MANUFACTURING KNOW-HOW USING SELF-CONDENSING BINDER FOR GLASS FIBER MAT

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ABSTRACT

We have developed both of powder type mat binder and emulsion type one which are supposed to utilize ion effect between glass fiber and binder. Making use of these binders, resource and energy will be decreased in manufacturing glass fiber mat. We report here about what is the effective way to utilize these binders in the production line.

KEYWORDS: Binder, Fiber mat, FRP, Powder, Emulsion

1. POWDER MAT BINDER

The developed mat binder is NBL-555 having property of cohering with rising temperature, whose specifications are shown in Fig.1, and constitutional formula is shown in Fig.2. NBL-555 is powder binder composed of unsaturated polyester resin used for FRP chopped strand mat. Since NBL-555 has similar molecular structure with resin for forming, it has good impregnancy to the resin for forming, and we can obtain high quality mat with good transparency and boiling-resistancy.

Specification:NBL-555

Apperance		Pale yellow colored powder		
item		unit	Range	
			Minimum	Maximum
Melting point		°C	110	120
particle size	over 355 μ m	%		1
	355–250 μ m	%		30
	250–150 μ m	%	45	
	150–75 μ m	%		35
	under 75 μ m	%		10

NBL-555

Fig.1: Specifications of powder binder NBL-555.

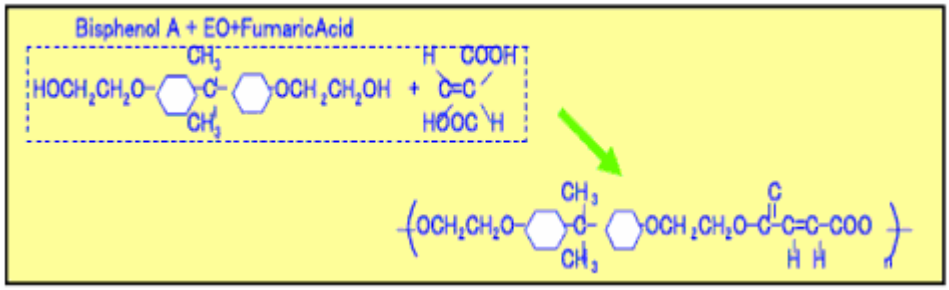


Fig.2: Constitutional formula of NBL-555.

2. HOT TO USE POWDER MAT BINDER

In order to reduce the binder quantity in the production process, it is important to keep conditions of the piled chopped strands (CS) of (A) spray water in 3 steps and scatter powder binder in 2 steps uniformly, (B) keep air flow temperature 200-220 C degrees, (C) keep air flow speed is 0.3-0.8 m/s, (D) keep surface temperature of the mat 200-210 C degrees,

