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# Manufacturing Process and Practical Examination for a 3D Structural Geocell Made from Recycled PET Fibers

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**Abstract.** In the recycle trend, this study used the low-melt polyethylene terephthalate fiber and the recycle wasted materials in producing nonwoven products. These two materials were combined together to form nonwoven products, which have good drain ability and high stress. Then, the high frequency plastic welding machine was used to manufacture the geocell of three dimension nonwoven cubic structure. This study discussed the bonding strength with different bonding length and width. The results show that the uniform of the bonding area resulted from the high frequency plastic welding machine affects the bonding strength. In low-power (tuner point to 2) bonding strength increases while the bonding time increases.

## Introduction

Within civil engineering applications confinement with cellular systems (prevention of horizontal movement) substantially improves the material shear strength and improves bearing capacity. The term geocell is a generic term describing a class of geosynthetic products manufactured from thin strips of polymeric material (usually high density polyethylene) bonded or welded together to form a three-dimensional cellular network that can be filled with compacted soil [1~2]. The idea of using geocell on ground reinforcement was proposed by Steve L.Webster in 1975 [3]. This study used recycle wasted materials in producing non-woven products to manufacture the geocell, that was bonded by the high frequency plastic welding machine form three-dimensional cellular structure. This study expected that the process of geocell could promote the quantity of recycle and decrease the pollution of the environment and the cost of raw materials.

## Experimental

The raw material in the study were 60% of recycle wasted materials in producing non-woven products and 40% of low melting point fiber (The tenacity is 3.7 g/d, the elongation is 55±15%, and the melting point is 110°C). The blended fibers were processed via beating, opening, blending, carding and lapping to produce fibrous web. Then, the fibrous web was needle-punched and thermal bonded to form rigid non-woven fabric with thickness of 1.5 mm and basis weights 650 g/m$^2$. The rigid non-woven fabrics were cut into stripes for the high frequency welding, and setting the tuner with point to 2, 4, 6, bonding time for 5-8 sec with 0.5 sec interval, overlapped 5.5 kg/cm$^2$ of welding pressure, and different bonding area as 450 mm$^2$ (length 90 mm × width 5 mm) , 700 mm$^2$ (length 140 mm × width 5 mm), 1260 mm$^2$ (length 140 mm × width 9 mm), 810 mm$^2$ (length 90 mm × width 9 mm). The non-woven stripes were bonded by the high frequency welding to form three-dimensional cellular structure. According to the standard of ASTM D4884 [4], the specimen of the bonding strength test was shown in Fig. 1, the distance between two clam is 8 inch, and the speed is 2 inch/minute in testing.

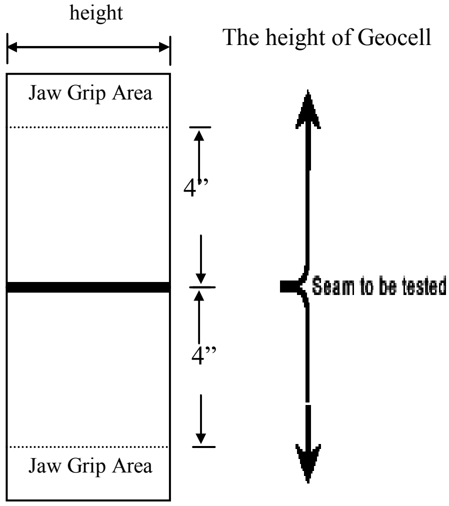


Fig. 1 The specimen of bonding strength test

## Results and Discussion

(1) The influence of tuner and bonding time on bonding strength

The experimental results show that the bonding time can decrease by the higher tuner value, while bonding length is 90 mm, as shows in Fig. 2. While the bonding area is 450 mm$^2$, the bonding strength exhibit higher value in tuner 4 than in tuner 2. Because the power increases with the increasing of the tuner value under same pressure, non-woven is melted when the temperature reaches the melting point, and bonding strength increases with increasing of the bonding point. In Fig. 3, while the tuner point to 6 on 6.5 sec the bonding strength is lower. The bonding strength increases with increasing of the bonding time, and the main reason is that the raw material used in this experiment was from recycle horniness non-woven, the length of fiber was hard controlled, and some part was still obtained in pellet state. Another reason is that the ratio of recycle non-woven is 60%, results in worse evenness of non-woven. While the high frequency plastic welding machine worked, sometimes fiber was not melted, this can cause electrode place conduct electricity with each other, and high frequency plastic welding machine will be turned off by itself. The non-woven could not be melted well, and the bonding strength decreased.

