FPCM-9 (2008)
The 9th International Conference on Flow Processes in Composite Materials
Montréal (Québec), Canada
8 ~ 10 July 2008

# EFFECT OF MOISTURE CONTENT ON NATURAL FIBER IMPREGNATION IN SMC

M. Sarata [1], M. Deconinck [2], Y. Hidekuma [1], A. Nakai [1, 3], H. Hamada [1]

[1] *Department of Advanced fibro science, Kyoto Institute of Technology, Gosyokaido-cho, Mastugasaki, Sakyo-ku, Kyoto, 606-8585, Japan*
[2] *Ecole des Mines de Douai*
[3] *Corresponding author's Email: nakai@kit.ac.jp*

**SUMMARY**: The automotive industry today requires that some parts of the automobile be made from environmental friendly materials, thus natural fiber filled polymer composites is considered as one of the candidate material system. In this paper, hemp fiber-filled sheet molding compound (SMC) was developed. Several parameters were considered while producing the composite. Here, the moisture content in hemp fiber mat and the state of impregnation by the compounds into the mat was focused. SMC composite panels were fabricated by compression molding, which were later used for static and impact testing. The effect of moisture on the processability and properties of the SMC composites were examined.

**KEYWORDS**: Sheet Molding Compound (SMC), natural fibers, hemp, automobile

## INTRODUCTION

SMC (Sheet Molding Compound) is high volume high speed production composite materials. By using compression die SMC flows from the charge part and create the complex shaped products. For that purpose SMC materials contain not only reinforcing fibers, but also the some fillers and thickening agents. Instead, SMC can be regarded as the worst recycle ability materials, because of these filler contents among the thermosetting polymer composites.

Recent earth environmental concern requires easy recycle material system and also using of biomass materials such as biodegradability polymer and natural fibers as reinforcement in composite materials. In SMC although it is not easy recycle materials natural fiber reinforcement can be used instead of the glass fibers, and it is resulted in that eco-friendly materials. In this paper we attempt to fabricate the natural fiber filled SMC. The most important point of the natural fiber composites is moisture content of fibers. During fabrication the moisture should come out due to high molding temperature and heat temperature by chemical reaction, and voids would be formed inside of materials. The moisture contents of SMC before molding were measured, and also mechanical properties were evaluated.

## SMC MACHINE

Normally raw SMC production equipment is very large, so that over 100 *l* resin should be used for one trial. In the case of developing a new SMC, we need many times trials by changing the fiber material; fiber fraction, different surface treatment and so on. Therefore we developed small SMC production machine as shown in Fig. 1. SMC production flow chart was shown in Fig. 2. The resin which poured on the film was spread evenly. The reinforcing fibers were distributed uniformly by handwork. 2 sheets of fiber distributed sheet were prepared, and they were stuck together. The stacked material which was covered by two plastic films was inserted into SMC production machine for impregnation of the resin into fiber bundles. This machine can accept 900 mm length and 300 mm width raw material. For the impregnation stage metal carpets are set. The impregnation stage is divided into several times and with increase of the times the distance of the metal carpets gradually can be decreased: for example from 2.5 mm to 0.1 mm. In this paper 6 times impregnation steps were adopted.

Fig.1 New small SMC production machine

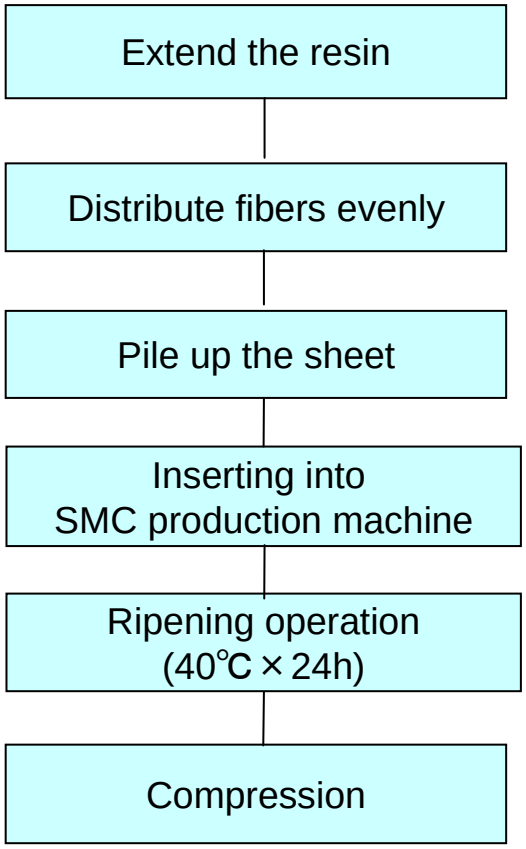


Fig.2 Flow Chart of SMC production

SMC composites panel was made by 100 ton compression machine. The dimension of the die was 300 mm x 300 mm. One plate of SMC was made with 2 layers of raw material, and the thickness of the plate was around 3.7 mm. Usually, chopped glass fiber strand was used as reinforcement. In this paper instead of glass fiber, Hemp fiber mat was used. Resin was unsaturated polyether resin and weight fraction of Hemp fibers was 20 %.