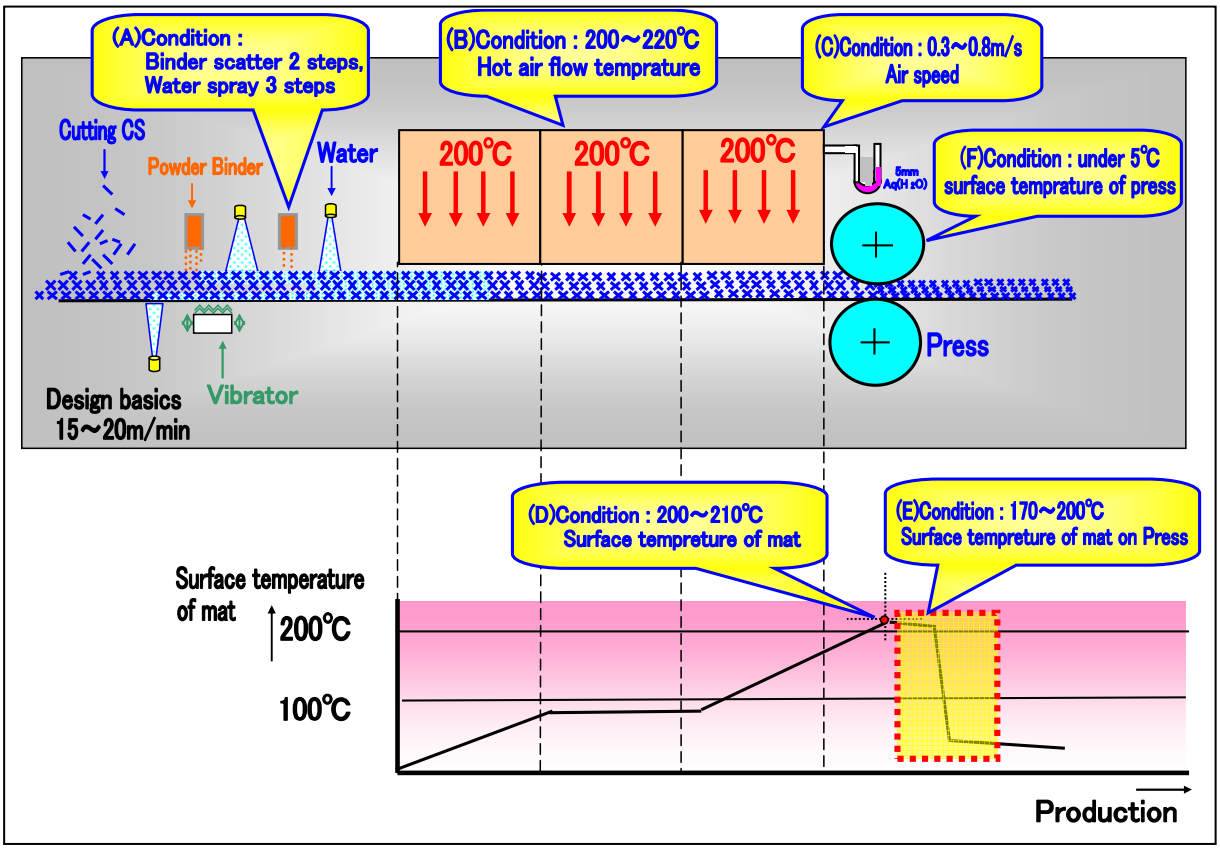


Fig.3: Setting condition of production facility.

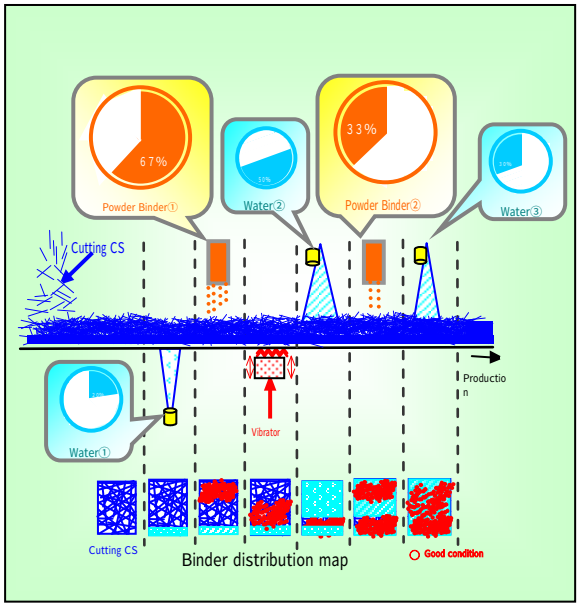


Fig.4: Effect A-1. Spray water in 3 steps and scatter powder binder in 2 steps uniformly. Then, the powder becomes distributed uniformly also in vertical direction.

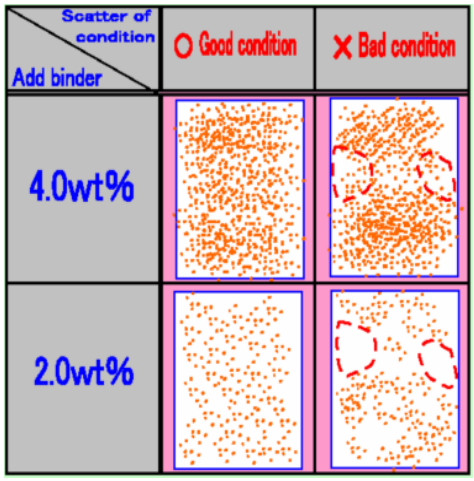


Fig.5: Effect A-2.
Effect of non-uniformity of the binder. In 2wt%, non-uniformity makes the weak point and consequently reduces the strength of the product.

