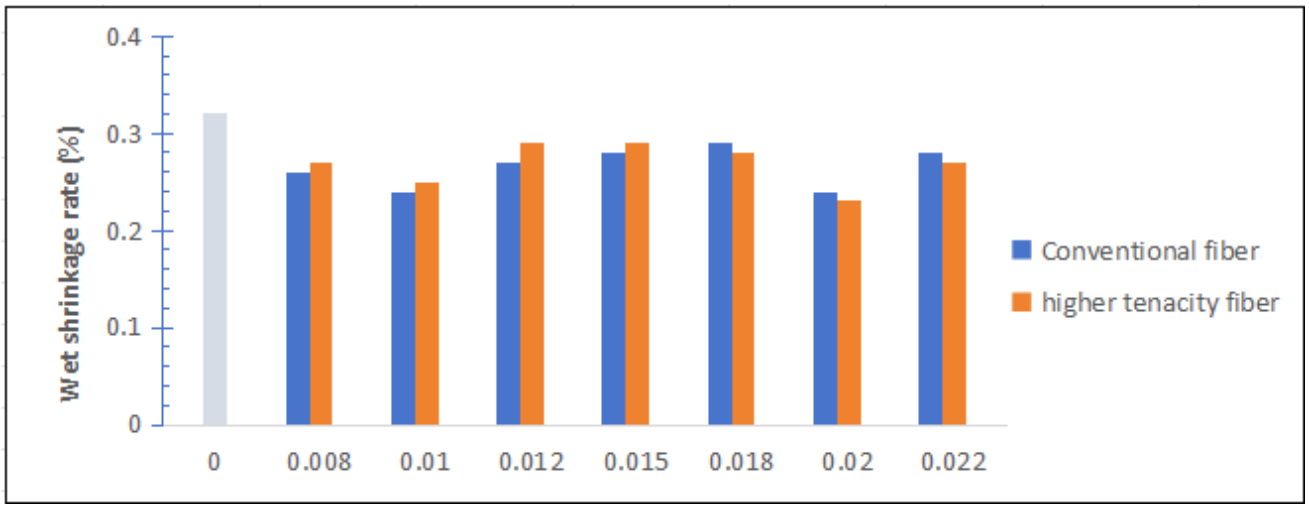

Figure 7 - Wet shrinkage rate of fiber cement boards prepared by conventional and higher tenacity fibers.

CONCLUSION

(1) The bending strength of different tenacity fiber cement boards increases with the increase of fiber addition amount, and the bending strength of higher tenacity fiber cement boards reaches the maximum when the fiber addition amount is 1.5%, 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.

(2) With the increase of fiber addition amount, the dry and wet density of the fiber cement boards prepared by conventional and higher tenacity fibers are reduced, but the overall dry density is more than 1.72 g/cm^3, and the wet density is more than 1.76 g/cm^3.

(3) The water absorption rate of fiber cement boards prepared by conventional and higher tenacity fibers had no significant difference.

(4) With the increase of fiber addition, the dry shrinkage rate and wet shrinkage rate of the fiber cement boards prepared with the same fiber has little change.

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