

Peeling and Tensile Properties of the Multi-layered Needle Punched Nonwoven Fabrics

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INTRODUCTION

The principle of the needle punching process is based on subjecting a web in the needle punching machine to the effect of needles oscillating in vertical, slanting or both direction to the surface of the web. As the needles penetrate the web, their barbs or grooves catch the fibers¹⁻³. The needle punched fabrics are used for industrial materials such as filters, geotextiles, carpets and insulating materials^{4,5}.

Accordingly, peeling and tensile strength of needle punching fabrics are required to end-uses and it is important to characterize the peeling and tensile properties of nonwoven fabrics. Since it is so, we are to investigate the peeling and tensile properties of multi-layered needle punched nonwoven fabrics.

EXPERIMENTAL

The multi-layered needled fabrics examined are made from blended web of 51mm polyester staple fiber(1.4, 2.5den.) and produced by preneedling on a double-sided needling machine(Asselin). The fabrics are needled at 100, 200, 300, 400, 500 punches/cm² and layered at 2, 3, 4, 5, 6 layers.

Instron machine(Shimadzu AGS-500B, Japan) is used to study tearing(Trapezoid method, ASTM D 1117-80) and tensile strength(Cut strip method, ASTM D 461-87) at the strain rate of 30mm/min. The thickness of specimens is measured according to ASTM D 461-87 with thickness gauge and average value is used to calculate the specific strength. The peeling strength was tested to investigate the bonded strength between layers at the strain rate 30mm/min with Instron machine. The specimen for peeling load test is shown in Fig. 1.

RESULTS AND DISCUSSION

The strength properties of multi-layered fabrics are given in Table 1. For the different punching density of multi-layered fabrics, specific strength is shown in Fig. 2 and initial modulus is shown in Table 1. The specific strength and initial modulus are increased up to 400 punches/cm² and decreased slightly over 400 punches/cm². However, strain is shown the opposite trend to specific strength(Table 1). It can be concluded that fiber entanglement is increased with increasing punching density. But, decreased value for excessive punching density is due to fiber or entangled fiber breakage.

The effect of punching density on the tearing strength of multi layered needle punched fabrics is given in Table 1. From this table, it can be observed that tearing strength for the MD(machine direction) is decreased with increasing punching density, while the CD(cross direction) is increased slightly up to 300 punches/cm² and decreased over 300 punches/cm².

Fig. 3 shows peeling strength between layers and it can be observed that peeling strength is decreased and increased with 3 and 4 layers in the center. This result is due to the fact that fiber or entangled fiber breakage is the largest occurred in the center of multi-layered nonwoven fabrics.

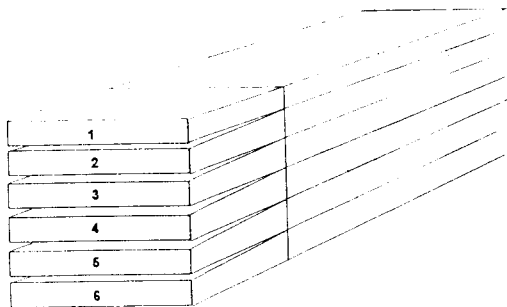


Fig. 1. Test specimen for peeling strength.

Table 1. The overall properties of multi layered needle punched nonwoven fabrics

Properties	punching density (#/cm ²)	Direction					
		0	100	200	300	400	500
Specific strength (kgf/mm ²)	MD	133.4	217.5	234.4	252.4	254.6	245.0
	CD	142.6	194.1	176.5	186.1	197.5	190.3
Strain(%)	MD	95.3	80.9	71.8	70.3	69.6	76.0
	CD	100.0	121.9	123.9	124.5	122.4	109.4
Initial modulus (gf/mm ²)	MD	63.5	190.1	244.5	270.9	282.6	231.8
	CD	40.2	43.7	37.1	39.4	51.5	59.9
Tearing strength (kgf)	MD	5.9	37.9	36.7	35.1	33.9	32.2
	CD	6.1	35.4	36.2	36.5	34.6	31.0

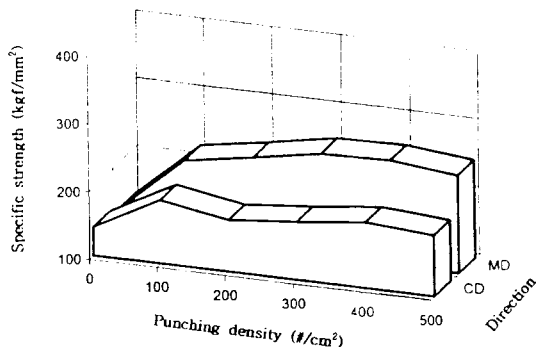


Fig. 2. The effect of punching density on the specific strength of multi-layered needle punched nonwoven fabrics.

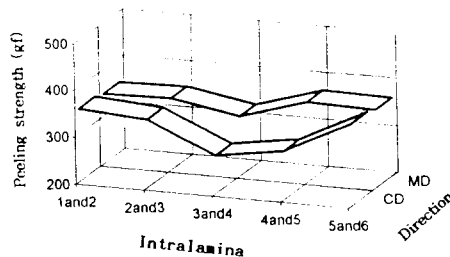


Fig. 3. The effect of intralamina on the peeling strength of multi-layered needle punched nonwoven fabrics.

CONCLUSION

We have studied to characterize the effect of punching density and layers on the

peeling and tensile properties of multi-layered needle punched nonwoven fabrics. The results obtained in this study are as follows:

1. The specific strength and initial modulus in different punching density of multi-layered fabrics are increased up to 400 punches/cm² and decreased slightly over 400 punches/cm².
2. The tearing strength for the MD is decreased with increasing punching density, while for the CD is increased slightly up to 300 punches/cm² and decreased over 300 punches/cm².
3. The peeling strength of multi-layered fabrics is decreased and increased with 3 and 4 layers in the center.

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