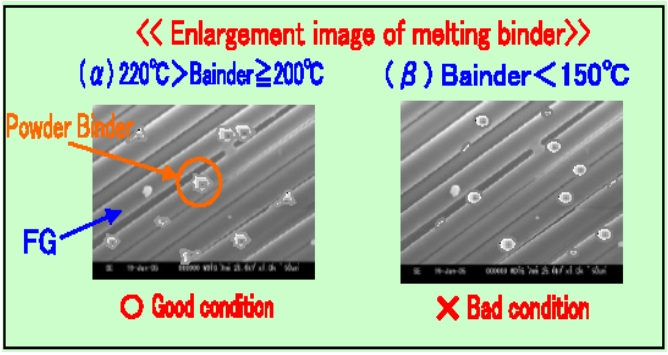


Fig.6: Effect D. Difference of the binder by the mat surface temperature

(E) keep surface temperature of the mat on press 170-200 C degrees, (F) press by roller whose surface temperature is 5 C degrees.

Fig.4 shows the effect of condition (A-1), and Fig.5 shows the effect of condition (A-2). If the powder is not distributed uniformly, the product strength will be decreased especially with 2wt% of low added binder. Fig.6 and Fig.7 shows the effect of condition (B, D). When the surface temperature is 200-220 C degrees, resin of the mat binder is melted and adheres to glass fiber, and when less than 150 C degrees, not melted and the shape not so much deformed. In over 220 C degrees, powder binder is burned. The tensile strength vs. surface temperature is shown in Fig.8.

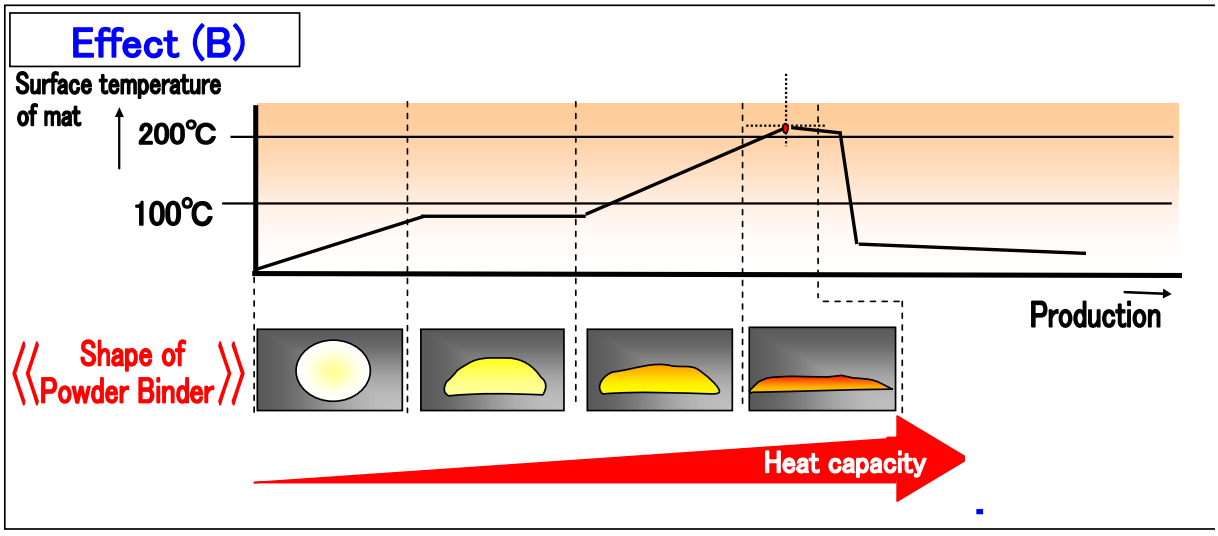
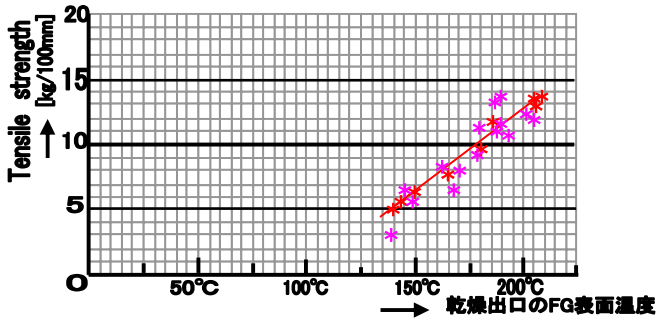