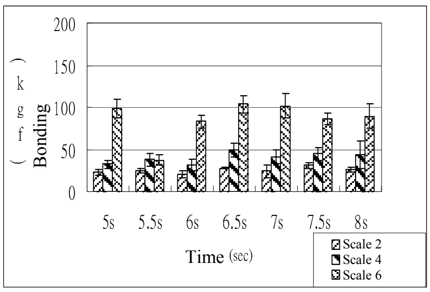


Fig. 2 bonding area 450 mm$^2$ (length90 mm × width 5 mm), Overloaded 5.5 kg/cm$^2$, with different tuner value and time to bonding strength.

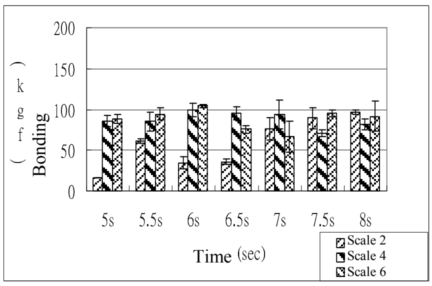


Fig. 3 bonding area 810 mm$^2$ (length90 mm × width 9 mm), Overloaded 5.5 kg/cm$^2$, with different tuner value and time to bonding strength.

(2)

The influence of different bonding width on boding strength

In Fig. 4 and Fig. 5, the results show while in same pressure with different tuner value (2 and 4), the bonding width in 9 mm is better than in 5 mm, the main reason is the fiber in bonding area did not melted all together while the bonding time was not enough. The more bonding area, the more overloaded in this circumstance, this circumstance also can avoid electrode place conduct electricity with each other, and the bonding strength decreases. In Fig. 6, the bonding strength is similar while the bonding width are in 9 mm and 5 mm, the reason is that the higher power can be melted in short time. In Fig. 7, while tuner point to 2 is below low-power, the bonding strength increases with increasing of the bonding area. While the bonding width is 9 mm, the bonding strength is better than 5 mm. While the bonding length is 140 mm with tuner point to 6, the bonding strength decreases, due to incomplete melting when the high frequency plastic welding machine was turned off by itself. As the bonding width is 9 mm, the rate of unequal is more than 5 mm as shown in Fig. 8 and Fig. 9, therefore the bonding strength is lower while in 9mm.

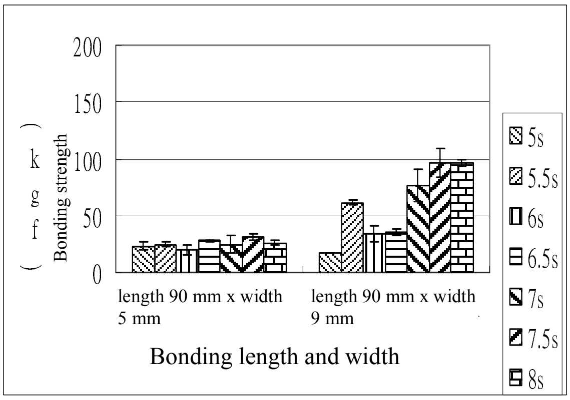


Fig. 4 Different bonding width to bonding strength with 90 mm of bonding height and tuner point to 2