## PROBLEM OF NATURAL FIBER FILLED SMC

Initially we often observed two major defeats in SMC molded panel by using hemp fiber mathese are shown in Fig. 3, delamination at inside and bubbles at surface. There are several reasons and here we focused on water content of Hemp fiber mat. Water of Hemp mat could become vapor during processing because of high heat generation and high molding die temperature. Phenomenologically, it seems that the defects mentioned above would be caused by vapor.

(a) cross section (b) aspect

Fig.3 Photographs of hemp mat SMC.

## WEIGHT CHANGE OF HEMP FIBER MAT

Hemp fiber mat was dried at 80 ℃. And Fig. 4 shows weight change of Hemp fiber mat with drying time. Within one hour 8 % weight loss was found and after that weight decreased slightly to 90.5 % until 5 hours. Here water content was 9.5 %. Fig. 5 shows water absorption of Hemp fiber mat, here the Hemp fiber mat was dried one hour and after that it exposed at normal humidity environment. Surprisingly, only 10 minutes later the fiber mat absorbed 2% water and after 40 minutes it reached to 5 %. This result indicates that the dried Hemp fiber mat was not dried material after 10 minutes before impregnation of resin.

We have not examined about the optimum, and lowest water content, which did not affect the mechanical properties of composites and create the bubble of products. The saturation level of water sentinel was 9.5 %, so that 2 % should be considered to be large. Here, we decided 5 minutes after drying before impregnation because Hemp fiber mat absorbed only 1%. Fig. 6 shows overview of composite panel by using the Hemp fiber mad of 5 minutes interval between drying and impregnation. The number of surface defects was very small. Compare with Fig. 3, it can be said that quick molding was required for high quality natural fiber SMC products. Consequently, the mechanical properties of Hemp fiber mat were measured. Table 1 shows the mechanical properties and density of Hemp fiber SMC and normal glass fiber mat SMC. Even though Hemp fiber mat SMC indicates higher mechanical properties than Glass fiber SMC.

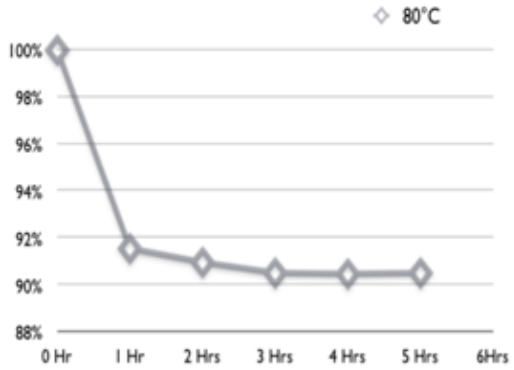


Fig.4 Weight loss during drying hemp

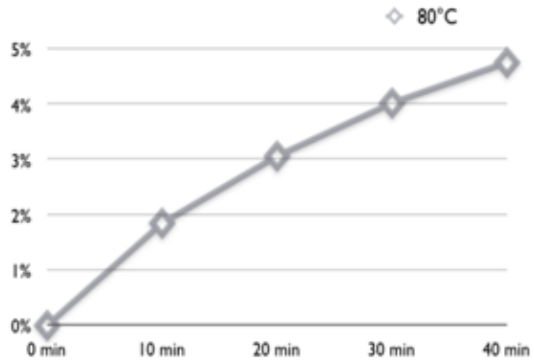


Fig.5 Water absorption of Hemp after drying

Fig.6 The aspect of dried Hemp mat SMC

Table 1 The Flexural properties of Hemp mat and Glass fiber filled SMC

| | Fiber content (wt%) | Specific gravity (-) | Specific modulus (GPa) | Specific strength (MPa) |
|---|---|---|---|---|
| Hemp | 20 | 1.72 | 5.18 | 49.1 |
| Glass | 15 | 1.81 | 3.31 | 27.6 |

## CONCLUSION

In this paper hemp fiber mat filled SMC was developed. First, the importance of water contain was indicated because various defects was appeared. Even if fiber mat was dried for one hour, the water content reached 2% within 10 minutes. This result suggests us to carry out quick molding after drying the fiber mat. Consequently, equivalent of higher mechanical properties was obtained by using the Hemp fiber mat than normal glass fiber SMC, under quick fabrication system.