Fig.7: Effect B. By melting the powder binder, it becomes spread and adhering area becomes large.

Condition: Weight 450g/m2, LOI 1.5wt%, Moisture 100wt%, Kind convection, Temp 150-200℃, Velocity 0.3m/s, Time 60sec, Cold Press						
Surface temp of Mat	150-170℃(Low)		170-200℃ (Middle)		200-210℃(High)	
	results	Average	Results	Average	results	Average
Tens. Strength (kg/100mm)	5.4	5.7	7.8	9.7	13.3	13.4
	5.3		11.6		13.4	
	6.3		9.6		13.4	



T_o

Fig.8: Effect B, C, D.
Tensile strength vs. mat surface temperature.
Mat is pressed immediately after taken out. That is, FG surface temperatures at the press and taken out are the same (T_0).

Effect (E)

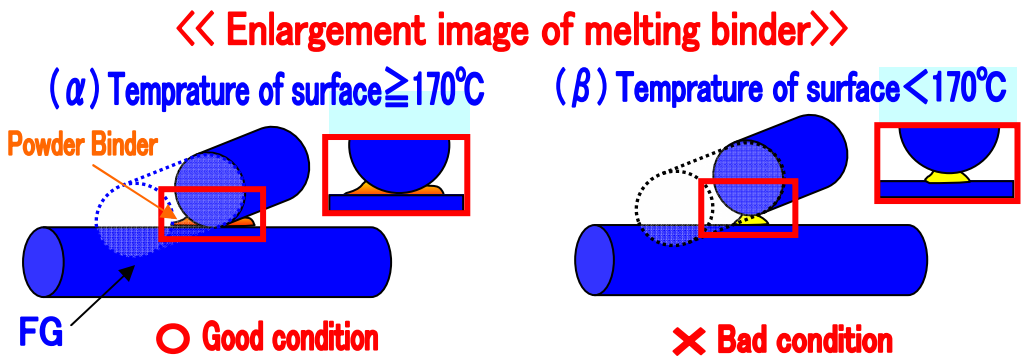


Fig. 9: Effect E. Strength of the mat is in proportional relation to adhering area between fibers.

Fig.9 shows effect E. Strength of the mat is in proportional relation to adhering area between fibers. To fix the adhering state well, the temperature of the press is important.

Fig.10 shows the effect F. Width of mat is changed three times before formed. The more binder particles at the contact point of fiber is, the more strong produced mat is. Then to increase the strength with small quantity of binder, it is desired to make density of fiber increased, that is to decrease width of mat.

Fig.11 shows the effect E, D. It shows tensile strength vs. surface temperature of the mat at the pressing. After the FG surface temperature was increased up to 200 C degrees, it was left as it is, and cool-pressed.

