

Properties of Woodceramics Chip Tile Made from Waste Wood(II)*¹

- Effect of Additions and Woodceramics Chip -

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ABSTRACT

In order to effectively use the waste wood, two types of woodceramics chip tile were made from woodceramics chip, gravel, zeolite and additions. The woodceramics chip was made from branch of apple tree (*Malus pumila* Mill.) Snow melting property, bending strength and compressive strength of woodceramics chip tile were tested according to the mixing rate of woodceramics chip. Snow melting properties of woodceramics chip tile increased after additions treatment but mechanical properties were reduced significantly after additions treatment. The results indicate that the additions are effective for snow melting property but negative effect on mechanical properties.

Keywords: Woodceramics chip tile, snow melting property, additions

1. INTRODUCTION

The global population is increasing rapidly, and there is an increasing need for more renewable resources and less damages to the environment. Specially, the wood waste constitutes a major portion and is a global problem. There is about 550million tons of waste wood generated and only about 22 percent is recycled every year. Much of the balance of the waste is landfilled or incinerated, both of which are harmful to the environment (Shutov, 1999). From this point of view, in order to effectively use the waste wood, woodceramics chip tile was made from woodceramics chip to use the snow melting tile in several place; for exam-

ples, entrance, park, road etc. Woodceramics are new porous carbon materials obtained by carbonized wood and woody materials impregnated phenol resin in a vacuum furnace (Okabe *et al.*, 1996a, 1996b; Okabe & Satio, 1996; Shibata *et al.*, 1996). They have superior electricity characteristics and heating properties (Nonaka *et al.*, 1999; Okabe *et al.*, 1996a; Shibata *et al.*, 1996). Their use in several applications such as structural materials, heat-resistant materials, filtering materials, shielding materials and acoustic materials has been investigated (Shibata *et al.*, 1996, 1997). In the present study, woodceramics chip was made from waste wood of apple tree. Previously, the properties of woodceramics chip tile with gravel

*¹ Received on May 12, 2001, accepted on August 2, 2001

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and zeolite without additions has been studied (Oh *et al.*, 2000). In this report, the manufacturing methods of 2-type woodceramics chip tile with gravel, zeolite and additions were described according to the mixing rate of woodceramics chip made from waste wood of apple tree. To find an effect of additions, snow melting experiment and mechanical properties were tested to obtain the basic data for the application of woodceramics.

2. EXPERIMENTAL PROCEDURE

2.1 Material preparation

2-type woodceramics chip tile was made from gravel (Limestone, 1 to 1.5 cm thickness), zeolite (3 to 6 mm thickness) and additions (NaCl 60%, MgCl₂ 30%, SiO₂ 10%) according to the mixing rate of woodceramics chip. Woodceramics chip was made from waste wood of apple tree (*Malus pumila* Mill.) branch. To make a chip, it was cut into small section with chipper. After that, it was impregnated with liquid phenol resin (PX-1600, Honen Corporation) using an ultrasonic impregnation system described in the previous reports (Okabe *et al.*, 1996a, 1996b; Okabe & Satio, 1996). Then they are dried on 8 hours at 60°C, 6 hours at 135°C and burned to make a woodceramics chip at 650°C using the indirect heating charcoal kiln (Okabe *et al.*, 1996a, 1996b; Okabe & Satio, 1996). When the additions was fixed at 10%, the ratio of woodceramics chip to gravel and zeolite is variable from 20:60 to 50:30 depending on methods of processing. To make a tile, they were mixed with epoxy resin (AC-201, Shouwa Highpolymer Co. Ltd.) in the ratio of 10:1 by weight. The mixed raw materials were put in a box made by MDF, which was enclosed with teflon. The boxes were fixed the cover and then pressed with the 10 kg metal

mass at room temperature for 5 hours. The curing agents were MEKPO/Na-Ca = 1.5 / 0.5.

2.2 Density measurement

After manufactured the woodceramics chip tile, dimension and weight were measured then calculated the density for obtains the basic property of it. Because the density plays an important role on several properties.