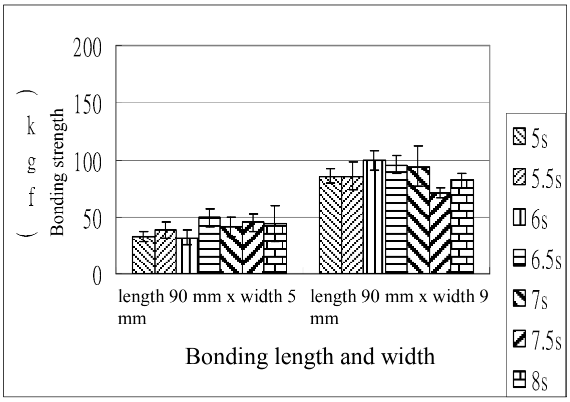


Fig. 5 Different bonding width to bonding strength with 90 mm of bonding height and tuner point to 4

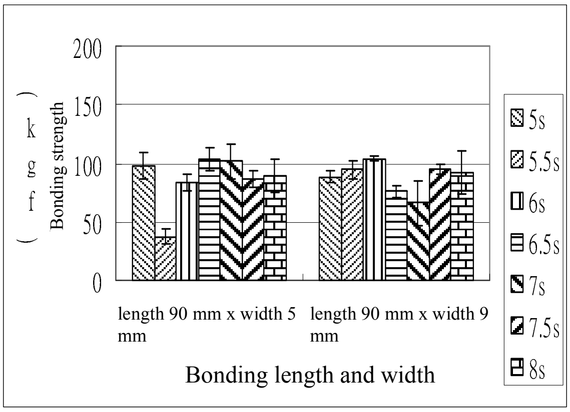


Fig. 6 Different bonding width to bonding strength with 90 mm of bonding height and tuner point to 6

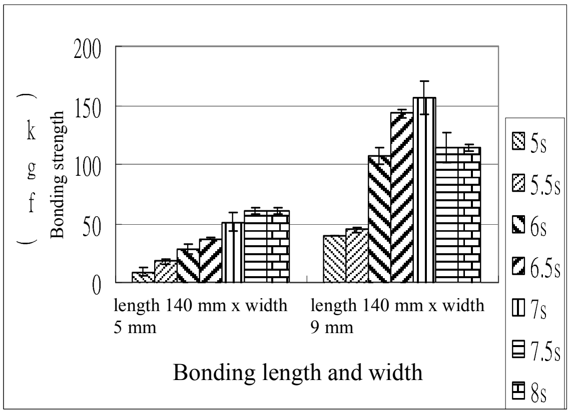


Fig. 7 Different bonding width to bonding strength with 140 mm of bonding height and tuner point to 2

(3) The influence of different bonding length on bonding strength

Table 1 shows the bonding conditions of specimen. In Fig. 10, while tuner point to 2, the bonding length with 140 mm is better than 90 mm in same bonding width, due to testing in the linear side, and the bonding is better by using high frequency plastic welding machine. In Fig. 11 and Fig. 12, while tuner point to 4 and 6, the bonding strength increases with increasing of the bonding length, and the reason is that the higher power may cause high frequency plastic welding machine to be shut down by itself, and the bonding strength decreases, due to incomplete melting.

**Summary**

The experimental results show that while the high frequency plastic welding machine tuner is two, the bonding strength is not affected by the bonding width, and the bonding strength increases while the length of bonding mold increases. The non-woven that was produced in the process conditions of 60% of the recycle wasted materials in producing non-woven products, 40% of low-melt fiber, and the basic weight of non-woven is 650 g/m$^2$ was used to manufacture the geocell that has better bonding strength and is not easily punctured by electric current, while the bonding length is 90 mm.