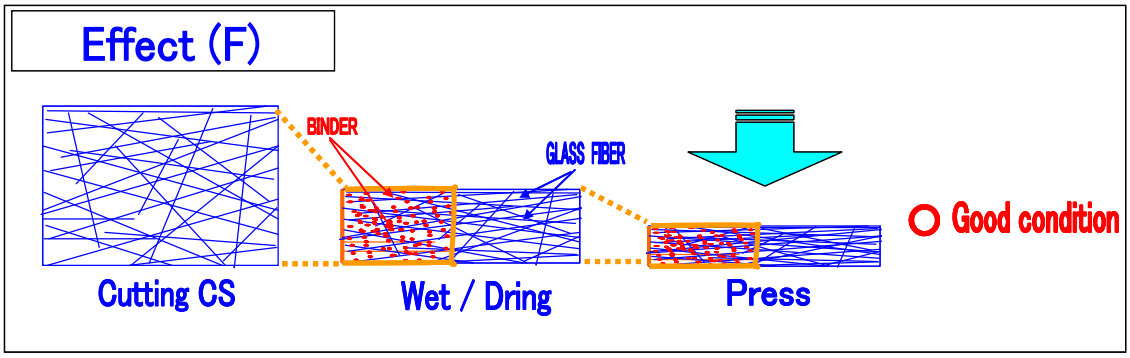
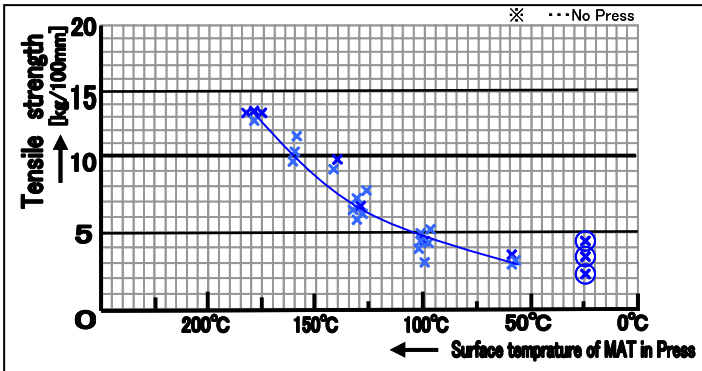


Fig.10: Effect F. Width of mat is changed three times before formed.



< <condition >>		
Factor		Value.
Weight		450 g/m²
Pw L.O.I.		1.5 wt%
Moisture cont.		100 wt%
Method	Kind	convection
	Temp.	200 ℃
	Velocity	0.3 m/s
	Time	60 sec
Cold Press		○, ×

Fig.11: Effect E, D. Tensile strength vs. surface temperature of mat at pressing.