2.3 Snow melting test

In order to investigate the snow melting degree, the snow block (10 × 10 × 2 cm, 100 g) were prepared. After it was put on the woodceramics chip tile (10 × 10 × 2 cm) and expose a tile to the sun from 10 a.m. to 1 p.m. during 3 hours on the concrete. Then the amount of snow melting was measured every 1 hour. Unfortunately, luminous intensity and ground temperature were not evaluated in this study. The weather conditions were shown in Table 1.

2.4 Mechanical property test

Bending and compression tests were done using a universal-testing machine (Autograph, AGS-10KNG, Shimadzu) in a constant temperature and humidity chamber. Twenty test samples 2 cm wide, 2 cm thickness and 10 cm long were cut from each panel and tested in

Table 1. Weather conditions of snow melting test.

Time	Temperature (°C)	Humidity (%)	Velocity of wind (m/sec)
10 a.m.	2.8	66	1.0
11 a.m.	3.0	81	0
12 p.m.	4.4	62	1.0
1 p.m.	4.8	53	1.0

bending. The span of bending test was 70 mm and load was applied to the center of the beam. The cross-head speed was at 0.5 mm/min in all.

3. RESULT and DISCUSSION

3.1 Density

The density variation of woodceramics chip tile with gravel, zeolite and additions according to the mixing rate of woodceramics chip was shown in Figure 1. It was ranged from 0.77 to 0.99 g/cm³ with gravel and 0.72 to 0.85 g/cm³ with zeolite. It was found that the density had a tendency to decrease, while the rate of woodceramics chip was increased. The density of woodceramics chip tile with gravel was higher than that with zeolite because the density of gravel was higher than zeolite. Oh *et al.* (2000) also reported the same tendencies for woodceramics chip tile without additions.

3.2 Property of snow melting

To find an effect of additions, the snow melting test was tried. The snow melting property of tile according to the mixing rate of woodceramics chip was shown in Figure 2. The amount of snow melting had a tendency to increase, when the mixing rate of woodceramics chip increased. Because woodceramics have a heating property, when the mixing rate of woodceramics chip was increased, the amount of snow melting was increased. This tendency was similar to already reported (Oh *et al.*, 2000). But total amount of snow melting was more than those of woodceramics chip tile without additions. Oh *et al.* (2000) reported that total amount of snow melting in woodceramics chip tile with gravel and zeolite is 7.5 g, 6 g respectively, when the mixing rate of woodceramics chip was 50%. In this paper, when the

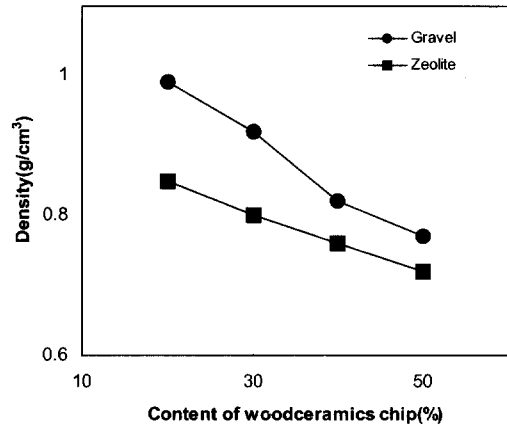


Fig. 1. Density of woodceramics chip tile with gravel-zeolite-sodium chloride compound.

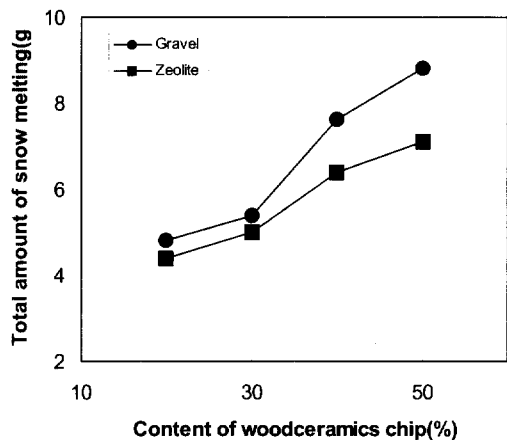


Fig. 2. The relationship between content of woodceramics chip and total amount of snow melting.

