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Effects of cold press time on compressive strength, deformation rates and soaked properties of biomass brick

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HIGHLIGHTS

- Compressive strengths of dried and soaked bricks are significantly affected by cold press time.
- Deformation rates of dried brick in thickness are significantly affected by cold press time.
- Water absorption content of soaked brick for 168 h is great, which averages 45.23%.
- Dimension stability of the soaked brick is good.
- The densities of soaked bricks for 168 h are slightly affected by cold press time.

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ABSTRACT

Corn stalk and waster poplar fibers can be molded into brick for building in order to increase their value. To explore effects of cold press time on the quality of brick, compressive strength, deformation rates and soaked properties are studied. Compressive strengths of dried and soaked bricks are significantly affected by cold press time. Wet compressive strength of the soaked brick is greater than compressive strength of the dried brick. Deformation rates of dried brick in length and width are slightly affected by cold press time and the rates in thickness are significantly affected by cold press time. Water absorption content of soaked brick is great, dimension stability of soaked brick is good. The densities of soaked bricks are slightly affected by cold press time. Compressive strengths of dried bricks average 1.33 MPa. To soaked bricks for 168 h, the pore rates average 40.55%, water absorption contents average 45.23%, densities average 1.42 g/cm^3, deformation rates average 0.54% in length, 0.71% in width and 2.08% in thickness, and wet compressive strengths average 1.17 MPa. It is an effective way to increase the compressive strength by prolonging the cold press time, which provides a basic theory for the manufacture and application of brick.

1. Introduction

Poplar wood stock volume is about 0.549 billion m^3 and corn stalk is 0.25 billion tons in China [1]. It is necessary to investigate value-added utilization. Fiberboard [2–4], wood plastic composites [5] and wooden ceramics [6,7] are made from poplar wood fiber. Corrugated paper [8], packaging material [9], foamed material [10], straw-cement composite material, straw-plastic composite material, straw-wood composite material [11] and biomass building material [12] are made from corn stalk fiber and particles. Calcium hydroxide slurry [13], cement mortar [14], tung oil mortar [15] and sticky rice mortar [16] in the field of building engineering [17] are made from calcium hydroxide. In order to provide a new way to utilize the abundant supply of poplar wood waste and corn stalk, poplar wood and corn stalk fibers with calcium hydroxide slurry are molded into light biomass bricks for indoor partition walls with. In China, there is currently about 40 billion m^2 of building area [8] and the area will reach 68.8 billion m^2 by 2020 [18]. Therefore, there is a vast market of brick application.

When brick is molded, it ranges from the loose and big volume to the compact and small solid one [8]. The fibers can be adhered together with interwoven friction, Van der Waals forces, glue nail, chemical bonds, and hydrogen bonds [19]. In order to promote the strength of the brick, drying process is important because that

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Table 1
Properties of raw materials.

Properties	Calcium hydroxide slurry	Corn stalk fiber	Poplar wood fiber
Density (g/cm^3)	1.145–1.317	0.097	0.016–0.074
Moisture content (%)	48.10–52.06	11.33	5.46–6.65

during the process water is evaporated, and carbon dioxide reacts with calcium hydroxide to form calcium carbonate [20,21]. As biomass brick is made from wooden fibers, the dimensional stability is affected by the water content. Therefore, the water resistance of the brick is vital in building applications.

When die is same, press is decided by the compressive ratio of die. When die is full of the mixture, press is same to different cold press schemes. Cold temperature is decided by the room environment, so that time is the only parameter which is easy to change. When the other parameters such as the ratio of raw materials and cold temperature and press are same, single factor experiment method is applied to study effects of cold press time on compressive strength, deformation and soaked properties of brick. The results provide a basic theory for the manufacture and application of biomass brick.

2. Materials and methods

2.1. Materials

In the present study, raw materials include poplar wood and corn stalk fibers and calcium hydroxide, their properties are shown in Table 1.

2.2. Methods

The process of biomass brick preparation is shown in Fig. 1. An electrical balance with a precision of 0.01 g (Model JA21002, Shanghai Jingtian Electrical Instrument Co., Shanghai, China), is used to weigh the mass of poplar wood fiber, corn stalk fiber and calcium hydroxide slurry. A halogen moisture detector (Model JT-K6, Jingtai Co., Taizhou, China), is used to test their moisture content. Poplar wood fiber and corn stalk fiber are mixed completely in the mixing machine (Model JJ-5, Shandong Luda Test Measurement Machine Co., Taian, China). Then, calcium hydroxide slurry is added. The mixture is mixed for 100 s firstly, and check the mixing degree. Then it is mixed for 20 s and put into a plastic basin. Finally, the mixture is checked again and it is rubbed by hands in order to assure the uniformity of raw materials.

Squeeze die is used to fill the raw materials, shown in Fig. 2. It includes squeeze head, bucket and backing board. The head is the loading body. The inner size of square bucket is 235 mm in length, 110 mm in width and 150 mm in thickness, which is container for the mixture. The backing board is the loaded body. The press machine (Model MY 50B, Qingdao Jilongchang Equipment Machine Co., Qingdao, China), is used to mold the brick. The head is pressed into the bucket completely in room temperature. Cold press time is equal to 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 min, respectively. A temperature humidification electrical meter (Model 310 RS-232, Center Technology Co., Taiwan, China), is used to test room temperature. A second meter with the precision of 0.01 s (Model PC 396, Shenzhen Huibo Industry and Trade Co., Shenzhen, China), is used to calculate time.

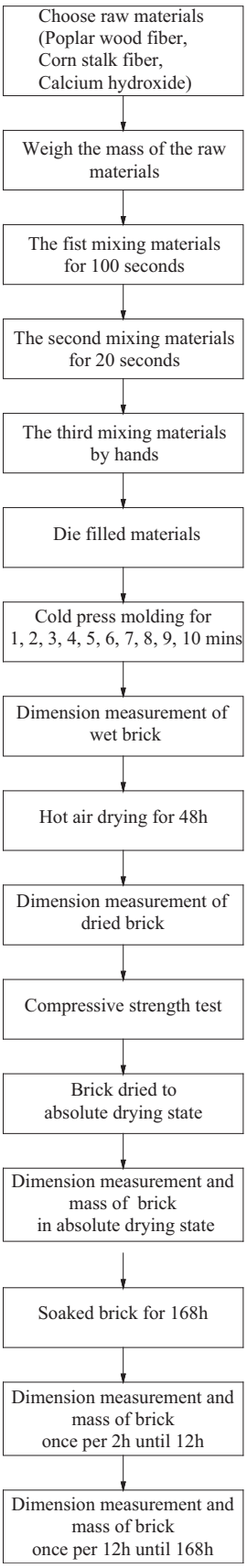

Fig. 1. Process flow chart.