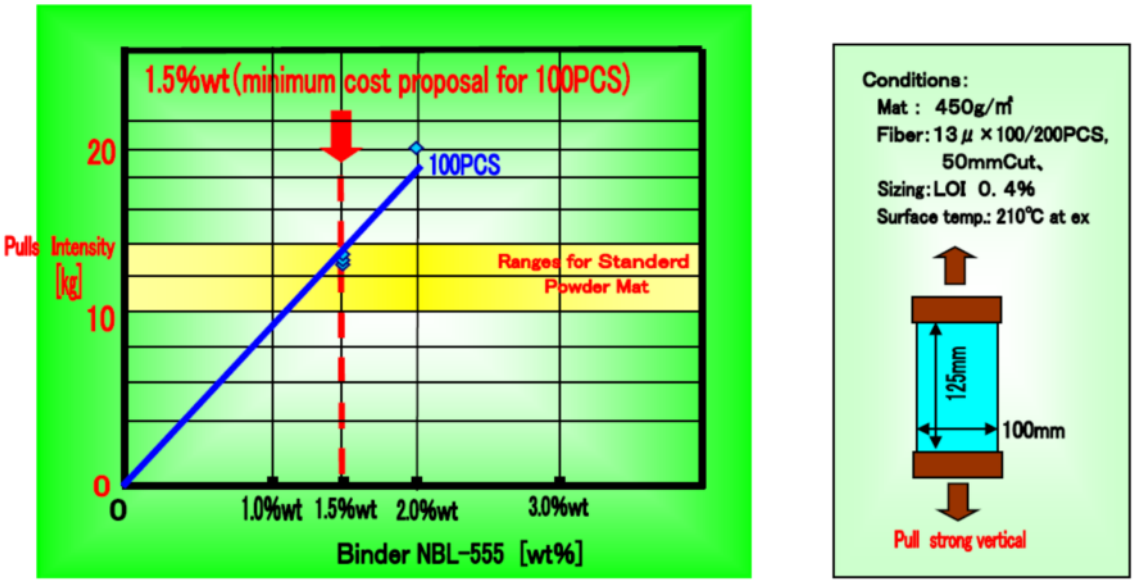


Fig.12: Effect of reducing powder type binder quantity

Fig.12 shows the result of reducing the powder type binder quantity, from which we can see 1.5wt% powder binder is possible.

3. EMULSION MAT BINDER

Specifications of emulsion type mat binder NS-001 is shown in Fig.13. In order to reduce the binder quantity in the production process, it is also important to keep conditions of (A) spray 330% of water including 3% of solid binder component with vacuum -450mmHg so as to produce 33wt% moisture wet raw mat, (B) keep air flow temperature 200 C.degrees and finally surface temperature of the mat 170-200 C.degrees, (C) air flow speed is 0.3 m/s, (D) press by roller whose surface temperature is less than 20 C.degrees. Spraying a lot of water including binder of (A) and pressing (D) make the raw mat thin, increase contact points in the mat, and consequently increase the strength of the mat. Fig.14 shows the effect of increasing contact points. Fig.15 shows the result of reducing the emulsion type binder quantity.

Specification:NS-001 Emulsion

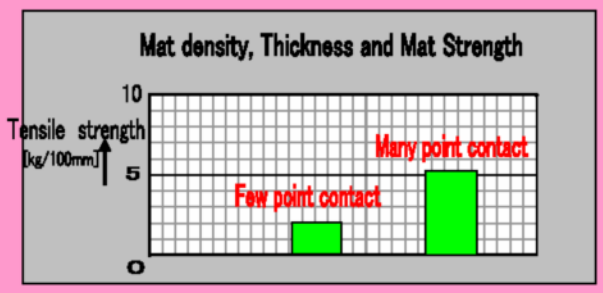
Use	Glass fiber mat
Mterial	vinyl acetate/acrylic ester resin co-polymer emulsion
Polymer	40%
Methyl Alcohol	1-5%
Water	55-59%
Viscosity (mPa・s)/25℃・20rpm	5780
Tg (℃)	-9
Ionicity	nonion
Diameter of a particle (nm)	1000
Dissolution of styrene	44.8

NS-001
Mat binder

Fig.13: Specifications of emulsion type mat binder NS-001

■Test data : Condition (A)

Test results on the effect of Condition (A) is shown below.
In order to perform production speed efficiently, the moisture content of C.S. is set to 50% before heating and drying.
LOI of NS-001 is set to 0.6wt%, and heated for 1 minute under 200 deg. C hot air.



< <condition >>		
Factor		Value,
Weight		450 g/m2
Em L.O.I.		0.6 wt%
Moisture cont.		50 wt%
Method	Kind	convection
	Temp.	200 ℃
	Velocity	0.3 m/s
	Time	60 sec
Cold Press		○

	Many point contact		Few point contact	
The rate of moisture before suction	330% → 50% by suction		50% (without suction)	
	results	Average	results	Average
Tens. Strength [kg / 100mm]	5.0 4.8 5.1	5.0	2.0 2.0 2.0	2.0

Fig.14: Effect of increasing contact points

The result shows Tensile strength of mat depends on Nos. of Contact points.
In the process of reducing the solution liquid, increased contact points ultimately contributes to Tensile Strength by more than 50%