rate of woodceramics chip was 50%, the total amount of snow melting with gravel and zeolite is the most at 8.8 g, 7.1 g respectively. It is regarded that the sodium chloride produced a heat of fusion, when it was melt in water. The total amount of snow melting with gravel was larger than that with zeolite at the same condition because the color of gravel was darker than zeolite. Then gravel absorbed the sunlight but the zeolite reflected it. This is

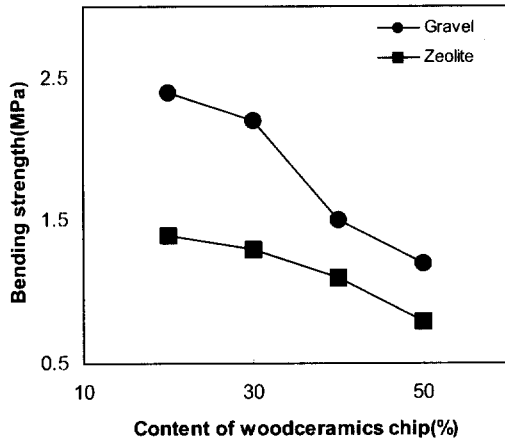


Fig. 3. The relationship between bending strength and content of woodceramics chip.

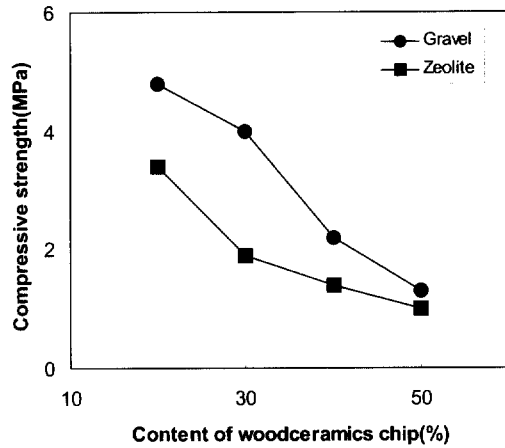


Fig. 4. The relationship between compressive strength and content of woodceramics chip.

thought that the additions have an influence on snow melting. Synthetically, when woodceramics chip tiles are bathed sunshine, melting heats that are created at the time of salt melting melts snows. This melting process makes the speed of snow melting fast.

3.3 Mechanical property

Figure 3, 4 showed the bending and compressive strength of woodceramics chip tile in additions treatment with gravel and zeolite according to the mixing rate of woodceramics chip. The relationship between the proportion of woodceramics chip and strength properties was inversely linear. The strength had a tendency decreased, when the mixing rate of woodceramics was increased in all. Because the density was decreased, when the mixing rate of woodceramics chip increased. The bending strength changed from 12.23 to 24.47 kg/cm² and compressive strength changed from 13.26 to 48.94 kg/cm² with gravel according to the mixing rate of woodceramics chip from 50 to 20%. The strength of tile with gravel was higher than that with zeolite. The reason is that

even though the important factors that affect strength of woodceramics chip tile are the combinations of binder among the materials, the weight of gravel is heavier than that of zeolite in a same capacity. Hence, it is considered that there are density differences in tiles which are made from those materials. The bending and compressive strength obtained in this experiment was lower than those of woodceramics chip tile without addition (Oh *et al.*, 2000). The results suggested that the additions have a bad effect on mechanical properties of woodceramics chip tile. Then, to use of woodceramics chip tile as a road tile, further researches should be carried out on friction property in the future.

4. CONCLUSION

In order to effectively use the waste wood, 2-types of woodceramics chip tile were made from waste wood of apple tree, gravel, zeolite and additions (NaCl 60%, MgCl₂ 30%, SiO₂ 10%) according to the mixing rate of woodceramics chip. And snow melting experiment and mechanical properties were also investigated. The amount of snow melting in additions

treatment woodceramics chip tile was more than woodceramics chip tile without additions. But the strength of addition treatment woodceramics chip tile lower than woodceramics chip tile without addition. And strength of woodceramics chip tile with gravel was higher than that with zeolite. With a view of using the Woodceramics chip as a tile, it must mix the gravel as compared with zeolite.

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