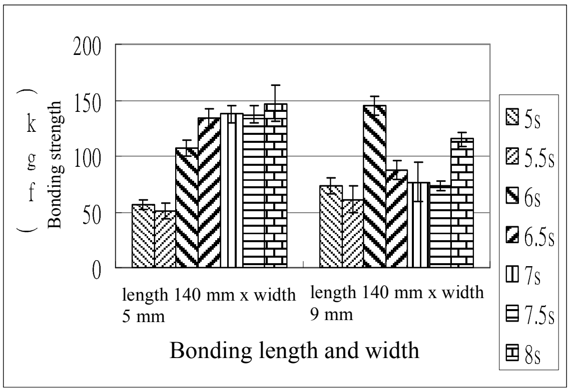


Fig. 8 Different bonding width to bonding strength with 140 mm of bonding height and tuner point to 6

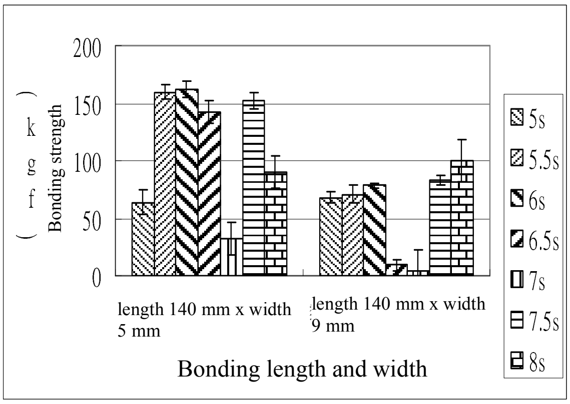


Fig. 9 Different bonding width to bonding strength with 140 mm of bonding height and tuner point to 6

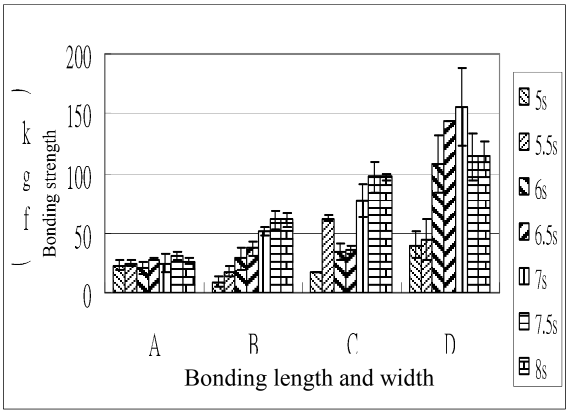


Fig. 10 Different bonding length to bonding strength with the tuner point to 2

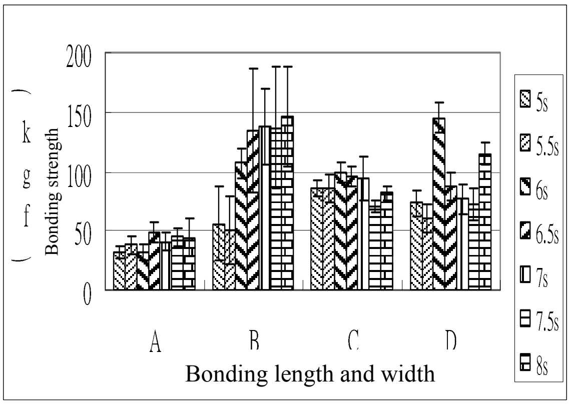


Fig. 11 Different bonding length to bonding strength with the tuner point to 4

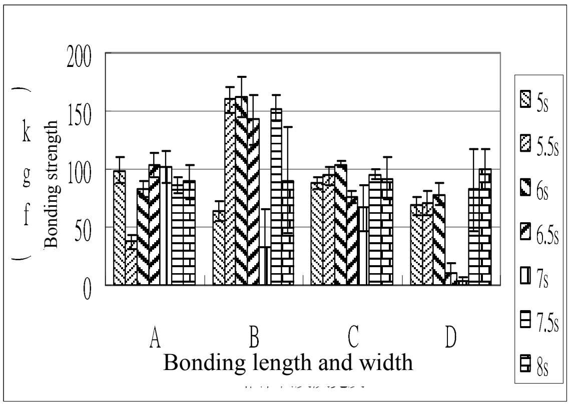


Fig. 12 Different bonding length to bonding strength with the tuner point to 6

Table 1. The bonding conditions of specimen

| | The bonding length (mm) | The bonding width (mm) |
|---|---|---|
| A | 90 | 5 |
| B | 140 | 5 |
| C | 90 | 9 |
| D | 140 | 9 |

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