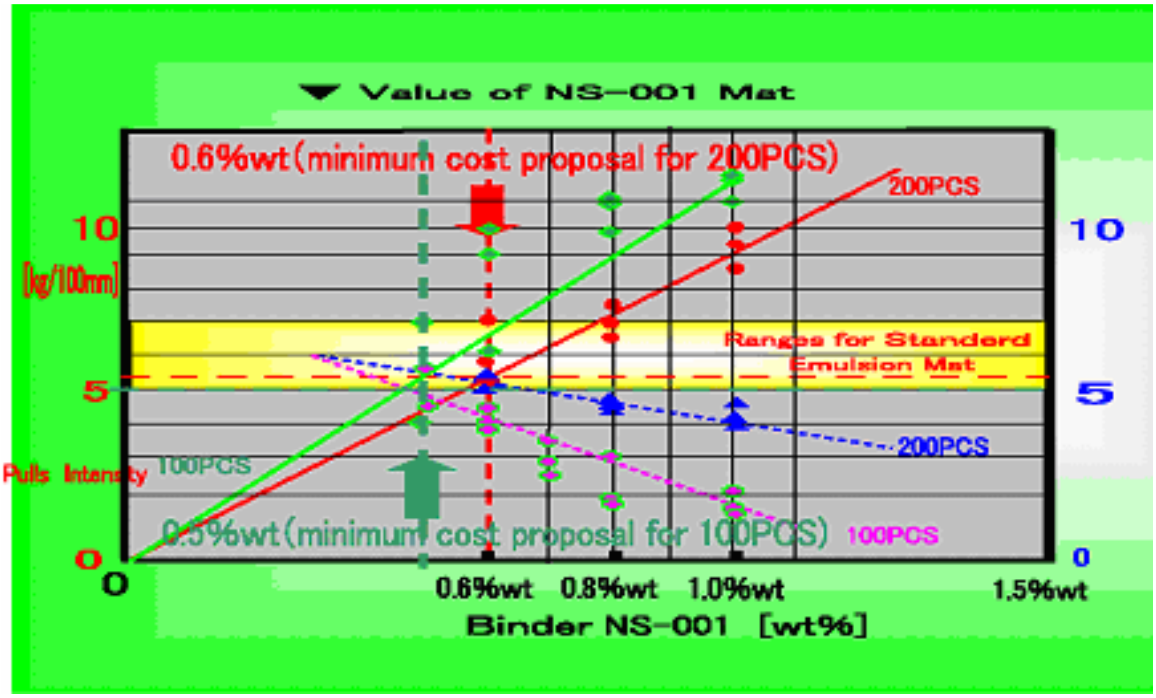


Fig.15 (a): Effect of reducing emulsion type binder quantity

4. CONCLUSIONS

It has been shown that by using new type of mat binders it is possible to reduce the binder quantity and consequently production cost. Analysis of the binder behavior from another aspects [1-3] will make more advancement.

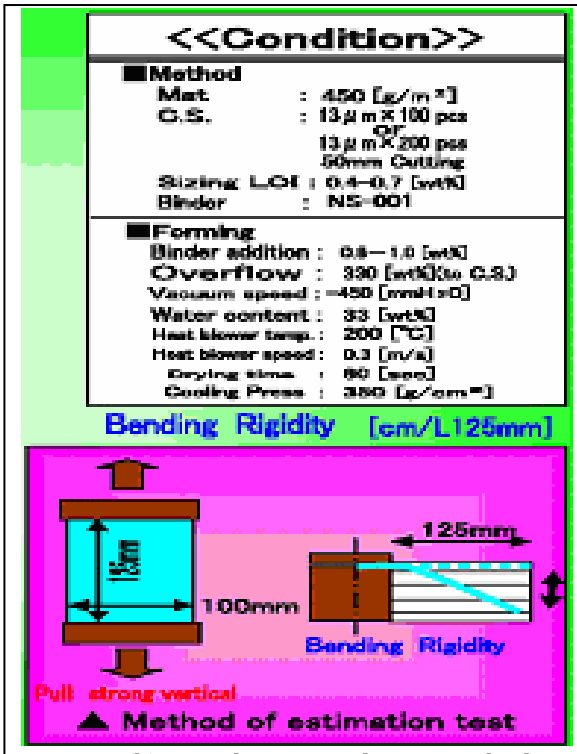


Fig.15 (b): Conditions and test.method.

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